A Beginner's Guide to MVS TCP/IP Socket Programming

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TITLE **Title Page**

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NOTICES **Notices**

Take Note!

Before using this information and the product it supports, be sure to read the general information under "Special Notices" in topic FRONT 1.

EDITION **Edition Notice**

First Edition (June 1995)

This edition applies to Version 3, Release 1 of IBM TCP/IP for MVS, Program Number 5655-HAL for use with the MVS/XA and MVS/ESA Operating Systems.

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ABSTRACT Abstract

This publication provides basic TCP/IP socket programming information to MVS program developers who plan to use the socket programming interfaces of IBM TCP/IP Version 3 Release 1 for MVS. The main focus is the Sockets Extended, REXX sockets, IMS sockets and CICS sockets programming interfaces of IBM TCP/IP Version 3 Release 1 for MVS. The reader is not required to be familiar with C programming syntax. Code samples are provided in COBOL, PL/I, assembler and REXX. No prerequisite socket programming knowledge is required, but the reader is supposed to be familiar with the MVS environment and its subsystems, including IMS and CICS, and the related application program development tools and techniques.

(355 pages)

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FRONT_1 Special Notices

This publication is intended to help application developers to develop MVS TCP/IP socket based client/server programs. The information in this publication is not intended as the specification of any programming interfaces that are provided by IBM TCP/IP Version 3 Release 1 for MVS. See the PUBLICATIONS section of the IBM Programming Announcement for IBM TCP/IP Version 3 Release 1 for MVS for more information about what publications are considered to be product documentation.

References in this publication to IBM products, programs or services do

PREFACE Preface

This book is for newcomers in the world of IBM TCP/IP for MVS socket programming.

We do not write for the experts who have written complicated C-socket code for the last 20 years or so. On the contrary, our focus is on those of you who have written MVS application programs for CICS, IMS or batch during the last many years, but have never written a socket program. We do not expect that you are familiar with C, and we do not expect you to learn C in order to develop socket programs. This book will illustrate most of the coding examples in COBOL, PL/I, assembler and REXX, which we believe is what most of you are familiar with. Some samples will also be shown in C.

We will focus on the Sockets Extended programming interfaces that are supplied with IBM TCP/IP Version 3 Release 1 for MVS. Emphasis will be on stream sockets, as the major part of all TCP/IP applications are stream socket applications.

Readers who already know sockets but who have little experience in IBM TCP/IP for MVS sockets may also benefit from this book.

PREFACE.1 How This Document is Organized

The document is organized as follows:

Chapter 1, "Cooperative Applications"

In this introductory chapter we will present some of the fundamental design considerations you have to make before you decide on a specific application design.

Chapter 2, "Introduction to TCP/IP Programming Interfaces"

The socket programming interface is just one of the programming interfaces that are used in a TCP/IP-based network. In this chapter we give you a short introduction to each of the programming interfaces that are delivered with IBM TCP/IP Version 3 Release 1 for MVS.

Chapter 3, "TCP/IP Concepts for Socket Programmers"

We do not expect that you are an expert in TCP/IP protocols, but a few basic concepts must be understood in order to develop good socket programs. In this chapter we will explain these basic concepts, without going into too much detail. Other books are devoted solely to the purpose of explaining the TCP/IP protocols, and we will refer you to some of these books for more detail.

Chapter 4, "The IBM TCP/IP for MVS Socket APIs"

In this chapter we will introduce you to each of the individual socket programming interfaces that are delivered with IBM TCP/IP Version 3 Release 1 for MVS. These include C-sockets, Sockets Extended (both the call instruction API and the assembler macro API), REXX sockets, Pascal sockets and some of the older socket programming interfaces that were used with previous versions of TCP/IP for MVS. The main focus of this book is on the Sockets Extended programming interfaces.

Chapter 5, "Your First Socket Program"

This chapter includes all the basic socket programming techniques you need to develop socket programs in MVS. We will guide you through the development of a Sockets Extended iterative COBOL server program, and we will explain how you work with distinct messages in a stream protocol like the Transmission Control Protocol (TCP).

Chapter 6, "Native MVS Concurrent Server Program"

For those of you who have the requirement to develop high performance server applications in MVS, this chapter will give you information on how you develop a concurrent server in a native MVS address space. The concurrent server in this chapter is based on the Sockets Extended assembler macro interface.

Chapter 7, "Socket Client Programs"

It is expected that the majority of socket applications in an MVS environment is server applications, but you will from time to time also have to develop socket client programs in MVS. In this chapter we will add client specific information to what you learned about socket programs in the two previous chapters. The client issues are illustrated by a sample client that uses REXX sockets.

Chapter 8, "Datagram Socket Programs"

In the three previous chapters we confined ourself to stream sockets based on the Transmission Control Protocol (TCP). The majority of socket applications use stream sockets, but occasionally you may have the need for a datagram socket application. This chapter explains the specific characteristics of datagram socket applications based on the User Datagram Protocol (UDP).

Chapter 9, "IMS Sockets"

This chapter explains how you implement socket programs in an IMS dependent region. It also includes guidelines on how you can use the same IMS Message Processing Program (MPP) from both IBM 3270 terminals and socket clients.

Chapter 10, "CICS Sockets"

If your requirement is to implement socket programs as CICS transaction programs, this chapter will give you information on how you do that.

Chapter 11, "Debugging and Tracing Socket Programs"

From time to time it may be necessary to debug a socket program that does not behave as you intended. In this chapter we give you some guidance on how you handle socket return codes, and how you can trace the Internet Protocol (IP) packets that are forwarded over the IP network as a result of your socket calls.

This book includes a fairly extensive appendix, where we have placed a number of sample programs we developed as part of this redbook project. The samples are of no use by themselves; they only serve an educational purpose. We do not guarantee that the samples show the best or only way of implementing socket programs; they show how we implemented socket programs. We will refer you to specific samples throughout the text and we will encourage you to study them, as they might give you that extra clue on how you could proceed with your own socket programs. But remember: the best way to learn is to do it yourself.

All the COBOL samples are developed with the COBOL ANSI85 standard, which allows lowercase keywords and identifiers.

Appendix A, "Sample Datagram Socket Programs"

Sample datagram socket programs in COBOL and in C.

Appendix B, "Sample Stream Socket Programs"

Sample stream socket programs written in COBOL and in C.

The COBOL socket server is the sample iterative server program we refer to in Chapter 5, "Your First Socket Program" in topic 5.0.

Appendix C, "Sample IMS Socket Programs"

In this appendix you find sample explicit and implicit mode IMS socket programs written in COBOL, and sample remote clients used to test the IMS socket programs with, written in COBOL and C.

Appendix D, "Sample CICS Socket Program"

These are sample CICS socket programs. You will find a COBOL stream socket program that acts as an echo server in CICS, and you will find a C implementation of the EZACICSC sample program that is distributed with IBM TCP/IP Version 3 Release 1 for MVS.

Appendix E, "Sample REXX Socket Programs"

Here you find a couple of sample REXX socket programs. One of these samples is an implementation of a NETSTAT function in NetView. This function is based on a REXX client that runs in the NetView address space and communicates with a REXX server that runs in a batch TSO address space.

Appendix F, "Sample PLI Socket Programs"

This appendix contains sample PL/I socket programs that use the Sockets Extended API.

Appendix G, "Socket Utilities for Sockets Extended Programs"

This appendix contains a number of useful utility programs we developed for use from Sockets Extended programs.

Appendix H, "Sample MVS Concurrent Server"

This is an Sockets Extended assembler macro sample application that is implemented as a multitasking concurrent server in MVS.

Appendix I, "Sample Compile and Link JCL Procedures"

Here you find the compile and link edit JCL procedures that were used to compile and link the sample programs shown throughout this book.

PREFACE.2 Related Publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this document.

IBM TCP/IP for MVS: User's Guide, SC31-7136

IBM TCP/IP for MVS: Customization and Administration Guide, SC31-7134-00

IBM TCP/IP for MVS: Offloading TCP/IP Processing, SC31-7133

IBM TCP/IP for MVS: Programmer's Reference, SC31-7135

Performance Tuning Guide, SC31-7188

IBM TCP/IP for MVS: CICS TCP/IP Socket Interface Guide and Reference, SC31-7131

IBM TCP/IP for MVS: IMS TCP/IP Application Development Guide and Reference, SC31-7186

IBM TCP/IP for MVS: Application Programming Interface Reference, SC31-7187

IBM TCP/IP for MVS: Quick Reference, SX75-0095

PREFACE.3 Additional Publications

John Tibbetts and Barbara Bernstein 1992, *Building Cooperative Processing Applications using SAA*, John Wiley & Sons, Inc. - ISBN 0-471-55485-5

W. Richard Stevens 1994, *TCP/IP Illustrated, Volume 1 - The Protocols*, Addison Wesley - ISBN 0-201-63346-9

Gary R. Wright and W. Richard Stevens 1995, *TCP/IP Illustrated, Volume 2 - The Implementation*, Addison Wesley - ISBN 0-201-63354-X

W. Richard Stevens 1990, *UNIX Network Programming*, Prentice Hall - ISBN 0-13-949876-1

PREFACE.4 International Technical Support Organization Publications

TCP/IP Tutorial and Technical Overview, GG24-3376

CICS/ESA and TCP/IP for MVS Sockets Interface, GG24-4026

Client/Server Computing with IMS/ESA Using APPC, GG24-3981

IBM TCP/IP V3R1 for MVS Implementation Guide, GG24-3687

A complete list of International Technical Support Organization publications, with a brief description of each, may be found in:

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PREFACE.5 Acknowledgments

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1.0 Chapter 1. Cooperative Applications

In the development of communication applications, such as TCP/IP applications, there are a number of common design topics that apply regardless of the actual technology being used. In this chapter we will discuss these topics in order to provide a common ground for the following chapters that are more implementation oriented.

TCP/IP programming is basically a question of creating cooperative applications based on the TCP/IP transport protocols and the programming interfaces associated with these protocols.

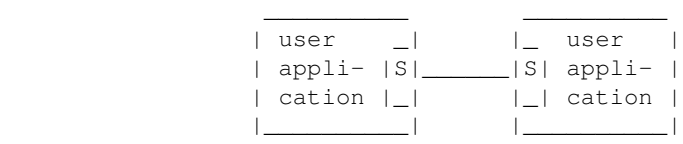
1.1 The Basic Socket Concept

Communications applications receive data from a network and send data to a network. In a way, communicating with a network is similar to reading from and writing to any other device.

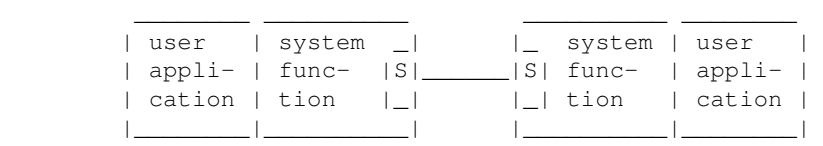
The socket concept essentially builds a communications application program interface (API) on this similarity. The socket API is said to be based on an *open/close/read/write* paradigm, as the most important socket routine calls are similar to the calls that are used to access flat files.

For a positioning of sockets, we can extend the analogy with flat files. For many applications, flat files offer exactly the functions required by the application; while in other cases more functionality is required, and the application requirements are best met by a database system instead of a flat file. Under the covers, databases eventually are implemented as a set of flat files. Databases can be accessed through specialized APIs from user-written application programs. Also, databases can be accessed using tools such as query programs that may even make it unnecessary to write any application program yourself.

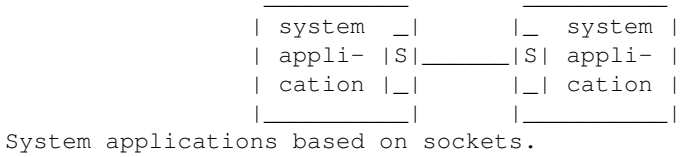
Similarly, TCP/IP provides application program interfaces beyond the socket interface. In addition, TCP/IP provides standardized tools: system applications, that require no user-written application at all (just as you can access a database with a query tool). Yet, internally most of these facilities are based on sockets, as is shown in Figure 1.



A socket application



Applications indirectly based on socket function: for instance RPC



System applications based on sockets.

Figure 1. Sockets in TCP/IP

If you have decided that you are going to write TCP/IP applications, you have the choice to either use the socket interface directly, or use it through one of the other TCP/IP-provided interfaces, such as RPC (more about RPC in "Remote Procedure Call Programming Interfaces" in topic 2.3).

Finally, TCP/IP products provide built-in system applications for various purposes such as file transfer (FTP), terminal emulation (TELNET) and remote file access (Network File System).

Figure 2 shows the various TCP/IP facilities in perspective. It shows how user-written socket programs in fact use an interface that is also used by many TCP/IP system applications and facilities. Not all components shown in Figure 2 will be discussed in this book. For a comprehensive introduction we would recommend another redbook, *TCP/IP Tutorial and Technical Overview*, GG24-3376.

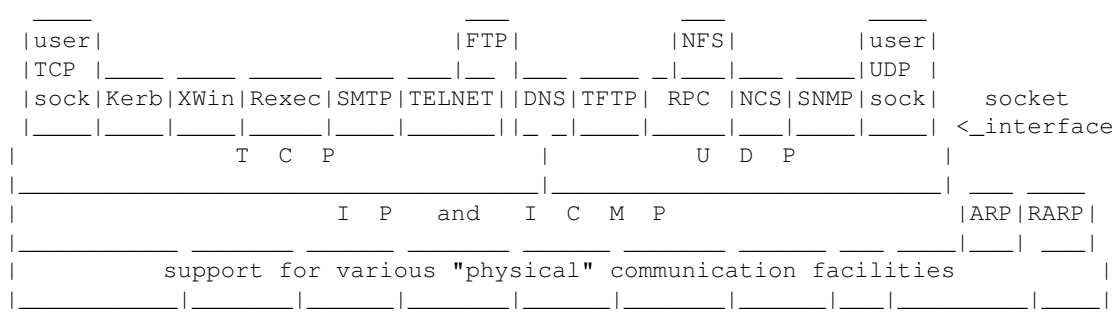


Figure 2. TCP/IP Layers

In most situations, it is the application requirements that dictate which solution is best. Sometimes the choice is obvious from an application point of view. At other times it is not obvious, and it might be useful to step back at some point in time (preferably early in a project) in order to critically review the requirements leading to a particular choice.

Occasionally you need a facility to access someone else's application over a network, or you create a service that can be accessed by someone else's application. In either case, you implement just one side of the communication, and the protocols and other application related specifications may be fully defined in advance.

On other occasions, you are in a position to design, from scratch, an application that partly runs on one machine and partly on another machine. Typically this is the case with intelligent workstations providing a graphical user interface to applications that run on other machines in the network where, for example, the database is located. Often this is called *client/server* computing, but actually client/server computing is just one of the models for cooperative application design, as we will discuss in the following sections.

1.2 Cooperative Application Design Models

In a cooperative application, one or more programs cooperate to implement the full application. When you design a cooperative application, you must decide where the application is split into separate programs, what the role of each program is, and how the programs communicate with each other in order to implement the appearance of a full cohesive application.

Cooperative application design can be very complex; however, viewed from a high-level perspective, the design considerations can be grouped into three major categories, which are known as:

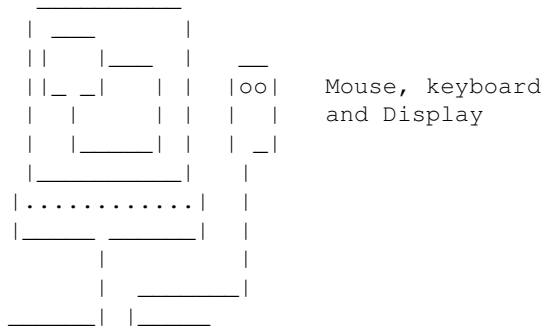
1. The *application model* - where do you split your application into separate application parts?

2. The *distribution model* - what is the role of each application part?

3. The *communication model* - what happens between the application parts?

1.2.1 Application Model

The application model describes where your application is split, so one part of the application is executing on one system and other parts of the application are executing on other systems.



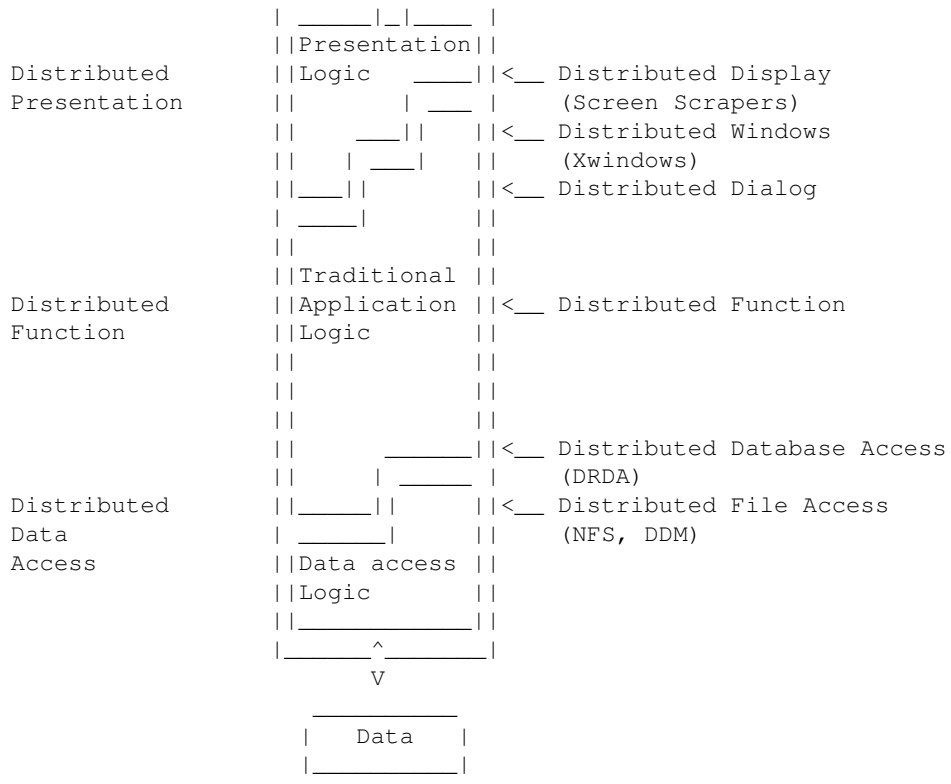


Figure 3. The Application Model - Where Do We Split the Application?

Three basic application models exist as follows:

1. Distributed Presentation

   The main body of the application, including data access and business logic is in one system, while the user dialog is distributed to another system. For a distributed presentation application, you may consider using some standardized protocols. These may include a simple 3270 data stream front-ended with screen-scrapers of various kind to a more sophisticated distributed dialog software like ISPF Version 4. In a TCP/IP environment, you have an excellent choice for distributed presentation applications, which is the X-Windows programming interfaces.

2. Distributed Function

   In a distributed function application, there is no easy way to characterize the split, which is located somewhere in the middle of your business logic. You have parts of the business logic in one system and other parts of the business logic on other systems. If you use this model, you have to design and implement your own application protocol. This would entail message formats, state switching, and exception handling, just to mention the most important aspects of such a design.

   Most of your TCP/IP socket based applications will probably be located within this category.

3. Distributed Data Access

With distributed data access, you have your business logic and presentation logic in one system, and your data or parts of it on another system. In this area, you will find more very powerful standardized protocols ranging from Structured Query Language (SQL) using Distributed Relation Data Architecture (DRDA) to simpler remote file access protocols like Network File System (NFS) in a TCP/IP environment or Distributed Data Management (DDM) in an SNA environment.

You may also use the Network DataBase (NDB) component of IBM TCP/IP for MVS for distributed access to DB2/MVS databases, but be aware that the NDB protocols do not implement any two-phase commit functions, so your local data updates are not synchronized with your DB2/MVS updates.

Distributed data access is often an attractive solution for implementing cooperative applications because your programs, with a correct implementation, are more or less unaware of the fact that the data is being accessed across a network. It makes it easy to implement programs and relatively easy to port them to other platforms.

Distributed data access may be very easy to implement, but there are situations, not only where application characteristics can lead to unacceptable poor performance in a distributed data access environment, but also where a distributed function design might prove to be a more feasible solution, at least from a performance point of view.

1.2.2 Distribution Model

The distribution model describes how the two parts of your application are distributed and how they interact with each other. The following are the three basic distribution models:

1. A Peer-to-Peer model

   In this model, no single part of the application is by definition slave or master, both parts are peers and both parts can initiate or terminate a conversation with the other.

   This model may well be flexible, but it is often difficult to implement in real life. It can in many situations be substituted by two applications that are based on the following client/server distribution model instead.

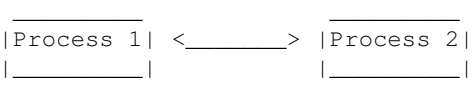


Figure 4. Peer-to-Peer Distribution Model

2. A Client/Server model

This is the most common distribution model. One part of your application (the client side) makes requests of the other part (the server side) which performs some service and sends back a reply.

The roles of the client and the server are specialized and constrained to a certain predefined type of interaction and function.

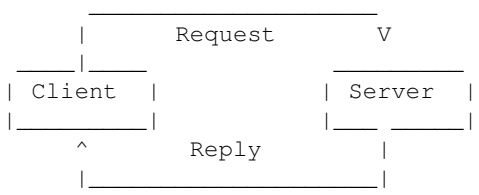


Figure 5. Client/Server Distribution Model

This model is relatively simple to implement, and most of your cooperative applications will most likely use the client/server distribution model.

The socket programming interface offers you a set of function calls that are very useful in making it easy for you to write cooperative applications that are based on the client/server distribution model.

3. A Processor Pool model

A processor pool model is very useful for parallel processing, as its basic idea is to have a coordinator process break a given job into small pieces, parcel these pieces out to a number of parallel work processes and finally assemble the individual result pieces into a final result.

This distribution model will be used for high performance specialized applications. It is difficult to implement.

1.2.3 Communications Model

The third and final design model category describes what happens between the two parts of your application. How is the communication flow?

Basically communication models can be grouped into three major groups:

1. A Conversational model

In a conversation, the two application parts implement a half-duplex, flip/flop application protocol. This has nothing to do with the transport protocol, which may very well be a full-duplex protocol like a TCP protocol. Here we focus on how the two application parts control their conversation. The conversation is synchronous; one side sends data, and the other side receives data. All components of the network must be available for a conversation to take place. Application programs must include logic to deal with network failures, which will break the conversation at unpredictable points. A well-implemented conversational protocol may include elements for coordinating synchronization points. If your distributed application

relies on synchronized updates of data at both involved end points, you will probably use a conversational model.

SNA LU6.2 protocols, with Common Programming Interface - Communications (CPI-C) used as a programming interface, is an excellent choice for an application that requires a conversational model.

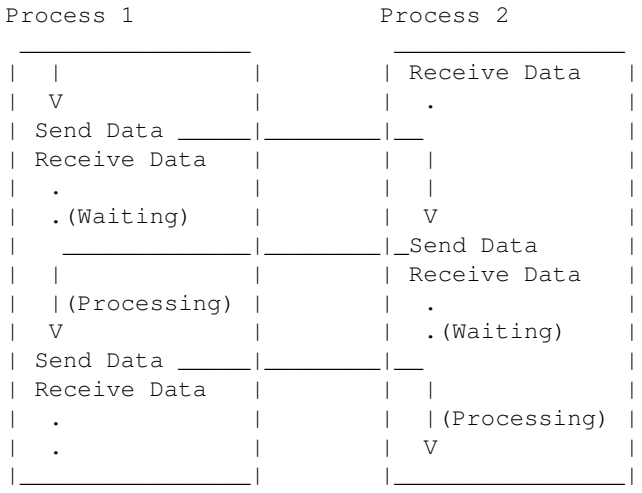


Figure 6. Conversational Communications Model

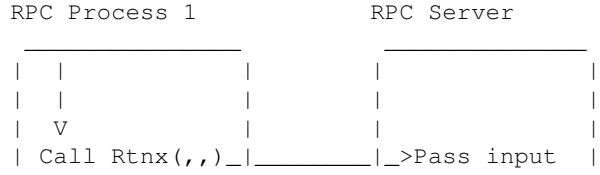
If you are using the socket programming interfaces, you have to build your own conversational protocol control (state control and state transition logic) into your application, because the socket programming interface does not enforce conversation states.

2. Remote Procedure Call model

This is a well-known communications model in the TCP/IP community where you will find more implementations based on this model. The basic concept of this model is call subroutine and return results.

Communication between the parts is synchronous; the requester calls a subroutine and blocks until the subroutine returns. In an RPC implementation, the subroutine is not part of the calling program but may be located on another system to which the call parameters are passed. The routine is executed and the return parameters are returned to the originating system where they are passed back to the calling program.

The Remote Procedure Call model is a simple and easy-to-use communication model.



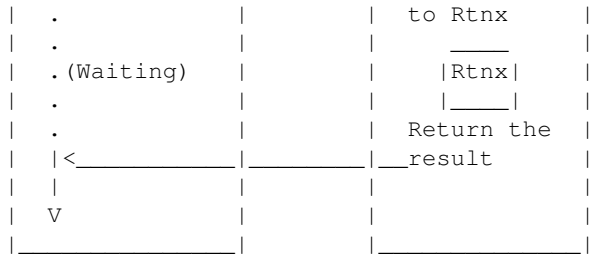


Figure 7. Remote Procedure Call Communications Model

IBM TCP/IP for MVS implements both SUN's Open Network Computing / Remote Procedure Call (ONC/RPC) and Appollo's Network Computing System / Remote Procedure Call (NCS/RPC).

In Open Software Foundation / Distributed Computing Environment (OSF/DCE), you will find a third remote procedure call implementation, which is called OSF/DCE Remote Procedure Call (DCE/RPC). In an MVS environment, DCE/RPC is implemented by MVS/ESA OpenEdition Distributed Computing Environment.

The CICS function called Distributed Program Link (DPL) between, for example, CICS-OS/2 and CICS/ESA is also an implementation of a remote procedure call model.

3. Message Queuing model.

The first two communication models were synchronous in the sense that the two parts were in direct interaction with each other. In a message queuing model, the requester queues a request for the receiver to process at some time later. The requesting and the receiving processes are fully asynchronous in nature. No connection exists between the two.

Message queuing inside one operating system has been known for many years, but it is not until recently that message queuing between heterogeneous environments has been implemented in commercial products.

To implement distributed applications based on a message queuing model, you may use the IBM MQSeries products, which implement recoverable store-and-forward queues and a uniform message queuing programming interface (MQI) across a range of operating system platforms.

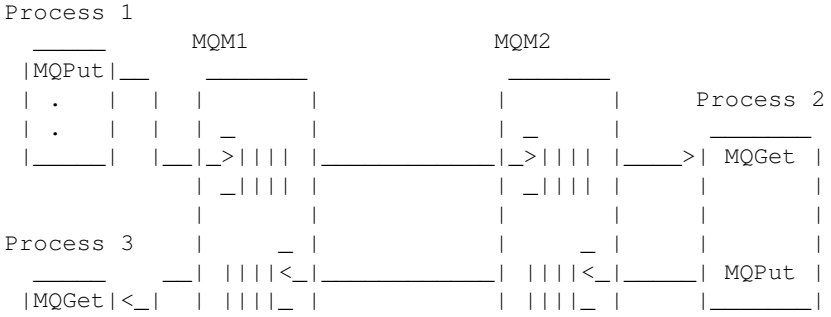


Figure 8. Message Queuing Communications Model

1.3 Cooperative Design Summary

In your design of a cooperative application, you have to consider the aspects of each of the models just described. Just to recap a few of these aspects:

Where can you split your application logic?

How well will alternative implementations perform?

How much effort must you put into implementing each of your alternatives?

How do you synchronize updates if such synchronization is required?

It really does not matter if you are able to refer your application to a specific set of models or not; what matters is that you consider the aspects of each model when you lay out the design of your cooperative application.

2.0 Chapter 2. Introduction to TCP/IP Programming Interfaces

In this chapter we will give you a short introduction to each of the programming interfaces that are delivered with IBM TCP/IP Version 3 Release 1 for MVS.

IBM TCP/IP Version 3 Release 1 for MVS gives you a broad range of programming interfaces that you can use to develop application programs that interact with the TCP/IP protocol layers and services at various levels.

Some of the programming interfaces are general use interfaces like the socket and Remote Procedure Call interfaces. Others are special purpose programming interface, like the SNMP DPI interface, which you will only use if you have to develop an SNMP subagent.

2.1 Choosing an API

The sockets application programming interface is often referred to as low-level, as opposed to interfaces such as RPC that are considered to be high-level.

What should you choose for your particular application? Will it always be a good idea to use a high-level programming interface? Well, it depends. Typically, a high-level interface offers more ease of use at the expense of flexibility. Sometimes, you would need flexibility. On other occasions, the standardized functionality of a high-level interface is exactly what you want.

Exploiting the facilities of IBM TCP/IP Version 3 for MVS is important for maximum application development productivity.

This book will help you decide whether to use sockets or not. On several occasions, we will tell you explicitly that sockets require you to decide yourself on certain design aspects. What this means is that sockets give you the freedom to decide on those aspects yourself, which may be really what you want.

Whether you are going to use the basic programming interfaces or you are going to use one of the higher-level interfaces for your application depends on many factors.

- What functions do you require in the programming interface?
- What are the operating system platforms you have to support with your application?
- Which transport protocols do the operating systems support?
- If a higher-level programming interface suits your needs, is the supporting program products available on all the operating systems where you want to implement your application?
- Can your application justify the cost of purchasing the supporting program products if it is available but not implemented?
- What are your programming skills, do you need extra training in order to use a specific programming interface and can you get that training in the right time before your development project starts?

Other factors, like company policy, may of course influence the choice of programming interface.

For some of your applications, you will probably end up with a choice of basic TCP/IP socket programming in MVS.

2.2 Socket Application Programming Interfaces

The socket programming interface has been implemented in more variations, but all implementations are in some way or another based on the original Berkeley Software Distribution (BSD) socket implementation, which has its roots in the UNIX environment. As we explained in the introduction, socket programming is a generalized file access mechanism where your socket programs interact with a socket in much the same way they would interact with a file. You open and close a socket. You read and write data from and to a socket. In a C program, you will actually use the same system calls to access a socket and a file.

You must understand that, when we talk about sockets, we are talking about a programming interface, not a protocol. The socket programming interface is a programming interface to the TCP/IP protocol layers (mainly the Transport Control Protocol (TCP) and User Datagram Protocol (UDP) layers).

But the socket programming interface also supplies you with interfaces to the Internet Protocol (IP) layer directly, if you want to develop special purpose network control applications. See Figure 9 for an overview of the relationship between the socket interface and the protocol layers.

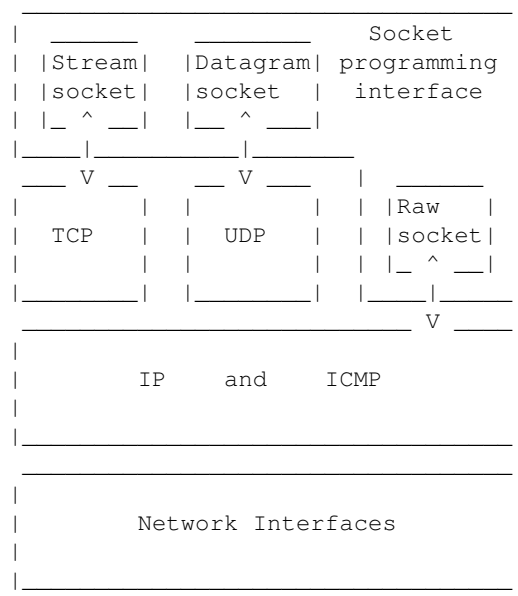


Figure 9. Socket Programming Interface

The socket programming interface is a general-use, wide spread and very flexible programming interface. It can be used for almost any application type you want to implement. On the other hand, this is also the weakness of the socket programming interface. The socket programming interface does, for example, not include functions to establish and to control conversation states between two applications that exchange data over a socket connection. If conversation states make sense in the application, then the application designer must design a conversation protocol based on both logic in the application programs and state data transmitted as part of the user data. If data is exchanged over a socket connection between programs that execute on different hardware platforms, then the programs must include logic to convert data from one data representation to the other.

In an MVS environment, applications run either natively on MVS (batch, TSO or started task), or exploit specific subsystems such as CICS or IMS. All of these subsystems provide several alternatives for TCP/IP applications.

Table 1. IBM TCP/IP Version 3 Release 1 for MVS Socket Libraries and MVS Environments

IBM TCP/IP Version 3 Release 1 for MVS Socket Libraries	**Native MVS or TSO**	**CICS**
C-sockets	X	X
REXX Sockets	X	
PASCAL Sockets	X	

	Macro	assembler	X		
		assembler	X	X	
Sockets Extended	Call	COBOL	X	X	
		PL/I	X	X	

TCP/IP for MVS Version 3 offers you the opportunity to develop socket programs in both the C language and other high-level languages, as is shown in Table 1.

In addition to the listed IBM TCP/IP Version 3 Release 1 for MVS socket libraries, you can in an MVS environment use OpenEdition/MVS sockets and AnyNet/MVS sockets. We will in "Integrated Sockets" in topic 3.6.1, return to a discussion of the relationship between these different socket libraries.

C-sockets.

This programming interface is based on the original BSD socket definitions and is widely used in the UNIX world. A C program using this interface can be ported between MVS and most UNIX environments with relative ease, if the program does not use any other MVS specific services.

C-socket applications can be implemented in normal MVS address spaces, CICS, and IMS transaction programs.

Sockets Extended - call interface.

This is a generalized call-based, high-level language interface to socket programming. The functions implemented in this call interface resembles the C-socket implementation, with some minor deviations. The Sockets Extended call interface is available to COBOL, PL/1 or assembler programmers.

Sockets Extended call based applications can be implemented in normal MVS address spaces, CICS, and IMS transaction programs.

Sockets Extended - assembler macro interface.

This programming interface is fundamentally the same as the Sockets Extended call interface, but it is implemented as assembler macros, which adds some extra features like multitasking support and support for asynchronous socket calls.

This programming interface can only be used to implement socket applications in normal MVS address spaces (batch, TSO or started task).

REXX sockets.

This programming interface implements facilities for socket communication directly from REXX programs via an **address socket** function.

REXX socket programs can execute in TSO (either TSO online or TSO batch) and in NetView.

Pascal sockets.

This is a Pascal socket interface allowing programmers to develop socket applications in Pascal language.

Environments supported are normal MVS address spaces.

While this API conceptually provides the same sockets interface, the actual implementation in routines is fairly different.

IUCV and VMCF sockets.

These are assembler macro based interfaces, which are relatively low-level and complex to use. These APIs are primarily included in IBM TCP/IP Version 3 Release 1 for MVS for compatibility reasons.

Reference information for all the IBM TCP/IP for MVS socket programming interfaces can be found in *IBM TCP/IP for MVS: Application Programming Interface Reference*, SC31-7187.

2.3 Remote Procedure Call Programming Interfaces

A Remote Procedure Call programming interface is located at a higher level in the protocol stack than the socket based programming interfaces. Somewhere down underneath the RPC interface the socket programming interface is used, but the details of the socket interface are hidden for the application programmer that uses the RPC programming interface.

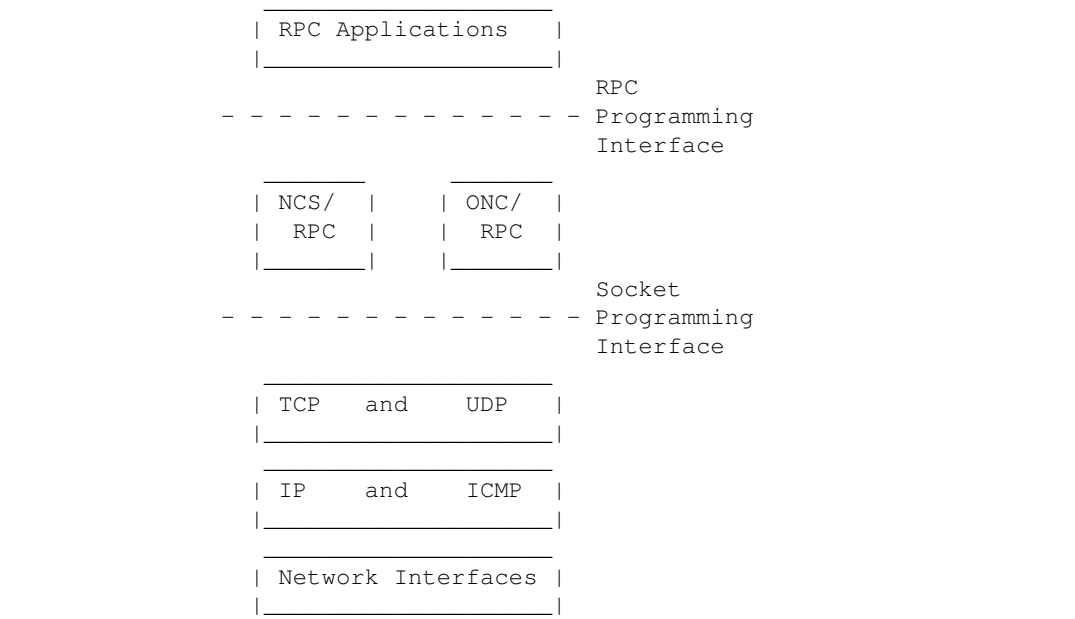


Figure 10. RPC Programming Interface and Protocol Layers

The RPC programming interfaces offer more ease of use to the application programmer than do the socket programming interfaces which makes the network programming job somewhat easier to accomplish. The RPC

programming interfaces generally deal with things like different data representation and some kind of state control over the dialog. On the other hand this also implies some restrictions; a dialog is normally limited to one procedure call. Each remote procedure call is stateless and independent of either preceding or succeeding calls. If an RPC client program requires more interactions with the server program, the state data has to be carried back and forth as user data in the parameters passed on each remote procedure call, or the server program has to implement some kind of Scratch Pad Area (SPA) implementation where state data per client is saved from call to call.

If you develop RPC programs, your only programming language choice is C.

In IBM TCP/IP for MVS you have two RPC implementations:

Sun Microsystems Open Network Computing / Remote Procedure Call (ONC/RPC).

Hewlet Packard Remote Procedure Call implementation, which is called Apollo Network Computing System / Remote Procedure Call (NCS/RPC).

Please refer to *IBM TCP/IP for MVS: Programmer's Reference*, SC31-7135, for reference information on both ONC/RPC and NCS/RPC.

2.4 X-Windows Programming Interfaces

If you want to develop distributed presentation programs, where your application program is running in MVS and the user interface is implemented on an X-Windows server in your IP network, you can use the X-Windows application programming interfaces that are supplied with IBM TCP/IP for MVS to develop X-Windows MVS client programs.

In an X-Windows environment, the term *server* is applied to the host where the display shows up, and the term *client* is applied to the host where the application program is executing.

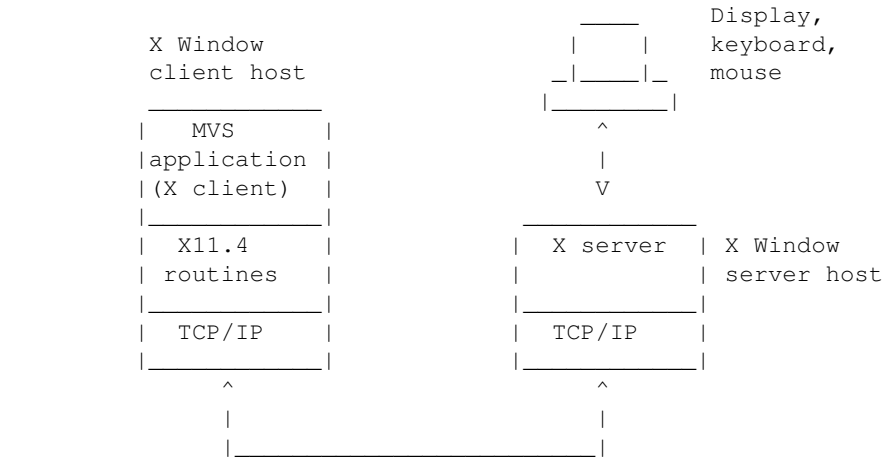


Figure 11. X-Windows Client and Server Hosts

One X server may be connected to many X clients thus sharing the physical display and input devices among many application programs. The clients may be located on different hosts.

MVS is only able to act as an X-Windows client, not as an X-Windows server which means you can execute X-Windows applications in MVS that communicate with X-Windows servers in TCP/IP workstations.

The X-Windows programming interfaces are, like the RPC programming interfaces, a higher level programming interface to the socket interface. But unlike the RPC programming interface, which is a general use interface, the X-Windows interface is a specialized programming interface that deals only with distributed presentation.

The X-Windows programming interface in IBM TCP/IP Version 3 Release 1 for MVS is based on the X11.4 specification. The X11.4 programming interface is extremely detailed and gives you a high number of low-level functions. On top of the basic X11.4 programming interface, you find some toolkits that implement generally used X-Windows functions (also called intrinsic functions). You can use the toolkits to develop X-Windows applications without the detailed coding you would have to use if you only had the X11.4 interface.

At an even higher level than the X-Windows toolkits, you find what is termed X-Windows widget sets. A widget set is a collection of procedures or functions that you use to create commonly used X-Windows objects. Examples of such objects are the following:

- Push buttons
- Scroll bars
- Dialog boxes
- Text boxes
- Pull-down menus

The widget sets that are supplied with IBM TCP/IP for MVS are:

- The Athena Widget set from Massachusetts Institute of Technology (MIT).
- The OSF/Motif Widget set release 1.1 from the Open Software Foundation (OSF).

You can only develop X-Windows programs in C.

For further details about X-Windows programming please see *IBM TCP/IP for MVS: Programmer's Reference*, SC31-7135, and *TCP/IP for MVS, VM, OS/2 and DOS X Window System Guide*, GG24-3911.

2.5 X/Open Transport Interface (XTI)

IBM TCP/IP for MVS implements an XTI programming interface in C that allows you to use XTI programs in a TCP/IP environment.

XTI is defined by X/Open and is a superset of UNIX System V Transport Layer Interface (TLI), which is a programming interface introduced in UNIX System V.

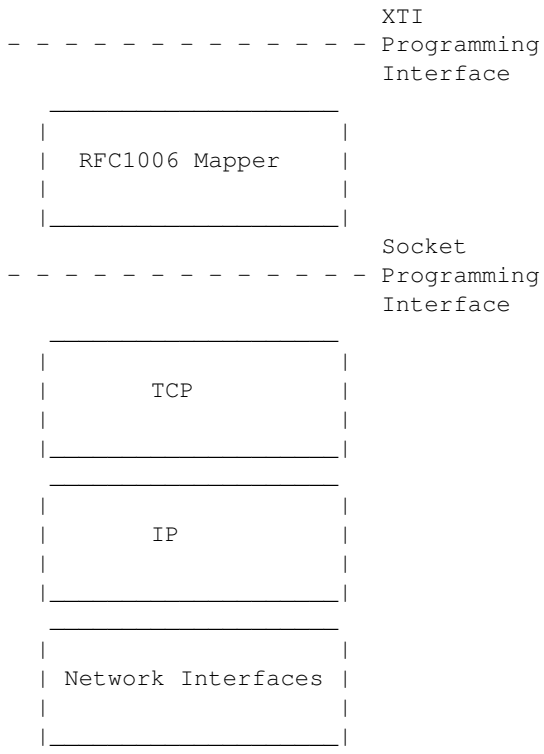


Figure 12. X/Open Transport Layer Programming Interface

The IBM TCP/IP for MVS implementation of XTI includes a mapping component which maps between XTI calls and TCP socket calls. The mapping component is based on RFC1006.

The XTI system calls are implemented as C function calls, so you must develop your XTI application in C.

For details about the XTI programming interface, please study *CAE Specifications: X/Open Transport Interface (XTI)* and *IBM TCP/IP for MVS: Application Programming Interface Reference*, SC31-7187.

2.6 SNMP Agent Distributed Programming Interface (DPI)

This is a special purpose programming interface that you can use if you want to implement dynamic Management Information Base (MIB) variables. In an SNMP environment, the MIB variables are defined in the *tcpip.v3r1*.MIBDESC.DATA data set. If you want to dynamically add, replace or delete MIB variables, you can develop an SNMP subagent program that uses the DPI programming interface to interact with the SNMP agent address space (SNMPD) to perform such functions.

If you develop an SNMP subagent, you can define your own MIB variables and SNMP traps.

The connection between the subagent address space and the SNMP agent is established as a TCP socket connection, so the DPI programming interface is again a higher level programming interface to the socket interface.

It is outside the scope of this book to explain the DPI programming interface in detail. For the socket based parts of an SNMP subagent you

can use the information in this book, but for the specifics of the DPI programming interface you can find useful information in *IBM TCP/IP for MVS: Programmer's Reference*, SC31-7135, where there is a good example of a C based SNMP subagent. The DPI programming interface is only supported for programs written in C.

2.7 Kerberos Programming Interface

Kerberos is an authentication system that you can use to identify clients and authenticate connection requests. Authentication depends on both client and server programs to include specific system calls to the Kerberos Authentication Server (KAS) and Ticket Granting Server (TGS).

The Kerberos calls are implemented in C, so you can only use the Kerberos authentication features if you develop your programs in C.

This book does not include details about the Kerberos program calls., You can find call reference information in *IBM TCP/IP for MVS: Programmer's Reference*, SC31-7135.

3.0 Chapter 3. TCP/IP Concepts for Socket Programmers

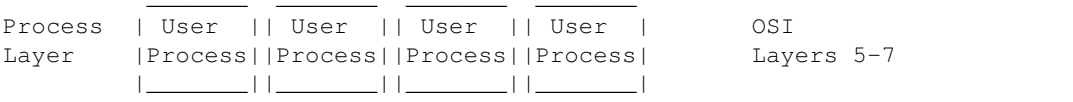
This chapter explains some very basic TCP/IP concepts which are required in order to understand the remaining parts of this book. We will not indulge into too much detail, but we will focus on the concepts where an explanation may ease your understanding of the TCP/IP socket programming issues that are presented in the succeeding chapters.

For a more thorough explanation of TCP/IP concepts, we refer you to *TCP/IP Tutorial and Technical Overview*, GG24-3376.

3.1 TCP/IP Protocol Layers

The TCP/IP protocol stack consists conceptually of four layers, each layer consisting of more protocols.

We will define a *protocol* as a set of rules or standards that two entities must follow to allow each other to receive and interpret messages sent to them. The entities could, for example, be two application programs, in which case we talk about an application protocol. The entities could also be two TCP protocol layers in two different IP hosts, in which case we talk about the TCP protocol.



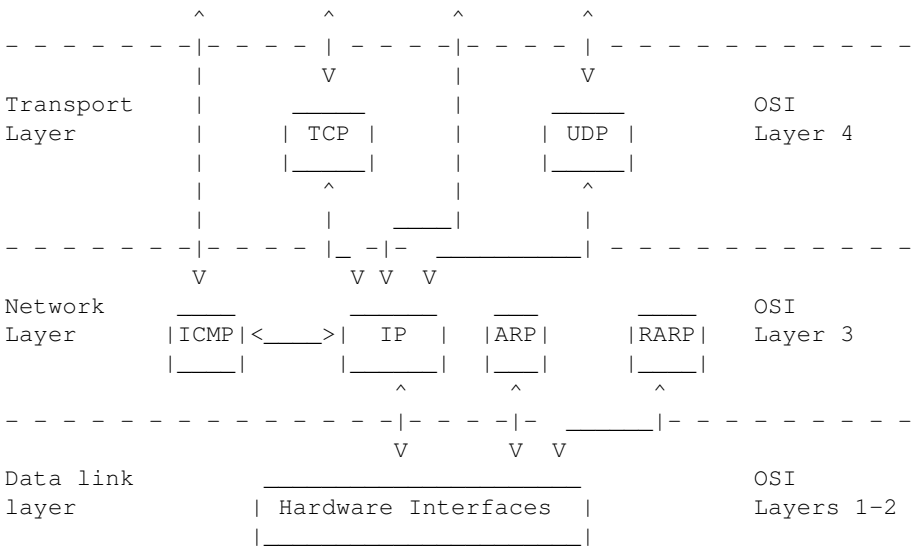


Figure 13. The TCP/IP Protocol Stack

Your programs are located at the process layer, where they may interface either to the two transport layer protocols (TCP and UDP) or directly to the network layer protocols ICMP and IP.

TCP Transmission Control Protocol

TCP is a connection-oriented transport protocol that provides a reliable, full-duplex byte stream. By far the majority of TCP/IP applications use the TCP transport protocol. It is estimated that between 80% and 90% of all TCP/IP applications are based on TCP, which is the reason why this book devotes most of the pages to explaining how to create TCP based applications.

UDP User Datagram Protocol

UDP is a connectionless protocol that provides datagram services. There are no guarantee that a UDP datagram ever reaches its intended destination, or that it reaches its destination only once and in the same shape as it was passed to the sending UDP layer by a UDP application.

ICMP Internet Control Message Protocol

ICMP is used to handle error and control information at the IP layer. ICMP is mostly used by network control applications that are part of the TCP/IP software product itself, but ICMP may be used by authorized user processes as well. PING and TRACEROUTE are examples of network control applications that use the ICMP protocol.

IP Internet Protocol

The IP layer provides the packet delivery services for TCP, UDP and ICMP. The IP layer protocol is in itself an unreliable and so-called best-effort protocol. There is no guarantee that IP packets will arrive to the destination or that they will arrive only once and error-free. Such reliability features are built

into the TCP protocol, but not into the UDP protocol. If you want a reliable transport between two UDP applications, the reliability functions must be built into the UDP applications.

ARP Address Resolution Protocol

This protocol is used by the networking layer to map an IP address into a hardware address. On a local area network, such an address would be a Media Access Control (MAC) address.

RARP Reverse Address Resolution Protocol

As the name suggests, this protocol is used to do the reverse operation of the ARP protocol: map a hardware address into an IP address.

Please note that both ARP packets and RARP packets are not forwarded in IP packets, but are media level packets themselves. ARP and RARP are not used on all network types as some networks do not need these protocols.

3.2 Addresses

One of the most basic requirements for network programming is the ability to find your communication partner by address or name.

From the perspective of an application program, the identity of a TCP/IP communication partner is defined in two steps:

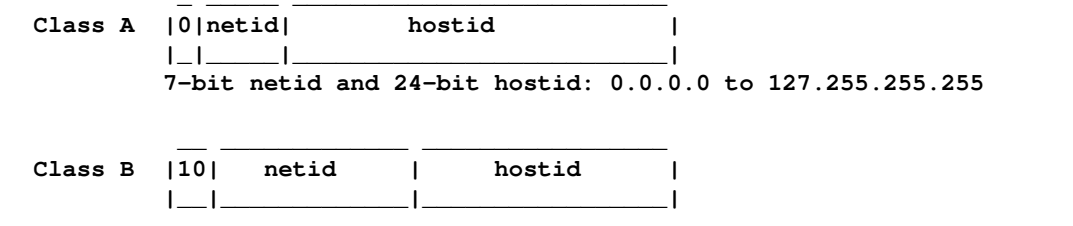
1. The first step is the address of the machine where the partner application is running. In an IP network, this is the *IP address*.

2. The second step is to identify the specific application on that machine. This is done through the *port* number.

3.2.1 IP Addresses

In the current version of the IP protocol (version 4), an IP address occupies 32 bits. These 32 bits are divided into a *network* part and a *host* part.

The split between the network part and the host part is determined by the *address class*. The first bits in an IP address identify the address class.



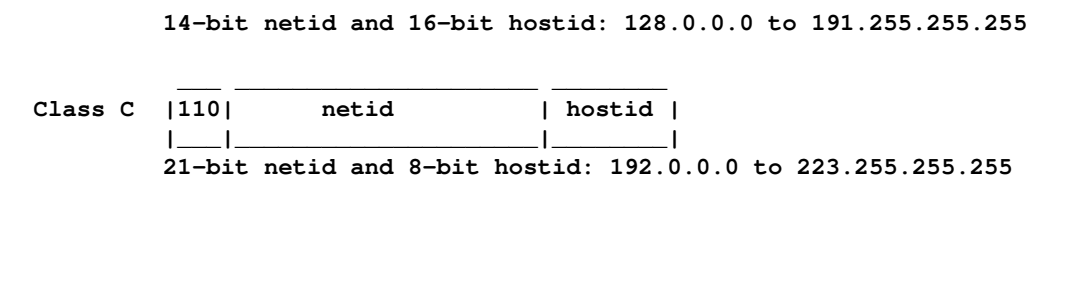


Figure 14. IP Address Classes

In addition to the three IP address classes presented in Figure 14, class D and E also exist. Class D addresses are called *multicast* addresses, and class E addresses is a group of addresses that is currently reserved for future use.

Every IP datagram contains the full 32-bit source IP address and the full 32-bit destination IP address in the 20-byte IP header. IP routers on the path, between the source and the destination IP host, only need to look at the IP addresses of an IP datagram in order to determine where to forward the IP datagram.

IP addresses in the form of numbers are hard to remember. And, as they are related to the internal structure of your IP network, they tend to change. A person may move to a different office and get a different IP address; but, of course, remains the same person.

For those reasons, TCP/IP provides facilities to assign a symbolic name to an IP address. Such a name is known as a *host name*.

The translation between host names and IP addresses is performed by a component called the *name resolver*. This component is part of every TCP/IP product. The name resolver finds its information in either some local *host tables* or it queries a special server called a *name server*. The socket programming interface includes calls you can use to translate a host name to an IP address or an IP address to a host name. These calls are **gethostbyname** and **gethostbyaddr**.

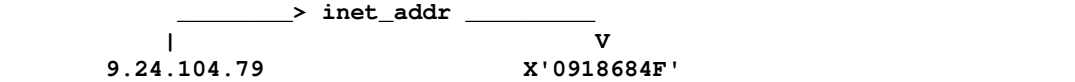
In a TCP/IP network, there are several other types of addresses, such as physical (LAN) addresses. TCP/IP software handles all of these addresses, so your application should not be concerned with those.

An IP address is by tradition expressed externally in dotted decimal form and internally in a 32 bit wide field. In a C-program you can use two library routines to convert an IP address from one format to the other:

inet_addr Converts a null-terminated character string to a full-word IP address

inet_ntoa Converts a full-word IP address to a null-terminated character string

In the C programming language a variable length character string is terminated with a hexadecimal zero (X'00'). This is the reason why such a string is called a null-terminated string.



```
          ^                              |
          |__________ inet_ntoa <________|
```

If you are writing your socket programs in languages other than C, you have to develop similar routines. You will find, in the appendix of this book, examples of two assembler routines that implement similar functions. These routines can be called from any high-level language that supports an assembler call interface. See "TPIINTOA Convert IP Address to Character String" in topic G.2, and "TPIIADDR Convert IP Address Character String to Full-word" in topic G.3.

An IP host may have more IP addresses. Such a host is, in IP terms, called a *multihomed* host. Actually an IP address does not identify an IP host but rather an IP network interface on an IP host.

Any multihomed host may act as an IP router. MVS TCP/IP allows the system programmer to disable IP routing for a multihomed MVS host by setting the *NOFWD* option in the *tcpip.v3r1*.TCPIP.PROFILE configuration data set.

If your MVS TCP/IP host has two IP network interfaces, for example, a token-ring interface and an Ethernet interface, it will have two distinct IP addresses; one for each network interface.

You have to consider the multihomed aspects of a host when you write socket programs. A server program can specify if it will accept client requests from all available network interfaces, or only from a specific network interface. A client program that sends requests to a server on a multihomed host may use any of the supplied network interfaces of the server host, if the server accepts requests on all the network interfaces.

In Figure 15, the MVS system with a host name of *mymvs* has two IP addresses (one for each physical network interface).

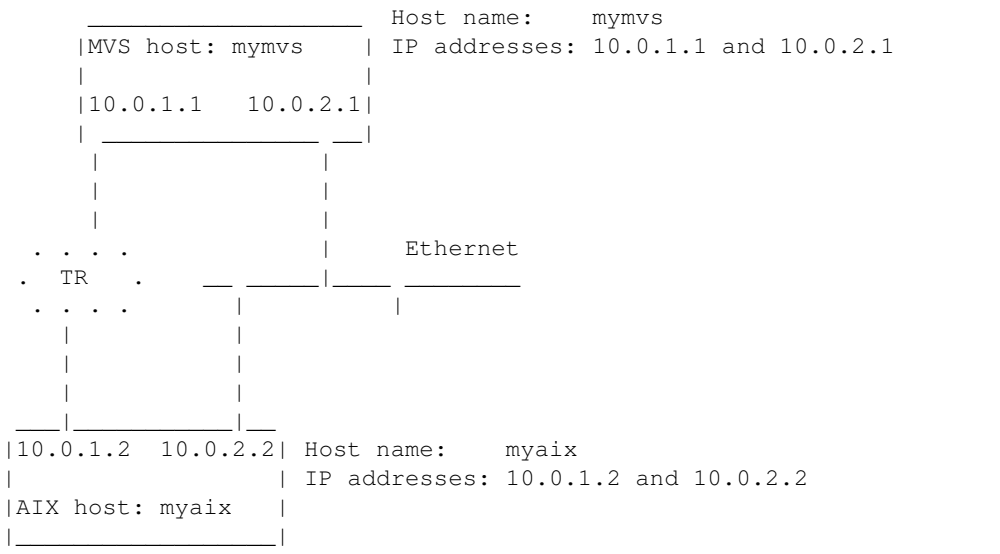


Figure 15. Multihomed IP Host

When your client program issues a **gethostbyname** call to find an IP address

for a host name, the name resolver will return not one IP address, but a list of IP addresses: one for each registered network interface for the host in question. It is a good programming practice to take the full list of IP addresses into consideration when you write your client program. If a connect to the first IP address in the returned list does not respond, your program should include code to pick up the next IP address in the returned list and try to connect to that one. If you write your client programs this way, you build into the code dynamic backup options for failed network interfaces on the server host.

In the example in Figure 15, the application that runs on host *myaix* will receive both IP address 10.0.1.1 and 10.0.2.1 on a **gethostbyname** call for the host name *mymvs*. If, for example, the Token-ring interface on *mymvs* is down, the client application on *myaix* will not be able to connect to address 10.0.1.1; but it will be able to successfully connect to address 10.0.2.1, which is on the Ethernet LAN.

3.2.2 Ports

A socket program in an IP host identifies itself to the underlying TCP/IP protocol layers by a *port* number.

A port is a 16-bit integer ranging from 0 to 65534. A port uniquely identifies this application to the underlying protocol (TCP, UDP or IP) in this TCP/IP host. Other applications in the TCP/IP network may contact this application via reference to the port number on this specific IP host.

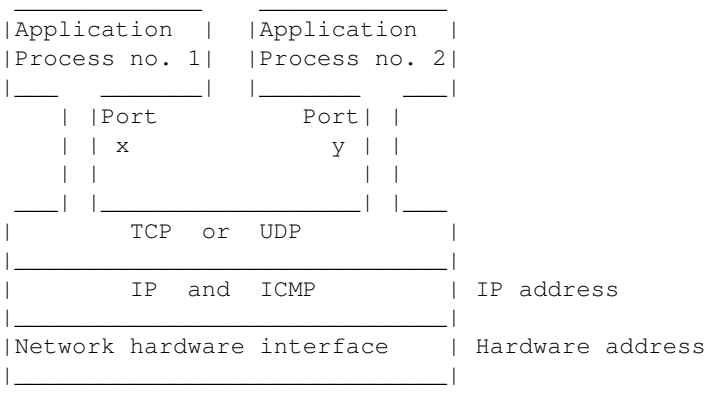


Figure 16. The Port Concept

Both server applications and client applications have port numbers. A server application will use a specific port number that uniquely identifies this server application. The port number can be reserved for this particular server so no other process ever uses it. In an IBM TCP/IP for MVS environment, you can do so via the **PORT** statement in the *tcpip.v3r1*.PROFILE.TCPIP configuration data set. When the server application initializes, it will, via the **bind** socket call, instruct the underlying protocol layers what its port number is. A client application must know the port number of a server application in order to be able to contact it.

Normally, no one needs to have advance knowledge of the port number of a

client, so a client leaves it often to TCP/IP to assign a free port number when the client issues the **connect** socket call to connect to a server. Such a port number is called an *ephemeral* port number, which means it is a port number with a short life. The selected port number is assigned to the client for the duration of the connection and is then made available for other processes to use. It is the responsibility of the TCP/IP software to ensure that a port number is only assigned to one process at a time.

Some application processes are themselves standardized protocols, such as FTP, SMTP, or TELNET. Such standardized applications will use the same port number on all TCP/IP hosts. These port numbers are called *well-known ports* and they represent *well-known services*. Well-known official Internet port numbers are all in the range from 0 to 255. You can find a list of these port numbers in *Assigned Numbers, RFC1700*. In addition, port numbers in the range 256 to 1023 are reserved for other well-known services. Port numbers in the range from 1024 to 5000 are used by TCP/IP when TCP/IP automatically assigns port numbers to client programs that do not use a specific port number. Your server applications should use port numbers above 5000.

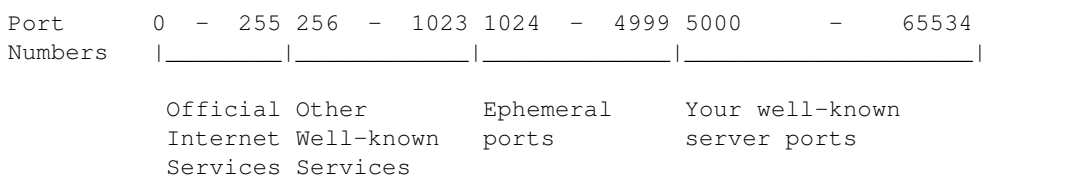


Figure 17. Port Number Assignment

Before you select a port number for your server application, you should consult the *tcpip.v3r1*.ETC.SERVICES data set. This data set is used to assign port numbers to server applications. The server application can use the **getservbyname** socket call to retrieve the port number assigned to a given server name. You may add the names of your server applications to this data set and use the **getservbyname** call. Using this technique, you avoid hard coding the port number into your server program. The client program must know the port number of the server on the server host. There is no socket call to obtain that information from the server host. One way to handle this could be to synchronize the contents of the ETC.SERVICES data sets on all TCP/IP hosts in your network. Your client application could then use the **getservbyname** socket call to query its local ETC.SERVICES data set for the port number of the server. Using this technique, you develop your own locally well-known services.

3.3 Sockets

A port represents an application process on a TCP/IP host, but the port number itself does not indicate what protocol is being used: either TCP, UDP or IP. The application process may use the same port number for all three protocols. To uniquely identify the destination of an IP packet that arrives over the network, we have to extend the port principle with information about the protocol used and the IP address of the network interface; this union is called a *socket*.

A socket is made up of 3 components:

{protocol, local-address, local-port}

A socket uniquely identifies the *endpoint* of a communication link between two application ports.

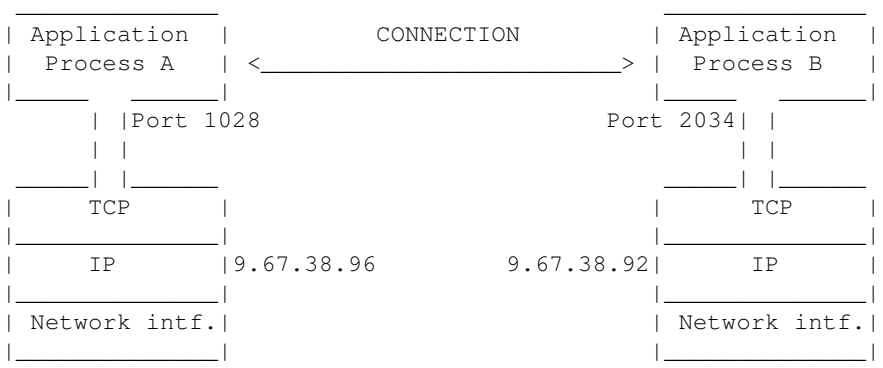


Figure 18. The Socket Concept

The term *association* is used to completely specify the two processes that comprise a *connection*:

{protocol,local-address,local-port,foreign-address,foreign-port}

A socket is also called a *half association* or a *transport address*.

If you have knowledge about SNA, some of these terms may seem familiar to you. The network part of an IP address resembles the SNA network name. The host part of the IP address resembles a System Services Control Point (SSCP) in an SNA subarea network, while the port number resembles a Logical Unit (LU) that is owned by that SSCP. A socket resembles a half-session, and the association resembles an SNA session.

The terms *socket* and *port* are sometimes used as synonyms, but please note that the terms *port number* and *socket address* are not synonymous. A port number is one of the three parts in a socket address. A port number can be represented by a single number; for example, 1028 and a socket address can be represented by {tcp,myhostname,1028}.

A *socket descriptor* (or sometimes referred to as a *socket number*) is a binary half-word (2 byte integer) that acts as an index into a table of sockets currently allocated to a given process. A socket descriptor represents a socket but is not the socket by itself.

3.4 Socket Types

When you write socket programs, you have to select what kind of service you require from the transport protocol layer.

Three different socket types are defined as follows:

Stream socket – a stream socket is characterized by:

- Connection-oriented, which means that the transport layer representing the two sockets establish a logical connection before they begin to exchange data.
- Full-duplex, which means data can be transmitted in both directions simultaneous.
- Reliable, which means that error-free data delivery is guaranteed in right order and without duplication.
- Byte stream – no boundaries are imposed on the data. The data being transmitted can be of virtually unlimited size.
- Flow control, which guarantees that the sender does not send data faster than the network and the receiver is able to manage.

The default protocol for such a service in a TCP/IP network is the TCP protocol. FTP is an example of an application that uses stream sockets.

Datagram socket – a datagram socket is characterized by:

- Connectionless, which means that datagrams are transmitted over the network without first establishing a connection between the two sockets. Each datagram must contain the full set of addressing information required for its delivery.
- No reliability guaranteed, which means that data may be duplicated, out of order, corrupted or never sent.
- No flow control, which means that a sender may monopolize the network and send datagrams faster than the receiver can manage.
- Messages have a maximum size. If you want to send more data than the amount you can send in a single datagram, you must send more independent datagrams.

The default protocol for such a service in a TCP/IP network is the UDP protocol. NFS is an example of an application that uses datagram sockets.

Raw socket – a raw socket can be characterized by:

- Access to lower-level protocols (IP and ICMP).
- Connectionless.
- Reliability not guaranteed.
- Messages have a maximum size.

PING is an example of an application that uses raw sockets.

Normally, you would not use raw sockets unless you intend to develop TCP/IP system software functions yourself.

Study Table 2 for an overview of the three socket types and a guide on when to use which one.

Table 2. Which Socket Type to Use

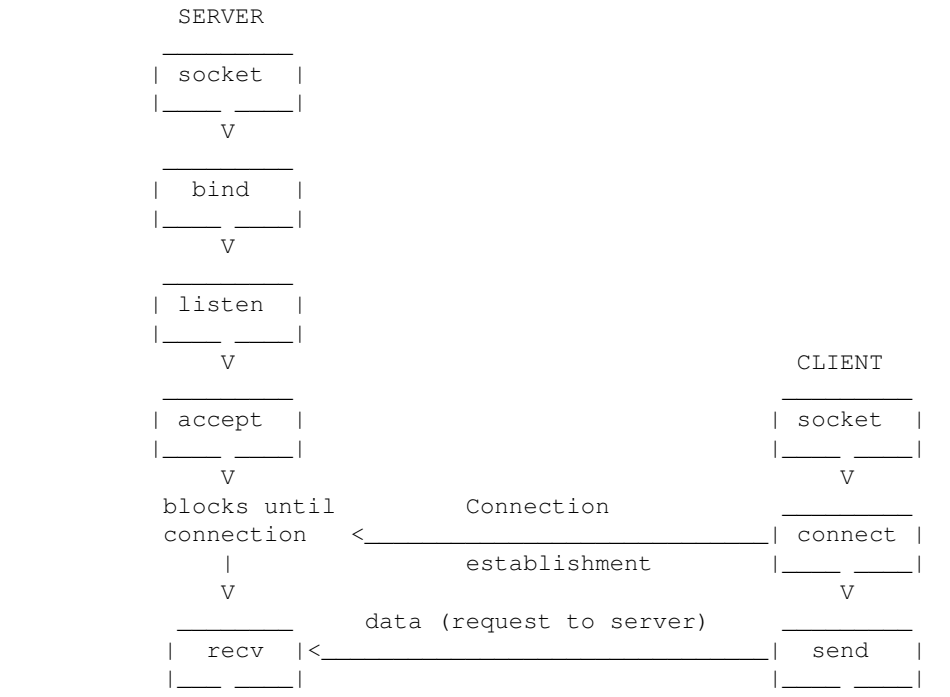
	Stream	**Datagram**	**Raw**
Reliable?	Yes	Only by adding reliability code	Only by ad code
Performance?	Connection and reliability overhead	Good	Best
Data size	Best choice for large amounts of data	Can only use up to maximum datagram size	Data must packet
Protocol used?	TCP	UDP	Any IP pro

A stream socket represents a connection-oriented protocol, while a datagram socket represents a connectionless-oriented protocol.

Figure 19 illustrates the typical socket calls that are used for a connection-oriented protocol. Other calls exist, but those shown here are the typical calls you will use.

Any number of **send** and **receive** calls from either side is possible. The figure primarily illustrates connection initiation and termination procedures.

The **listen/accept** sequence by definition characterizes a connection-oriented *server*, whereas the *client* is characterized by the **connect** call.



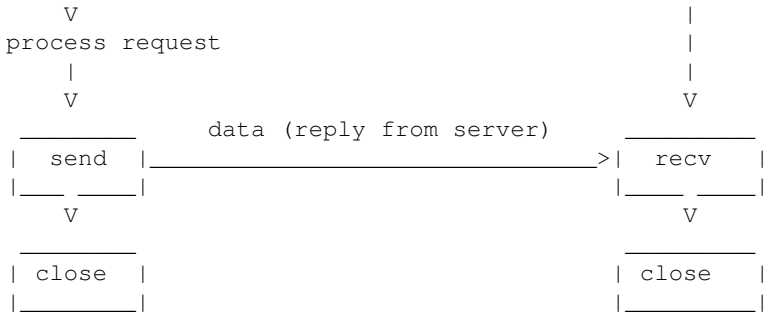


Figure 19. Socket Calls for a Connection Oriented Protocol

Figure 20 illustrates the typical socket calls for a connectionless protocol. Other calls exist, but those shown are the typical calls you will use.

The important thing to note here is that there is no connection establishment.

Both the connectionless server and client will use a **bind** call. The client does it in order to ensure it has a unique address, so the server may be able to send a response back to it. You can compare it to placing a valid return address on an envelope.

Normally a connectionless application will not use a **connect** call, but it may do so. In that case, no connection is established, but the connect call just stores the peer address of the partner application. Anything sent on the socket goes to that address, and only data from that peer address is returned to the application that issued the **connect** call.

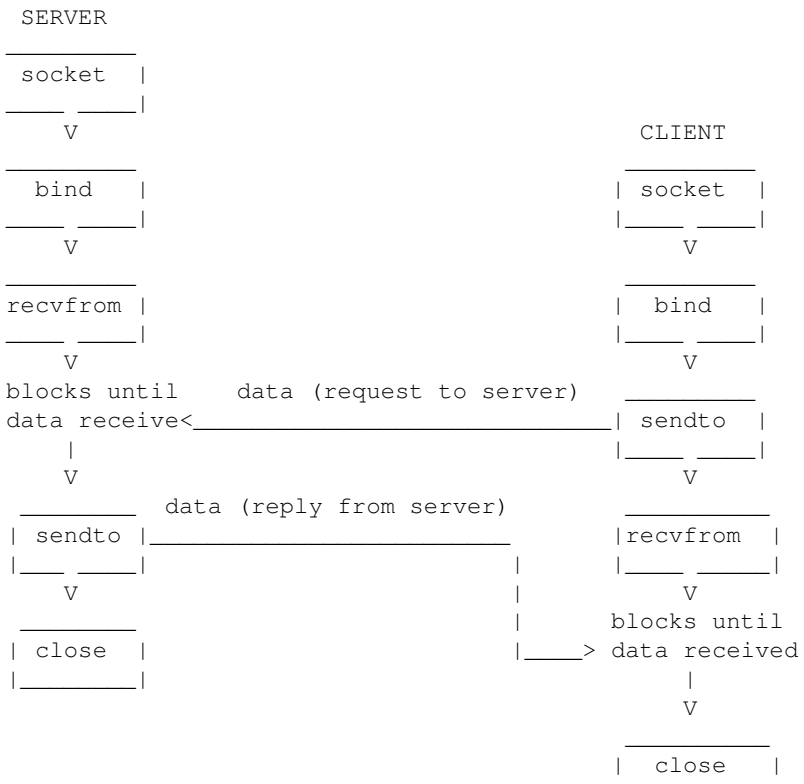


Figure 20. Socket Calls for a Connectionless-Oriented Protocol

3.5 Encapsulation

When your program, which is located at the process layer in the TCP/IP protocol stack, passes data to the underlying protocol layers, each protocol layer will add some extra bytes in front of your data and, for certain protocols, also extra bytes following your data. This process is called encapsulation and is the source of most of the confusion about datagram sizes, IP packet sizes and MTU (Maximum Transmission Unit) sizes.

See Figure 21 for an overview of the encapsulation process.

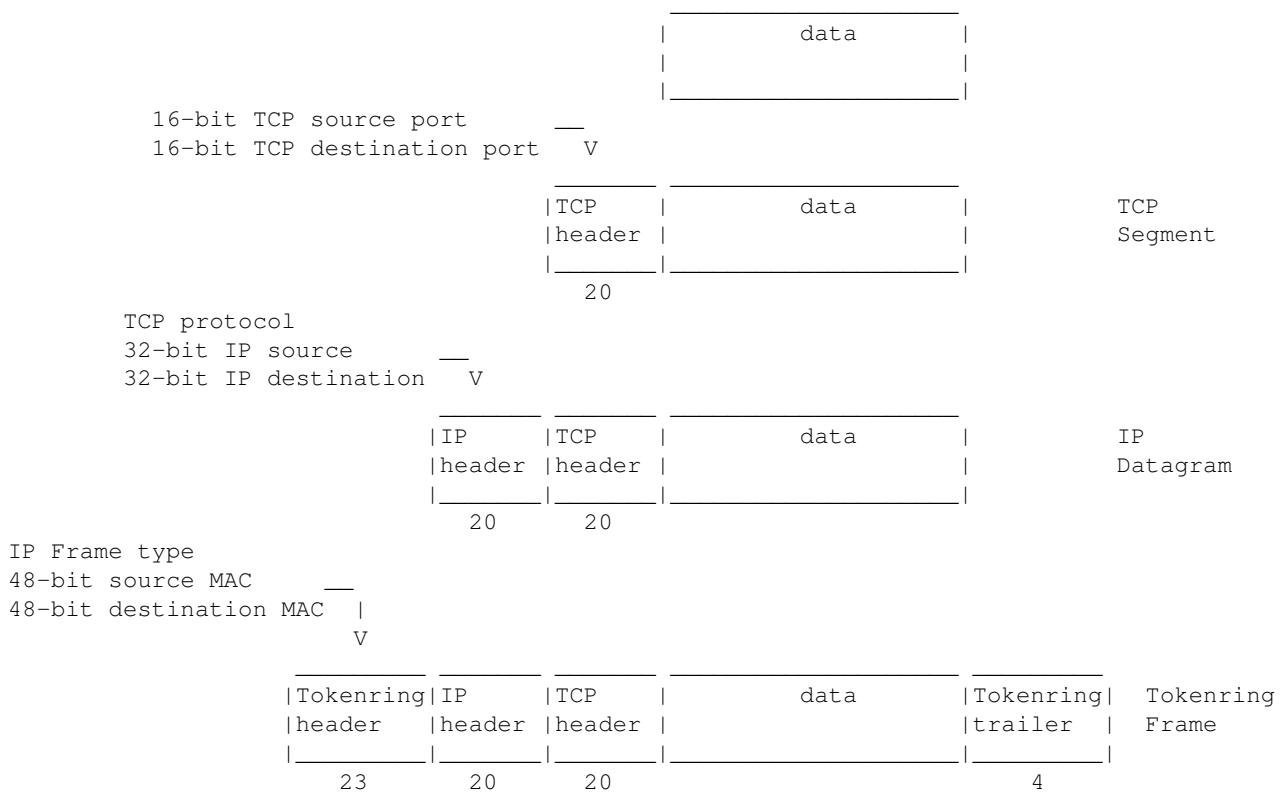


Figure 21. TCP/IP Encapsulation

The MTU size dictates the maximum size of an IP datagram that can be transmitted over a given interface, given the physical characteristics of that interface.

See Table 3 for an overview of typical MTU sizes.

Network Interface	**MTU size in bytes**

16 Mbps Token-Ring	17914
4 Mbps Token-Ring	4464
FDDI	4352
Ethernet	1492
IEEE 802.3	1500
X.25	576
Serial point-to-point	296

Table 3. Network Interface and Typical MTU Values

If the size of an IP datagram exceeds the MTU value of your network interface, the IP layer will fragment the IP datagram and transmit the TCP segment as a number of IP datagram fragments.

From a performance point of view, it is normally advisable to prevent fragmentation. The TCP protocol works with a unit that is called a TCP segment. When a TCP segment is passed to the IP layer, a 20-byte IP header is added to the TCP segment to form an IP datagram. The size of a TCP segment is determined by the two TCP protocol layers that are involved in setting up a TCP connection.

Your application program cannot influence the decision made by TCP in determining the segment size. Your application passes a stream of bytes to the TCP layer. It is up to the TCP layer to chop your data up into TCP segments and send these segments over the IP network. The receiving TCP layer assembles the TCP segments into the right order and passes them to your application as a stream of bytes without any apparent boundaries.

If you use UDP protocols instead of TCP, your data is placed into a UDP datagram preceded with an 8 byte UDP header. If you pass 8192 bytes of data to the UDP layer, a UDP datagram of 8200 bytes is handed over to the IP layer. Sending that size UDP datagrams will almost always result in IP datagram fragmentation. Many UDP applications restrict themselves to sending UDP datagrams that do not exceed 512 bytes in order to reduce the risk of fragmentation.

3.6 Addressing Families

Until now we have more or less let you believe that socket programming only was used with TCP/IP transport protocols; but that is not the full truth.

The socket programming interface is not limited to TCP/IP. Sockets can also be used for interprocess communication within a computer without any network involvement or between computers using network protocols other than TCP/IP. Generally speaking, sockets can be used for interprocess communication using a whole range of protocol suites.

A socket is the endpoint of a communication path; it identifies the address of a specific process at a specific computer using a specific transport protocol. The exact syntax of a socket address depends on the protocol being used; on its *addressing family*. When you obtain a socket

via the **socket** system call, you pass a parameter that tells the socket library to which addressing family the socket should belong. All socket addresses within one addressing family use the same syntax to identify sockets; in other words, they belong to the same family.

In an MVS environment, you are able to use the following addressing families:

Family	**Description**
AF_INET	Addressing family Internet - also referred to as the Internet domain.

This addressing family is used within the TCP/IP domain to identify sockets on IP hosts. A socket address in AF_INET consists of the following:

Family	Half-word binary with a value of 2, which identifies the socket address as belonging to the AF_INET addressing family.
Port	Half-word binary with port number (see "Ports" in topic 3.2.2) that identifies the process.
IP address	Full-word binary with IP address of IP host in network byte order format.
Reserved	8 reserved bytes.

The following is an example of an AF_INET address that represents the telnet server (port number 23) on an IP host with the IP address of 9.24.104.74:

```
AF_INET 23 9.24.104.74
```

AF_IUCV Addressing family IUCV (Inter User Communication Vehicle).

This addressing family is unique to IBM TCP/IP for MVS and is only used within MVS. It can be used in C programs to implement a form of interprocess communication between processes in the same MVS system, or what is also termed as local sockets. You can use AF_INET for the same purpose, but AF_IUCV has some performance advantages over AF_INET, as AF_IUCV communication takes place directly between two MVS address spaces without involving the TCP/IP address space. In a UNIX or in an OpenEdition/MVS environment, you would use the AF_UNIX addressing family for the same purpose. The syntax of an AF_IUCV address is as the following:

Family	Half-word binary with a value of 17, which identifies the socket address as belonging to the AF_IUCV addressing family.
Port	Half-word binary. Reserved for future use. Must be set to zero.
Address	Full-word binary. Reserved for future use. Must be set to zero.
Node ID	8 characters. Reserved for future use. Must be set to space.

User ID 8 characters set to the address space name of the application that binds the socket to a specific process.

Name 8 characters set to a name by which the process wants to be known to other processes within the AF_IUCV addressing family.

The following is an example of an IUCV address of a program called TESTPGM in the TESTAS MVS address space:

AF_IUCV 0 0 <space> TESTAS TESTPGM

AF_UNIX Addressing family UNIX - also referred to as the UNIX domain.

This addressing family is not, as the name might suggest, restricted to UNIX environments. It just has its roots in the UNIX environment where it can be used for socket based interprocess communication between processes within one UNIX operating system. IBM TCP/IP for MVS does not support AF_UNIX sockets. You can use AF_UNIX with OpenEdition/MVS sockets, where this addressing family is used for interprocess communication between OpenEdition/MVS processes within one MVS operating system. The syntax of an AF_UNIX address is as the following:

Family Half-word binary with a value of 1, which identifies the socket address as belonging to the AF_UNIX addressing family

Path 108 characters holding a pathname (similar to a hierarchical file system path name) by which this local process wants to be known by other local processes.

The following is an example of an address in the AF_UNIX addressing family:

AF_UNIX /u/xyz/testsrv

Other addressing families exist, and new families may be added in the future; but these three are the families you will meet in an MVS environment today. The two most important are the AF_INET and the AF_UNIX addressing families.

See Table 4 for an overview of which addressing families are supported by which socket library in MVS.

In the coming chapters, we will restrict our discussion to mostly TCP/IP sockets, which are sockets that belong to the AF_INET addressing family.

Table 4. Addressing Families and Programming Interfaces

	Network sockets	**Local so**
Socket Library Support	**AF_INET**	**AF_UNIX**
Open/MVS with integrated socket support (1)	**X**	**X**

C with IBM TCP/IP for MVS socket support (2)	**X**		
IBM TCP/IP for MVS Sockets Extended assembler macro	**X**		
IBM TCP/IP for MVS Sockets Extended call interface	**X**		
IBM TCP/IP for MVS REXX socket support(3)	**X**		
IBM TCP/IP for MVS assembler IUCV macro interface	**X**		
IBM TCP/IP for MVS Pascal socket interface	**X**		
C with AnyNet/MVS socket support (5)	**X**		

Note:

1. Integrated socket support requires AD/Cycle C/370 V1R2, AD/Cycle LE/370 V1R3 and OpenEdition/MVS 5.1.

2. The socket support in terms of C header files and runtime support is provided with IBM TCP/IP fo

3. The REXX socket support as it is provided with IBM TCP/IP for MVS.

4. If you have a profound knowledge of the IUCV assembler macro interface, the AF_IUCV form of inte communication is supported with the IUCV macro interface.

5. Currently AnyNet/MVS sockets cannot be used concurrently from a program that also uses IBM TCP/I sockets, because the program is statically linked with either the AnyNet/MVS socket library or t for MVS socket library.

3.6.1 Integrated Sockets

3.6.1 Integrated Sockets

Integrated sockets is a concept introduced with OpenEdition/MVS in MVS/ESA SP 5.1, and it deserves some explanation in this context.

An OpenEdition/MVS application uses the same system calls, for example, to read and write data to and from local sockets and to and from files in the OpenEdition/MVS hierarchical file system. In an OpenEdition/MVS application a descriptor that is used in, for example, a **read** system call may either be a socket descriptor or a file descriptor. Descriptor four is, for example, a socket descriptor representing an AF_UNIX socket, and descriptor five might be a file descriptor used to read data from a file in the hierarchical file system. On, for example, a **read** system call an OpenEdition/MVS application will pass a descriptor. If the descriptor represents a socket, data will be read from the socket. If it represents a file, data will be read from the file.

In the MVS/ESA 4.3 OpenEdition/MVS implementation, descriptors had to be managed by different environments. The OpenEdition/MVS environment for file descriptors and local socket descriptors and the TCP/IP or AnyNet/MVS environment for network socket descriptors. This gave problems in the assignment and management of descriptor numbers across the involved environments and made it practically impossible to use both OpenEdition/MVS services and TCP/IP services from the same application program.

In the MVS/ESA SP 5.1 OpenEdition/MVS implementation, integrated socket support was introduced. This support creates an OpenEdition/MVS socket

environment that supports both file descriptors, local sockets, and network sockets concurrently in the same OpenEdition/MVS program.

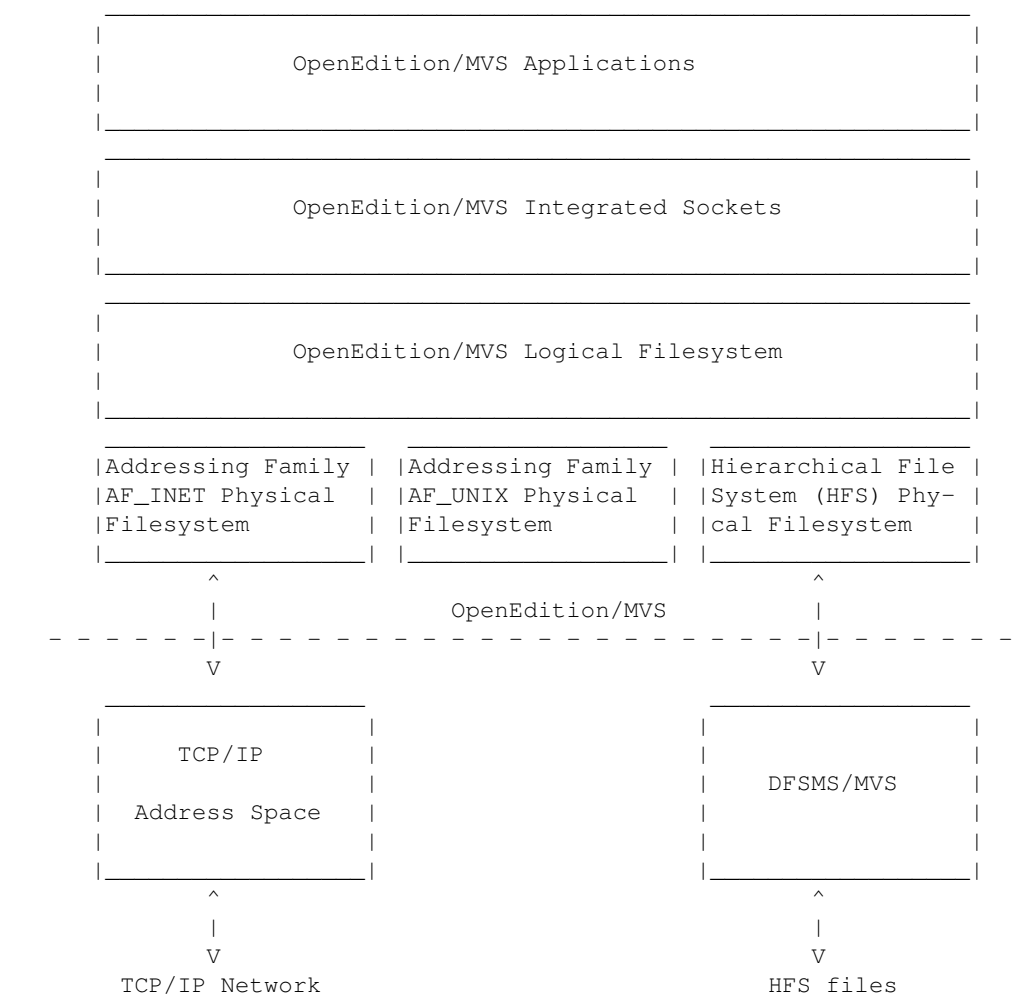


Figure 22. Integrated Sockets in OpenEdition/MVS

OpenEdition/MVS integrated sockets handles the following:

- Descriptor assignment and management
- Socket inheritance when an OpenEdition/MVS application uses the **fork** system call
- Select processing with a mix of socket, pipes and file descriptors

IBM TCP/IP for MVS handles the following:

- Management of TCP/IP protocols and the physical network connectivity
- Name translation by means of the Domain Name System
- TCP/IP applications like FTP, TELNET, etc.

In an OpenEdition/MVS system, you have a number of C-socket libraries you can choose among. See Figure 23 for an overview of some of your options in an MVS/ESA SP 5.1 OpenEdition/MVS system.

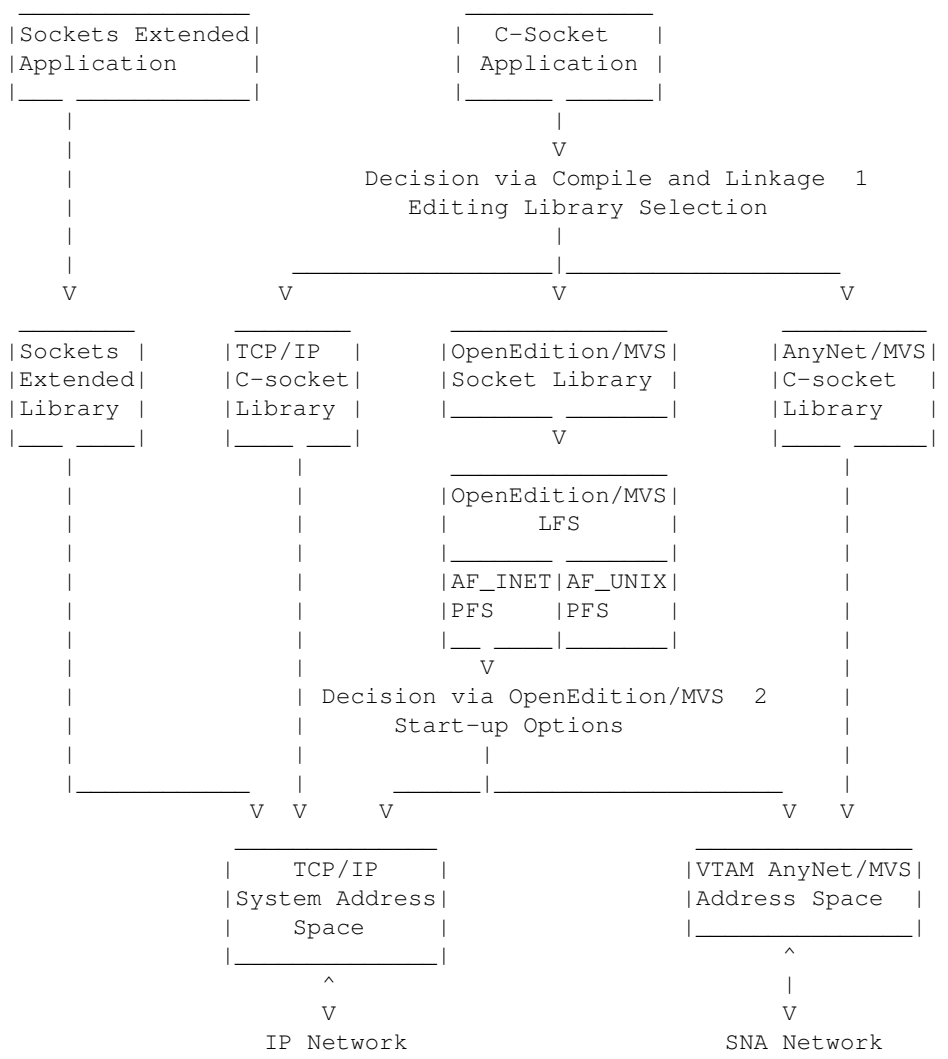


Figure 23. Socket Libraries in an OpenEdition/MVS Environment

1 The choice between TCP/IP C-sockets, OpenEdition/MVS sockets or AnyNet/MVS sockets is made when you compile and link edit your C-socket program. This is a static choice. If you want to use the same source program with both AnyNet/MVS and TCP/IP, you must compile and link it into two separate load modules.

2 If you choose OpenEdition/MVS sockets for your compile and link job, you are able to use the same program with both TCP/IP and AnyNet/MVS as AF_INET provider, but not concurrently. The choice here is made when the OpenEdition/MVS kernel address space is started. In the OpenEdition/MVS start-up parameters, you specify if the AF_INET provider is TCP/IP or AnyNet/MVS, and that is in effect for all AF_INET communication from all OpenEdition/MVS socket programs until you restart the OpenEdition/MVS kernel address space. This description applies to OpenEdition/MVS as it is implemented in MVS/ESA SP 5.1. The support for AnyNet/MVS as OpenEdition/MVS AF_INET transport provider was added with PTF UW17057.

In the MVS/ESA SP 5.2.2 OpenEdition/MVS environment you will be able to use *converged sockets*. Converged sockets enable an OpenEdition/MVS socket program to use both TCP/IP and AnyNet/MVS concurrently as AF_INET transport provider. This support will, for example, enable an OpenEdition/MVS socket program to listen for TCP connections from both TCP/IP and AnyNet/MVS concurrently and to use a **select** call with a mix of file descriptors, local socket descriptors, TCP/IP network socket descriptors and AnyNet/MVS network socket descriptors.

3.7 General Socket Program Structure

The terms *client* and *server* are very common words within the TCP/IP community. More definitions of these terms exist. Often specific machines in a network are called servers. In this context, we talk about roles of communicating programs and more specifically about the distribution aspects of a cooperative application as discussed in Chapter 1, "Cooperative Applications" in topic 1.0.

In a TCP/IP context, the terms are defined as follows:

Server A process that identifies itself to the network providing one or more specific services to clients. A server process responds to client requests.

Client A process that initiates a request for some service from a server.

The client/server distribution model indicates a master/slave role; the client is the master requesting some service from the server (acting as the slave) that obediently responds to the requests from the client.

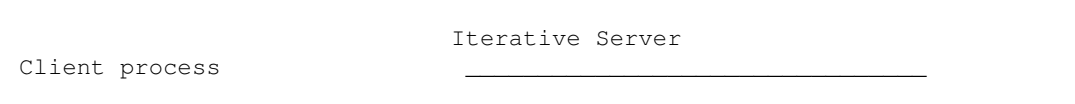
The model also implies a one-to-many relationship; a server typically serves multiple clients while a client deals with a single server.

No matter which of the socket programming interfaces you select, the functions you use will be the same. The syntax may vary, but the underlying concept is the same.

While clients communicate with one server at a time, servers may serve multiple clients. Consequently, when you design a server program, you may feel a need for multiple concurrent processes. Special socket calls are available for that purpose of *concurrent servers*, as opposed to the more simple type of *iterative servers.*

3.7.1 Iterative Server

An *iterative server* processes requests from clients in a serial manner; one connection is served and responded to before the server accepts a new client connection.



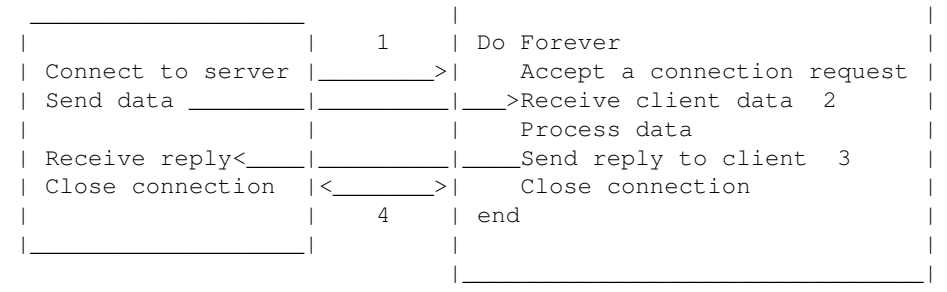


Figure 24. Iterative Server Main Logic

The iterative server waits for connection requests from the IP network.

1 When a connection request arrives, it accepts the connection, and 2 receives the client data.

The iterative server processes the received data and does whatever has to be done before it builds a reply, which is sent back to the client 3 .

4 The iterative server closes the socket and waits again for the next connection request from the network.

An iterative server may be implemented in more ways in MVS as follows:

As a batch job or MVS started task that is started manually or by automation software. The job will stay active until it is closed down by some operator intervention.

As a TSO transaction. You may start your iterative server as a TSO transaction. For a production implementation, we recommend you do so by submitting a job that executes a batch Terminal Monitor Program (TMP).

As a long-running CICS task. The task will normally be started during CICS start-up, but it may also be started by an authorized CICS operator that types in the appropriate CICS transaction code.

As a Batch Message Program (BMP) in IMS.

From a socket programming perspective there is no difference between an iterative server that runs in a native MVS environment (batch job, started task or TSO) and one that runs as a CICS task or BMP under IMS.

A general concern for iterative servers is how to terminate the server process. For iterative servers, that execute in traditional MVS address spaces (batch job, started task, TSO, IMS BMP), you may implement functions in the server that enables an operator to use the MVS modify command to signal the iterative server to stop: **F SERVER,STOP.** This technique cannot be used for CICS tasks. Another solution to this problem is to include a shutdown message in the application protocol. By doing so, you can develop a shutdown client program that connects to the server and sends a shutdown message. When the server receives such a shutdown message from a socket client, it terminates itself.

3.7.2 **Concurrent Server**

A *concurrent server* accepts a client connection, delegates the connection to a child process of some kind, and immediately signals its willingness to receive the next client connection.

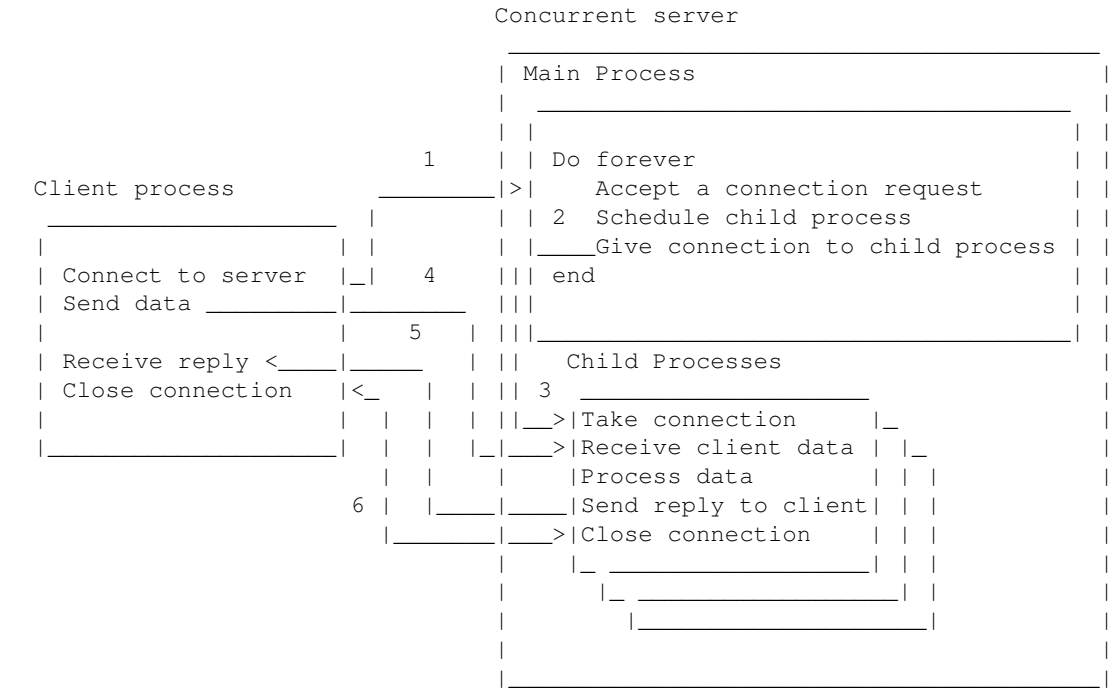


Figure 25. Concurrent Server Main Logic

1 When a connection request arrives in the main process of a concurrent server, it will schedule a child process and forward the connection 2 to the child process.

3 The child process takes the connection, which is given to it by the main process.

4 The child process receives the client request, processes it and sends back a reply 5 to the client.

6 The connection is closed, and the child process either terminates or signals to the main process that it is available for a new connection.

You may implement a concurrent server in the following MVS environments:

Implement it in the native MVS environment (batch job, started task or TSO). In this environment you implement concurrency by using the traditional MVS subtasking facilities. These facilities are available from assembler language programs or from high-level languages that support multi-tasking or multi-threading, such as C/370.

Implement it in a CICS environment, where the concurrent main process is started as a long-running CICS task that accepts connection requests from clients and initiates child processes via the **EXEC CICS START** command. CICS sockets includes a generic concurrent server main program called the CICS LISTENER.

Implement it in an IMS environment, where the concurrent main process is started as a BMP that accepts connection requests from clients and initiates child processes via the IMS message switch facilities. The child processes execute as IMS Message Processing Programs (MPP). IMS sockets include a generic concurrent server main program called the IMS LISTENER.

In both the iterative server and the concurrent server scenarios above, the client and server process could have exchanged a series of request/reply sequences before they decided to close down the connection. For the sake of simplicity, only a single interaction is shown in these diagrams.

3.7.3 Socket Program Categories

To distinguish between these generic program types, we will use the following terminology in the rest of this book:

Client programs for a socket program that acts as a client.

Iterative server programs for a socket program that acts as a server and that processes one client request fully before accepting a new client request.

Concurrent server main programs for that part of a concurrent server that manages child processes, accepts client connections and schedules client connections to child processes.

Concurrent server child programs for that part of a concurrent server that processes the client requests.

The term *process* is used for an instance of a program. In a concurrent server, the child program may be active in many parallel child processes, each processing a client request.

In an MVS environment, a process is either an MVS task, a CICS transaction, or an IMS transaction.

4.0 Chapter 4. The IBM TCP/IP for MVS Socket APIs

This chapter introduces each of the IBM TCP/IP for MVS socket APIs and gives specific usage guidelines for each API.

4.1 API Relationship

Figure 26 shows how the different socket APIs are related to each other and to the TCP/IP protocol layers.

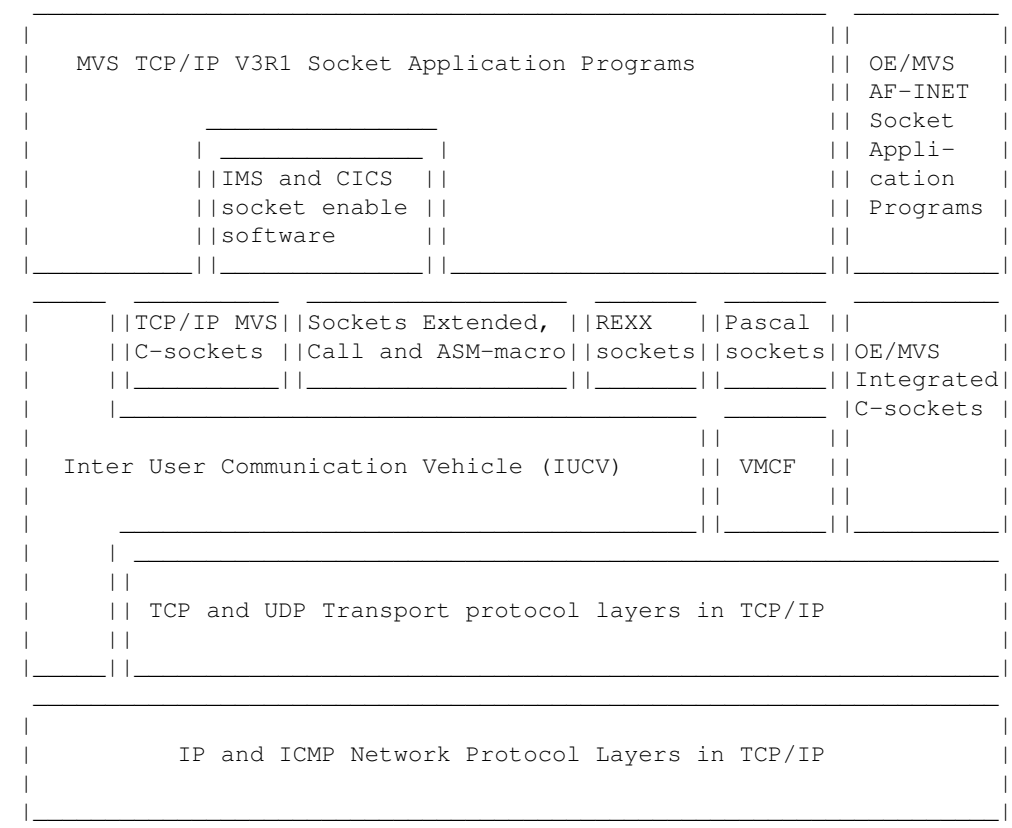


Figure 26. Socket API Relationship to TCP/IP Protocol Layers

See Table 5 for an overview of the socket functions that are available in the most commonly used TCP/IP socket programming interfaces.

Table 5. Functional Comparison of the TCP/IP Socket APIs

C-sockets(1)	**Sockets Extended(2)**	**CICS C-sockets**	**CICS EZACICAL sockets(3)**	**REXX**
accept	ACCEPT	accept	ACCEPT	acce
bind	BIND	bind	BIND	bind
close	CLOSE	close	CLOSE	clos
connect	CONNECT	connect	CONNECT	conn
endhostent				
endnetent				
endprotoent				

endservent				
fcntl	FCNTL	fcntl	FCNTL	fcnt
getclientid	GETCLIENTID	getclientid	GETCLIENTID	getc
				getc
getdtablesize				
gethostbyaddress	GETHOSTBYADDR			geth
gethostbyname	GETHOSTBYNAME			geth
gethostent				
gethostid	GETHOSTID	gethostid	GETHOSTID	geth
gethostname	GETHOSTNAME	gethostname	GETHOSTNAME	geth
getibmsockopt				
getnetbyaddr				
getnetbyname				
getnetent				
getpeername	GETPEERNAME	getpeername	GETPEERNAME	getp
getprotobyname				getp
getprotobynumber				getp
getprotoent				
getservbyname				gets
getservbyport				gets
getservent				
getsockname	GETSOCKNAME	getsockname	GETSOCKNAME	gets
getsockopt	GETSOCKOPT	getsockopt	GETSOCKOPT	gets
givesocket	GIVESOCKET	givesocket	GIVESOCKET	give
htonl				
htons				
ibmflush				
inet_addr				
inet_lnaof				
inet_makeaddr				
inet_netof				

inet_network				
inet_ntoa				
	INITAPI	initapi	INITAPI	init
ioctl	IOCTL	ioctl	IOCTL	ioct
listen	LISTEN	listen	LISTEN	list
maxdesc				
ntohl				
ntohs				
read	READ		READ	read
readv				
recv	RECV	recv		recv
recvfrom	RECVFROM	recvfrom	RECVFROM	recv
recvmsg				
				resc
select	SELECT	select	SELECT	sele
selectex				
send	SEND	send	SEND	send
sendmsg				
sendto	SENDTO	sendto	SENDTO	send
sethostent				
setibmsockopt				
setnetent				
setprotoent				
setservent				
setsockopt	SETSOCKOPT	setsockopt	SETSOCKOPT	sets
shutdown	SHUTDOWN	shutdown	SHUTDOWN	shut
sock_debug				
sock_debug_bulk_perf0				
sock_do_bulkmode				
sock_do_teststor				
socket	SOCKET	socket	SOCKET	sock

				sock
				sock
				sock
takesocket	TAKESOCKET	takesocket	TAKESOCKET	take
tcperror				
	TERMAPI			term
				vers
write	WRITE	write	WRITE	writ
writev				

Notes:

1. C-sockets as they can be used in the native MVS environment and in the IMS environment.

2. Sockets Extended including call interface and assembler macro interface. Call interface may be environments including CICS and IMS, while assembler macro interface can be used in normal MVS a (Batch, TSO or started task).

3. The C-socket function that can be used in the CICS environment.

4.2 IBM TCP/IP for MVS C-Sockets

The Berkeley socket programming interface is a C-based interface. To use it, you must develop your programs in the C programming language.

The interface is, to a large extent, compatible with the C socket interfaces available on many other system platforms. Like on most system platforms, you should observe some precautions if you port C-socket applications to MVS:

You must include an additional header file (*tcperrno.h*) if you want to reference all possible networking errors.

You should use the *tcperror* routine to print networking error messages. On other platforms, you would use the **perror** call instead of the **tcperror** call.

You must include the *manifest.h* header file, which is used to remap the socket function long names to 8-character names supported by MVS.

The functions *ioctl, getsockopt, setsockopt and fnctl* do not support all the BSD specified options.

The additional addressing family AF_IUCV is supported in C sockets. AF_IUCV allows MVS address spaces on the same host to communicate with each other using IUCV.

IBM TCP/IP for MVS C sockets use a number of socket calls that are specific to the IBM TCP/IP for MVS environment, for example, **givesocket**, **takesocket** and **setibmsockopt**.

For details please refer to *IBM TCP/IP for MVS: Programmer's Reference*, SC31-7135.

You are able to use the C/370 multitasking facilities to create C based multitasking concurrent server applications.

We created and tested small C socket applications using the IBM C/370 Compiler Version 2 Release 1 (5688-187).

IBM TCP/IP for MVS C socket programs may be developed for both the CICS and IMS environment. Please note that not all C-socket functions are available in the CICS C-socket implementation.

The C header files are distributed in the *tcpip.v3r1*.SEZACMAC library, which you must concatenate to your C compiler SYSLIB DD statement. The runtime library routines are distributed in the *tcpip.v3r1*.SEZACMTX library, which you must concatenate to your MVS Binder SYSLIB DD statement.

See "C/370 Compile JCL Procedure" in topic I.3 for a sample C compile procedure and "Link/Edit JCL Procedure" in topic I.4 for a sample MVS binder procedure.

4.3 Sockets Extended Call Interface

The Sockets Extended call interface supports all the basic socket functions, but it does not support all the extra data conversion or IP address manipulation functions you find in the C-sockets implementation.

Some of the extra functions are implemented in a set of EZACICxx routines; they are as follows:

EZACIC04 Translate a character string from EBCDIC to ASCII.

EZACIC05 Translate a character string from ASCII to EBCDIC.

EZACIC06 Translate between a character array and a bit string. You can use this routine, for example, in a COBOL program to manipulate bit strings in a select mask.

EZACIC08 Parse the contents of a host entry structure returned by a **gethostbyname** or **gethostbyaddr** call.

All the Sockets Extended calls use a return code parameter (RETCODE) to pass back a return code from the function you called. Most of the calls, in addition to the return code parameter, also use an error number parameter (ERRNO), which is used to pass back the specific error code that applies to the error situation that was the result of the call. If the return code parameter has been set to a negative value, the error number parameter holds the specific error code, which corresponds to the value returned to a C program on a **tcperror** function call.

It is good programming practice to include logic after each call, which tests the return code and, in case it is negative, formats an error message based on the value passed back in the error number parameter. During initial development and testing of a socket program, such a practice will prove to be very valuable.

When you call the Sockets Extended interface, you always pass a string of 16 characters as the first parameter holding the function code you want to use. We recommend you define these function code strings once and put them into a copy structure or include member.

```
*-----------------------------------------------------------------*
* Socket interface function codes                                 *
*-----------------------------------------------------------------*
 01  soket-functions.
     02 soket-accept          pic x(16) value 'ACCEPT          '.
     02 soket-bind            pic x(16) value 'BIND            '.
     02 soket-close           pic x(16) value 'CLOSE           '.
     02 soket-connect         pic x(16) value 'CONNECT         '.
     02 soket-fcntl           pic x(16) value 'FCNTL           '.
     02 soket-getclientid     pic x(16) value 'GETCLIENTID     '.
     02 soket-gethostbyaddr   pic x(16) value 'GETHOSTBYADDR   '.
     02 soket-gethostbyname   pic x(16) value 'GETHOSTBYNAME   '.
     02 soket-gethostid       pic x(16) value 'GETHOSTID       '.
     02 soket-gethostname     pic x(16) value 'GETHOSTNAME     '.
     02 soket-getpeername     pic x(16) value 'GETPEERNAME     '.
     02 soket-getsockname     pic x(16) value 'GETSOCKNAME     '.
     02 soket-getsockopt      pic x(16) value 'GETSOCKOPT      '.
     02 soket-givesocket      pic x(16) value 'GIVESOCKET      '.
     02 soket-initapi         pic x(16) value 'INITAPI         '.
     02 soket-ioctl           pic x(16) value 'IOCTL           '.
     02 soket-listen          pic x(16) value 'LISTEN          '.
     02 soket-read            pic x(16) value 'READ            '.
     02 soket-recv            pic x(16) value 'RECV            '.
     02 soket-recvfrom        pic x(16) value 'RECVFROM        '.
     02 soket-select          pic x(16) value 'SELECT          '.
     02 soket-send            pic x(16) value 'SEND            '.
     02 soket-sendto          pic x(16) value 'SENDTO          '.
     02 soket-setsockopt      pic x(16) value 'SETSOCKOPT      '.
     02 soket-shutdown        pic x(16) value 'SHUTDOWN        '.
     02 soket-socket          pic x(16) value 'SOCKET          '.
     02 soket-takesocket      pic x(16) value 'TAKESOCKET      '.
     02 soket-termapi         pic x(16) value 'TERMAPI         '.
     02 soket-write           pic x(16) value 'WRITE           '.
```

The function code must be in uppercase.

The Sockets Extended call interface does not support MVS multitasking, which means you can not use it to develop concurrent servers that are implemented in a single MVS address space. Concurrent server implementations based on the IMS or the CICS listener, where your Sockets Extended call-based program is the child process, started either in an IMS Message Processing Region (MPR) or as a started transaction in CICS, is fully supported.

When you bind your program with the MVS binder, you must concatenate the *tcpip.v3r1*.SEZATCP library to your SYSLIB DD statement.

```
//SYSLIB   DD  DSN=.....
//         DD  DSN=TCPIP.V3R1.SEZATCP,DISP=SHR
//         DD  DSN=.....
```

See "COBOL Compile JCL Procedure" in topic I.2 for a sample COBOL compile procedure and "Link/Edit JCL Procedure" in topic I.4 for a sample MVS binder procedure.

4.3.1 PL/I Programs

4.3.1 PL/I Programs

If you use the IBM PL/I Optimizing Compiler Version 2 (5668-910), you have to declare the Sockets Extended interface routine with:

```
DCL EZASOKET ENTRY OPTIONS(RETCODE,ASM,INTER) EXT;
```

This causes the compiler to print the following warning message:

```
IEL0983I EXTERNAL NAME 'EZASOKET' EXCEEDS 7 CHARACTERS.
EXECUTION IS UNDEFINED IF 'EZASOKET' IS THE SAME AS A COMPILER GENERATED
NAME.
```

We did not experience any difficulties by ignoring this message.

When you use the new AD/CYCLE PLI compiler (5688-235) you may code:

```
DCL MYSOKET ENTRY OPTIONS(RETCODE,ASM,INTER) EXT('EZASOKET');
```

which also requires all other references to EZASOKET in the program to be replaced by references to MYSOKET. In this case you do not get a warning message. Effectively, however, the situation is not fundamentally different from the situation with PL/I Version 2.

If one is really in doubt, the interface routine may be re-link-edited under a different name:

```
//jobname JOB  .............
//LKED    EXEC LKED
//SYSLMOD  DD  DISP=SHR,DSN=load module library - for PL/I link-edit
//TCPLIB   DD  DISP=SHR,DSN=hlq.SEZATCP
//SYSIN    DD  *
 CHANGE EZASOKET(MYSOKET)
 INCLUDE TCPLIB(EZASOKET)
 ENTRY MYSOKET
 NAME MYSOKET(R)
```

4.3.2 User Abend 4093

When you test Sockets Extended programs, you may encounter user abend code 4093.

This does not indicate a system problem, but it signals a syntax error in the parameters passed to the EZASOKET call, such as a wrong number of parameters or an invalid function code.

4.4 Sockets Extended Assembler Macro Interface

The socket functions available in the Sockets Extended macro-based interface are similar to those you find in the call-based interface.

You do have some extra facilities in the macro-based interface, which are mainly the following:

1. Support for multitasking environments

2. Support for asynchronous socket calls

3. Support for API type three (APITYPE-3) programs

From your macro-based assembler socket programs you can use the same EZACICxx routines as we mentioned earlier (see "Sockets Extended Call Interface" in topic 4.3), or you can implement similar functions in your assembler language environment.

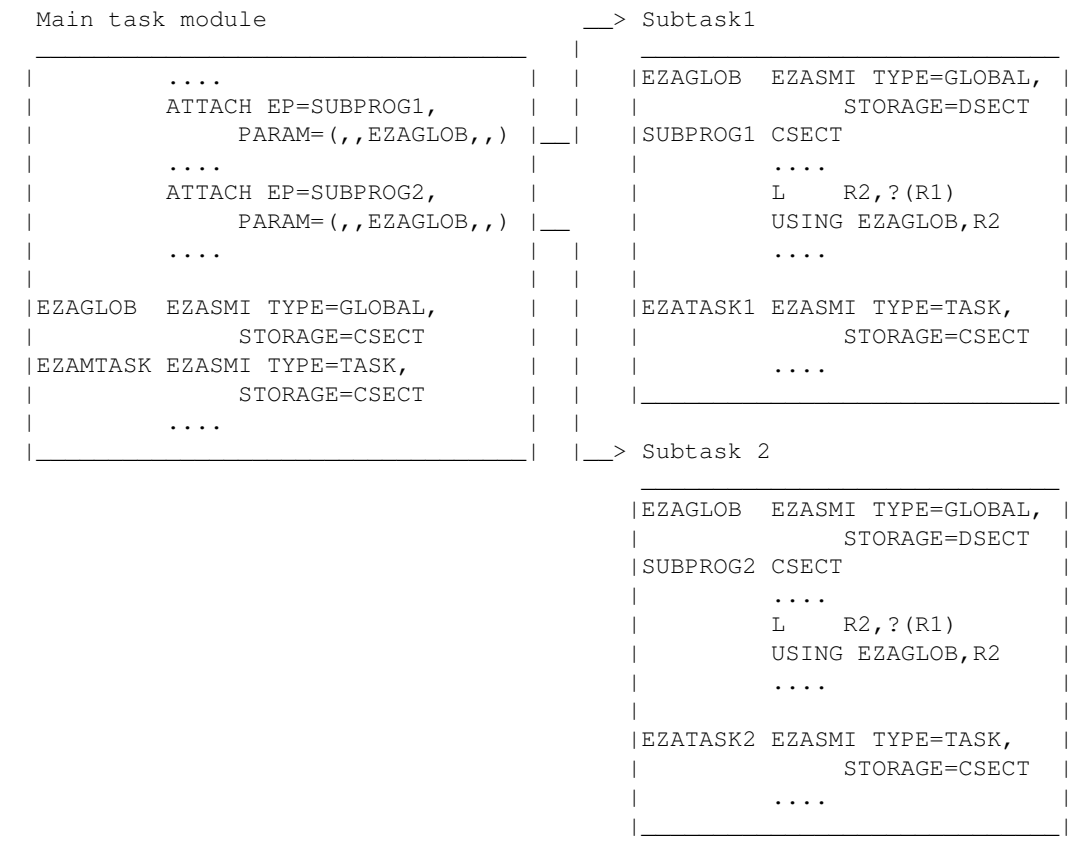


Figure 27. Sockets Extended Macro Interface Storage Areas

When you use the Sockets Extended macro interface you must provide the following couple of storage areas that are used by the socket macros:

1. A global storage area

   This storage area must exist once for an address space. The storage area can be allocated by the single task of your single-tasking application or the main task of your multitasking application.

   The storage area must be accessible from all program modules that issue socket macro calls inside your address space. The module that allocates this storage area must pass a pointer to the area to all modules inside the address space that uses socket calls.

2. A task storage area

If you develop a single-tasking socket application, you allocate one task storage area.

If you develop a multitasking socket application, you must allocate one task storage area per task.

The task storage area must be accessible from all program modules that issue socket calls in a task.

In the example illustrated in Figure 27, you will find the following four Sockets Extended storage areas:

1. The global storage area (EZAGLOB), which is allocated in the main task. A pointer to the global storage area is passed to each subtask in the **PARAM** keyword on the **ATTACH** macro call. Each of the subtasks establishes a DSECT for the global work area and sets up a base register for it.
2. The task storage area for the main task (EZAMTASK), which is only accessible to the main task.
3. The task storage area for subtask 1 (EZATASK1), which is only accessible to subtask 1.
4. The task storage area for subtask 2 (EZATASK2), which is only accessible to subtask 2.

If you use the asynchronous option on the socket macro calls by means of the **ECB=** keyword, you must remember to issue a socket **sync** macro call after the ECB associated with the asynchronous call has been posted. Returned information from the asynchronous socket call is not placed into your program variables until you issue the **sync** macro call. Please note that the **ECB=** keyword must point to an Event Control Block (ECB) followed by a 100 byte work area, which the socket macro interface will use to store temporary status information in.

When you assemble your Sockets Extended macro programs, you must include the *tcpip.v3r1*.SEZACMAC library in your assembler SYSLIB concatenation. See "Assemble JCL Procedure" in topic I.1 for a sample assemble procedure.

When you bind your program with the MVS Binder, you must include the *tcpip.v3r1*.SEZATCP library in your binder SYSLIB concatenation. See "Link/Edit JCL Procedure" in topic I.4 for a sample MVS binder procedure.

4.5 REXX Sockets

The REXX language is well suited for the development of prototypes. As REXX is an interpreted language, no time is lost by compilations. This is very useful if you want to test a number of alternatives; once you have saved a REXX procedure, you can run it. Also, REXX can be used for production applications as long as the performance requirements are within certain limits.

Coding REXX procedures for TCP/IP for MVS is pretty straightforward.

The only requirement for using the REXX socket interface is that you have access to the *tcpip.v3r1*.SEZALINK library. This library will normally be accessible through your system LINKLIST concatenation. If it is not, you will have to concatenate it to your TSO STEPLIB allocation.

Some hints may be helpful:

Before using any other call, you have to identify the TCP/IP system

you are using with an **initialize** call.

In this call you specify the following:

- The jobname of the TCP/IP system address space.

- The name of your so-called *socket set*. This name can be anything as long as it is used consistently within your job.

- Optionally, you can specify the number of sockets you would like to have preallocated, if the default of 40 is not appropriate.

Socketsets can be reused and should eventually be terminated. There is an option to inquire if there are presently any available socket set(s). If you re-initialize a socketset that was not closed, you will get an error.

If you run two REXX socket programs in each session of an ISPF split environment, the two REXX programs must use different socketset names.

All TCP/IP for MVS REXX socket calls are implemented as REXX functions that return a string that contains the return code as the first token. (The standard REXX **rc** return code variable is not used, so a **signal on error** statement does not cause the socket call errors to be caught.)

- If the call completed successfully, the return code is zero and the remainder of the returned string may contain other information, as defined by the called function.

- If the call did not complete successfully, an error message is passed after the return code.

You can handle TCP/IP for MVS REXX return codes as follows:

```
parse value socket(function,other parameters) with rc rest
if rc=0 then parse value rest call related return values ...
        else say 'Error, reason:' rest
```

If you are use to writing REXX procedures on OS/2 and/or VM/CMS but not on MVS, you should be aware that TSO/E requires you to start your procedure explicitly with **/* REXX ...*/.** If you omit the word **REXX**, it will not work.

Please see Appendix E, "Sample REXX Socket Programs" in topic E.0 for a sample REXX server and client program.

4.6 Pascal API

The Pascal programming interface is based on Pascal procedures and functions that implement conceptually the same functions as the C socket interface. The routines have different names though, so in practical terms there is a considerable difference with the C socket calls.

You can use stream sockets, datagram sockets or raw sockets.

If you are a skilled Pascal programmer, you should be able to develop socket programs relatively easily using this Pascal programming interface.

To compile a Pascal program, you need the IBM Pascal compiler and library (5668-767).

The include files you will need are in the *tcpip.v3r1*.SEZACMAC library, which you will have to concatenate to the SYSLIB DD statement of your Pascal compile JCL. The library routines are in the *tcpip.v3r1*.SEZACMTX library, which you will have to concatenate to the SYSLIB DD statement of your linkage editor.

4.7 Inter-User Communication Vehicle (IUCV) Sockets

The IUCV socket programming interface is language independent. It is based on standard linkage calls for transferring data or control to IUCV and on asynchronous exits implemented via IRBs (Interrupt Request Blocks) for receiving data from IUCV. The programming interface is provided as assembler macros.

The IUCV programming interface is only provided with IBM TCP/IP Version 3 Release 1 for MVS for reason of compatibility with IBM TCP/IP Version 2 Release 2 for MVS, and we will not describe it in any further detail in this book.

Recommendation

We will recommend that, wherever it makes sense, you use the Sockets Extended programming interfaces instead of the IUCV interface.

5.0 Chapter 5. Your First Socket Program

In this chapter we will guide you through the development of a simple stream socket program. The program's purpose is to act as an iterative echo server program. An echo server just returns any data it receives to the client.

In this chapter we will explain all the basics of the individual socket calls, the data structures that are used with the socket calls, and the programming techniques associated with some of the more complicated socket calls, and we will discuss some general security aspects of socket programs.

See "Sample Stream Socket COBOL Server" in topic B.1 for the full sample server code, and "Sample Stream Socket COBOL Client" in topic B.2 for a sample client that can be used to test the server.

The description will be fairly elaborate as this is the first time you are facing actual socket programming. In the succeeding chapters, where we look more into the CICS and IMS socket environments, we will not go into the same kind of detail, but rather we will refer back to the examples you find in this chapter. So even if your purpose for reading this book is to develop IMS or CICS socket programs, we recommend you read this chapter before continuing with the IMS and CICS chapters.

The coding examples in this chapter will be in COBOL and based on the Sockets Extended call interface.

5.1 Type Conversion Between Programming Languages

We will not show you the samples in all available programming languages. We have, for the major part of our samples, chosen COBOL because of both its widespread use and readability. Most readers, who are not familiar with COBOL, may be able to read the COBOL samples as pseudo-code. To enable you to convert the variable declarations, we have included a short type-conversion table (please see Table 6).

Generic type	**assembler**	**COBOL**	**PL/I**	**C/37**
4 byte binary integer	*name* DC F'0'	*name* pic S9(8) binary value zero.	dcl *name* fixed(31) binary init(0);	long
2 byte binary integer	*name* DC H'0'	*name* pic S9(4) binary value zero.	dcl *name* fixed(15) binary init(0);	int
String of n bytes	*name* DC CLn'text'	*name* pic X(n) value 'text'.	dcl *name* char(n) init('text');	char
Notes:				
name denotes identifier name				

Table 6. Language Type Definition Conversion

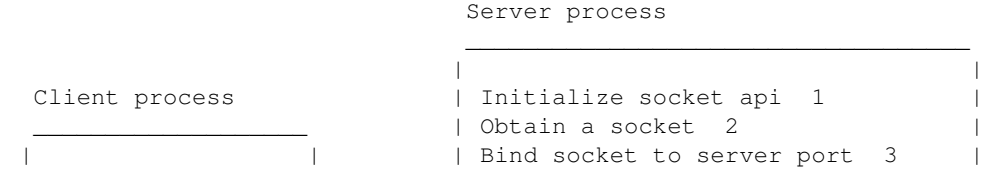
5.2 Iterative Server Program Structure

The reason we start with an iterative server is because it is quite simple to implement, and it allows us to introduce all the major basic socket calls with which you will have to work.

If each connection from a client is of a short duration, you may implement your server as an iterative server.

A typical scenario for an iterative server is that the client and the iterative server exchange a single request/reply sequence per connection.

If the lifetime of a connection is of a longer duration, involving a sequence of request/reply interactions possibly with user think-time involved, you should consider implementing your server as a concurrent server.



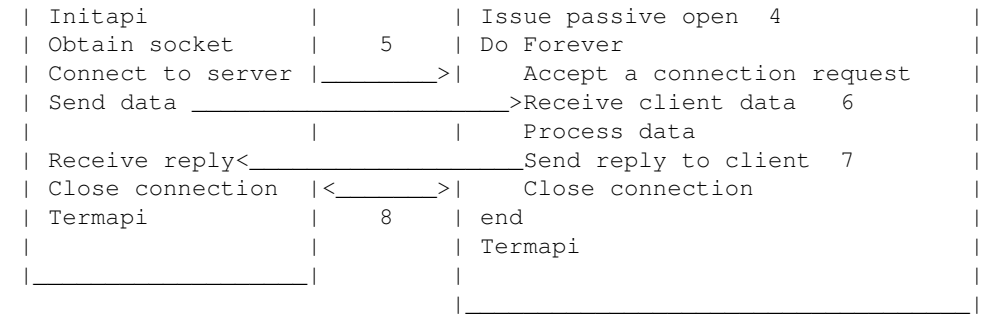


Figure 28. Iterative Server Main Logic

The sequence numbers in the following text are related to the corresponding numbers in Figure 28.

From a socket interface point of view, there is no difference between an iterative server that is implemented as a native MVS program, as a CICS transaction program or an IMS transaction program. The only difference is the way the iterative server program is started.

MVS You can start the server as a batch job, as a started task, as a TSO transaction or as an APPC/MVS transaction.

IMS You can start your iterative server as a Batch Message Program (BMP) or as a long-running Message Processing Program (MPP).

CICS You can start the server as a long-running CICS task.

5.3 Initialize the Socket API

1 in Figure 28 in topic 5.2. For the Sockets Extended programming interface, the first call is an **initapi** call, where you identify your own process to the TCP/IP system address space.

```
*-------------------------------------------------------------*
* Variables used for the INITAPI call                        *
*-------------------------------------------------------------*
 01  soket-initapi                pic x(16) value 'INITAPI        '.
 01  maxsoc                       pic 9(4) Binary Value 50.
 01  initapi-ident.
     05  tcpname                  pic x(8) Value 'T18ATCP'.
     05  myasname                 pic x(8) Value space.
 01  subtask                      pic x(8) Value space.
 01  maxsno                       pic 9(8) Binary Value zero.
 01  errno                        pic 9(8) Binary Value zero.
 01  retcode                      pic s9(8) Binary Value zero.

*-------------------------------------------------------------*
* Initialize socket API                                       *
*-------------------------------------------------------------*
     Call 'EZASOKET' using soket-initapi
        maxsoc
        initapi-ident
        subtask
        maxsno
        errno
        retcode.
```

```
If retcode < 0 then
   - process error -
```

You use the **initapi** call to both establish a communication path between your program and a TCP/IP address space, and identify your program to that TCP/IP address space.

If you have both a test and a production TCP/IP system executing in your MVS environment, you can control which system you are using via the TCPNAME parameter. You must initialize this parameter with the correct address space name of your TCP/IP system address space. The Sockets Extended programming interface does not pick up any default value from the *tcpip.v3r1*.TCPIP.DATA configuration data set.

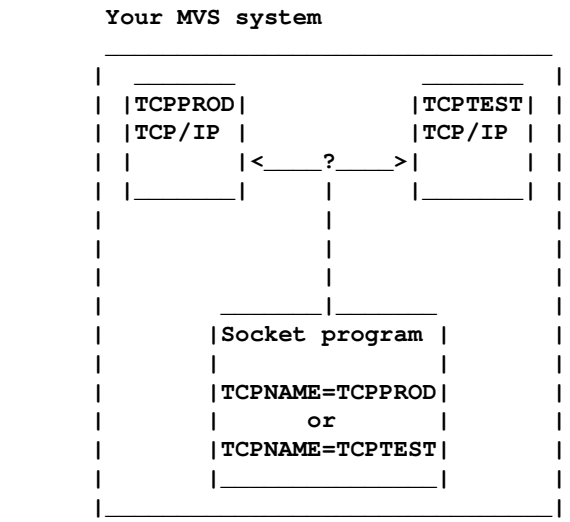


Figure 29. Identifying Your TCP/IP Address Space via TCPNAME

If you receive an error number of 10191 (**IUCV returned an error code**) during **initapi** processing, the most likely reason is that you did not specify a TCPNAME value that matches the name of any currently active TCP/IP system address space.

Ask your MVS TCP/IP systems programmer for the name of the TCP/IP system address space. You may want to implement logic that allows you to pass the name via, for example, either the PARM field on the EXEC JCL statement or a parameter SYSIN file that your program reads before it issues the **initapi** call. If you implement such logic, your operations department is able to change the TCP/IP setup without having to ask you to modify your program.

In order to identify your program, you use the fields MYASNAME and SUBTASK.

Single-threaded

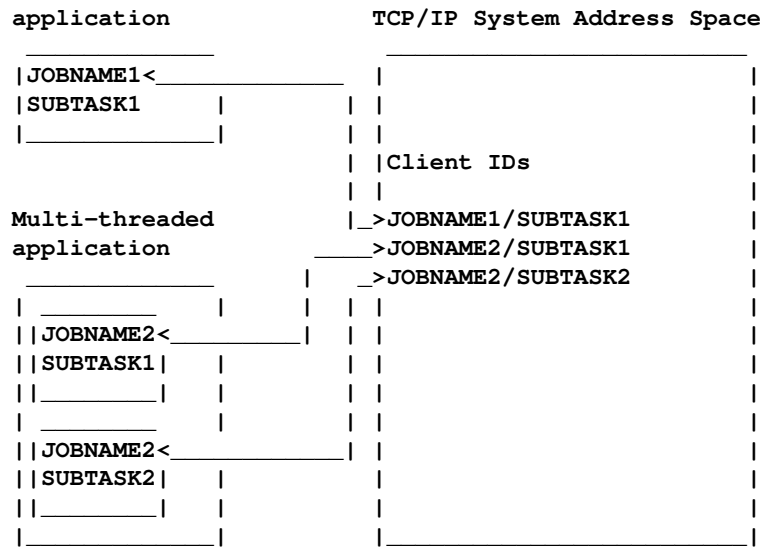


Figure 30. Identifying Your Own Program with a Client ID

You can use any values you find relevant, but the combination of address space name and subtask ID must be different from the values used by any other program that connects to the same TCP/IP system address space.

For a single-threaded program, you can pass MYASNAME and SUBTASK initialized to space (X'40'). The Sockets Extended programming interface will pick up your correct address space name. However, your subtask ID will be 8 blanks. That will work for a single-threaded socket program, like our sample iterative echo server, but it will not work for multi-threaded programs, as each subtask must have a unique subtask ID. See "TPICLNID Obtain Values for TCP/IP Client ID" in topic G.1 for a sample subroutine that will return the current address space name and Task Control Block (TCB) address as two 8-byte character fields that you can use as MYASNAME and SUBTASK from both single-threaded and multi-threaded socket programs in a native MVS environment.

Note: In a CICS environment the subtask ID has a slightly different meaning. In CICS, all programs run under one MVS task control block. This is also the case for a concurrent server implementation. You can, instead of the TCB address, use the internal CICS task number as the source for your subtask ID. In a CICS program, you can find your current CICS task number by picking up the EIBTASKN field in the CICS command level interface block (EIB). Convert the task number to an EBCDIC representation and make that part of your subtask ID. If your current CICS task number is, for example, 129, you can use a subtask ID of **00000129**; or, to identify it uniquely as a CICS task number and not a TCB address, you may prefix or suffix it by a non-hexadecimal character: **0000129T**.

We recommend that you always pass a subtask ID on the **initapi** call in a CICS program. If you have two CICS socket programs that start at the same time and they both use a subtask ID of space, they will both specify the same client ID, as they both execute in the same address space.

MYASNAME and SUBTASK are used to complete a structure that is called the *client ID* structure. The client ID is specific to the IBM TCP/IP for MVS

implementation. It is the identifier by which a process is known to the TCP/IP address space in MVS, hence the term *client ID*, which must be interpreted as the client of the TCP/IP system address space. Do not confuse this client ID with the client/server role of your application programs. From the TCP/IP system address space point of view, every application program in your MVS system that uses TCP/IP facilities is a client of the TCP/IP system address space. This client ID has actually nothing to do with the underlying protocols (TCP, UDP or IP). It is never exchanged over the IP network. The client ID is unique for the IBM TCP/IP for MVS socket interfaces. It is not part of the original BSD specifications.

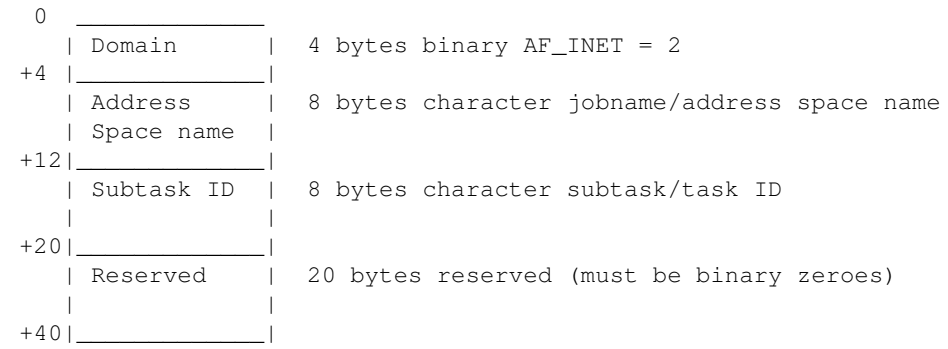


Figure 31. The Client ID Structure

Note: Please observe that the domain field in the client ID structure is a 4-byte field and not a 2-byte field.

The MAXSOC parameter on the **initapi** call is used to reserve storage for the maximum number of sockets this program intends to work with concurrently. The default value is 50 and the maximum in IBM TCP/IP Version 3 Release 1 for MVS is 2000.

The MAXSNO parameter is an output parameter from the **initapi** call. When the call returns to your program, it contains the highest socket descriptor number that can be assigned to your program.

5.3.1 Initializing a C-socket Program
5.3.2 Getclientid

5.3.1 Initializing a C-socket Program

In the C-socket API, you do not have an **initapi** function.

When the C-socket API processes the first valid socket call in a C-program, it performs a function that is equivalent to the **initapi** call. The C-socket API locates the TCP/IP address space to connect to via the *tcpip.v3r1*.TCPIP.DATA configuration data set. You can override the installation default by allocating the TCPIP.DATA data set of a test TCP/IP system to a DD name of SYSTCPD in the address space in which your C program executes. A socket call return code of **EIBMIUCVERR** accompanied by **CONNECT** error messages with a return code of 1011 usually means that you try to use a TCP/IP system address space that is not currently active on your MVS system.

If you use C-sockets, you have no influence on the content of your client ID. The C socket library routines sets it to the name of your address space and an EBCDIC representation of a storage address, which meaning is known to the C runtime environment.

A C-socket program may use the **maxdesc** socket call to increase the number of available socket descriptors.

5.3.2 Getclientid

You can, in all environments, retrieve your client ID by using the **getclientid** call. This call will return a client ID structure with the current client ID of the calling process.

```
*-------------------------------------------------------------*
* Variables used by the GETCLIENTID Call                     *
*-------------------------------------------------------------*
 01  soket-getclientid              pic x(16) value 'GETCLIENTID     '.
 01  clientid.
     05  clientid-domain            pic 9(8) Binary.
     05  clientid-name              pic x(8) value space.
     05  clientid-task              pic x(8) value space.
     05  filler                     pic x(20) value low-value.
 01  errno                          pic 9(8) binary value zero.
 01  retcode                        pic s9(8) binary value zero.

*-------------------------------------------------------------*
* Let us see the client-id                                    *
*-------------------------------------------------------------*
     Call 'EZASOKET' using soket-getclientid
        clientid
        errno
        retcode.
     If retcode < 0 then
        - process error -
```

When you write iterative server programs, you are normally not concerned with the client ID, but if you write concurrent server programs, you use client IDs to give sockets to and take sockets from.

The **getclientid** call is not part of the original BSD socket implementation. If you use it in C-programs, you must consider portability issues if you want to be able to port your C-program to other operating system platforms.

5.4 Create a Socket

2 in Figure 28 in topic 5.2. The server obtains a socket via the **socket** call. You must specify to what domain the socket belongs and what type of socket you want.

```
*-------------------------------------------------------------*
* Variables used for the SOCKET call                         *
*-------------------------------------------------------------*
 01  soket-socket                   pic x(16) value 'SOCKET          '.
 01  afinet                         pic 9(8) Binary Value 2.
 01  soctype-stream                 pic 9(8) Binary Value 1.
 01  proto                          pic 9(8) Binary Value zero.
 01  socket-descriptor              pic 9(4) Binary Value zero.
```

```
 01  errno                          pic 9(8) Binary Value zero.
 01  retcode                        pic s9(8) Binary Value zero.

*---------------------------------------------------------------*
* Get us a socket descriptor                                    *
*---------------------------------------------------------------*
     Call 'EZASOKET' using soket-socket
        afinet
        soctype-stream
        proto
        errno
        retcode.
     If retcode < 0 then
        - process error -
     else
        Move retcode to socket-descriptor.
```

The internet domain has a value of two. A stream socket is requested by passing a value of one as type. The proto field is normally zero, which means that the socket API should choose the protocol to use for the domain and socket type requested. In this example the socket will use TCP protocols.

A socket descriptor representing an unnamed socket is returned from the **socket** call. An unnamed socket has no port and no IP address information associated; only the protocol information is available. The socket descriptor is a 2-byte binary field and must be passed on subsequent socket calls as such.

A socket is an unhandy concept for a program to work with because it consists of three different things: a protocol specification, a port number and an IP address. To represent the socket in a more handy way, we use the socket descriptor.

The socket descriptor is not in itself a socket, but it represents a socket and is used by the socket library routines as an index into a table of sockets owned by a given MVS TCP/IP client (represented by a client ID: address space name and task ID). On all socket calls that reference a specific socket, you must pass the socket descriptor that represents the socket with which you want to work.

Socket Descriptor	Socket
0	Our Listen socket
1	Our connected socket

Figure 32. MVS TCP/IP Socket Descriptor Table

The first socket descriptor your program is assigned is zero for a Sockets Extended program. If your program is a C-program, socket descriptors zero, one and two are reserved for std.in, std.out and std.err, and the first socket descriptor that is assigned for your AF_INET sockets is three or higher.

When a socket is closed, the socket descriptor becomes available and will be returned as a new socket descriptor representing a new socket at a succeeding request for a socket.

In the reference documentation, the socket descriptor is normally represented by a single letter: **S** or as two letters: **SD**.

When you have the socket descriptor, you can request the socket address structure from the socket programming interface via the **getsockname** call. Remember that a socket is not fully named (including both port and IP address) until after a successful **bind**, **connect**, or **accept** call.

If your socket program is capable of handling more sockets simultaneously, you must keep track of your socket descriptors. A good idea is to build a socket descriptor table inside your program where you store information related to the socket and the status of the socket. You will need this information if, for example, you use the **select** call. Besides that purpose, it is good to have in debugging situations.

5.5 Bind a Socket to a Specific Port Number

3 in Figure 28 in topic 5.2. The socket is bound to a specific port number via the **bind** call. By binding the socket to a specific port number, you avoid having an ephemeral port number assigned to the socket.

For servers it would be rather inconvenient to have an ephemeral port number assigned, because clients would have to connect to different port numbers for every instance of the server. By using a predefined port number, clients can be developed so they always connect to the same port number.

Client programs may also use the **bind** socket call, but normally client programs do not benefit from using the same port number every time they execute.

```
*-------------------------------------------------------------*
* Variables used for the BIND Call                           *
*-------------------------------------------------------------*
 01  soket-bind                   pic x(16) value 'BIND            '.
 01  server-socket-address.
     05  server-afinet            pic 9(4) Binary Value 2.
     05  server-port              pic 9(4) Binary Value 9998.
     05  server-ipaddr            pic 9(8) Binary Value zero.
     05  filler                   pic x(8) value low-value.
 01  socket-descriptor            pic 9(4) Binary.
 01  errno                        pic 9(8) Binary Value zero.
 01  retcode                      pic s9(8) Binary Value zero.

*-------------------------------------------------------------*
* Bind socket to our server port number                       *
*-------------------------------------------------------------*
     Call 'EZASOKET' using soket-bind
        socket-descriptor
        server-socket-address
        errno
        retcode.
     If retcode < 0 then
        - process error -
```

Before you issue this call, you must build a socket address structure for your own socket with the following information:

1. Addressing family = two, which means: AF_INET.

2. Port number for your server application. For a Sockets Extended program, you will have to use a predefined port number, which is either a constant in your program or is passed to your program as an initialization parameter. If you develop your socket program in C, you can issue a **getservbyname** call to find the port number that is reserved for your server application in the *tcpip.v3r1*.ETC.SERVICES data set.

3. IP address on which your server application will accept incoming requests. If your application is executing on a multihomed host and you want to accept incoming requests over all available network interfaces, you must set this field to binary zeroes, which means: INADDR_ANY.

Until this point, you have not told TCP/IP anything about the purpose of the socket you obtained. You can use it as a client to issue connect requests to servers in the IP network, or you can use it to become a server yourself.

In socket terms, the socket at the moment is an *active socket*, which is the default status for a newly created socket.

5.6 Listen for Client Connection Requests

4 in Figure 28 in topic 5.2. When you call **listen**, you inform TCP/IP that you intend to be a server that will accept incoming requests from the IP network. By doing so, the socket status is changed from its default active status to a *passive socket*.

A passive socket does not take the initiative to initiate a connection; it just waits passively for clients to connect to it.

```
*-------------------------------------------------------------*
* Variables used by the LISTEN Call                          *
*-------------------------------------------------------------*
 01  soket-listen                  pic x(16) value 'LISTEN          '.
 01  backlog-queue                 pic 9(8) Binary Value 10.
 01  socket-descriptor             pic 9(4) Binary.
 01  errno                         pic 9(8) Binary Value zero.
 01  retcode                       pic s9(8) Binary Value zero.

*-------------------------------------------------------------*
* Issue passive open via Listen call                         *
*-------------------------------------------------------------*
     Call 'EZASOKET' using soket-listen
        socket-descriptor
        backlog-queue
        errno
        retcode.
     If retcode < 0 then
        - process error -
```

The *backlog queue* value is used by the TCP/IP address space when a connect request arrives and your server program is already connected to another client and is busy serving that client's request. TCP/IP will queue new connection requests up to the number you specify in the backlog queue parameter. If further connection requests arrive, they will be rejected by TCP/IP. You cannot in a C program specify a backlog value that exceeds the value assigned to SOMAXCONN in the socket header file supplied in *tcpip.v3r1*.SEZACMAC. The current implementation of IBM TCP/IP for MVS

uses a value of 10. Most UNIX systems use a default value of 5 for the backlog queue.

The **listen** call does not establish any connections; it just turns the socket into a passive state, so it is prepared for connection requests from the IP network. If a connection request for this server arrives between the time of the **listen** call and the succeeding **accept** call, it will be queued according to the backlog value passed on the **listen** call.

5.7 Accepting Connection Requests from Clients

5 in Figure 28 in topic 5.2. The **accept** call dequeues the first queued connection request or blocks the caller until a connection request arrives over the IP network.

```
*-------------------------------------------------------------*
* Variables used by the ACCEPT Call                          *
*-------------------------------------------------------------*
 01  soket-accept                  pic x(16) value 'ACCEPT          '.
 01  client-socket-address.
     05  client-afinet             pic 9(4) Binary Value zero.
     05  client-port               pic 9(4) Binary Value zero.
     05  client-ipaddr             pic 9(8) Binary Value zero.
     05  filler                    pic x(8) value low-value.
 01  accepted-socket-descriptor    pic 9(4) Binary Value zero.
 01  socket-descriptor             pic 9(4) Binary.
 01  errno                         pic 9(8) Binary Value zero.
 01  retcode                       pic s9(8) Binary Value zero.

*-------------------------------------------------------------*
* Start iterative server loop with a blocking Accept Call     *
*-------------------------------------------------------------*
     Call 'EZASOKET' using soket-accept
        socket-descriptor
        client-socket-address
        errno
        retcode.
     If retcode < 0 then
        - process error -
     else
        Move retcode to accepted-socket-descriptor.
```

This call works with two socket descriptors:

1. The first socket descriptor is representing the socket that was obtained, bound to the server port and optionally IP address, and turned into a passive state via the **listen** call.

2. The **accept** call will return a new socket descriptor, which will represent a complete association:

   Accepted_socket_descriptor represents:

   {TCP, server IP address, server port, client IP address, client port}

   The original socket, which was passed to the **accept** call, is unchanged and is still representing only our server half association:

   Original_socket_descriptor represents:

   {TCP, server IP address, server port}

When control returns to your program, the socket address structure passed on the call has been filled with the socket address information of the connecting client.

The succeeding socket calls for the exchange of data between the client and the server will use the new socket descriptor. The original socket descriptor will remain unused until the iterative server has finished processing the client request, and it has closed the new socket. The iterative server will then reissue the **accept** call using the original socket descriptor and wait for a new connection.

5.8 Transferring Data Over a Stream Socket

6 and 7 in Figure 28 in topic 5.2. The stream concept implies two continuous streams of bytes flowing independent of each other in opposite directions.

In the case of stream sockets there is no one-to-one correspondence between *send* calls on one side and *receive* calls on the other side. Data, for example, that is sent by a single **send** call may have to be retrieved by a number of successive **recv** calls. The other way around may be equally likely.

The TCP protocol layer does not know anything about application-related boundaries on the stream; it is unaware of application *records*. As a consequence of this, part of your application design must be to develop a message design that your two application partners can use to determine when to stop issuing receive calls, when to start processing, and when to send something back. This design is important because, if two applications wait for each other to send data on the stream, they can wait forever.

The socket APIs do provide a technique to determine if any data on the stream is ready to be received. This is done via an **ioctl** socket call with a command of FIONREAD. The number of bytes that are currently available to be read from the stream is returned in the RETARG parameter as a binary full-word.

You can use the **ioctl** call to learn how many bytes are currently available to be read and then issue a **recv** call for that amount of bytes. But, if the message you expect to receive is longer than the available bytes, you have to wait a short amount of time and then repeat the process until you have the full message. This technique allows you to detect a faulty partner program that does not send a full message. You can implement timeout logic that determines the partner program is in error if you have not received a full message within a predefined amount of time.

Note

It is important to note that TCP leaves the design of application records and application protocols entirely to the application developer.

5.8.1 Streams and Messages
5.8.2 Reading and Writing Data From and To a Socket
5.8.3 Data Representation

5.8.1 Streams and Messages

How do you design an application protocol so that the partner program is able to chop the receive stream into individual messages?

Some socket applications are so simple that the receiver can just go on receiving data until the sender closes the socket. This might be the case for a simple file transfer application. Most applications are not that simple and usually require that the stream can be divided into a number of distinct messages.

A message exchanged between two socket programs must imbed information so that the receiver is able to decide how many bytes to expect from the sender and optionally what to do with the received message. The last aspect may not be important for some applications if the function of the application is so limited that all messages are treated in the same way; however, the first aspect is important to all applications.

There are a couple of commonly used techniques to imbed information about the length of a message into the stream as follows:

1. The message type identifier technique

   If your messages are fixed length messages, you can implement a message ID per message type you work with. Each message type has a predefined length that is known by your client and server program. If you place the message ID in the start of each message, the receiving program is able to decide how long the message is (if it knows the content of the first couple of bytes in the message).

```
*-------------------------------------------------------------*
* Layout of a message between TPI client and TPI server       *
*-------------------------------------------------------------*
 01  tpi-message.
     05  tpi-message-id             pic x.
         88  tpi-request-add        value '1'.
         88  tpi-request-update     value '2'.
         88  tpi-request-query      value '3'.
         88  tpi-request-delete     value '4'.
         88  tpi-query-reply        value 'A'.
         88  tpi-response           value 'B'.
     05  tpi-constant               pic x(4).
         88  tpi-identifier         value 'TPI '.
     .......
```

   Each message ID is associated with a fixed length, which is known to your application.

2. The record descriptor word (RDW) technique

   If your messages are variable length messages, you can implement a length field in the beginning of each message. Normally you would implement the length in a binary half-word with the value encoded in network byte order, but you may as well implement it as a text field.

```
*-------------------------------------------------------------*
* Transaction Request Message segment                         *
*-------------------------------------------------------------*
 01  TRM-message.
     05  TRM-message-length         pic 9(4) Binary Value 20.
     05  filler                     pic x(2) Value low-value.
```

```
           05  TRM-identifier              pic x(8) Value '*TRNREQ*'.
           05  TRM-trancode                pic x(8) Value '?????'.
```

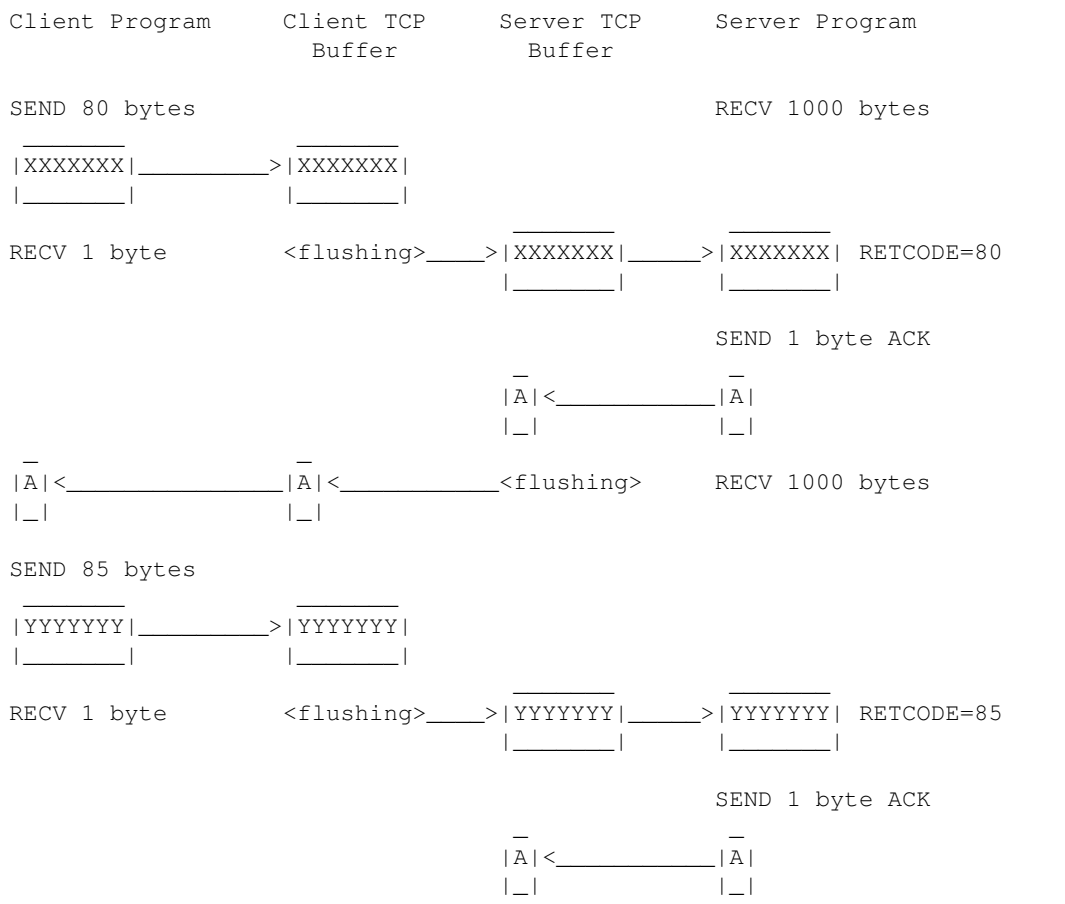
3. The end-of-message marker technique

   A third technique that is most often seen in C-programs is to send a null-terminated string. A null-terminated string is a string of bytes terminated by a byte with binary zero. The receiving program reads whatever data is on the stream and then loops through the received buffer separating each record where a null-byte is found. When the received records have been processed, the program issues a new read for the next chunk of data on the stream.

   If your messages only contain character data, you may designate any non-display byte value as your end-of-message marker. Although this technique is most often seen with C-programs, it may be used with any programming language.

4. The TCP/IP buffer flushing technique

   This technique is based on the observed behavior of the TCP protocol, where a **send** call followed by a **recv** call forces the sending TCP protocol layer to flush its buffers and forward whatever data may exist on the stream to the receiving TCP protocol layer. You can use this behavior to implement a half-duplex, flip-flop application protocol, where your two partner programs acknowledge the receipt of each message with, for example, a one-byte application acknowledgement message.



```
---- and so it continues ----
```

Figure 33. The TCP Buffer Flush Technique

In the above example, the client sends an 80 byte message. The server has issued a **recv** call for 1000 bytes but receives only the 80 bytes (RETCODE=80). The problem with this technique is that there is no guarantee that the server will receive the full 80-byte message on its receive call. It might only receive, for example, 30 bytes; but, with this technique, it has no way of detecting that it is missing another 50 bytes. The smaller the messages are the less likely it is that the server will only receive a part of the full message but you can never be fully sure.

If your partner program resides on any computer, ranging from mainframe computers to the smallest personal computer of any kind, you should not rely on this observed behavior; but use one of the safer techniques mentioned earlier.

___ Recommendation _____

We have included this technique in our description because we know it is widely used but we recommend that you only use it in controlled environments or in programs where you use non-blocking socket calls to implement your own time-out logic.

The first two techniques require that the receiving program is able to learn what is the content of the first bytes in the message, before it actually reads the entire message.

One way of solving this problem is to use the **peek** flag on a **recv** socket call.

A **recv** call with the peek flag on does not remove the data from the TCP buffers, but just copies the amount of bytes, you requested, into the application buffer you specified on the **recv** call.

If your message length field or message ID field is located, for example, within the first five bytes of each message, you can issue the following **recv** call:

```
*-------------------------------------------------------------*
* Peek buffer and length fields for RECV call                *
*-------------------------------------------------------------*
 01  soket-recv                   pic x(16) value 'RECV           '.
 01  recv-flag-peek               pic 9(8) Binary value 2.
 01  recv-peek-len                pic 9(8) Binary value 5.
 01  recv-peek-buffer.
     05  message-id               pic x value space.
         88  tpi-query-reply      value 'A'.
         88  tpi-response         value 'B'.
     05  message-constant         pic x(4).
         88  tpi-identifier       value 'TPI '.
 01  socket-descriptor            pic 9(4) Binary Value zero.
 01  errno                        pic 9(8) binary value zero.
 01  retcode                      pic s9(8) binary value zero.
```

```
*-------------------------------------------------------------*
* Peek at first 5 bytes of client data                        *
*-------------------------------------------------------------*
     Call 'EZASOKET' using soket-recv
        socket-descriptor
        recv-flag-peek
        recv-peek-len
        recv-peek-buffer
        errno
        retcode.
     If retcode < 0 then
        - process error -
     If retcode = 0 then
        - process client closed socket -
     If not TPI-identifier then
        - translate recv-peek-buffer from ASCII to EBCDIC -
```

The **recv** call will block until some bytes have been received or the sender closes its socket. The above example is not complete because you cannot be sure that you actually received the requested 5 bytes. Your call may come back to you with only 1 byte received. In order to cope with that situation, you will have to repeat your **recv** call until all 5 bytes have been received. See "Reading and Writing Data From and To a Socket" in topic 5.8.2 for the technique to use.

If the other half connection closes the socket, the **recv** call will return zero in the retcode field.

The data is copied only into your application program buffer; it is still available for a real **recv** call, where you can specify the full length of the message you now know is available.

5.8.2 Reading and Writing Data From and To a Socket

Stream sockets during **read** and **write** calls may behave in a way that at a first glance you would expect to be an error. The **read** call may return fewer bytes, and the **write** call may write fewer bytes than requested. This is not an error, but a normal situation which your programs must deal with when they read or write data over a socket.

You may have to use a series of **read** calls to read a given number of bytes from a stream socket.

Each successful **read** call, returns in the **retcode** field, how many bytes were actually read. If you know you have to read, for example, 4000 bytes and the **read** call returns 2500, you have to reissue the **read** call with a new requested length of 4000 minus the 2500 already received (1500).

If you develop your program in COBOL, the following example will show you an implementation of such logic. In this example, the message to be read has a fixed size of 8192 bytes.

```
*-------------------------------------------------------------*
* Variables used by the READ call                             *
*-------------------------------------------------------------*
 01  soket-read                  pic x(16) value 'READ            '.
 01  read-request-read           pic 9(8) Binary Value zero.
 01  read-request-remaining      pic 9(8) Binary Value zero.
 01  read-buffer.
     05  read-buffer-total       pic x(8192) Value space.
```

```
      05  read-buffer-byte redefines read-buffer-total
                                  pic x occurs 8192 times.
   01  errno                      pic 9(8) binary value zero.
   01  retcode                    pic s9(8) binary value zero.

  *-------------------------------------------------------------*
  * Read 8K block from server                                   *
  *-------------------------------------------------------------*
      move zero to read-request-read.
      move 8192 to read-request-remaining.
      Perform until read-request-remaining = 0
         Call 'EZASOKET' using soket-read
            socket-descriptor
            read-request-remaining
            read-buffer-byte(read-request-read + 1)
            errno
            retcode
         If retcode < 0 then
            - process error and exit -
         end-if
         Add retcode to read-request-read
         Subtract retcode from read-request-remaining
         If retcode = 0 then
            Move zero to read-request-remaining
         end-if
      end-perform.
```

An actual execution of the program, with the above logic, used four **read** calls to retrieve the 8K of data. The first call returned 1960, the second call 3920, the third 1960 and the final call 352 bytes. It is not possible to predict in advance how many calls are needed to retrieve the message. It depends on the internal buffer utilization in TCP/IP. We observed other test cases where only two calls were needed to retrieve 8K.

In general, it would be good programming practice, whenever you know how many bytes to read, to issue **read** calls imbedded in logic, which is similar to the above.

If you work with short messages, you will in most situations receive the full message on the first **read** call; but there is absolutely no guarantee that it will work in all situations.

The behavior of a **write** call is similar to that of a **read** call. You may have to issue more **write** calls in order to write out all the data you want to write.

```
  *-------------------------------------------------------------*
  * Buffer and length fields for write operation                *
  *-------------------------------------------------------------*
   01  soket-write                pic x(16) value 'WRITE           '.
   01  send-request-sent          pic 9(8) Binary value zero.
   01  send-request-remaining     pic 9(8) Binary value zero.
   01  send-buffer.
       05  send-buffer-total      pic x(8192) value space.
       05  send-buffer-byte redefines send-buffer-total
                                  pic x occurs 8192 times.
   01  errno                      pic 9(8) binary value zero.
   01  retcode                    pic s9(8) binary value zero.

  *-------------------------------------------------------------*
  * Send 8K data block                                          *
  *-------------------------------------------------------------*
```

```
move 8192 to send-request-remaining.
move 0 to send-request-sent.
Perform until send-request-remaining = 0
   Call 'EZASOKET' using soket-write
      socket-descriptor
      send-request-remaining
      send-buffer-byte(send-request-sent + 1)
      errno
      retcode
   If retcode < 0 then
      - process error and exit -
   end-if
   add retcode to send-request-sent
   subtract retcode from send-request-remaining
   If retcode = 0 then
      Move zero to send-request-remaining
   end-if
end-perform.
```

There are three groups of calls to use for reading and writing data over sockets:

read and **write**. These calls can only be used with connected sockets. No processing flags can be passed on these calls.

recv and **send**. These calls also only work with connected sockets. You can pass processing flags on these calls:

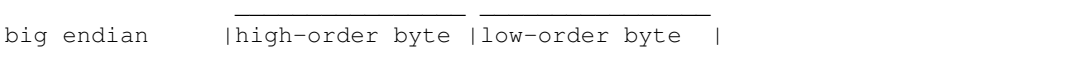
> **NOFLAG** - read or write data the same way as a **read** call or a **write** call would.
> **OOB** - read or write Out Of Band data (expedited data).
> **PEEK** - peek at data, but do not remove data from the buffers.

recvfrom and **sendto**. These calls work with both connected and non-connected sockets. You can pass addressing information directly as parameters on these calls. The available flags are the same as described above.

A connected socket is either a stream socket for which a connection has been established, or it is a datagram socket for which you have issued a **connect** call to specify the remote datagram socket address.

5.8.3 Data Representation

If you use the socket API, your application must handle the issues related to different data representations on different hardware platforms. For character based data, some hosts use ASCII, while other hosts use EBCDIC. Translation between the two representations must be handled by your application. For integers, some hardware platforms use the big endian byte order approach (S/370/390, Motorola style), while others use little endian byte orders (Intel style). Figure 34 shows an example of the difference between big and little endian byte orders.



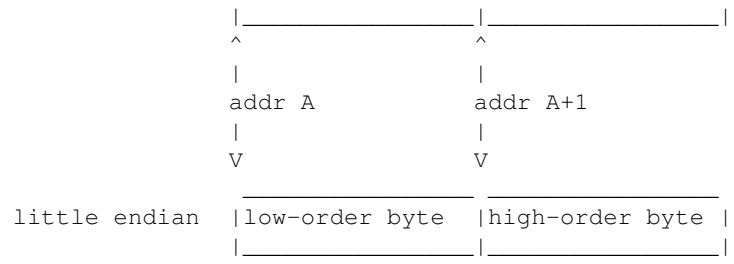


Figure 34. Big or Little Endian Byte Order for a 2-Byte Integer

IBM S/370 and S/390 based computers all use the big endian byte order, while an IBM PS/2 uses the little endian byte order.

For data in protocol headers, these matters have been taken care of. TCP/IP has defined a *network byte order* standard to be used for all 16-bit and 32-bit integers that appear in protocol headers. This network byte order is based on the big endian byte order. This is the reason why, in the C-socket interface, you will find function calls like the following:

htons This translates a short integer (2 bytes) from host byte order to network byte order.

ntohs This translates a short integer from network byte order to host byte order.

htonl This translates a long integer (4 bytes) from host byte order to network byte order.

ntohl This translates a long integer from network byte order to host byte order.

For the application data part of a message, it is all up to your socket-based application to deal with these matters. If you develop a server that serves clients on different hardware platforms, you must define your own standard and implement it as part of your application protocol.

In some instances it will be easiest for you to base your messages on text data. If you, as part of your message design, define a fixed text string in the beginning of each message, your application can test the contents of this string and decide if the data is in EBCDIC or is in ASCII. If the data is in ASCII, you can translate the full message from ASCII to EBCDIC on input and from EBCDIC to ASCII on output from MVS. An example of this design is the Transaction Request Message format used by the IMS Listener program. Bytes 4 to 11 have a fixed value of ***TRNREQ***, which is used both to distinguish this message from other messages and to find out if the client is transmitting data in ASCII or EBCDIC.

If you mix text data and binary data in your messages, you must be sure to only apply translation between ASCII and EBCDIC to the text fields in your message.

If you use binary integer fields in your messages, it is recommended that you use the network byte order standard, which TCP/IP uses for all integers in protocol headers. If you design your messages according to the network byte order standard, your MVS programs do not need to translate or rearrange the bytes in binary integer fields. Your programs executing on little-endian hosts must use the integer conversion routines

to convert integers between local format and the format used in the messages they exchange with your MVS programs.

Text data and binary two and four byte integers are fairly easy to handle in a heterogeneous computer environment. When it comes to more complex data types like floating point numbers or packed decimal, it becomes much more complicated because there is no generally accepted standard, and there is no easy support for transforming between the different formats. If you include these data types in your messages, be sure that the partner program knows how to interpret them. If the two computer systems use the same architecture, this is fully valid. If you exchange messages via socket programs between two MVS systems, you do not need to be worried about conversion.

5.9 Closing a Connection

For a connection-oriented reliable protocol, closing a socket imposes some problems because the TCP protocol layer must ensure that all data has been successfully transmitted and received before the socket resources can be safely freed at both ends.

The program that starts the close-down process, by issuing the first **close** call, is said to do an *active close*. The program that does the **close** call, as a consequence of the other program's **close** call, is said to do a *passive close*.

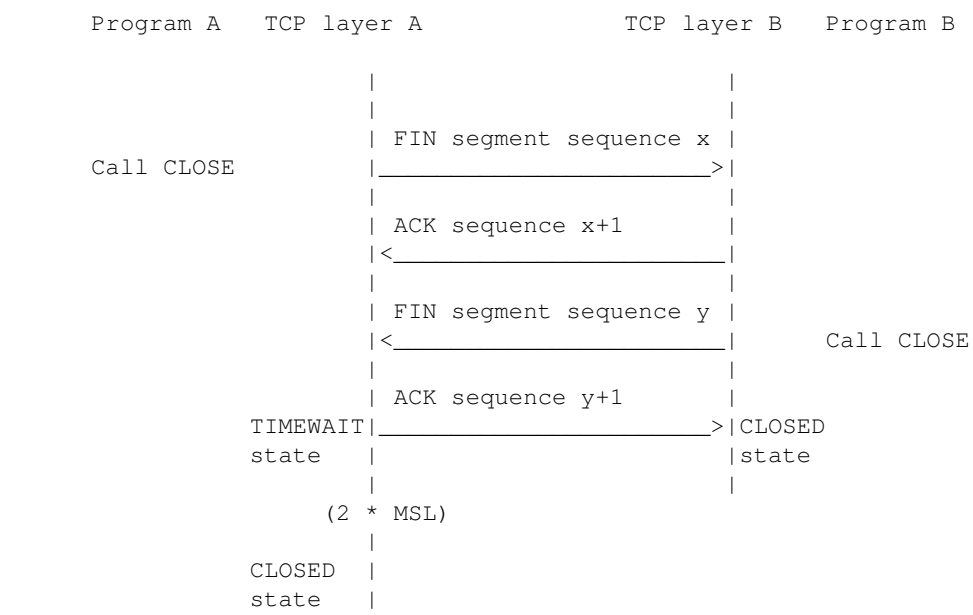


Figure 35. Closing Sockets

Program A does the active close, while program B does the passive close.

When a program calls the **close** socket function, the TCP protocol layer sends a segment that is known as a FIN (FINish) segment.

When program B receives the last acknowledgement segment, it knows that all data has been successfully transferred and that A has received and

processed the final FIN segment. The TCP protocol layer for program B can then safely remove the resources that were occupied by program B's socket.

The TCP protocol layer for program A sends out an acknowledgement to the FIN segment it received from B; but program A's TCP protocol layer does not know if that ACK segment arrived at program B's TCP protocol layer or not. It must wait a reasonable amount of time to see if the final FIN segment from B is retransmitted indicating that B never received the final ACK segment from A. In that case, A must be able to retransmit the final ACK segment.

Program A's socket cannot be freed until this time period has elapsed. The time period is defined to be twice the maximum segment life time, and it is normally between one and four minutes, depending on the TCP implementation.

If program A is the client in a TCP connection, this TIMEWAIT state does not impose any major problems. A client normally uses an ephemeral port number; and, if the client restarts before the TIMEWAIT period has elapsed, it is just assigned another ephemeral port number.

If program A, on the other hand, is the server in a TCP connection, this TIMEWAIT state does impose a problem. A server binds its socket to a predefined port number; and, if the server tries to restart and bind the same port number before the TIMEWAIT period has elapsed, it will receive an EADDRINUSE error code on the **bind** call. This situation may arise if a server crashes and you try to restart it immediately before the TIMEWAIT period has elapsed. In that case, you just have to be a little patient before you restart your server.

If the server is an important server and you cannot wait these one to four minutes, you may use the **setsockopt** call in the server to specify SO_REUSEADDR before it issues the **bind** call. In that case, the server will be able to bind its socket to the same port number as before even if the TIMEWAIT period has not elapsed; but the TCP protocol layer still prevents it from establishing a connection to the *same* partner socket address within the TIMEWAIT period. As clients normally initiate connections and clients use ephemeral port numbers, the probability of this situation arising is not very high.

5.9.1 Half Close

If you only want to close the stream in one direction, but still allow data to be transferred in the other direction, you may use the **shutdown** socket call instead of the **close** call. On the **shutdown** call, you are able to specify in which direction the stream should be closed down.

See Table 7 for effects on **read** and **write** calls when the stream is being shut down in one or both directions.

Table 7. Effect of Shutdown Socket Call

Socket calls in local program	**Local program**		**Remote program**	
	Shutdown SEND	**Shutdown RECEIVE**	**Shutdown RECEIVE**	**Shut**
write type calls	Error number EPIPE on		Error number EPIPE on	

	first call		second call(1)	
read type calls		Zero length return code		Zero code

Note:

1. If you issue two **write** calls immediately after each other, both may be successful and an EPIPE e not be returned until yet another **write** call is issued.

5.9.2 The Linger Option

By default a **close** socket call will return control to your program immediately, even if there is unsent data on the socket that still has to be transmitted. The data will be transmitted by the TCP protocol layer, but your program will not be notified of any errors. This is true for both blocking and non-blocking sockets.

You can request that you do not want control returned to your program before any unsent data has been transmitted and acknowledged by the receiver. You do so via the SO_LINGER option on a **setsockopt** call before you issue the actual **close** call. On the **setsockopt** call you pass the following two option value fields:

ONOFF This is a full-word used to enable or disable the SO_LINGER option. Any non-zero value enables the option. A zero value disables the option.

LINGER This is the linger time in seconds. This is the maximum time the **close** call will linger. If data is successfully transmitted before this time interval, control will be returned to your program. If this time interval expires before data has been successfully transmitted, control will also be returned to your program. You have no way you can distinguish between the two return causes.

Please note that, if you set a zero linger time, the connection will not be orderly closed but aborted, resulting in a RESET segment being sent to the connection partner instead of a normal close sequence.

Also note that, if the socket is in non-blocking mode, the **close** call is treated as if no linger option was set.

5.10 Blocking, Non-blocking and Asynchronous Socket Calls

The default mode of a socket call is *blocking* mode. All IBM TCP/IP for MVS socket APIs also support *non-blocking* socket calls. Some APIs, in addition to non-blocking calls, also support *asynchronous* socket calls.

Blocking Let us first explain the default behavior of a socket call: the *blocking* mode. A blocking call will not return to your program until the event, you requested, has been completed. If, for example, you issue a blocking **recv** call, the call will not return to your program until data is available from the other socket application. A blocking **accept** call will not return to your program until a client connects to your socket program.

Non-blocking You turn a socket into non-blocking mode via the **ioctl** call that specifies a command of FIONBIO and an argument that is a full-word (4 bytes) with a value of binary one (F'1'). Any succeeding socket calls against the involved socket descriptor will be non-blocking calls.

An alternative method is to use the **fcntl** call with a command code of binary four (F'4') and an argument with a value of four (F'4') to turn on non-blocking mode.

Non-blocking calls return to your program immediately with return information that tells you if the requested event happened or not. If the requested event did not happen, the error number is set to EWOULDBLOCK. This error number means that your call would have blocked if it had been a blocking call. If the call was, for example, a **recv** call, your program may implement its own wait logic and reissue the non-blocking **recv** call later. By using such a technique, your program may implement its own *timeout* rules and, for example, close the socket if it has not received any data from the partner program within an application determined period of time.

A new **ioctl** call can be used to turn the socket back into blocking mode with a command of FIONBIO and an argument that is a full-word with the value zero (F'0').

Please see "Datagram Socket COBOL Client Program" in topic A.2 for an example of a datagram socket program that uses non-blocking **recvfrom** calls in order to implement its own timeout logic.

Note: The APPC Common Programming Interface for Communications (CPI-C) also provides so-called non-blocking calls. These calls, however, actually provide the more advanced facilities of TCP/IP asynchronous calls.

Asynchronous Asynchronous calls are available with the Sockets Extended assembler macro API via the ECB keyword on the EZASMI macro call and in the IUCV API.

Like non-blocking calls, an asynchronous call also returns control to your program immediately. But in this case, there is no need to re-issue the call. When the requested event has taken place, the event control block that was specified on the EZASMI macro call is posted by the socket interface. Your program can either, at regular intervals, test if the wait bit is still on in the ECB, or it can issue an MVS WAIT macro call on this ECB or a combination of ECBs, where the socket call ECB is just one of a number of events for which the program is waiting.

Table 8 summarizes the actions taken by the socket programming interface (depending on the blocking or non-blocking state of a socket).

Table 8. Effect of Blocking or Non-blocking Mode

Call Type	**Socket State**	**Blocking**	**Non-Blocki**
read type calls	Input is available	Immediate return	Immediate

	No input is available	Wait for input	Immediate EWOULDBLOC (**select** ex
write type calls	Output buffers available	Immediate return	Immediate
	No output buffers available	Wait for output buffers	Immediate EWOULDBLOC (**select** ex
accept call	New connection queued	Immediate return	Immediate
	No connections queued	Wait for new connection	Immediate EWOULDBLOC (**select** ex
connect call		Wait	Immediate EINPROGRES (**select** ex

Unless you are using the Sockets Extended assembler macro interface with an APITYPE of three on the **initapi** call, you are only allowed to have one outstanding socket call at any one time. The IUCV API also supports an APITYPE of three. The way you test pending activity on a number of sockets in a non-APITYPE three program is by using the **select** call. You pass a list of socket descriptors that you want to test for activity to the **select** call. You specify per socket descriptor what type of activity you want to test for:

Pending data to read

Ready for new write

Any exception conditions

The **select** call can itself be blocking, non-blocking or, for the Sockets Extended assembler macro API or the IUCV API, asynchronous. If the call is blocking and none of the socket descriptors that are included in the list passed to the **select** call have had any activity, the call will not return to your program until one of them has activity, or until a timer value you pass on the **select** call expires.

In an Sockets Extended assembler macro program, you can use the asynchronous mode to control your own wait logic, where your program waits either for socket activity or some other events. A server program will typically have to wait for either socket activity or some operator command to shut it down. An Sockets Extended assembler macro program may wait on a list of two ECBs, where the first is the asynchronous **select** ECB, and the other one is an MVS modify command ECB (a CIB ECB).

A C-socket program may use the **selectex** call to include an external event in the list of events to wait for. This external event is typically an MVS modify command ECB.

Sockets Extended assembler macro APITYPE three programs will not be discussed further in this book. For more information on APITYPE three, please see Chapter 8 in *IBM TCP/IP for MVS: Application Programming Interface Reference*, SC31-7187. The information in the referenced chapter

about APITYPE three also applies to Sockets Extended assembler macro programs.

5.11 Socket Programs and MVS Security

There are two aspects of security that we will include in the following discussion:

1. User or client authentication: Do we know the user and is the user who he/she claims to be?

2. Resource access authorization: Is the user allowed to use a specific resource or perform a specific function in MVS?

Unlike SNA LU 6.2, where user authentication can be made part of the conversation initiation, the TCP/IP transport protocol layers do not include any function that handles these aspects for us. If such functions are required, we must implement them in the socket applications and in the application protocol.

The following guidelines are related to socket programs running in native MVS address spaces. Both IMS sockets and CICS sockets include a security exit, you can use to authenticate client users that want to start IMS or CICS transactions via the IMS or CICS listener programs.

5.11.1 User or Client Authentication

In MVS we normally verify the authenticity of a user based on a user ID and a password that is passed to the MVS Security Access Facility (SAF) interface.

The client process will have to request the following information from the user:

    MVS user ID
    MVS password
    Optionally MVS group
    Optionally new MVS password

The application protocol must be designed so the client is able to pass the requested information to the server process, which must invoke the proper MVS functions to authenticate the user and return a positive or negative response to the client. Your application protocol should allow for a response from the server that tells the client user if the password has expired. The client process should allow the user to repeat the sign-on dialog enabling the user to type in a new password in addition to the previously entered user ID and current password.

In order to authenticate the user, the MVS program must use an authorized function in MVS: the RACROUTE REQUEST=VERIFY function. This function can only be used from an MVS process that runs in an authorized state. We will not recommend that you allow your server programs to run in an authorized MVS state, so our suggestion is to develop a user SVC routine, where you package the user authentication function into one SVC routine, which you invoke from your non-authorized server processes via the

designated SVC number.

Please see "TPIRACF Interface to RACROUTE REQUEST=VERIFY User SVC" in topic G.6 for a sample callable routine that can be used from any high-level language program, and "User SVC for RACROUTE REQUEST=VERIFY" in topic G.7 for a sample type 4 user SVC. In our implementation, we have added a check in the SVC code to see if the address space user of the calling program is authorized to use the SVC call. We have implemented this check to avoid giving all the programs in MVS access to the functions of the user SVC.

If you define your servers as resources in the RACF APPL resource class and permit your selected client users to use the individual APPL resources, you can add the server application name on the RACROUTE REQUEST=VERIFY call in order to decide if this particular user is or is not authorized to use this particular server.

As this authentication is done by the application code in the server, it is important to emphasize that an ill-behaving server can ignore the authentication return codes and continue processing the socket client request even if the user is unknown or not authorized to use the server program. You must ensure proper protection of the libraries where your server programs reside, in order to avoid having a healthy server program replaced by an ill-behaving replica.

Please see "Sample Stream Socket COBOL Server" in topic B.1 for a sample iterative server that authenticates each client user.

If you develop your server programs in C, you may optionally use the Kerberos services to authenticate your client users. But if you want to let the server issue further authorization requests in order to see if the client user may access specific MVS resources, like MVS data sets, you need an MVS user ID in addition to the Kerberos authentication.

5.11.2 **Authorizing Access to MVS Resources**

When you issue the RACROUTE REQUEST=VERIFY, an accessor environment element (ACEE) is constructed and a pointer to the ACEE is placed in the TCBSENV field in the current task control block (TCB).

If your server program opens an MVS data set, normal MVS authorization will be performed based on the ACEE pointed to by TCBSENV.

If your server program opens an MVS data set during initialization, before any clients have connected, the authorization will be done based on the address space security environment. The address space runs under the user ID of the batch job, or the started task user ID of a started task. The address space ACEE is pointed to by the ASXBSENV field in the address space control block extension.

You can extend the access authorization to each individual user by a RACROUTE REQUEST=AUTH call. Under normal circumstances, your program does not have to run in an MVS authorized state in order to issue RACROUTE REQUEST=AUTH calls.

You are not limited to authorizing data set access. You can issue RACROUTE REQUEST=AUTH calls for any RACF defined resource.

Please see "TPIAUTH Issue RACROUTE REQUEST=AUTH for FACILITY Class" in topic G.8 for a sample callable routine that can be called from any high-level language program. The routine will issue an RACROUTE

REQUEST=AUTH call for the FACILITY class resource name passed to the routine by the calling program.

6.0 Chapter 6. Native MVS Concurrent Server Program

In this chapter we will guide you through the development of a concurrent server in the native MVS environment. Our sample concurrent server uses MVS subtasking and is implemented in assembler using the Sockets Extended assembler macro programming interface.

6.1 Concurrent Servers in the Native MVS Environment

The concurrent server is somewhat more complicated to implement. You have to split your logic into a main program and a child program. In addition to this split of your logic, you have to include logic to manage the different processes, which makes up your application.

In a UNIX based environment, you would implement such logic by means of the UNIX **fork** call. This call is not available in a traditional MVS environment, so you have to use some other facilities, which we will describe in the following sections of this book.

In an OpenEdition/MVS environment, the **fork** function is implemented using APPC/MVS to schedule and initiate a child process in another MVS address space, than the address space in which the original process is executing.

For the MVS address space examples presented in this book, we use the more traditional MVS subtasking facilities, where the main process and child processes operate as tasks within the same address space.

You can implement your concurrent server in both an IMS, a CICS and in a traditional MVS address space environment; but unlike the implementation of an iterative server, the implementation of a concurrent server differs between the environments. In this chapter, we will discus the implementation of a concurrent server in an MVS address space, while we will return to the IMS and CICS concurrent server implementation in Chapter 9, "IMS Sockets" in topic 9.0 and Chapter 10, "CICS Sockets" in topic 10.0.

For the sake of simplicity, we will again limit the scope of our applications to the AF_INET addressing family and stream sockets.

If you are going to implement a high-performance server application that creates or accesses MVS resources of various kind, especially MVS data sets, you will most likely implement your server as a concurrent server in an MVS address space. The address space can be either TSO, batch or started task.

In order to implement concurrency in an MVS address space, you will have to use MVS multitasking facilities, which limits your available programming interfaces to Sockets Extended assembler macro programming interface or C sockets. You may also use the IUCV assembler programming

interface, but we see no real reason for doing so when you have the Sockets Extended assembler macro interface available.

For the Sockets Extended assembler macro interface, you can use standard MVS subtasking facilities by means of **ATTACH** and **DETACH** assembler macros.

If you use C sockets, you can use the subtasking facilities, which are part of the IBM implementation of C in an MVS environment.

We will use Sockets Extended assembler macro examples to illustrate the implementation of a concurrent server in an MVS address space environment.

6.2 MVS Subtasking Considerations

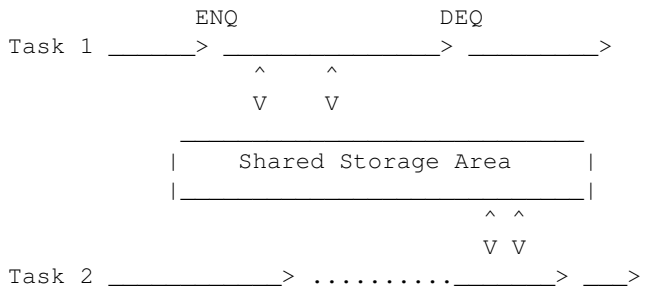
The fact that you use multiple tasks in an address space is the cause of some extra considerations, which you must take into account, when you design your application. These considerations apply equally to assembler programming and high-level languages that support subtasking.

When you use multiple tasks in an address space, your tasks may be concurrently dispatched on different processors if you execute your application on an n-way system. Two or more tasks may execute in parallel, one perhaps passing the other.

6.2.1 Access to Shared Storage Areas

If two tasks access the same storage area inside your address space, you must impose full control over the use of this storage area. If the storage area is a read-only area from which your tasks just fetch static information, there is no need for special attention. If the storage area is used to pass parameters between the tasks, you must ensure that only one task at a time is able to modify the contents of the storage area, and you must ensure that the task that is going to use the information in the storage area reads the information before it is modified by a third task. In other words, you have to serialize access to the shared resource (the storage area).

In an MVS environment you can do so via MVS latching services or the more traditional enqueue and dequeue system calls. In assembler you use the **ENQ** and **DEQ** macros.



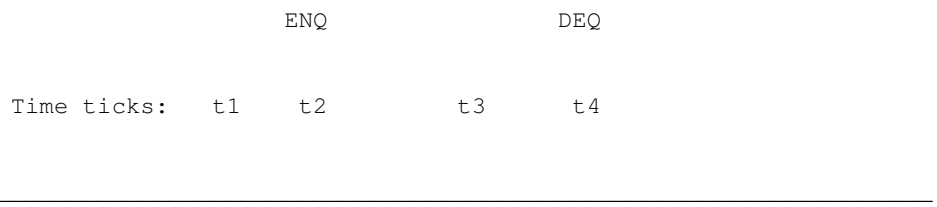


Figure 36. Serialize Access to a Shared Storage Area

1. At time *t1*, task 1 issues a serialize request by means of an enqueue call. On the enqueue call it passes two character fields that uniquely identifies the resource in question. What the value of these two fields are does not really matter; what matters is that other tasks use exactly the same values when they want to access this storage area. As no other task has issued an enqueue for the resource in question, task1 gets access to it and goes on making the required modifications in the storage area.

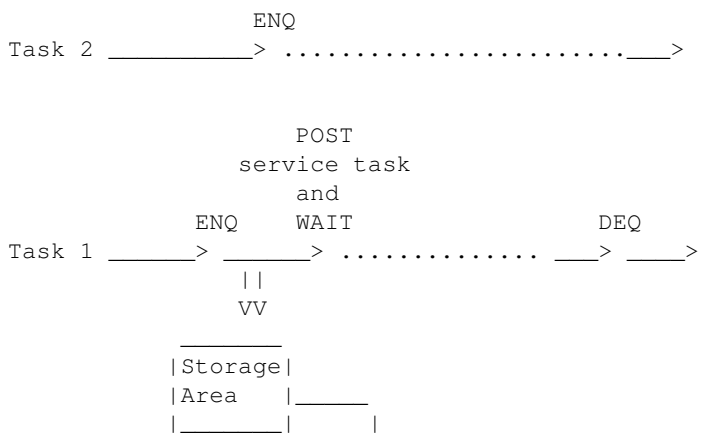
2. At time *t2*, task 2 wants to access the same storage area and issues an enqueue call with the same resource names as task 1. Because task 1 already has enqueued, task 2 is placed in a wait and stays there until task 1 releases the resource.

3. At time *t3*, task 1 releases the resource with a dequeue system call, and task 2 is immediately taken out of its wait and can now begin to make its modifications to the shared storage area.

4. At time *t4*, task 2 has finished updating the shared storage area and releases the resource with a dequeue system call.

In the above example we assumed that we only needed to serialize access when the tasks wanted to update information in the shared storage area. There are situations where this is not sufficient. If you use a storage area to pass parameters to some kind of service task inside your address space, you must ensure that the service task has read the information and acted accordingly before another task in your address space tries to pass information to the service task in the same storage area.

Let us, for example, imagine that we have a service task, to which other tasks pass information that has to be written to some kind of logging or trace sysout file. In our design we have a common storage area, which is accessible from all tasks within our address space. We use fields in this common storage to pass parameters to the service task in order for it to print information on sysout.



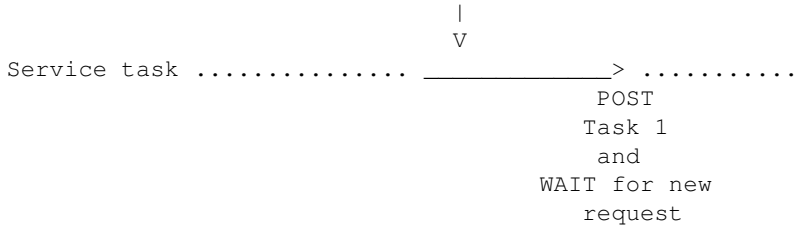


Figure 37. Synchronize Use of a Common Service Task

1. At time *t1*, task 1 gets access both to the common storage area and to implicitly use the service task in question.

2. At time *t2*, task 2 also has a need to use the services of our service task, but it is placed into a wait, because task 1 already has the resource.

3. At time *t3*, task 1 has finished placing values into the common storage area and signals the service task to start processing it. This is done via a **POST** system call. Immediately following this call, task 1 enters a wait, where it waits until the service task has completed its processing. The service task starts, processes the data in the common storage and prints, for example, a line or two to a sysout file.

4. At time *t4*, the service task has finished its work and signals back to task 1 that task 1 can continue, while it enters a new wait for a new work request.

5. At time *t5*, task 1 releases the lock it obtained at time *t1*, and task 2 is immediately taken out of its wait and now starts filling in its values into the common storage area before posting the same service task to process a new request.

The above technique is relatively simple. It can be made much more complicated and also more efficient by using internal request queues where the requesting task does not need to wait for the service task to complete the request. You can experiment with such implementations, but they are outside the scope of this book.

When you use the enqueue system call, you have an option to test if a resource is available or not. In some situations, this might be handy if you do not want to enter a wait at some particular point in your processing but want to take some other action if the resource is not available.

6.2.2 Data Set Access

When you access MVS data sets in a multitasking environment, you must observe some general rules as follows:

1. A given DD-name can only be used by one open Data Control Block (DCB) at a time. If you need to have more DCBs open for the same data set, you have to use different DD-names. It can only be recommended for read access.

2. Only the task that opens a DCB can issue read and write requests using

that DCB. You cannot let your main task open a DCB and then have your subtasks issue read or write requests to that DCB. One way to deal with this is the technique we described above with a special services task that opens a DCB to a particular data set. Other tasks then issue requests to this service task for access to the data set. Such a service task is in general called a Data Services Task (DST). One very common implementation of a DST is the example we used above, which was to print out log and trace information to a sysout file.

3. A last reminder for data set access is that authorization checking for access to a data set is done when the data set is opened and not for each read or write request. If you develop a multitasking server, where you establish task level security environments for each transaction entering your server, you have to consider how you will authorize access to the information in a data set owned by a DST. You can, of course, open and close the data set for each transaction, but that may prove to be unacceptable from a performance point of view. It depends on the nature of your application.

6.2.3 Task and Workload Management

When your program is started by MVS, it is executing as the main task of the address space in which it was started.

In the examples we use in this book, we use the main task as the main process of our concurrent server implementation. The child processes will then be started as subtasks of the main task.

You have generally two ways to manage your child processes as: follows:

1. Every time a connection request arrives, you start a new subtask, which processes one connection and then terminates.

2. During initialization, the main task starts a number of subtasks. Each subtask initializes and enters a wait-for-work status. When a connection request arrives, the main process selects the first subtask that is waiting for work and schedules the connection to that subtask. The subtask processes the connection and, when done, enters a new wait-for-work status.

The last approach is the most efficient because we only indulge the overhead of creating new tasks once during server startup. It is also a bit more complicated to implement than the first approach:

You must decide on the number of server subtasks you start during initialization. If more connection requests arrive, than you have server subtasks available, you must include code to deal with that situation: either reject a connection or dynamically increase the number of subtasks in your concurrent server address space. If you include logic to increase subtasks dynamically during peak hours, you might also include logic to decrease number of subtasks dynamically during low-activity hours. This is what we term *workload management*.

The subtasks must be reusable and include logic to enter wait-for-work status and be able to process connection requests serially.

The main process must be able to deal with situations where a server subtask abends or terminates because of some other reason. Should the subtask be reinstated, and how do you avoid reinstate-abend loops?

To implement what we call graceful shutdown, you also have to

implement a technique for signalling to the subtasks that they should terminate in an orderly manner. A simple technique is to post the subtask from the main process with a return code of zero for work and some other return code value for termination.

In the concurrent MVS server example you find in this book, we used the technique with a pool of subtasks that waited for work. We did not implement a dynamic increase of subtasks, but chose to send a negative reply back to the requester if no server subtasks were available.

6.2.4 Security Considerations

When you start your server address space in MVS, a security environment is established for the address space based on the user ID of your batch job or TSO user or based on the started task user ID associated with your started task procedure name in RACF started task table (ICHRIN03).

If you do nothing else, all tasks in your address space will execute under the security environment of the address space. Access to MVS resources during processing of client requests will be authorized based on the MVS address space security environment.

For some applications this may be sufficient. For others it is not.

You are able to work with task level security environments where each task in an address space may have a different security environment. You build and delete task level security environments with the **RACROUTE REQUEST=VERIFY** function in MVS. To use this, your task must run in an authorized state, so it is a function you must implement carefully in order not to jeopardize security in your environment. See "Socket Programs and MVS Security" in topic 5.11 for a general discussion on socket programs and security considerations.

6.2.5 Reentrant Code

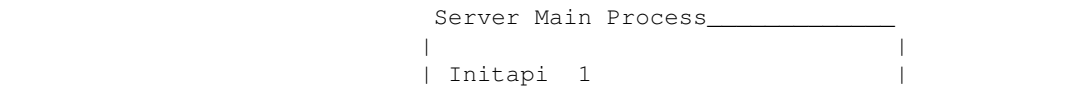
It is not a requirement to develop reentrant code, but it is a more efficient use of main storage resources to do it. If you start 20 subtasks all using the same program, the program will be loaded into virtual storage in 20 copies if it is not reentrant but only in one copy if it is reentrant.

For most high-level languages, it is often just a matter of an option on the compile step.

If you develop your program in assembler, it might be somewhat more complicated; however, good use of macros for program initiation and termination may solve parts of the burden.

6.3 Program Structure

Figure 38 shows the basic logic in a multitasking concurrent server.



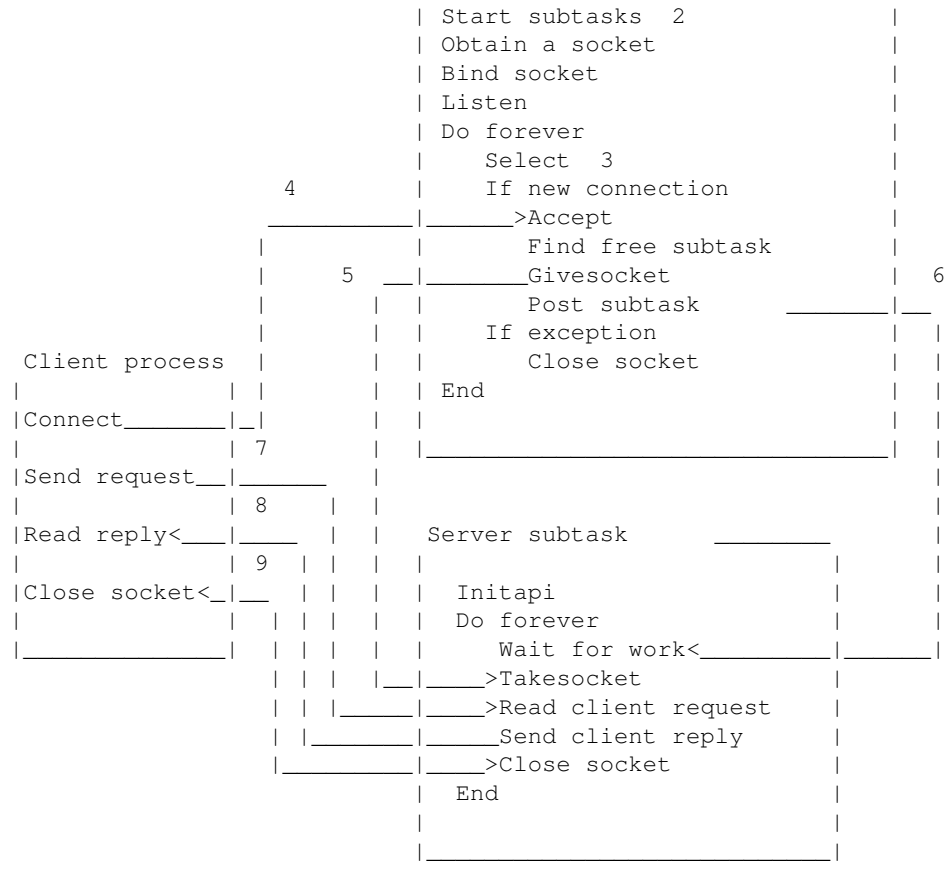


Figure 38. Concurrent Server in an MVS Address Space

The sequence numbers in the following sections all refer to the corresponding numbers in Figure 38.

Please refer to Appendix H, "Sample MVS Concurrent Server" in topic H.0 for the complete sample code of an MVS concurrent server.

6.4 Initializing the Concurrent Server Program

1 The server must as always start out with an **initapi** call before it uses any other socket calls.

```
*-------------------------------------------------------------------*
* Initialize socket API                                             *
*-------------------------------------------------------------------*
         EZASMI TYPE=INITAPI,      *Initialize socket interface       C
               MAXSOC=TPIMMAXS,    *So many concurrent sockets        C
               SUBTASK=TPIMTCBE,   *My TCB address in EBCDIC          C
               IDENT=IDENTSTR,     *TCP/IP AS name and my AS name     C
               MAXSNO=TPIMMAXD,    *Max. no of socket descriptors     C
               ERRNO=ERRNO,                                           C
               RETCODE=RETCODE,                                       C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *Initapi OK
         BM    EZAERROR            *- No.
*
IDENTSTR DS    0F                 *INITAPI: Ident structure
```

```
IDENTTCP DC    CL8'T18ATCP'        *TCP/IP Address space name
IDENTJOB DC    CL8' '              *My Address space name
*
TPIMTCBE DC    CL8' '              *TCB Address in EBCDIC - task ID
*
TPIMMAXS DC    AL2(50)             *Maximum number of sockets
TPIMMAXD DC    AL4(50)             *Maximum descriptor number
*
ERRNO    DC    A(0)                *Errorno from EZASMI
RETCODE  DC    A(0)                *Returncode from EZASMI
```

Jobname and task ID is initialized to address space name and EBCDIC representation of TCB address before the call is issued.

2 During initialization the server main process attaches a number of subtasks. How you do this, what program you start and what parameters you pass is, of course, application dependent. In our sample server the subtask program is called TPISERV. For each subtask, the main process maintains a control block that we called TPISCB (Subtask Control Block). A pointer to this control block is passed to the subtask program.

```
*-------------------------------------------------------------------*
* Attach a subtask                                                  *
*-------------------------------------------------------------------*
         LA    R3,TPISCB           *-> Subtask Control Block
         LA    R8,TPISTECB         *-> Term. ECB
         ATTACH EP=TPISERV,        *Server subtask main module         C
               PARAM=((R3)),       *Pass TPISCB as only parameter      C
               ECB=(R8)            *Termination ECB
         ST    R1,TPISTCB          *-> TCB of subtask
```

When the subtask terminates, either because of an abend or because of normal termination, the Event Control Block (ECB) at label TPISTECB is posted by MVS.

During subtask initialization, the subtasks issue **initapi** calls, where they identify themselves with the same address space name as the main process and with an EBCDIC representation of their TCB addresses.

```
*-------------------------------------------------------------------*
* Initialize socket API in subtask with passed values               *
*-------------------------------------------------------------------*
         MVC   IAPITCP,TPIMTCPI    *TCP/IP address space name
         MVC   IAPIAS,TPIMCNAM     *Our address space name
         EZASMI TYPE=INITAPI,      *Initialize socket API              C
               MAXSOC=IAPISOCC,    *This many sockets                  C
               SUBTASK=TPISTCBE,   *My TCB address in EBCDIC           C
               IDENT=IAPIIDEN,     *TCP/IP AS name and my AS name      C
               MAXSNO=IAPISNO,     *This many socket descriptors       C
               ERRNO=ERRNO,                                            C
               RETCODE=RETCODE
         ICM   R15,15,RETCODE      *Did we do well ?
         BM    EZAERROR            *- No, deal with it.
*
IAPIIDEN DS    0C
IAPITCP  DC    CL8' '              *TCP/IP Address space name
IAPIAS   DC    CL8' '              *Child process address space name
*
TPISTCBE DC    CL8' '              *Child process TCB address in EBCDIC
*
IAPISNO  DC    AL4(10)             *Max socket descriptors
IAPISOCC DC    AL2(10)             *Max sockets
```

```
*
ERRNO    DC    A(0)                *Errorno from EZASMI
RETCODE  DC    A(0)                *Returncode from EZASMI
```

The subtasks then enter a wait for work status, waiting for the main process to pass work.

The server main process now issues the same series of socket calls as the iterative server to obtain a socket, bind it to the server port number and open it in passive mode via a listen call.

6.5 Select Processing

3 When all initialization has been done, and the server main process is ready to enter normal work, it builds a bit mask for a **select** call. The **select** call is used to test pending activity on a list of socket descriptors owned by this process. Before you issue the **select** call, you must construct three bit strings representing the sockets you want to test for as follows:

Pending read activity
Pending write activity
Pending exceptional activity

The format of the bit strings is a bit awkward for an assembler programmer who is used to bit strings starting off from the left. These do not.

The first rule is that the length of a bit string is always expressed as a number of full-words. If the highest socket descriptor you want to test is socket descriptor number three, you have to pass a 4 byte bit string as this is the minimum length. If the highest number is 32, you must pass 8 bytes (2 full-words).

The number of full-words in each select mask can be calculated as

INT(number of socket descriptors / 32) + 1

Let us look at the first full-word you pass in a bit string:

```
Bit nbr: !  0  1  2  3    4  5  6  7
---------+-------------------------
Byte 0:  !  x  x  x  x    x  x  x  x
SD nbr:  ! 31 30 29 28   27 26 25 24
         !
Byte 1:  !  x  x  x  x    x  x  x  x
Sd nbr:  ! 23 22 21 20   19 18 17 16
         !
Byte 2:  !  x  x  x  x    x  x  x  x
SD nbr:  ! 15 14 13 12   11 10  9  8
         !
Byte 3:  !  x  x  x  x    x  x  x  x
Sd nbr:  !  7  6  5  4    3  2  1  0
```

We use standard assembler numbering notation; the left most bit or byte is relative zero.

If you want to test socket descriptor number 5 for pending read activity, you raise bit2 in byte 3 of the first full-word (X'00000020'). If you want to test both socket descriptor 4 and 5, you raise both bit2 and bit3 in byte3 of the first full-word (X'00000030').

If you want to test socket descriptor number 32, you must pass two full-words, where the numbering scheme for the second full-word resembles that of the first. Socket descriptor number 32 is bit7 in byte3 of the second full-word. If you wanted to test socket descriptors 5 and 32, you would pass two full-words with the following content: X'0000002000000001'.

The bits in the second full-word represents the following socket descriptor numbers:

```
Bit nbr: !  0  1  2  3    4  5  6  7
---------+-------------------------
Byte 4:  !  x  x  x  x    x  x  x  x
SD nbr:  ! 63 62 61 60   59 58 57 56
         !
Byte 5:  !  x  x  x  x    x  x  x  x
Sd nbr:  ! 55 54 53 52   51 50 49 48
         !
Byte 6:  !  x  x  x  x    x  x  x  x
SD nbr:  ! 47 46 45 44   43 42 41 40
         !
Byte 7:  !  x  x  x  x    x  x  x  x
Sd nbr:  ! 39 38 37 36   35 34 33 32
```

To set and test these bits in an easy way, we developed the following assembler macro:

```
         MACRO
         TPIMASK &TYPE,&MASK=,&SD=
.* ****************************************************************
.* TYPE is either:                                                 *
.*      TEST for testing a bit                                     *
.*           Follow the TPIMASK TEST invocation by                 *
.*           a Branch Equal for bit on, and a                      *
.*           a Branch Not Equal for bit off.                       *
.*      SET  for setting a bit                                     *
.* MASK Bit mask area                                              *
.* SD   A halfword containing socket descriptor                    *
.* ****************************************************************
         SR    R14,R14             *Nullify
         AIF   ('&SD'(1,1) EQ '(').SDREG
         LH    R15,&SD             *Socket descriptor
         AGO   .SDOK
.SDREG ANOP
         LR    R15,&SD             *Socket descriptor
.SDOK ANOP
         D     R14,=A(32)          *Divide by 32
         SLL   R15,2               *Multiply offset with word length
         AIF   ('&MASK'(1,1) EQ '(').MASKREG
         LA    R1,&MASK            *Here mask starts
         AGO   .MASKOK
.MASKREG ANOP
         LR    R1,&MASK            *Here mask starts
.MASKOK ANOP
         AR    R15,R1              *Here our word starts
         LA    R1,1                *Rightmost bit on
         SLL   R1,0(R14)           *Shift left rest from division
         O     R1,0(R15)           *Or bits from mask
         AIF   ('&TYPE' EQ 'SET').DOSET
         C     R1,0(R15)           *If equal, bit was on
         MEXIT
```

```
.DOSET ANOP
         ST    R1,0(R15)           *New mask
         MEND
```

If you develop your program in another programming language, you may be able to benefit from the EZACIC06 routine, which is provided as part of IBM TCP/IP for MVS. This routine translates between a character string mask (one byte per flag) and a bit string mask (one bit per flag). If you use the **select** call in COBOL, you will find EZACIC06 very useful.

You build the three bit strings for the socket descriptors you want to test, and the **select** call passes back three corresponding bit strings with bits raised for those of the tested socket descriptors that have pending activity.

```
*-------------------------------------------------------------------*
* Test for socket descriptor activity via the SELECT call           *
*-------------------------------------------------------------------*
         EZASMI TYPE=SELECT,       *Select call                     C
               MAXSOC=TPIMMAXD,    *Max. this many descr. to test   C
               TIMEOUT=SELTIMEO,   *One hour timeout value          C
               RSNDMSK=RSNDMASK,   *Read mask                       C
               RRETMSK=RRETMASK,   *Returned read mask              C
               WSNDMSK=WSNDMASK,   *Write mask                      C
               WRETMSK=WRETMASK,   *Returned write mask             C
               ESNDMSK=ESNDMASK,   *Exception mask                  C
               ERETMSK=ERETMASK,   *Returned exception mask         C
               ECB=ECBSELE,        *Post this ECB when activity occurs C
               ERRNO=ERRNO,        *- ECB points to an ECB plus 100 C
               RETCODE=RETCODE,    *- bytes of workarea for socket  C
               ERROR=EZAERROR      *- interface to use.
         ICM   R2,15,RETCODE       *If Retcode < zero it is
         BM    EZAERROR            *- an error
*
SELMASKS DS    0F
RSNDMASK DC    XL8'00000000'       *Read mask
RRETMASK DC    XL8'00000000'       *Returned read mask
WSNDMASK DC    XL8'00000000'       *Write mask
WRETMASK DC    XL8'00000000'       *Returned write mask
ESNDMASK DC    XL8'00000000'       *Exception mask
ERETMASK DC    XL8'00000000'       *Returned exception mask
*
NOSELCD  DC    A(0)                *Keep track of selected sd's
SELTIMEO DC    A(3600,0)           *One hour timeout
ECBSELE  DC    A(0)                *Select ECB
         DC    100X'00'            *Required by EZASMI
*
TPIMMAXD DC    AL4(50)             *Maximum descriptor number
*
ERRNO    DC    A(0)                *Errorno from EZASMI
RETCODE  DC    A(0)                *Returncode from EZASMI
```

In the above **select** call we use the asynchronous facilities of the Sockets Extended assembler macro interface. By placing an ECB parameter on the **EZASMI** macro call, the **select** call will not block our process; we will receive control immediately even if none of the specified socket descriptors had activity. You can use this technique, if you want to enter a wait, waiting for a series of events of which the completion of a **select** call is just one. In our sample application, we placed the main process into a wait from where it would return if any of the following

events occurred:

1. Socket descriptor activity occurred and the **select** call was posted.
2. One of our subtasks terminated unexpectedly.
3. The MVS operator issued a **Modify** command to stop the server.

If the reason for exiting the wait is socket activity, you must synchronize your task with the socket interface by issuing an **EZASMI Synchronize** call.

```
*-------------------------------------------------------------------*
* Synchronize after asynchronous SELECT call                        *
*-------------------------------------------------------------------*
         EZASMI TYPE=SYNC,          *Synchronize function               C
               ECB=ECBSELE,         *Select ECB plus 100 bytes workarea C
               ERRNO=ERRNO,                                             C
               RETCODE=RETCODE,                                         C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE       *Was everything OK
         BM    EZAERROR             *- No, some error
         ST    R15,NOSELCD          *Number of sd's selected
```

The areas pointed to by the return mask keywords on the previous **select** call is not filled in with the returned bit masks until you issue the **synchronize** call.

The number of socket descriptors with pending activity is returned in the **RETCODE** field. You must process all selected socket descriptors before you issue a new **select** call. A selected socket descriptor will only be selected once.

When a connection request is pending on the socket for which the main process issued the **listen** call, it will be reported as a pending read.

When the main process has given a socket, and the subtask has taken the socket, the main process socket descriptor is selected with an exception condition. The main process is expected to **close** the socket descriptor when this happens.

6.6 Accepting Connection Requests from Clients

4 If the listener socket was selected with a pending read, a new connection request has arrived, and the following socket call must be an **accept**:

```
*-------------------------------------------------------------------*
* ACCEPT the connection from a client                               *
*-------------------------------------------------------------------*
         EZASMI TYPE=ACCEPT,        *Accept new connection              C
               S=TPIMSNO,           *On listener socket descriptor      C
               NAME=SOCSTRUC,       *Returned client socket structure   C
               ERRNO=ERRNO,                                             C
               RETCODE=RETCODE,                                         C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE       *OK?
         BM    EZAERROR             *- No, error indicated
         STH   R15,NEWSOC           *Returned new socket descriptor
*
SOCSTRUC DS    0F                   *ACCEPT Socket address structure
SSTRFAM  DC    AL2(2)               *TCP/IP Addressing family
SSTRPORT DC    AL2(0)               *Port number
```

```
SSTRADDR DC    AL4(0)              *IP Address
SSTRRESV DC    8X'00'              *Reserved
*
TPIMSNO  DC    AL2(0)              *Listen socket descriptor
*
NEWSOC   DC    AL2(0)              *Returned socket descriptor
*
ERRNO    DC    A(0)                *Errorno from EZASMI
RETCODE  DC    A(0)                *Returncode from EZASMI
```

The **accept** call returns a new socket descriptor representing the connection with the client. The original listen socket descriptor is available for a new **select** call.

6.6.1 Give Socket to Subtask

The socket represented by the new socket descriptor has to be passed on to an available subtask. What technique the main process uses to find an available subtask is not so important. Let us assume that the main process has found an available subtask to which it gives the socket via a **givesocket** call.:

```
*-------------------------------------------------------------------*
* Give socket to subtask                                           *
*-------------------------------------------------------------------*
         MVC   CLNNAME,TPIMCNAM    *Our Client ID Address Space Name
         MVC   CLNTASK,TPISTCBE    *Give to this subtask
         EZASMI TYPE=GIVESOCKET,   *Givesocket                      C
               S=NEWSOC,           *Give this socket descriptor     C
               CLIENT=CLNSTRUC,    *- to a specific child process   C
               ERRNO=ERRNO,                                         C
               RETCODE=RETCODE,                                     C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *OK ?
         BM    EZAERROR            *- No, tell about it.
*
CLNSTRUC DS    0F                  *GIVESOCKET: Client structure
CLNFAM   DC    A(2)                *TCP/IP Adressing family
CLNNAME  DC    CL8' '              *Address space name of target
CLNTASK  DC    CL8' '              *Task ID of child process subtask
CLNRESV  DC    XL20'00'            *Reserved
*
NEWSOC   DC    AL2(0)              *Socket descriptor from Accept
*
ERRNO    DC    A(0)                *Errorno from EZASMI
RETCODE  DC    A(0)                *Returncode from EZASMI
```

If you are programming in C, for example, you may not be able to decide the full client ID of the subtask. In that case, you can pass the task ID field as eight blanks on the **givesocket** call, which means that any task within your own address space can take the socket. But only the task to which you pass the socket descriptor number will actually take it, so it is not a big exposure.

After you have issued the **givesocket** call, you must remember to include the given socket descriptor in the exception select mask on the next **select** call.

Your main process is now ready to wake up the selected subtask via a **POST** system call.

If there were no more sockets selected on the previous **select** call, your main process can now build a new set of select masks and issue a new **select** call.

6.6.2 Take Socket from Main Process

6 The subtask is brought back to life as a result of the **POST** system call issued from the main process, and it immediately issues a **takesocket** call to receive the socket, which was passed from the main process.

```
*-------------------------------------------------------------------*
* Take socket from main process                                     *
*-------------------------------------------------------------------*
         EZASMI TYPE=TAKESOCKET,   *Takesocket                      C
               CLIENT=TPIMCLNI,    *Main task client id structure   C
               SOCRECV=TPISSOD,    *Main task socket descriptor     C
               ERRNO=ERRNO,                                         C
               RETCODE=RETCODE,                                     C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *Did we do well ?
         BM    EZAERROR            *- No, deal with it.
         STH   R15,TPISNSOD        *Server subtask socket descr.no
*
TPIMCLNI DS    0C                  *Main task client id
TPIMCDOM DC    A(0)                *Domain: AF-INET
TPIMCNAM DC    CL8' '              *Our address space name
TPIMCTSK DC    CL8' '              *Main task TCB address in EBCDIC
         DC    20X'00'             *Reserved (part of clientid)
*
TPISSOD  DC    AL2(0)              *Parent socket descr. no.
TPISNSOD DC    AL2(0)              *Subtask socket descr. no.
```

In order to take a socket, the subtask must have knowledge of the client ID of the task that gave the socket and the socket descriptor used by that task. These values must be passed to the subtask from the main process before a **takesocket** call can be issued.

On the **takesocket** call, you specify the full client ID of the process that gave the socket, and you specify the socket descriptor number used by the process that gave the socket.

A new socket descriptor number to be used by the subtask is returned in the **RETCODE** field if the **takesocket** call is successful.

As soon as your subtask has taken the socket, the main process will be posted in its pending **select** with a pending exception activity, which means that the main process must close its socket descriptor.

From here on, processing is quite trivial.

7 The client sends its request to the subtask, which processes it and sends back a reply 8 .

9 Finally the client process and the server subtask close their sockets, and the server subtask enters a new wait for work status.

7.0 Chapter 7. Socket Client Programs

A socket based client program will use a subset of the socket calls we have discussed so far, plus a few extra, which are mainly used by client programs.

As many of the calls apply to both server and client programs, and we have shown both COBOL and assembler examples of server program socket calls until now; we will now illustrate the client socket calls with REXX samples.

From a socket point of view, there is no difference between a client program that executes in a normal MVS address space and one that executes in an IMS or CICS environment. There is a difference in programming language support. REXX sockets for example, is not supported in either IMS or CICS environments.

For a sample COBOL based client, please see "Sample Stream Socket COBOL Client" in topic B.2.

For a sample REXX based client, please see "REXX Client" in topic E.1 or "TPI REXX Client" in topic H.2.1.

7.1 General REXX Subroutine for Socket Calls

In the sample REXX programs we developed, we packaged the actual REXX socket call into a REXX subroutine in order to enable easy tracing facilities. If we had problems with the socket calls, we could just add the appropriate REXX statements to this one subroutine, and we would enable trace output for all socket calls.

See "TPI REXX Client" in topic H.2.1 for a sample REXX that uses this subroutine with trace points imbedded.

We called the subroutine *DoSocket*.

```
/*--------------------------------------------------------------------*/
/*                                                                    */
/* DoSocket procedure.                                                */
/*                                                                    */
/* Do the actual socket call, and parse the return code.              */
/* Return rest of string returned from socket call.                   */
/*                                                                    */
/*--------------------------------------------------------------------*/
DoSocket:
  numargs = arg()                          /*Number of passed args */
  argstring = ''                           /*Init arg string       */
  do subix=1 to numargs                    /*Build argument string */
    argstring = argstring||'arg('subix')'  /*for the socket call   */
    if subix<numargs then do               /*If not last argument -*/
       argstring = argstring||','          /*add a comma           */
    end                                    /*                      */
  end                                      /*                      */
```

```
    msgstat = msg()                          /*Save message status   */
    z = msg("OFF")                           /*Turn messages off     */
    interpret 'Parse value Socket('||argstring||') with sockrc sockres'
    z = msg(msgstat)                         /*Restore message status*/
  return sockres                             /*Return socket result  */
```

7.2 Initializing the Socket API

If you use the Sockets Extended programming interfaces, you will have to issue the **initapi** call in order to establish your client programs clientID with the TCP/IP system address space.

In a REXX program you use the **initialize** call to do this:

```
  /*-------------------------------------------------------------------*/
  /* Initialize REXX socket interface                                  */
  /*-------------------------------------------------------------------*/
  sockval = DoSocket('Initialize', 'tpirexxc')
  if sockrc <> 0 then do
     say 'Socket initialize failed, rc='sockrc
     say sockval
     exit(sockrc)
  end
```

A REXX socket program will get a client ID, where the address space name is set to the correct address space name and the task ID is set to the value of the first parameter passed on the **initialize** call, which in the above scenario is a text string with the value **tpirexxc**.

7.2.1 Getclientid

7.2.1 Getclientid

You use the **getclientid** call to obtain the client ID by which your program has been identified to the TCP/IP address space.

A **getclientid** call will in REXX look like:

```
  /*-------------------------------------------------------------------*/
  /* Get our client ID                                                 */
  /*-------------------------------------------------------------------*/
  sockval = DoSocket('Getclientid')
  if sockrc <> 0 then do
     say 'Getclientid failed, rc='sockrc
     say sockval
     exit(sockrc)
  end
```

The client ID is returned as a string. In the above example, the value of the returned string is:

```
  AF_INET TSOUSER1 tpirexxc
```

Domain is AF_INET, address space name is TSO user ID and task ID is the value that was passed on the **initialize** call.

7.3 Connecting a Client to a Server

If you know the IP address of the server, you can go on issuing a **socket** call followed by a **connect** call.

If you only know the host name, you will have to resolve the host name into one or more IP addresses using the **gethostbyname** call.

```
/*-------------------------------------------------------------------*/
/* Find IP addresses of server host                                  */
/*-------------------------------------------------------------------*/
servipaddr = DoSocket('Gethostbyname', tpiserver)
if sockrc <> 0 then do
   say 'Gethostbyname failed, rc='sockrc
   say sockval
   x=Doclean
   exit(sockrc)
end
```

The REXX **gethostbyname** call returns a list of IP addresses if the host is a multihomed host. You can parse the REXX string and place the IP addresses into a REXX stem variable using the following piece of REXX code:

```
/*-------------------------------------------------------------------*/
/* Parse returned IP address list                                    */
/*-------------------------------------------------------------------*/
numips = words(servipaddr)
do i = 1 to numips
  sipaddr.i = word(servipaddr, i)
end
sipaddr.0 = numips
```

When you issue a **connect** call to an IP address that is currently not available, your connect call will eventually time out, giving an error number of 60 (ETIMEDOUT). The socket you used on such a failed **connect** call cannot be reused for another **connect** call. If you try to do it, you will receive error number 22 (EINVAL). You have to close the socket, and get a new socket before you reissue the **connect** call with the next IP address in the list of IP addresses that were returned by the **gethostbyname** call.

The **connect** call can be placed in a loop that is terminated when either a connect is successful or the list of IP addresses is exhausted.

```
    /*-------------------------------------------------------------------*/
    /*                                                                   */
    /* Get a socket and try to connect to the server                     */
    /*                                                                   */
    /* If connect fails (ETIMEDOUT), we must close the socket,           */
    /* get a new one and try to connect to the next IP address           */
    /* in the list, we received on the gethostbyname call.               */
    /*                                                                   */
    /*-------------------------------------------------------------------*/
    i = 1
    connected = 0
    do until (i > sipaddr.0 | connected)
       sockdescr = DoSocket('Socket')
       if sockrc <> 0 then do
          say 'Socket failed, rc='sockrc
          exit(sockrc)
       end
```

```
      name = 'AF_INET '||tpiport||' '||sipaddr.i
      sockval = DoSocket('Connect', sockdescr, name)
      if sockrc = 0 then do
         connected = 1
      end
      else do
         sockval = DoSocket('Close', sockdescr)
         if sockrc <> 0 then do
            say 'Close failed, rc='sockrc
            exit(sockrc)
         end
      end
      i = i + 1
   end
   if ,connected then do
      say 'Connect failed, rc='sockrc
      exit(sockrc)
   end
```

7.3.1 Accessing a Host Entry Structure with EZACIC08

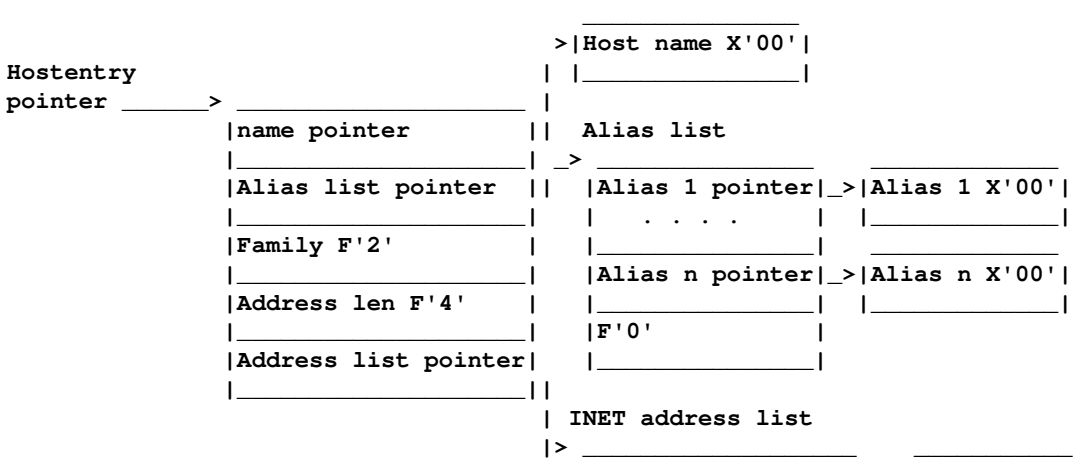
7.3.1 Accessing a Host Entry Structure with EZACIC08

If you develop your socket program in other programming languages other than REXX, the **gethostbyname** call will not return a string with IP addresses but a pointer to a storage area that is known as a *host entry structure* or, for short, a HOSTENT structure. A **gethostbyaddress** call will also return a host entry structure to your program.

The host entry structure may be complicated depending on the number of aliases and IP addresses a given host has.

If you develop your programs in assembler, this structure is quite straight forward and does not impose any major problems to you. But if you develop your program in, for example, COBOL, you could have problems extracting relevant information from this structure because COBOL is not famous for its pointer manipulation features.

IBM TCP/IP for MVS supplies you with a routine that makes it more simple to extract information from the host entry structure. The name of this routine is EZACIC08.



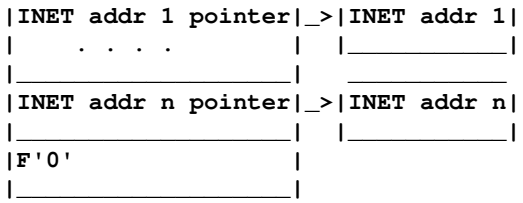


Figure 39. Host Entry Structure

The notation *X'00'* is used to show that the value is a variable length string that is terminated by a null-byte.

In a COBOL program, the **gethostbyname** call and the use of EZACIC08 followed by a **socket** call and a **connect** call could be implemented as follows:

```
*-------------------------------------------------------------*
* Variables used for socket calls in general                  *
*-------------------------------------------------------------*
 01  errno                        pic 9(8) binary value zero.
 01  retcode                      pic s9(8) binary value zero.
*-------------------------------------------------------------*
* Variables used for the GETHOSTBYNAME Call                   *
*-------------------------------------------------------------*
 01  soket-gethostbyname          pic x(16) value 'GETHOSTBYNAME   '.
 01  host-namelen                 pic 9(8) Binary Value 5.
 01  host-name                    pic x(5) Value 'mvs18'.
 01  host-entry-addr              pic x(4) Value low-value.
*-------------------------------------------------------------*
* Variables used for the call to EZACIC08                     *
*-------------------------------------------------------------*
 01  host-alias-seq               pic 9(4) Binary Value zero.
 01  host-addr-seq                pic 9(4) Binary Value zero.
 01  host-name-length             pic 9(4) Binary Value zero.
 01  host-name-value              pic x(255) Value space.
 01  host-alias-count             pic 9(4) Binary Value zero.
 01  host-alias-length            pic 9(4) Binary Value zero.
 01  host-alias-value             pic x(255) Value space.
 01  host-addr-type               pic 9(4) Binary Value zero.
 01  host-addr-length             pic 9(4) Binary Value zero.
 01  host-addr-count              pic 9(4) Binary Value zero.
 01  host-addr-value              pic x(4) Value low-value.
 01  host-return-code             pic s9(8) Binary Value zero.
*-------------------------------------------------------------*
* Variables used for the CONNECT Call                         *
*-------------------------------------------------------------*
 01  soket-connect                pic x(16) value 'CONNECT         '.
 01  server-socket-address.
     05  server-afinet            pic 9(4) Binary Value 2.
     05  server-port              pic 9(4) Binary Value 3001.
     05  server-ipaddr            pic x(4) Value low-value.
     05  filler                   pic x(8) value low-value.
 01  connect-status               pic 9(4) Binary value zero.
     88  connect-done             value 1.

*-------------------------------------------------------------*
* Get IP addresses out of the HOST Entry structure.           *
*                                                             *
```

```
* Loop pulling IP addresses out of the host entry structure,    *
* getting a socket and trying to connect to IP address.         *
*                                                               *
* Loop until the returned list of IP addresses is               *
* exhausted or a connect is successful                          *
*---------------------------------------------------------------*

     Move zero to connect-status.
     Perform until ((host-addr-count = host-addr-seq and
        host-addr-seq > 0) or
        connect-done)
        If host-alias-seq > host-alias-count then  1
           subtract 1 from host-alias-seq
        end-if
        Call 'EZACIC08' using host-entry-addr
           host-name-length
           host-name-value
           host-alias-count
           host-alias-seq
           host-alias-length
           host-alias-value
           host-addr-type
           host-addr-length
           host-addr-count
           host-addr-seq
           host-addr-value
           host-return-code
        If host-return-code < 0 then
           - process error -
        end-if
        Move host-addr-value to server-ipaddr

*---------------------------------------------------------------*
* Get an AF_INET socket to use for connect                      *
*---------------------------------------------------------------*

        Call 'EZASOKET' using soket-socket
           afinet
           soctype-stream
           proto
           errno
           retcode
        If retcode < 0 then
           - process error -
        end-if
        Move retcode to socket-descriptor

*---------------------------------------------------------------*
* Try to connect to iterative server on returned IP address     *
*---------------------------------------------------------------*

        If host-return-code = 0 then
           Call 'EZASOKET' using soket-connect
              socket-descriptor
              server-socket-address
              errno
              retcode
           If retcode < 0 then
              Call 'EZASOKET' using soket-close
                 socket-descriptor
                 errno
                 retcode
```

```
               If retcode < 0 then
                  - process error -
               end-if
            else
               move 1 to connect-status
            end-if
         end-if
      end-perform.

      if not connect-done then
         - process error -
      else
         - connected to server -
      end-if
```

1 Each call to EZACIC08 will advance the alias sequence and address sequence numbers. In this context we are only interested in the IP addresses; so, in order to avoid a retcode -2 from EZACIC08, we reset the alias sequence to the last alias sequence number if the alias sequence number exceeds the available alias names.

Please note that EZACIC08 may return the following return code values:

-1 The host entry structure is invalid.

-2 The alias sequence field is invalid (greater than the alias count field).

-3 The address sequence field is invalid (greater than the address count field).

7.4 Closing the Socket

When your client program has connected to the server, they can exchange whatever amount of data they find relevant until one of them closes down the socket.

```
/*-------------------------------------------------------------------*/
/* Close the socket                                                  */
/*-------------------------------------------------------------------*/
sockval = DoSocket('Close', sockdescr)
if sockrc <> 0 then do
   say 'Socket Close failed, rc='sockrc
   say sockval
   exit(sockrc)
end
```

7.5 Terminating the REXX Socket API

In a REXX socket environment you will finish off using the socket interface with a **terminate** socket call.

```
/*-------------------------------------------------------------------*/
/* Terminate socket interface                                        */
/*-------------------------------------------------------------------*/
sockval = DoSocket('Terminate')
if sockrc <> 0 then do
   say 'Terminate failed, rc='sockrc
   say sockval
```

```
    exit(sockrc)
end
```

8.0 Chapter 8. Datagram Socket Programs

This chapter explains the special characteristics of a datagram socket program that uses UDP protocols.

Please see Appendix A, "Sample Datagram Socket Programs" in topic A.0 for sample datagram socket programs.

8.1 Datagram Socket Characteristics

The most significant characteristics of datagram sockets are as follows:

1. Datagram sockets are connection-less.

   There is no connection setup done by the UDP protocol layer. No data is exchanged between sending and receiving UDP protocol layers until your application issues its first **send** call.

   If your UDP server program has not been started or it resides on a host that is currently unreachable from your client host, your client UDP application may wait forever for a reply to the datagram it sent to a UDP server. You will normally have to implement time-out logic in your client UDP program to detect this situation.

2. The UDP protocol layer does not implement any reliability functions.

   The implication of this is that a datagram sent from one UDP program to another may never arrive. Neither the sending program nor the anticipated receiving program will ever learn from the UDP protocol layer that such a condition exists.

   If your UDP application requires reliability, you must implement reliability code in your UDP client and server programs. This includes the ability to detect missing datagrams, datagrams arriving out of sequence, duplicated datagrams or corrupted datagrams.

   It is not a trivial matter to implement such functions, and we recommend you use the TCP protocols and not the UDP protocols if your application has strict reliability requirements.

3. Unlike a TCP socket, where there is no one-to-one relationship between **send** calls and **recv** calls, a UDP socket **send** corresponds to exactly one UDP socket **recv** call.

8.2 Datagram Socket Program Structure

The terms client and server are somewhat misleading for datagram socket programs. Two socket programs that have each bound a socket to a local address may send any number of datagrams to each other in any sequence.

The program that sends the first datagram will, in our terminology, act as a client. Any datagram sent to a destination address for which no program has bound a socket is lost. Care must be taken so that the program you intend to be the client does not begin sending datagrams until after the server program has bound its socket to the expected destination address.

The typical structure for a datagram socket server is a structure that resembles the iterative server we defined in "Iterative Server" in topic 3.7.1.

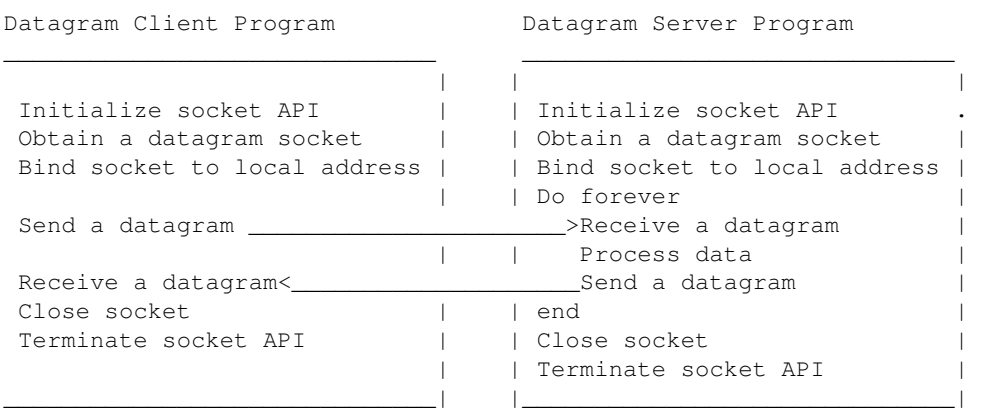


Figure 40. Datagram Server Program Structure

The server program must bind its socket to a predefined server port number, so the clients know to which port they should send their datagrams. In the socket address structure that the server passes on the **bind** call, it can specify if it will accept datagrams from all the available network interfaces, or if it will only receive incoming datagrams from a specific network interface. This is done by setting the IP address field of the socket address structure to either INADDR_ANY or a specific IP address.

The client program will also need to bind its socket to a local address, if it wants the server program to be able to return a datagram to it. In contrast to the server, the client does not need to specify any specific port number on the **bind** call; an ephemeral port number chosen by the UDP protocol layer will be sufficient. This is called a dynamic bind.

The server enters a blocking **recvfrom** call. In this example, we use the **recvfrom** call, because in addition to a datagram, it also returns the remote socket address. Our UDP server needs that address in order to return a reply to the client, which it does by issuing a **sendto** call, where it passes both a datagram and the remote socket address of the client as parameters on the call.

After the server has processed one request, it loops back into a new blocking **recvfrom** call, waiting for another datagram from possibly another client.

If more UDP datagrams arrive in the UDP protocol layer destined for the server UDP socket, the UDP protocol layer queues those datagrams and passes them to the server one after the other on succeeding **recvfrom** calls.

The UDP receive queue size in IBM TCP/IP Version 3 Release 1 for MVS is by default 20, but you can customize IBM TCP/IP for MVS to use an unlimited queue size by specifying the NOUDPQUEUELIMIT keyword in the ASSORTEDPARMS section of the *tcpip.v3r1*.PROFILE.TCPIP configuration data set.

If the UDP receive queue exceeds its maximum size, any excess datagrams are discarded without further notification.

8.3 Use of Connect on a Datagram Socket

You are able to use the **connect** call on a datagram socket, but it does not perform the same function for a datagram socket as it does for a stream socket.

On a **connect** call, you specify the remote socket address you want to exchange datagrams with. This serves two purposes:

1. On succeeding calls to send datagrams, you can use the **send** call without specifying a destination socket address. The datagram will be sent to the socket address you specified on the **connect** call.

2. On succeeding calls to receive datagrams, only datagrams that originate from the socket address you specified on the **connect** call will be passed to your program from the UDP protocol layer.

Please remember, that a **connect** call for a datagram socket does not establish any connection. No data is exchanged over the IP network as a result of a **connect** call for a datagram socket. The functions performed are local, and control is returned to your application immediately.

8.4 Transferring Data Over a Datagram Socket

If you are use to the MVS notion of records, it is extremely simple to transfer data over a datagram socket. You send and you receive records of data. One **send** call results in exactly one **recv** call.

If your sending program sends a datagram of, for example, 8192 bytes and your receiving program issues a **recv** call, where it specifies a buffer size of, for example, 4096 bytes, it will receive the 4096 bytes it requested and the remaining 4096 bytes in the datagram will be discarded by the UDP protocol layer without further notification to either sender or receiver.

9.0 Chapter 9. IMS Sockets

This chapter includes information on how you develop IMS applications that use the IMS sockets feature of IBM TCP/IP for MVS.

We will explain how IMS sockets is implemented in IBM TCP/IP Version 3 Release 1 for MVS and discuss the impact this implementation has on your application design.

For basic socket programming information, please refer to Chapter 5, "Your First Socket Program" in topic 5.0.

If you need IMS socket call reference information or information on how

you customize the IMS socket feature, please see *IBM TCP/IP for MVS: IMS TCP/IP Application Development Guide and Reference*, SC31-7186, and *MVS TCP/IP V3R1 Implementation Guide*, GG24-3687.

9.1 IMS and TCP/IP Networks

You may roughly divide IMS applications into the following two major groups:

1. IMS applications that communicate with a user based on the traditional IBM 3270 protocol

   The IMS applications typically use the Message Formatting Services (MFS) component of IMS to translate between the 3270 data stream and the record oriented data format, the IMS applications use.

   If the end user is connected via a TCP/IP network, the end user can use TN3270 emulation software to emulate an IBM 3270 terminal. From an IMS point of view, such a terminal is a fully normal IBM 3270 terminal, and no extra software is needed in IMS to support such connections. All existing IBM 3270 based IMS applications can be used from TCP/IP workstations in this way.

2. IMS applications that communicate with another application in a typical client/server fashion

   The programming interfaces used by IMS client/server applications vary and depend on the ability of both the client and the server platform:

   Advanced Program to Program Communication (APPC) is supported by IMS.

   IMS applications may use the Common Programming Interface Communications (CPI-C) API for such applications. If the client platform supports the LU6.2 protocols, those protocols offer you many good features that you will not find in, for example, TCP or UDP protocols. Such features are session and conversation security, synchronization levels and conversation state control.

   Message Queuing Interface (MQI) applications are supported by IMS.

   If your applications are fully asynchronous in nature, and both your IMS platform and your partner platform supports MQI applications, this is an easy way to implement client/server applications.

   Distributed Computing Environment / Remote Procedure Call (DCE/RPC) server applications are supported in IMS if you use the MVS/ESA OpenEdition Distributed Computing Environment Application Support Server for IMS (IMS/AS) feature.

   If your partner program resides on a platform that supports the Distributed Computing Environment, DCE/RPC is both a good and strategic choice. Remote Procedure Call APIs are generally easier

to use than native socket APIs, because RPC APIs hide many of the differences in data formats you typically find in a distributed environment. DCE/RPC also includes directory services that will assist your clients in locating a server and integrating security features based on the DCE security implementation.

Native socket APIs are supported in the IMS environment if you install the IBM TCP/IP Version 3 Release 1 for MVS IMS sockets feature.

IMS sockets have been developed to provide access to IMS resources from hosts that only support TCP/IP and the native socket APIs. Currently you will find many platforms that do not support either SNA LU6.2 or DCE/RPC but do support native TCP/IP.

9.2 Overview of IMS Sockets

The IMS socket feature consists of software that enables you to use socket programs in an IMS dependent region. As we defined in "General Socket Program Structure" in topic 3.7, socket programs can fall into the following three categories:

1. Client programs that request services from a server program

   Any IMS application can turn itself into a socket client by issuing the proper socket calls for a socket client.

   The IMS application can be a Message Processing Program (MPP) or a Batch Message Program (BMP) that has been scheduled by traditional IMS methods.

2. Iterative server programs that process client requests one at a time in a serial fashion

   Such a server program will typically be a BMP that is started once and sits around forever to serve client requests serially. From an IMS socket point of view, an iterative server may also be implemented as an MPP; but that is not expected to be a typical implementation because of the region occupancy characteristics of an iterative server program.

3. Concurrent server programs that consist of both a concurrent server main process (the scheduling process) and a number of parallel child processes that process the client requests in parallel

   The IMS sockets implementation of a concurrent server in IMS is based on a BMP that runs the concurrent server main process and a number of Message Processing Regions (MPR) that execute the concurrent server child processes. The main process inserts IMS transaction requests to the IMS message queues, and IMS schedules these transactions in the MPRs.

The IMS socket feature includes the following two components:

The IMS listener

The IMS listener is a generic concurrent server main process.

The IMS listener is supplied as a general purpose concurrent server main process. If you have requirements that go beyond the features of

this general purpose implementation, you are able to write your own concurrent server main process and use that instead of the IMS listener.

The IMS assist module

The IMS assist module enables you to develop concurrent server programs that use the normal IMS call API to receive and send data over a socket. This mode of programming is called *implicit-mode* as opposed to programs that include explicit socket calls, called *explicit-mode* programs. In an implicit-mode COBOL IMS sockets program, you call CBLADLI instead of the normal CBLTDLI module, but the call syntax is identicical. For PLI programs, you use PLIADLI; for assembler programs, you use ASMADLI, and for C programs you use CADLI. We will use the collective term xxxADLI for all four assist module entry points. Please note that the AIBTDLI programming interface that was introduced with IMS/ESA Version 3.3 is *not* supported by the IMS sockets assist module.

Client programs and iterative server programs can only be developed as explicit-mode programs. Server programs that are started by the IMS listener may be developed as either explicit-mode or implicit-mode programs.

See Figure 41 for an overview of the structure of IMS sockets.

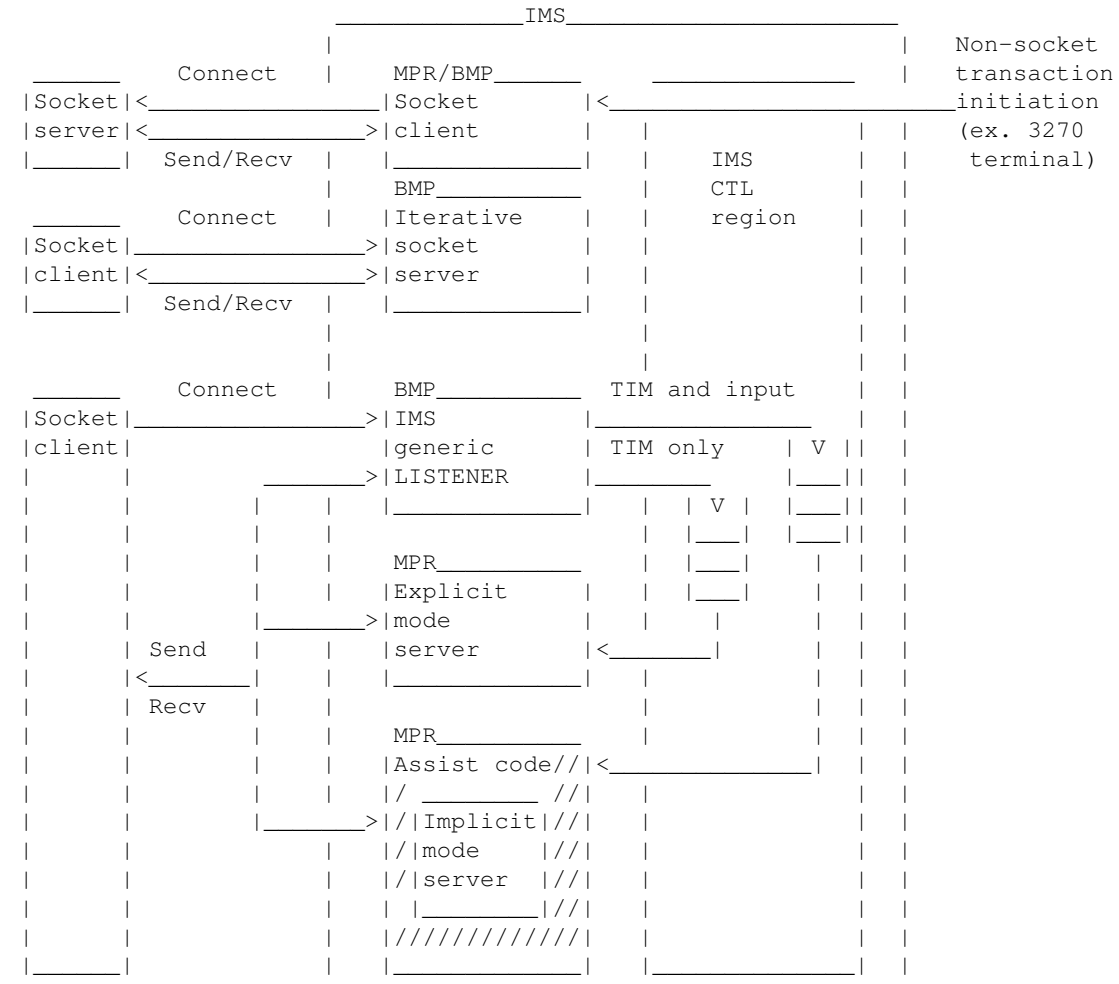


Figure 41. IMS Sockets Structural Overview

IMS sockets do not introduce any new programming interfaces. IMS sockets utilize existing APIs:

- The C-socket API for IMS sockets explicit-mode applications written in C
- The Sockets Extended call API for IMS sockets explicit-mode applications written in, for example, COBOL or PL/I
- The IMS call API for IMS sockets implicit-mode applications written in any IMS supported programming language

IMS sockets do not limit your programs to stream sockets (TCP protocols). You may also use datagram sockets (UDP protocols) or even raw sockets (IP protocols). Due to the unreliable nature of both datagram sockets and raw sockets, most IMS socket applications are assumed to use stream sockets. The IMS listener will only accept transaction requests via stream sockets.

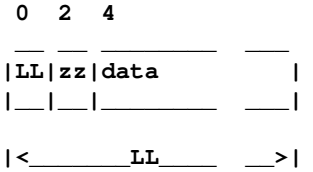
Client and iterative server IMS socket applications are not different in design or implementation from any normal MVS client and iterative server socket applications, so we will not describe these in further detail in this chapter. Instead, refer to Chapter 5, "Your First Socket Program" in topic 5.0 and Chapter 7, "Socket Client Programs" in topic 7.0 for information on such programs.

9.3 Concurrent Server in an IMS Environment

It is expected that the major part of your IMS socket applications will be based on the concurrent server implementation using the IMS listener, and this implementation is what the rest of this chapter will focus on.

The following section will define some terms that are used by the IMS sockets implementation:

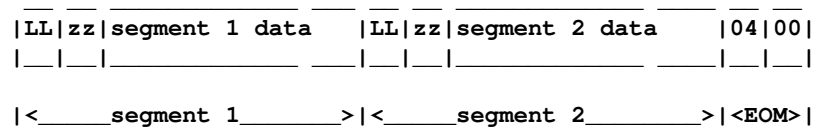
segment — A segment is a segment of data that is formatted according to IMS message standards, where the first 2 bytes contains the length in binary network byte order of the data including the length bytes:



The value of the **zz** field is not defined; we recommend you initialize it to binary zeroes.

message — A message is a sequence of segments where the last segment is an End Of Message (EOM) segment:

A message may consist of many segments, terminated by an EOM segment.



9.3.1 IMS Listener Security Exit

You can optionally develop an exit routine to be included in the IMS listener. The exit routine is called IMSLSECX, and it is called by the IMS listener every time a new transaction request message is received.

The user exit is passed the client IP address, the client port number, and the optional user data area of the TRM. See *IBM TCP/IP for MVS: IMS TCP/IP Application Development Guide and Reference*, SC31-7186, for details on the exit interface.

You can define an installation standard for your IMS socket environment that covers the layout and content of the optional user data area in the TRM.

In the ITSO-Raleigh sample installation, we defined the following layout of the user data area in the TRM:

```
USERID      8 bytes user ID of client user
PASSWORD    8 bytes password of client user
NEWPASW     8 bytes optional new password of client user
GROUP       8 bytes optional RACF group ID
```

The sample security exit that was developed in the ITSO-Raleigh installation performs the following functions:

1. Authenticate the user by issuing a RACROUTE REQUEST=VERIFY.

2. Test if the user is authorized to run the requested IMS transaction code through the IMS socket interface by issuing a RACROUTE REQUEST=AUTH for a FACILITY class resource called TPI.IMSSOCK.*trancode*, where *trancode* is the IMS transaction code the client user wants to start.

You could add additional checks based on the client IP address and/or port number.

Depending on the above security checks, the TRM request is accepted or an appropriate return code and reason code is returned to the client in the

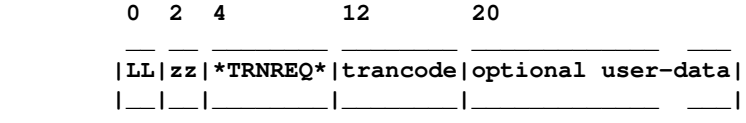
RSM segment.

See "IMS Listener Security Exit" in topic C.4 for the sample IMS listener security exit.

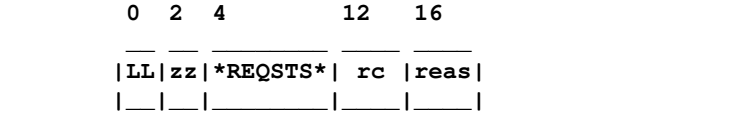
9.3.2 Remote Client Design Considerations

Use of the IMS listener imposes some design restrictions on your client program:

- When the client has established a connection with the IMS listener, it must send a Transaction Request Message (TRM) segment with a layout as expected by the IMS listener.



- The client must be prepared to receive a Request Status Message (RSM) segment from the IMS listener, in case the IMS listener can not initiate the requested transaction successfully.



- The returncode and reasoncode are returned as binary 2 byte fields with the appropriate codes in network byte order.

- The possible codes are defined in *IBM TCP/IP for MVS: IMS TCP/IP Application Development Guide and Reference*, SC31-7186, and by your listener security exit.

If the server program is an explicit-mode server program, the rest of the interactions between the client and the server are left to be designed by you. You are free to implement as many interactions (send / receive) sequences as required by your application. There are no restrictions on format, length or number of interactions.

If the server program is an implicit-mode server program, there are more client design considerations that must be taken into account. Please see "Implicit-mode Server Program" in topic 9.3.4, for information on these additional considerations.

Your client programs must include logic that examines the first received data from IMS to decide if it is an RSM segment that rejects the transaction or if it is valid output from the IMS server program. One technique to simplify this is always to let the server program send a positive RSM segment as the first output. A positive RSM segment can be defined as an RSM segment with rc=0 and reason code=0. In this way the client program will always receive an RSM segment. It is either a

confirmation that the transaction request was successfully started or that it was rejected, and the client program can act accordingly.

When the IMS listener receives a valid TRM segment, it inserts a Transaction Initiation Message (TIM) segment on an IO Program Control Block (IO PCB) in order to let IMS schedule the proper MPP.

All IMS transaction codes that the IMS listener must be able to initiate are defined in a configuration data set that is read by the IMS listener program when it is started. If a client sends a TRM segment with an IMS transaction code that is not defined in this configuration data set, the request will be rejected with a reason code of 1 in the RSM segment.

For every IMS transaction code in the IMS listener configuration data set, there is an attribute associated that tells the IMS listener if the transaction is implemented as an explicit-mode or as an implicit-mode server program. The reason for this attribute is that the IMS listener process is different for explicit-mode and implicit-mode server programs.

9.3.3 **Explicit-mode Server Program**

For an explicit-mode server program, the IMS listener only inserts the TIM on the IMS message queue. When the server MPP is scheduled by IMS, it receives the TIM on its initial Get Unique (GU) on the IO PCB. All the data exchanged between the client and the server program are handled via explicit socket calls in the server.

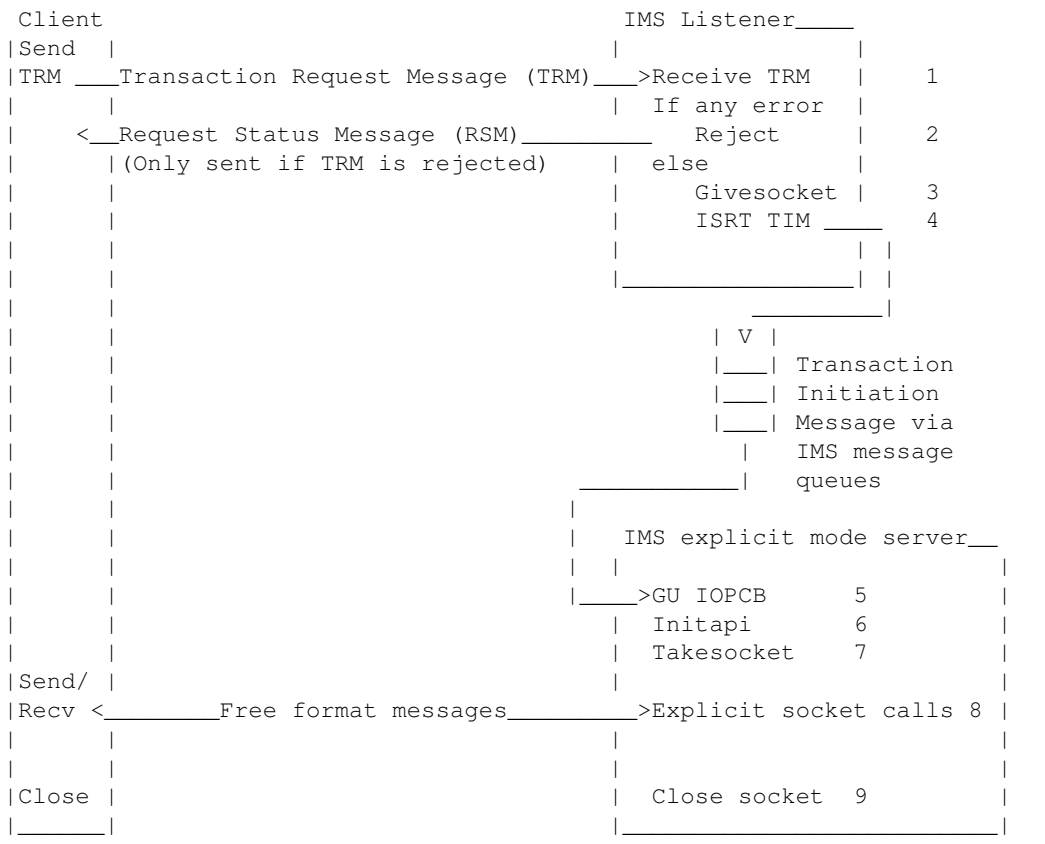


Figure 42. Explicit-mode Server Program Initiation

The sequence numbers in the following explanation are all related to Figure 42.

The sample data structures and coding examples are provided in COBOL.

The IMS listener is started as an IMS Batch Message Program (BMP) that opens a socket and listens on a port that you define for connections from the TCP/IP network and retrieval 1 of Transaction Request Messages (TRM) from TCP/IP clients.

The layout of a TRM without optional user security data is:

```
*-----------------------------------------------------------------*
* Transaction Request Message segment                             *
*-----------------------------------------------------------------*
 01  TRM-message.
     05  TRM-length-ll              pic 9(4) Binary Value 20.
     05  TRM-length-zz              pic x(2) Value low-value.
     05  TRM-id                     pic x(8) Value '*TRNREQ*'.
     05  TRM-trancode               pic x(8) Value 'TRANCODE'.
     05  TRM-security-data.
```

If your installation has implemented an IMS listener security exit routine, you pass the required security related data as part of the TRM segment. You do so by extending the segment with your data following the TRM-trancode field. Remember to update the TRM-length-ll field with the correct segment length according to your extension.

2 If a condition that is detectable by the IMS listener prevents it from scheduling the requested IMS transaction, it will send back a Request Status Message (RSM) segment to the client, informing the client of the cause of rejection.

The format of an RSM segment is:

```
*-----------------------------------------------------------------*
* Transaction Request Status Message segment                      *
*-----------------------------------------------------------------*
 01  RSM-message.
     05  RSM-length-ll              pic 9(4) Binary Value 20.
     05  RSM-length-zz              pic x(2) Value low-value.
     05  RSM-reqsts                 pic x(8).
         88  RSM-msg                Value '*REQSTS*'.
     05  RSM-return-code            pic 9(8) Binary Value zero.
         88  RSM-OK                 Value zero.
         88  RSM-error              Value 8.
     05  RSM-reason-code            pic 9(8) Binary Value zero.
         88  RSM-not-defined        Value 1.
         88  RSM-IMS-error          Value 2.
         88  RSM-buffer-full        Value 4.
         88  RSM-AIB-error          Value 5.
         88  RSM-tran-unavailable   Value 6.
         88  RSM-format-error       Value 7.
```

3 If the TRM is accepted, the IMS listener issues a **givesocket** call, where it gives the socket to the child process.

The IMS listener constructs an address space name and a task ID to be used by the child process. The address space name is constructed according to the **ADDRSPCPFX** keyword value in the listener configuration data set. If this value is for example **IL**, the address space names generated by the listener will be **IL000000** and upwards. The task ID is set to a fixed value of **IMSERVER**.

This information is passed in the TIM to the child process. If the child process is a Sockets Extended program, it can use these values on its **initapi** call.

4 Based on information in the TRM, the IMS listener initiates IMS transactions by inserting IMS messages, called Transaction Initiation Messages (TIM), over an IMS alternate IO PCB.

5 The concurrent server child processes are scheduled as normal IMS message processing programs that retrieve the TIM on their first Get Unique (GU) on the IO PCB.

```
*-------------------------------------------------------------*
* Transaction Initiation Message segment                      *
*-------------------------------------------------------------*
 01  TIM-message.
     05  TIM-length-ll              pic 9(4) Binary Value zero.
     05  TIM-length-zz              pic x(2) value low-value.
     05  TIM-id                     pic x(8) value space.
     05  TIM-lstn-name              pic x(8) value space.
     05  TIM-lstn-task              pic x(8) value space.
     05  TIM-srv-name               pic x(8) value space.
     05  TIM-srv-task               pic x(8) value space.
     05  TIM-lstn-socketid          pic 9(4) Binary value zero.
     05  TIM-tcpip-name             pic x(8) value space.
     05  TIM-data-type              pic 9(4) value zero.
         88  TIM-ascii              value 0.
         88  TIM-ebcdic             value 1.

*-------------------------------------------------------------*
* Receive TIM from listener                                   *
*-------------------------------------------------------------*
     Call 'CBLTDLI' using dli-gu
        iopcb
        TIM-message.
     If iopcb-status = 'QC' then
        Move zero to return-code
        Goback.
```

Please note that the TIM message segment includes a half-word where you can test the contents to decide if the client process is an ASCII client or an EBCDIC client. The IMS listener is able to make that decision based on the fixed text (*TRNREQ*) in the TRM.

```
*-------------------------------------------------------------*
* If client is ascii, translate RSM text to ascii before send *
*-------------------------------------------------------------*
     If TIM-ascii then
        Move 8 to ezacic-len
        Call 'EZACIC04' using RSM-oky
           ezacic-len.
```

6 If the child process is an Sockets Extended application, it starts

with an **initapi** call, where it identifies itself as a client of the TCP/IP address space named in the TIM (TIM-tcpip-name). It is recommended that the child process identifies itself with the client ID constructed by the IMS listener and passed to the child process in the TIM (TIM-srv-name and TIM-srv-task); but, in the IBM TCP/IP Version 3 Release 1 for MVS implementation, it is actually not a requirement. The IMS listener does not give the socket to a specific client ID but rather to a client ID with a blank address space name and task name. This means that any task that refers to a socket descriptor that has been given by the IMS listener, but not yet taken, will receive it. This is, under normal circumstances, not a big exposure because the time period between the **givesocket** and the **takesocket** is normally less than a few hundred milliseconds.

```
*---------------------------------------------------------------*
* Variables used for the INITAPI call                           *
*---------------------------------------------------------------*
 01  soket-initapi                pic x(16) value 'INITAPI'.
 01  maxsoc                       pic 9(4) Binary Value 50.
 01  initapi-ident.
     05  tcpname                  pic x(8) Value space.
     05  myjobname                pic x(8) Value space.
 01  subtask                      pic x(8) value space.
 01  maxsno                       pic 9(8) Binary Value zero.
 01  errno                        pic 9(8) binary value zero.
 01  retcode                      pic s9(8) binary value zero.

*---------------------------------------------------------------*
* Initialize socket API with the values, we got from            *
* the IMS listener.                                             *
*---------------------------------------------------------------*
     Move TIM-srv-name to myjobname.
     Move TIM-srv-task to subtask.
     Move TIM-tcpip-name to tcpname.
     Call 'EZASOKET' using soket-initapi
        maxsoc
        initapi-ident
        subtask
        maxsno
        errno
        retcode.
     If retcode < 0 then
        - process error -
```

7 When the child process has identified itself, it can issue a **takesocket** call to take over the socket from the listener.

```
*---------------------------------------------------------------*
* Variables used by the TAKESOCKET Call                         *
*---------------------------------------------------------------*
 01  soket-takesocket             pic x(16) value 'TAKESOCKET      '.
 01  take-from-clientid.
     05  take-from-domain         pic 9(8) Binary Value 2.
     05  take-from-name           pic x(8) value space.
     05  take-from-task           pic x(8) value space.
     05  filler                   pic x(20) value low-value.
 01  errno                        pic 9(8) binary value zero.
 01  retcode                      pic s9(8) binary value zero.
 01  socket-descriptor            pic 9(4) Binary value zero.

*---------------------------------------------------------------*
* Issue a take-socket with the values we got from               *
```

```
* the IMS listener.                                                *
*-----------------------------------------------------------------*
     move TIM-lstn-name to take-from-name.
     move TIM-lstn-task to take-from-task.
     Call 'EZASOKET' using soket-takesocket
        TIM-lstn-socketid
        take-from-clientid
        errno
        retcode.
     If retcode < 0 then
        - process error -
     else
        move retcode to socket-descriptor.
```

On the **takesocket** call, the child process passes the client ID of the IMS listener as the client ID of the process that gave the socket.

8 The socket is now fully transferred to the child process, and the socket applications may exchange data with each other. When you use explicit-mode, your server program is responsible for applying any required translation to the data it receives or transmits.

9 Finally the client and the server child processes close their sockets and break the connection.

9.3.4 Implicit-mode Server Program

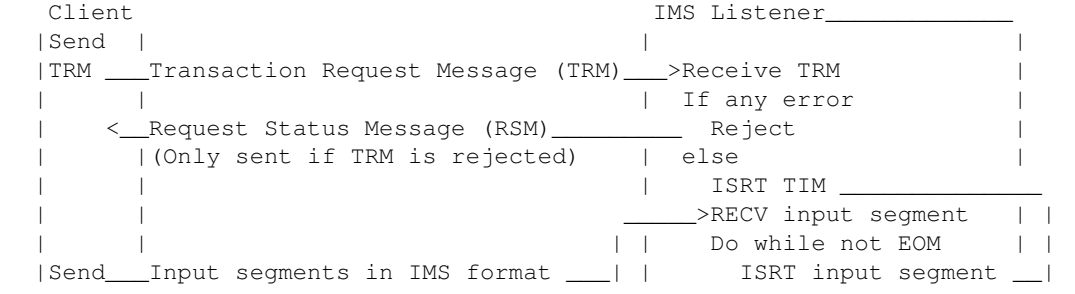
For an implicit mode server program, the IMS listener performs a number of actions in addition to those performed for explicit-mode server programs:

1. It receives all input segments from the client. The client signals the end of input by sending an EOM segment.

2. If the client is an ASCII client (determined by examining the contents of the TRNREQ constant in the TRM), the full input message is translated from ASCII to EBCDIC. This action implies that you must be careful with the design of the implicit mode application messages so that you do not include any non-character data fields except the length field in each segment.

3. The IMS listener then inserts the TIM as the first message segment on the IMS message queue and follows it by all the input segments retrieved from the client program (leaving out the EOM segment).

The reason for doing it this way is that the implicit mode server program retrieves its input via normal IMS GU and Get Next (GN) calls on its IO PCB.



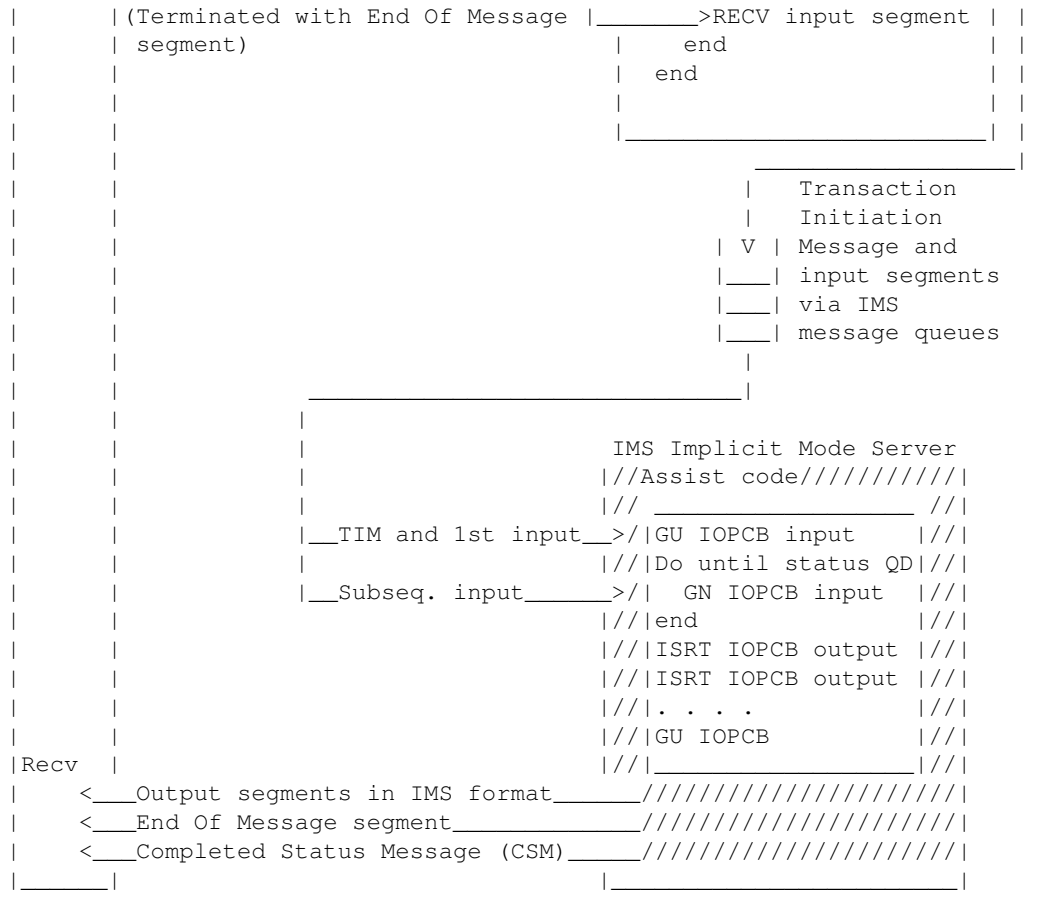


Figure 43. Implicit-mode Server Program Initiation

For an IMS programmer, it is an easy task to write an implicit mode server program in IMS. No socket calls are used at all. The server program uses only normal DLI calls. The only difference from a traditional IMS program is that you do not call the conventional IMS language interface routines, but instead you call routines which are supplied as part of the IMS socket support (the IMS assist routines). They are identified by module names that are almost identical to those you already know: *CBLADLI*, *PLIADLI*, *ASMADLI* and *CADLI*. The call syntax is identical to the syntax used with the conventional routines.

The logic in an implicit mode echo server program could look like the following (this example has, for the sake of simplicity, been stripped for error checking logic):

```
*-------------------------------------------------------------*
* Receive input segments from client and echo them back       *
*-------------------------------------------------------------*
 Get-unique.
     Call 'CBLADLI' using dli-gu
        iopcb
        buffer.
     If iopcb-status = 'QC' then
        go to exit-now.
     Perform until iopcb-status not equal space
        Call 'CBLADLI' using dli-isrt
           iopcb
```

```
            buffer
          Call 'CBLADLI' using dli-gn
            iopcb
            buffer
       end-perform.
       Go to get-unique.
   exit-now.
       Goback.
```

The server program is easy to write for your IMS programmer, but your client programmer must adhere to a set of rules and restrictions that are imposed by the assist routines. Please see Figure 44 for an overview of the processing performed by the assist module.

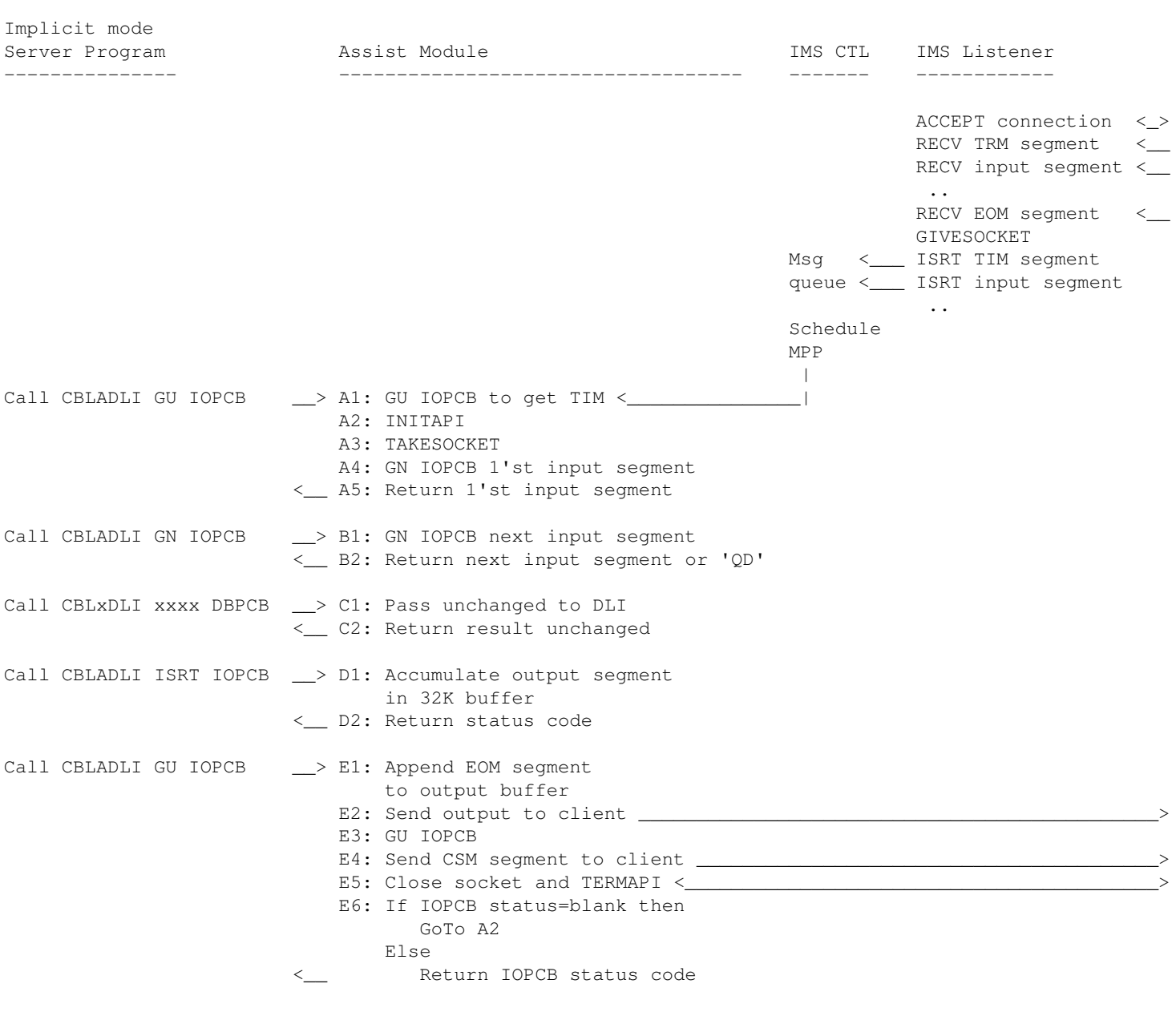


Figure 44. IMS Assist Module Process Flow

The assist module acts as an interface between an implicit mode server program and the actual socket programming interface.

The design restrictions that apply to a client program that communicates with an implicit-mode server program are:

There can only be one interaction per IMS transaction. Your client must send all input data before it turns around and issues the first read for output data from the IMS transaction. No continued dialog between the client and server process is possible. IMS conversational transaction mode is not supported.

Your client program must send data in the required format, which is 2 bytes segment length followed by two bytes binary zero followed by your input data. In the following example, 20 bytes of user data is sent to the server:

```
01  Message-segment.
    05  Segment-length-ll          pic 9(4) Binary value 24.
    05  Segment-length-zz          pic xx value low-value.
    05  Segment-data               pic x(20)
                                   Value 'Data segment 1'.
```

The client program may send more succeeding segments of variable length input data. The last segment must always be an End Of Message (EOM) segment:

```
01  EOM-message-segment.
    05  filler                     pic 9(4) Binary value 4.
    05  filler                     pic xx value low-value.
```

The total length of the input message must not exceed 32K.

If your client program is running on an ASCII host, all data in all input segments are translated from ASCII to EBCDIC, and all data in all output segments from the server program is translated from EBCDIC to ASCII. You had better ensure that all data exchanged between the client and the server is text data, otherwise unexpected results might occur (or will certainly occur).

When the IMS server program inserts output segments to the client on its IO PCB, the assist module accumulates the output into a buffer, which has a maximum size of 32K, but the assist module does not send anything over the socket connection until the server program signals a commit point (by means of a new GU on the IO PCB). At this time, the assist module sends each accumulated output segment in the same format as the input segments. When the last segment has been sent, the assist module generates an EOM segment and sends it to the client.

All output segments are sent directly over the socket connection, so the IMS message queues are not used for output data.

The assist module then passes the GU call to the real DLI language interface routines, which perform the real IMS commit and optionally returns a new input message. If the GU is successful (either passing a new transaction or returning a QC status code), the assist module finishes the previous transaction by sending a Completed Status Message (CSM) segment to the client, and the socket is closed.

Please see "IMS Recovery Considerations" in topic 9.5 for information on unsuccessful DL/I calls and recovery considerations.

```
*-----------------------------------------------------------------*
* Complete Status Message segment                                 *
*-----------------------------------------------------------------*
 01  CSM-message.
     05  CSM-length-ll              pic 9(4) Binary Value 12.
     05  CSM-length-zz              pic x(2) Value low-value.
     05  CSM-oky                    pic x(8) value '*CSMOKY*'.
```

Note: Do not define your implicit mode server IMS applications as Wait For Input (WFI), as IMS will not return control on a GU on the IO PCB for such an application until a new transaction has entered IMS. The socket client on the previous transaction will wait for a CSM segment until this happens. You must also ensure that you have disabled the IMS pseudo-WFI scheduling option by specifying an MPR JCL keyword of PWFI=N.

9.4 Dual-purpose IMS Programs

An IMS MPP that uses MFS to communicate with IBM 3270 terminals interfaces with MFS using record formats as defined in an MFS message input descriptor (MID) and an MFS message output descriptor (MOD). If you develop your socket client so it bases its interface to the IMS MPP on the exact same formats as defined in the MPP's MID and MOD, the same MPP may be used concurrently with IBM 3270 terminals and socket clients.

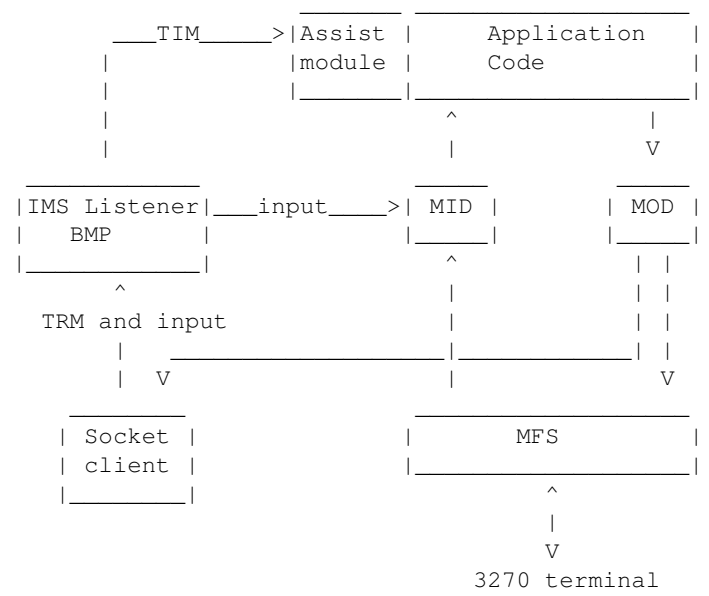
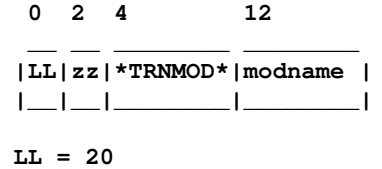


Figure 45. Dual-purpose IMS Program Input/Output Flow

It is easiest to develop the socket client if the MPP uses MFS formatting option 1, but both formatting option 2 and 3 may be used. Option 2 and 3 do add some complexity to the socket client program, as it must emulate the MFS processing done for each formatting option.

The IMS socket interface does not pass a MOD name back to a socket client.

As long as the MID - MOD sequence is predetermined via the NEXT keywords in the MFS format set, this is not a problem. If your MPP changes the next MOD name dynamically, the socket client will probably need that information in order to apply the correct interpretation to the segments it receives from the IMS MPP. If the decision cannot be made based on segment length or content, you may have to add code to the MPP that imbeds the MOD name in a segment sent to the socket client. The MPP is able to detect if input is from a socket client or from an IBM 3270 terminal by looking at the input segment ZZ field. If input is from an IBM 3270 terminal, it contains the MFS formatting option used for the segment. You can design your socket clients so that they send a ZZ value of zero and use that value to detect that input is from a socket client. When your MPP needs to change the MOD name, you can add code that adds a special output segment to the socket output stream with the MOD name imbedded. Such a segment could, for example, be:



Based on your MPP logic, this segment will only be sent to a socket client, and the socket client uses it to determine that the following segment is formatted according to the MOD name passed in the preceding *TRNMOD* segment.

To use an existing MPP as a dual-purpose program, you must change all DL/I calls from xxxTDLI to xxxADLI. xxxADLI is the IMS sockets assist module. It will act as the normal xxxTDLI module if input is not from a socket client. If your existing MPP uses the AIBTDLI interface, the call syntax must be changed to the older xxxTDLI calls.

Please see "Dual Purpose Implicit Mode IMS Server Program" in topic C.1, for a sample COBOL based dual-purpose IMS program.

9.5 IMS Recovery Considerations

There are some issues with the IMS implementation of sockets that you must be aware of when you plan to use IMS sockets.

1. In the IBM TCP/IP Version 3 Release 1 for MVS implementation of IMS sockets, a socket is not a recoverable IMS resource, and the messages exchanged over a socket are not recoverable because they are not passing through the IMS message queues. The only IMS recoverable message in this context is the TIM segment, which is being inserted by the IMS listener as a normal IMS message segment. When an MPP is scheduled, the TIM is read and a socket is taken from the IMS listener. For an implicit mode server the input segments from the client is also passed to the server via the IMS message queue; so, for an implicit mode server, both the TIM and the input message are IMS recoverable resources. IMS may pseudo abend an MPP after it has taken a socket and rescheduled it. When the MPP is rescheduled, possibly in another MPR, the TIM is reread on the first GU (because the TIM is recovered by IMS), but the socket is no longer available for a **takesocket** call, and the **takesocket** call will fail.

An explicit mode program can test the socket return code and error number fields and take appropriate action, but an implicit mode program is supposed to use the standard IMS call interface, so it does not see any socket return codes or error numbers. If an underlying socket call results in an error situation, the status must be returned to the implicit mode program via the standard IMS IO PCB status code field. The IMS IO PCB may be defined as follows:

```
*----------------------------------------------------------------*
* Input-Output PCB layout                                        *
*----------------------------------------------------------------*
 01  iopcb.
     05  iopcb-lterm               pic x(8).
     05  iopcb-assist-status-bin   pic s9(4) comp.
     05  iopcb-assist-status-char redefines
         iopcb-assist-status-bin   pic x(2).
         88  iopcb-assist-aib-error   value 'EA'.
         88  iopcb-assist-buffer-full value 'EB'.
         88  iopcb-assist-tim-only    value 'EC'.
     05  iopcb-status              pic x(2).
         88  iopcb-dli-stop        value 'QC'.
         88  iopcb-dli-ok          value '  '.
         88  iopcb-assist-error    value 'ZZ'.
     05  iopcb-cdate               pic s9(7) comp-3.
     05  iopcb-ctime               pic s9(7) comp-3.
     05  iopcb-input-msgno         pic 9(8) binary.
     05  iopcb-output-mod          pic x(8).
     05  iopcb-userid              pic x(8).
```

If a socket interface error occurs, an IO PCB status code of ZZ will be returned to the implicit mode application. More information about the socket error is located in the two reserved bytes of the IMS IO PCB that follows the LTERM name.

2. You must also be aware that IMS sockets do not assist you in synchronizing updates done by your IMS socket server and socket client. The assist module does send back the CSM segment at a point in time where the IMS resources have been committed by IMS, but this is *not* a two-phase commit protocol that can be used to ensure synchronization of updates. IMS will never know if the client was able to commit or not commit its resources following the receipt of the CSM segment.

3. If the transaction code in the TRM segment is unavailable (either not defined to IMS or temporarily stopped), the IMS listener sends back an RSM segment with proper return codes. We recommend that you always include code in your client programs that are able to deal with an RSM segment, and interpret the return code in order to inform the user of the reason for rejection. When the IMS listener rejects a transaction, it does write out a short message on SYSPRINT in the listener BMP address space. You may be able to look at that with SDSF.

10.0 Chapter 10. CICS Sockets

This chapter explains how CICS sockets are implemented and how you can use CICS sockets to implement a concurrent socket server as CICS transaction programs.

For a more detailed explanation of CICS sockets, you may read *CICS/ESA and TCP/IP for MVS Socket Interface*, GG24-4026. It was written for IBM TCP/IP

Version 2 Release 2 for MVS but is still a good introduction to CICS sockets.

For basic socket programming information, please refer to Chapter 5, "Your First Socket Program" in topic 5.0.

If you need CICS socket call reference information or information on how to customize the CICS socket feature, please see *IBM TCP/IP for MVS: CICS TCP/IP Socket Interface Guide and Reference*, SC31-7131, and *MVS TCP/IP V3R1 Implementation Guide*, GG24-3687.

10.1 CICS and TCP/IP Networks

CICS applications may be divided into the same major groups as we used for IMS applications:

1. The first major group is CICS applications that communicate with a user based on the traditional IBM 3270 protocol.

   Such CICS applications typically uses the Basic Mapping Support (BMS) facilities of CICS to translate between the 3270 data stream and the record oriented format that is expected by a CICS application.

   Users in a TCP/IP network may use this type of CICS applications if their workstation has TN3270 emulation software.

2. The second major group is CICS applications that communicate with another application in a typical client/server fashion.

   Like IMS, CICS supports a range of programming interfaces to be used by client/server applications:

   Advanced Program to Program Communication (APPC) is supported by CICS, including the Common Programming Interface for Communications (CPI-C).

   Message Queuing Interface (MQI) applications are supported by CICS.

   Distributed Computing Environment/Remote Procedure Call (DCE/RPC) server applications are supported in CICS, if you use the MVS/ESA OpenEdition Distributed Computing Environment Application Support Server for CICS (CICS/AS) feature with CICS/ESA Version 4.

   IBM CICS Open Network Computing Remote Procedure Call feature supports ONC/RPC server programs to run in CICS/ESA Version 3.3 and Version 4.

   CICS intercommunication facilities enables you to use standard CICS functions across CICS systems implemented on different platforms, for example, CICS/ESA, CICS OS/2 or CICS/6000. The CICS intercommunication facilities include:

   - Function shipping

   - Distributed program link (DPL)

- Asynchronous processing

- Transaction routing

- Distributed transaction processing (DTP)

We refer you to the relevant CICS documentation for details on these very powerful facilities.

If you develop client/server applications for platforms that support CICS, the CICS intercommunication facilities offer you a consistent way to implement your application across a number of platforms.

Native socket APIs are supported in CICS, if you install the IBM TCP/IP Version 3 Release 1 for MVS CICS sockets feature.

If your partner programs are located on hosts that only support TCP/IP and the native socket APIs, the CICS sockets feature is your choice for creating CICS client/server applications.

10.2 Overview of CICS Sockets

The CICS sockets feature consists of software that enables you to use TCP/IP socket programs in a CICS task:

1. Client programs that request service from remote servers

   Any CICS task may turn itself into a socket client program by issuing the proper client socket calls.

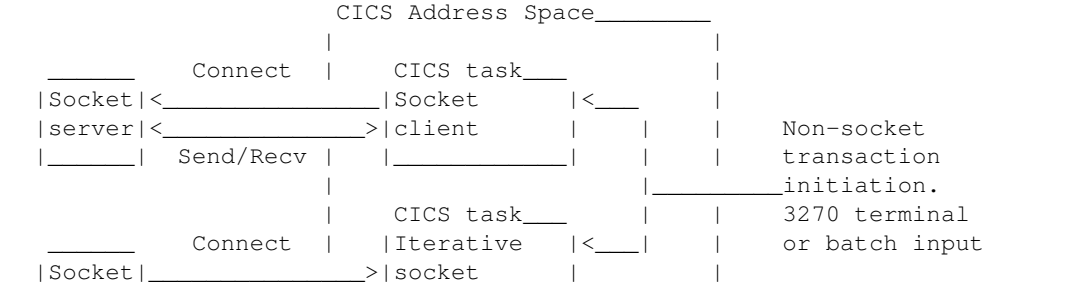
2. Iterative server programs that process client requests one at a time in a serial fashion

   In a CICS environment, an iterative server will be considered a long-running CICS task. Such a server task is typically started when CICS is started and keeps running until CICS is shut down.

3. Concurrent server programs

   In the CICS environment, the concurrent server main process will be a long-running CICS task that accepts connection requests from the network and initiates child processes by issuing **EXEC CICS START** commands. The child processes execute as normal short CICS tasks.

See Figure 46 for an overview of how the different application types are implemented in a CICS environment.



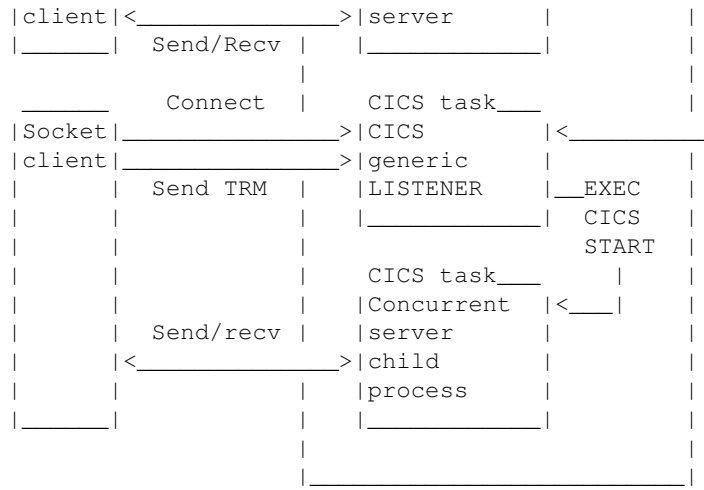


Figure 46. CICS Socket Application Overview

The CICS sockets feature includes the following components:

The CICS listener

The CICS listener is a general purpose concurrent server main process. The name of the program is **EZACIC02**, and it is started by the **CSKL** CICS transaction code. When you enter the **CSKE** transaction code to enable the task related user exit, the transaction code **CSKL** is started by the enable program.

A CICS adapter that provides an interface between CICS tasks and the TCP/IP system address space.

The CICS adapter consists of four components:

1. The first is a stub module that must be link edited with any CICS program that uses socket functions. The stub module is called **EZACICAL**.

2. The second is a CICS task related user exit (TRUE) that acts as the interface between a CICS task, which uses socket functions, and the TCP/IP communicating subtasks in the CICS address space. The name of the task related user exit is **EZACIC01**.

3. Every time a CICS task issues its first socket call, a companion MVS subtask is started in the CICS address space. This subtask handles the actual socket communication between the CICS address space and the TCP/IP system address space. When the CICS task terminates, the companion MVS subtask is terminated too. The name of the module that executes in these subtasks is **EZACIC03**.

4. The last is a set of administrative routines that are used to enable and disable the CICS sockets task related user exit function. CICS transaction code **CSKE** is used to enable the task related user exit, and transaction code **CSKD** is used to disable it.

Figure 47 shows an overview of the CICS adapter components.

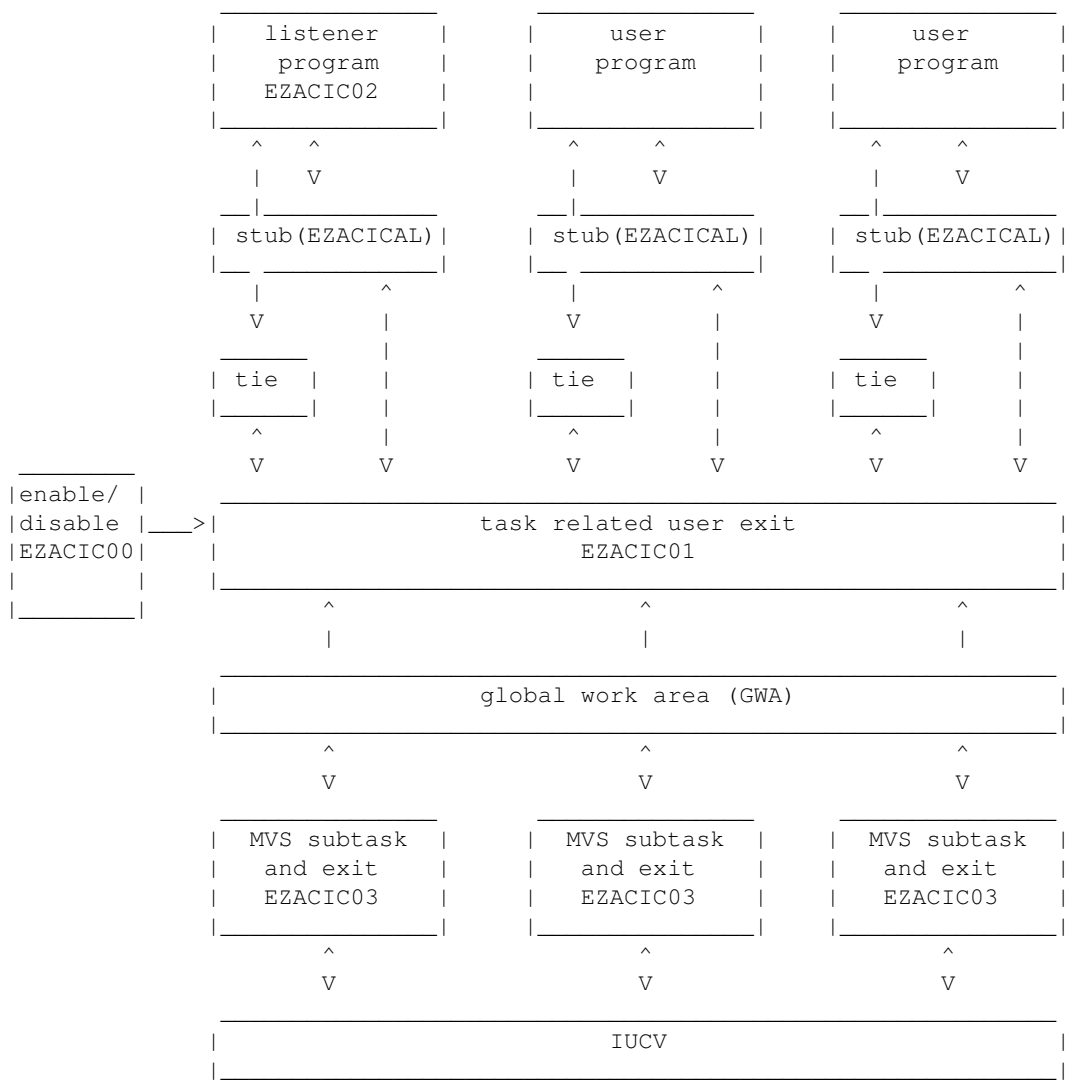


Figure 47. CICS Sockets Infrastructure

You may develop your CICS sockets programs using one of the following IBM TCP/IP for MVS socket APIs:

- The C-socket API for C based CICS programs (not all C socket calls are supported in the CICS sockets environment).
- The Sockets Extended call API for programs written in, for example, COBOL or PL/I.
- The IBM TCP/IP Version 2 Release 2 for MVS CICS sockets call API. This call API is supported by IBM TCP/IP Version 3 Release 1 for MVS for compatibility purposes. We recommend that you use the Sockets Extended API for development of new CICS sockets applications.

The CICS sockets feature supports stream sockets (TCP protocols) and datagram sockets (UDP protocols), but not raw sockets.

Client and iterative server CICS sockets applications do not differ from

similar programs in a native MVS environment, so we will not go into detail with those in this chapter. The concurrent server implementation is specific to the CICS environment, and we will discuss that in more details in the sections that follow.

10.3 Concurrent Server in a CICS Environment

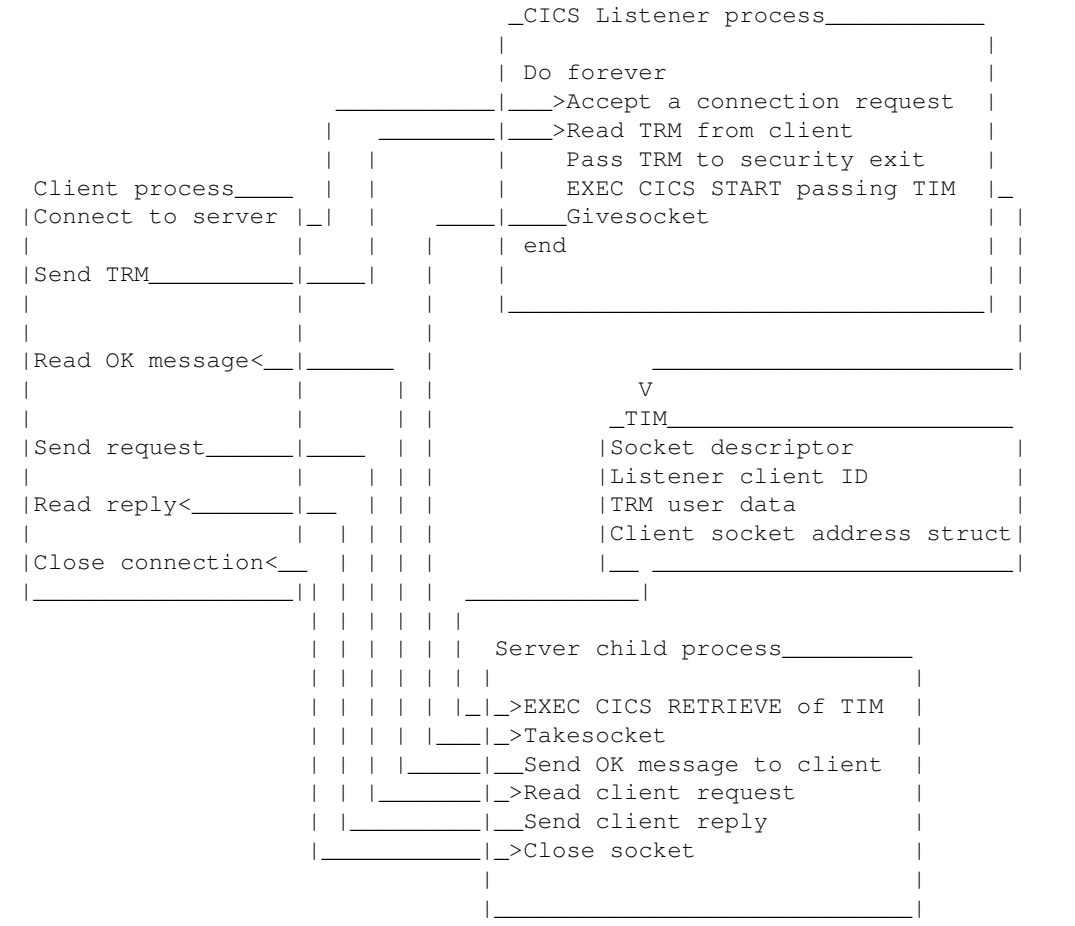


Figure 48. Concurrent Server in CICS

IBM TCP/IP for MVS supplies a generic concurrent server main process called the *CICS listener*. The CICS listener is generic in the sense that it acts as a CICS transaction scheduler that receives Transaction Request Messages (TRM) from the TCP/IP network.

The CICS listener is implemented as a long-running CICS transaction (CSKL) that is started when you enable the socket programming interface in CICS via the **CSKE** CICS transaction.

The CICS listener uses **EXEC CICS START** commands to schedule new transactions in CICS. The transaction to start is derived from fields in a predefined layout of the Transaction Request Message, which a TCP/IP client sends to the CICS listener over a socket connection.

The format of the TRM for the CICS listener is shown in Figure 49.

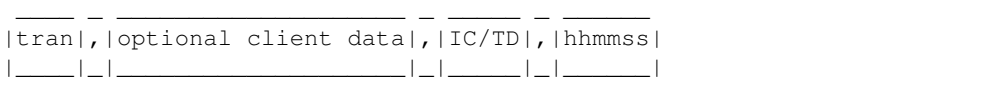


Figure 49. CICS Listener Transaction Request Message Format

The CICS listener TRM is variable in length, but the listener always issues a **recv** call for 50 bytes, which is the maximum allowed lenght of a TRM. If your client sends a TRM of, for example, four bytes and then goes on pushing data to the child server onto the stream, some of this data may be returned to the CICS listener and may be lost. We recommend that you always either send a 50 byte TRM message holding your actual TRM data padded with spaces up to the 50 byte limit, or that your remote clients always issue a **receive** call immediately after having sent the TRM in order to flush the TCP send buffer (See "Streams and Messages" in topic 5.8.1 for details on this technique).

Each field in the TRM is separated by a comma. The absence of a field for example, the client data field is signalled by two successive comma's: **TRN,,IC,113015**.

tran This is the CICS transaction code you want to start.

client-data You can optionally include up to 35 bytes of data, but it might be a more clean design to reserve these 35 bytes for other purposes. You could for example define a standard for inclusion of security related information in the transaction request message. You can write a security exit to be included in the CICS listener. This exit will receive the 35 bytes of user data, and can make user verification decisions based on this. Please see *CICS/ESA and TCP/IP for MVS Sockets Interface*, GG24-4026, for recommendations on how you can implement a listener security exit in CICS.

IC or TD IC or TD means Transient Data or Interval Control. If you specify IC, then you can specify the interval time following (**hhmmss**) as the last part of the TRM.

To have the CICS listener start, for example, CICS transaction TPIT immediately and without any client-data, the client would connect via the socket interface to the CICS listener and send the following TRM to the listener:

TPIT (padded with blanks up to 50 bytes)

If the user security exit accepts the transaction request, the CICS listener will issue a **givesocket** and an **EXEC CICS START** of the TPIT CICS transaction.

Under normal circumstances, the CICS listener will not send data back to the client over the socket connection. However, if the CICS listener is unable to start a CICS transaction, either because of validation errors or because the user security exit rejected the transaction, it will send back a 72 byte long error message to the socket client in the following format:

TCPCICSERR: specific error text (padded with blanks to 72)

The CICS listener will translate the error message to ASCII if the client sent a TRM in ASCII. Good programming practices recommend that you include logic in your client program to test for the fixed text **TCPCICSERR** in the first 10 bytes of the first message it receives from the server side and act accordingly.

The CICS listener gives the socket to a process in the same address space as itself, but it does not give it to a specific task id. The implication of this is that the CICS transaction must start in the same CICS address space as the one where the listener is executing.

On the **EXEC CICS START** command in the CICS listener, a Transaction Initiation Message (TIM) is passed to the started CICS transaction. The TIM includes the following information:

1. It includes the socket descriptor, which was returned to the listener on an **accept** call and which was given via a **givesocket** call.

2. It includes 8 bytes with the CICS address space name, where the listener is executing.

3. It includes another 8 bytes with the subtask id of the listener.

4. It includes the 35 bytes of client data that can be included in the transaction request. The security user exit may optionally exclude this information from the area passed to the CICS transaction.

5. Finally it includes a socket address structure for the client that initiated this request.

```
*-------------------------------------------------------------*
* Transaction Initiation Message from CICS listener           *
*-------------------------------------------------------------*
 01  TIM.
     05 give-take-sd                pic 9(8) Binary.
     05 lstn-asname                 pic x(8).
     05 lstn-subtask                pic x(8).
     05 client-in-data              pic x(35).
     05 filler                      pic x(1).
     05 sockaddr-in.
       10  sin-family               pic 9(4) Binary.
       10  sin-port                 pic 9(4) Binary.
       10  sin-addr                 pic 9(8) Binary.
       10  sin-zero                 pic x(8).
```

When the transaction is scheduled by CICS, it must first retrieve the TIM from CICS.

```
*-------------------------------------------------------------*
* Retrieve Transaction Initiation Message from Listener       *
*-------------------------------------------------------------*
     move 72 to cleng.
     exec cics retrieve
        into(TIM)
        length(cleng)
     end-exec.
```

The server program may then issue an **initapi** call to identify itself.

```
*-------------------------------------------------------------*
```

```
*    initapi parameters                                          *
*----------------------------------------------------------------*
 01  errno                    pic 9(8) binary value zero.
 01  retcode                  pic s9(8) binary value zero.
 01  init-maxsoc              pic 9(4) Binary value 10.
 01  init-ident.
     05  init-tcpname         pic x(8) value 'T18ATCP'.
     05  init-asname          pic x(8) value space.
 01  init-subtask.
     05  init-cics-task       pic 9(7).
     05  filler               pic x    value 'I'.
 01  init-maxsno              pic 9(8) Binary value zero.


*----------------------------------------------------------------*
*    Initialize socket API                                       *
*----------------------------------------------------------------*
     move space to init-asname.
     move eibtaskn to init-cics-task.
     call 'EZASOKET' using soket-initapi,
         init-maxsoc
         init-ident
         init-subtask
         init-maxsno
         errno
         retcode.
     if retcode <  0 then
        move 'Initapi failed' to cics-msg-area
        perform write-cics thru write-cics-exit
        go to pgm-exit.
```

The concurrent server child program may, instead of an **initapi** call, start out directly with a **takesocket** call. If the server program starts with the **takesocket** call, the CICS sockets interface will assign default values to the client ID. The address space name will be set to the CICS address space name, and the subtask ID will be set to the CICS task number suffixed with the letter T. The maximum number of sockets that will be available for a program, that does not issue the **initapi** call, is 50.

The **takesocket** call parameters are based on the TIM values. The server program must take the socket from the client ID passed in the TIM fields: LSTN-ASNAME and LSTN-SUBTASK. The socket descriptor to take is passed in the TIM field: GIVE-TAKE-SD.

```
*----------------------------------------------------------------*
*    Takesocket parameters                                       *
*----------------------------------------------------------------*
 01  soket-takesocket              pic x(16) value 'TAKESOCKET      '.
 01  sockid                        pic 9(4) binary.
 01  errno                         pic 9(8) binary value zero.
 01  retcode                       pic s9(8) binary value zero.
 01  clientid-lstn.
     05 cid-domain-lstn            pic 9(8) binary.
     05 cid-name-lstn              pic x(8) value space.
     05 cid-subtask-lstn           pic x(8) value space.
     05 cid-res-lstn               pic x(20) value low-value.

*----------------------------------------------------------------*
*    Take socket from CICS Listener                              *
*----------------------------------------------------------------*
     move sin-family to cid-domain-lstn.
     move lstn-asname to cid-name-lstn.
```

```
move lstn-subtask to cid-subtask-lstn.
move low-value to cid-res-lstn.
move give-take-sd to sockid.
call 'ezasoket' using soket-takesocket
   sockid
   clientid-lstn
   errno
   retcode.

if retcode <  0 then
   move 'Take socket error' to cics-msg-area
   perform write-cics thru write-cics-exit
   go to pgm-exit
else
   move retcode to sockid
end-if.
```

After your CICS program has taken the socket from the CICS listener, it will, from a socket program point of view, act as any other socket program in MVS. It may enter a number of receive/send sequences and will finally close the socket and call the **termapi** function.

If your client process may run on non-EBCDIC platforms, you must remember to include in your message design a way for the server to detect that the client sends and expects data in ASCII.

As for any CICS program, you should try to avoid long conversations with the end-user. The CICS task ties up resources for other CICS tasks while it is active. From a CICS resource point of view, a design, where your socket client starts a number of short consecutive CICS transactions, will be better than a design where your socket client starts one CICS transaction that stays active for a longer period. The issues are well-known to most CICS programmers. Try to avoid conversational transactions and base your design on some kind of pseudo-conversational implementation instead.

You can use the supplied CICS listener function as it is, or you can of course also write your own listener application, which basically serves the same purpose as the supplied CICS listener.

10.4 Link Editing CICS Socket Programs

When you develop your CICS socket programs, you may use either the EZACICAL call interface or the EZASOKET call interface that is supplied with IBM TCP/IP Version 3 Release 1 for MVS. You may even mix calls to the two interfaces in the same program.

When you link edit your CICS sockets program, you must always explicitly include the EZACICAL module even if you do not call EZACICAL. The EZACICAL module will resolve all external references to EZASOKET for CICS socket programs, in addition to bringing in the proper CICS socket interface code.

Please see "COBOL Compile JCL Procedure" in topic I.2 and "Link/Edit JCL Procedure" in topic I.4 for sample compile and MVS binder JCL for a COBOL language CICS socket program.

Note: Be aware that, if your CICS sockets program only uses the Sockets Extended API (calls to EZASOKET), a link edit step without specific inclusion of EZACICAL will give a returncode of zero, but the EZASOKET code included will not be the CICS sockets version. When you execute the

CICS program, it may seem to work, but each socket call will put the CICS main task TCB into an MVS wait, which is not to be recommended.

11.0 Chapter 11. Debugging and Tracing Socket Programs

This chapter will include information on the techniques you have available for debugging socket applications.

We will recommend some programming practices that will provide you with accurate information in exception situations, and we will introduce relevant tracing facilities in IBM TCP/IP Version 3 Release 1 for MVS.

11.1 Exception Handling

All socket calls return some kind of status information. Most calls return a socket interface return code (RETCODE) and an error identification number (ERRNO).

The return code can have one of the following values on return from a socket call:

-1 The socket call was unsuccessful. The ERRNO field should be examined to determine the cause of the error.

0 The socket call was successful.

>0 The socket call was successful. The value returned in RETCODE is call specific. For read and write type socket calls, the value informs you of how many bytes were actually read or written on this call. Other calls that may return a positive return code are:

accept	The value returned is the new socket descriptor number.
fcntl	For a query call, a return code of four means that the socket is in non-blocking mode.
select	A positive return code represents the number of ready sockets in the select masks.
socket	A return code of zero or above, represents the new socket descriptor.
takesocket	A return code of zero or above, represents the new socket descriptor.

For some calls a RETCODE of -1 may be acceptable, and the situation must be handled by the program. An example of such a call is the **connect** call that returns a RETCODE of -1 (and an ERRNO value of EADDRNOTAVAIL or ETIMEDOUT), when a connect request to an IP address fails. If the host that the program tries to connect to has more network interfaces, the program can retry the connect with the next IP address in the host entry structure.

Another example is socket calls for sockets that are in non-blocking mode. If the call had been in blocking mode and the call because of this blocking mode would have blocked, the non-blocking call will instead return a RETCODE of -1 and an ERRNO value of EWOULDBLOCK.

We strongly recommend that you include logic after each socket call to filter out acceptable RETCODE and ERRNO combinations, and process these as appropriate. All unacceptable combinations should, as a minimum, result in logging of an error message and proper logic to clean up any sockets that were left in an uncertain state. This most often means: closing the socket.

In a C program you can print out a socket error message by using the **tcperror()** routine.

```
if (send(sd, buf, sizeof(buf), 0) < 0)
    tcperror("Write returned error");
    s=close(sd);
    exit(8);
}
```

A corresponding routine does not exist for the other socket programming interfaces. If you use one of these, you will have to create a similar routine as part of your application.

```
*-------------------------------------------------------------*
* Error message for socket interface errors                  *
*-------------------------------------------------------------*
 01  ezaerror-msg.
     05  filler                   pic x(9) Value 'Function='.
     05  ezaerror-function        pic x(16) Value space.
     05  filler                   pic x(9) Value ' Retcode='.
     05  ezaerror-retcode         pic ---99.
     05  filler                   pic x(9) Value ' Errorno='.
     05  ezaerror-errno           pic zzz99.
     05  filler                   pic x(1) Value ' '.
     05  ezaerror-text            pic x(50) Value ' '.

*-------------------------------------------------------------*
* Send data and check exceptions                              *
*-------------------------------------------------------------*
     Call 'EZASOKET' using soket-write
        socket-descriptor
        send-request-remaining
        send-buffer-byte(send-request-sent + 1)
        errno
        retcode
     If retcode < 0 then
        move soket-write to ezaerror-function
        move 'Write call failed' to ezaerror-text
        move errno to ezaerror-errno
        move retcode to ezaerror-retcode
        display ezaerror-msg
        Call 'EZASOKET' using soket-close
           socket-descriptor
           errno
           retcode
        move 8 to return-code
        goback
     endif
```

You may have to use different techniques for printing the error message depending on your runtime environment. For a CICS program, you may want to direct the error message to a CICS transient data queue:

```
*-------------------------------------------------------------*
* Write out an error message to CSMT                          *
*-------------------------------------------------------------*
     exec cics writeq td
        queue('CSMT')
        from(ezaerror-msg)
        length(ezaerror-msg-len) nohandle
     end-exec.
```

Refer to *IBM TCP/IP for MVS: Application Programming Interface Reference*, SC31-7187, Appendix B for a complete list of error codes that may be returned by each of the socket programming interfaces.

11.2 Application Trace Facilities

If you include proper logic to both deal with exception situations and log error information, you will have a good chance of identifying the cause of most problems your programs may encounter.

During the development phase of new socket applications, it has proven to be useful to include logic in your programs that will actually log tracing information for both successful and unsuccessful socket calls. If you do include such logic, base your tracing logic on some global switch so that you can turn tracing on or off either by passing a runtime parameter to the program when it starts or by setting a constant in the programs static working storage and recompile it.

If you encounter problems, which can not be identified by your application trace facilities, you have a couple of tracing options you can use within the TCP/IP product.

Tracing within the TCP/IP product can take place at a number of different levels. We recommend that you limit yourself to the following two of these levels:

A trace of the IP packets that are received or transmitted over a network interface

If you suspect that you have a problem with the contents of data you receive or send out or that there is a problem with the sequence of data you receive, the packet trace is likely to reveal those problems to you.

We recommend that you start with this level of tracing. The tracing operation is easy to perform, and the amount of trace data can be controlled via the parameters that are passed to the packet trace function of TCP/IP.

A trace of the IUCV based socket API (these are C-sockets, Sockets Extended and REXX sockets)

If the socket calls you execute in your program do not result in any IP packets being exchanged over the network, this level of tracing can be necessary to identify the source of your problem.

This is very detailed and complicated to perform. We recommend that you only use this trace in extreme cases, where all other methods of

identifying your problem have failed.

Both of the traces can only be performed by system personnel. They are initiated via OBEYFILE TCP/IP commands. The OBEYFILE command can only be executed from specially authorized users on your MVS system.

11.3 TCP/IP Packet Trace

Packet tracing captures IP packets as they enter or leave the device drivers, which are part of TCP/IP for MVS. A packet trace shows you the actual IP packets that are exchanged over the IP network. You can analyze IP and TCP or UDP headers as well as your own application data.

The tracing function is implemented in the TCP/IP address space for those device drivers that are part of the TCP/IP address space in the SNALINK LU0 and SNALINK LU6.2 address spaces for the SNALINK devices and finally in the X.25 address space for the X.25 device driver.

You select what you want to trace via the PKTTRACE command, which is passed either to the TCP/IP address space via an OBEYFILE command or to the other device driver address spaces via an MVS console modify command.

The trace data is collected by MVS Generalized Trace Facility (GTF). You must start a GTF collection address space before you start the actual packet trace function in TCP/IP:

```
//GTFTCPIP PROC MEMBER=GTFPARM
//*
//IEFPROC EXEC PGM=AHLGTF,PARM='MODE=EXT,DEBUG=NO,TIME=YES',
//             REGION=2280K,DPRTY=(15,15)
//IEFRDER DD   DSN=TCPIP.V3R1.GTF.TRACE,DISP=SHR
//SYSLIB  DD   DSN=TCPIP.PROCLIB(&MEMBER.),DISP=SHR
```

The IEFRDER DD statement defines the data set that is used to capture the packet trace records.

The GTF parameters for collection of TCP/IP packet trace records are:

```
TRACE=USRP
USR=(5E4)
END
```

In the above example, these parameters are located in TCPIP.PROCLIB(GTFPARM).

TCP/IP uses x'5E4' as GTF event identifier. If you only want to collect the TCP/IP packet trace records in your GTF trace data set, specify the GTF parameters as above.

When GTF has initialized you can start the actual packet trace function in TCP/IP. The following example shows the OBEYFILE data set that we used to start the packet trace function in the TCP/IP address space:

```
PKTTRACE CLEAR
PKTTRACE PROT=TCP IP=9.67.56.18 DSTPORT=9997 SRCPORT=9997
TRACE PACKET
```

You can limit the packet trace to certain source or destination ports using a specific protocol on a certain IP address. Please refer to *IBM TCP/IP for MVS: Customization and Administration Guide*, SC31-7134, for

details about the PKTTRACE command.

In the above example all packets that come from port number 9997 or go to port number 9997 on this host are traced if they come from or go to the remote host with IP address 9.67.56.18. This example was used to trace the packets that were exchanged between a server application bound to port 9997 on our host and a client running on the 9.67.56.18 host.

After you have started the tracing functions, you execute your application programs. If your own program produces its own tracing output, be sure to save this output so that you will be able to correlate it with the packet trace output.

You stop the packet trace again via another OBEYFILE command:

```
NOTRACE PACKET
```

After you have stopped the packet trace function in TCP/IP, you can stop the GTF collection address space, and format the GTF trace data set with a TCP/IP utility program called TRCFMT, or you can format the GTF trace data set using your normal IPCS or AMDPRDMP program, which will invoke the TCP/IP formatting routines for the packet trace records.

```
//jobname JOB 1,pgmname,CLASS=A,MSGCLASS=X,NOTIFY=tsouser
//TRACE  EXEC PGM=IKJEFT01
//FMTIN    DD DSN=TCPIP.V3R1.GTF.TRACE,DISP=SHR
//FMTOUT   DD SYSOUT=*
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD *
 TRCFMT PRINT=EBCDIC
/*
```

The FMTIN DD statement identifies the trace data set that you specified on the GTF collection address space JCL.

The formatting routines format the protocol headers and dumps the user data area in hexadecimal in either EBCDIC or in ASCII translation depending on your TRCFMT options.

You can request that TRCFMT formats the packet trace not for print but for download to a Sniffer Network Analyzer or a DatagLANce* Network Analyzer, if you prefer to use that instead of a printed report.

Figure 50 shows an example of an IP packet that has been formatted by the TRCFMT formatting program.

```
PKT  0000004 DATE=95/02/28 TIME=12:12:02.699893
     FROM LINK=IUCLM18A         DEV=IUCV
IP   SRC=9.67.56.18        DST=9.67.56.81
     VER=4  HDLEN=5  TOS=X'00' TOTLEN=576   ID=22670 FLAGS=B'000'
     FRAGOFF=0    TTL=60   PROTOCOL=TCP          CHECKSUM=X'A141'
TCP  SRC=1031        DST=9997   SEQ=903654777  ACK=898100877  HDLEN
     WINDOW=28672 CHECKSUM=X'8D9F' URGPTR=0     ACK
DATA LEN=536
     F0F0F0F0 F1404040 F0F0F0F0 F2404040 F0F0F0F0 *0000 1    0000 2    0000*
     F3404040 F0F0F0F0 F4404040 F0F0F0F0 F5404040 *3    0000 4    0000 5   *
     F0F0F0F0 F6404040 F0F0F0F0 F7404040 F0F0F0F0 *0000 6    0000 7    0000*
     F8404040 F0F0F0F0 F9404040 F0F0F0F1 F0404040 *8    0000 9    0001 0   *
     F0F0F0F1 F1404040 F0F0F0F1 F2404040 F0F0F0F1 *0001 1    0001 2    0001*
     F3404040 F0F0F0F1 F4404040 F0F0F0F1 F5404040 *3    0001 4    0001 5   *
```

```
--more--
```

Figure 50. Sample Packet Trace Output

Each IP packet is printed. The packet number, since the start of the trace and the absolute timestamp, is included on each packet so you can calculate elapse time between packets.

The IP header section contains formatted information from the IP header. In this section you find the source and destination IP address of the packet, and you find information on the underlying protocol (in this example it is a TCP segment that is contained within this IP packet).

In the TCP header section you can see the source and destination port numbers.

This IP packet is a 536 bytes long TCP segment that is sent from port 1031 on IP host 9.67.56.18 to port 9997 on IP host 9.67.56.81.

The samples in Figure 51 to Figure 53 show you a successful TCP connection setup (the so-called three-way handshake sequence).

The client application is located on host 9.67.56.18 and the server application on host 9.67.56.81 port 9997.

```
PKT  0000001 DATE=95/02/28 TIME=12:12:02.574173
     FROM LINK=IUCLM18A         DEV=IUCV
IP   SRC=9.67.56.18         DST=9.67.56.81
     VER=4  HDLEN=5  TOS=X'00' TOTLEN=44    ID=22668 FLAGS=B'000'
     FRAGOFF=0    TTL=60   PROTOCOL=TCP         CHECKSUM=X'A357'
TCP  SRC=1031        DST=9997        SEQ=903654776  ACK=82487328   HDLEN=6
     WINDOW=28672 CHECKSUM=X'E7D5' URGPTR=0     SYN
     OPTION=MAX_SEG_SIZE SIZE=536
```

Figure 51. Packet Trace of TCP Connection: SYN Segment

The client TCP protocol layer starts the TCP connection setup when the client application issues a **connect** socket call. The first TCP segment sent is a SYN segment, where the client host advertises its receive TCP window size and the maximum TCP segment size it is prepared to receive. In this example, the server host may send segments of maximum 536 bytes to the client host, and the client host opens a TCP window of 28672 bytes.

The client host chooses its initial sequence number (ISN) for this connection. This initial value depends on TCP implementation and the amount of time elapsed since the start of TCP/IP on this host. In this example, the initial value chosen by the client TCP/IP host is 903654776.

```
PKT  0000002 DATE=95/02/28 TIME=12:12:02.649455
     TO   LINK=IUCLM18A         DEV=IUCV
IP   SRC=9.67.56.81         DST=9.67.56.18
     VER=4  HDLEN=5  TOS=X'00' TOTLEN=44    ID=22575 FLAGS=B'000'
```

```
     FRAGOFF=0    TTL=60   PROTOCOL=TCP          CHECKSUM=X'A3B4'
TCP  SRC=9997        DST=1031        SEQ=898100876  ACK=903654777  HDLEN=6
     WINDOW=28672 CHECKSUM=X'764B' URGPTR=0     ACK SYN
     OPTION=MAX_SEG_SIZE SIZE=536
```

Figure 52. Packet Trace of TCP Connection: SYN + ACK Segment

The server host responds with a TCP segment where both the ACK and the SYN flags are set. This segment acknowledges the FIN segment sent from the client by returning an ACK sequence number of 903654777, which is the ISN sent by the client plus one, as the SYN segment itself is defined to consume one sequence number. The server host chooses its initial sequence number as 898100876 and advertises its current receive TCP window size and a maximum TCP segment size of 536 bytes.

```
PKT  0000003 DATE=95/02/28 TIME=12:12:02.674138
     FROM LINK=IUCLM18A         DEV=IUCV
IP   SRC=9.67.56.18         DST=9.67.56.81
     VER=4  HDLEN=5  TOS=X'00' TOTLEN=40    ID=22669 FLAGS=B'000'
     FRAGOFF=0    TTL=60   PROTOCOL=TCP          CHECKSUM=X'A35A'
TCP  SRC=1031        DST=9997        SEQ=903654777  ACK=898100877  HDLEN=5
     WINDOW=28672 CHECKSUM=X'8A6C' URGPTR=0     ACK
```

Figure 53. Packet Trace of TCP Connection: ACK Segment

The last segment exchanged in this connection setup sequence is an ACK segment from the client acknowledging the SYN + ACK segment from the server.

The TCP connection is now established and the two socket applications may begin to exchange data over the socket connection.

For further analysis of packet trace output, we refer you to two excellent books by W. Richard Stevens: *TCP/IP Illustrated Volume 1 by W. Richard Stevens*, SR28-5586, and *TCP/IP Illustrated Volume 2 by Gary R. Wright and W. Richard Stevens*, SR28-5630.

11.4 IUCV Socket API Trace Function

The packet trace component sends its trace records to GTF. This is not the case with the IUCV socket trace. The socket trace data is written in formatted form directly to an output data set allocated to the TCP/IP address space. By default the TCP/IP address space will write the trace data to a SYSDEBUG DD statement, but you can modify this dynamically via an OBEYFILE command.

The main issue, when you want to use the socket API trace, is that you can not limit the trace in any way. When you start the socket API trace, *all* socket activity on your TCP/IP system is traced. You have the following two ways in which you can handle this:

1. You quiesce your TCP/IP system so that all activity except your test application is brought to a halt. Depending on your environment, this

may or may not be possible.

2. You implement a secondary TCP/IP stack on your MVS system with an IUCV link connecting it to your primary TCP/IP system. This secondary TCP/IP system can run completely stripped of anything else, other than your test application. This was the technique we used in the ITSO-Raleigh environment to exercise the socket API trace functions. We ran our test server connected to the secondary TCP/IP system, and the client connected to the primary TCP/IP system on the same MVS system. Please refer to *MVS TCP/IP V3R1 Implementation Guide*, GG24-3687, for instructions on how you can run two TCP/IP stacks on the same MVS system.

You start the socket API trace via an OBEYFILE command with the following content:

```
FILE 'TCPIP.V3R1.RAIANJE.B.TRACE'
TRACE SOCKET
MORETRACE SOCKET
```

The FILE statement instructs the TCP/IP address space to direct trace output to the specified sequential data set. If the data set already exists, it will be overwritten. If you allocate the data set in advance, you must allocate it with RECFM=VB and LRECL=137.

The TRACE statement instructs the TCP/IP address space to start the socket API trace. If you want the trace output to include the data you send and receive, you must also specify the MORETRACE statement.

You then start the application you want to trace. Do not run unnecessary long tests. The amount of trace data can be quite voluminous.

You stop the trace with another OBEYFILE command containing the following:

```
NOTRACE SOCKET
SCREEN
```

The NOTRACE statement stops the socket trace.

The SCREEN statement closes and deallocates the trace data set you specified on the FILE statement when you started your socket trace, and it returns trace output to the default SYSDEBUG DD allocation.

The trace data set contains formatted trace information ready for print or browse.

The samples in Figure 54 to Figure 61 cover the initial socket calls of an iterative server. A few of the lines have been split into two lines in order to make the samples more readable. The extra lines can be identified by the lack of timestamp and message number.

```
17:00:55 EZB7254E IUCV API greeter called for ACB    67531840:
17:00:55 EZB6710I    IUCV interrupt -> IUCV-API-greeter (from External interrupt handler)
17:00:55 EZB6696I    Interrupt type: Pending connection
17:00:55 EZB6697I       Path id: 2
17:00:55 EZB6698I       Address space: AsID00FB, User1:
17:00:55 EZB7274I IucvAccMsglim: Path ExtInt 2 (No CCB), msgid '6956577', user1 'TCPIP   ', user2 'T
                  msglim 2, retcc 0, iprc
17:00:55 EZB7254E IUCV API greeter called for ACB    67531840:
```

```
17:00:55 EZB6710I    IUCV interrupt -> IUCV-API-greeter (from External interrupt handler)
17:00:55 EZB6696I    Interrupt type: Pending message
17:00:55 EZB6697I       Path id: 2
17:00:55 EZB7106I       MsgId 6958551, Length 20, TrgCls: 00000000, Reply len 8, Flags 07
17:00:55 EZB7266I IucvReceive: Path ExtInt 2 (No CCB), msgid 6958551, trgcls 00000000, bfadr1 040553
                  retcc 0, iprcode 0
17:00:55 EZB5062I 055380: C9E4C3E5 C1D7C940 00020002 D3C1D9C7 C5404040
17:00:55 EZB7255I SkSimpleResponse: Client AsID00FB, MsgId 6958551, retcode 0 errno 49
17:00:55 EZB7268I IucvReply: Path ExtInt 2 (AsID00FB LARGE ), msgid 6958551, trgcls 00000000, bfadr2
                  bfln2f 8, retcc 0, i
17:00:55 EZB5062I 055500:00000000 00000031
```

Figure 54. Socket API Trace: INITAPI Call

Figure 54 represents one call. The call type can be determined by examining the **TrgCls** field. See Table 9 for a list of possible values.

The first call is an **initapi** call, and it results in an initial IUCV message, that includes:

The maximum number of sockets your program will work with (0002), which is the value passed on the MAXSOC parameter. The default value is 50, but you may specify a maximum value of 2000.
The APITYPE (0002).
Your subtask ID (LARGE), which is the value you pass on the SUBTASK parameter.

The reply message includes the maximum socket descriptor that your application can use (X'00000031'), which is equal to 49. So even if you specify a MAXSOC value of 2, your default maximum socket descriptor number is 49 (lowest is 0 and highest is 49).

```
17:00:55 EZB7259I Sock-request called for ACB    67531840:
17:00:55 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
17:00:55 EZB6696I    Interrupt type: Pending message
17:00:55 EZB6697I       Path id: 2
17:00:55 EZB7106I       MsgId 6958552, Length 0, TrgCls: 001E0000, Reply len 48, Flags 87
17:00:55 EZB7107I       PrmMsgHi 0, PrmMsgLo 0
17:00:55 EZB7256I SkResponse: Client AsID00FB, MsgId 6958552, length 40, retcode 0 errno 0
17:00:55 EZB7271I IucvAlReply: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958552, trgcls 001E0000,
                  bfadr2 04055570, bfln2f 48, retcc 0
17:00:55 EZB7272I Address list:
17:00:55 EZB5062I 0556F8:04055618 00000008 04055490 00000028
17:00:55 EZB7273I Data, length = 8:
17:00:55 EZB5062I 055618:00000000 00000000
17:00:55 EZB7273I Data, length = 40:
17:00:55 EZB5062I 055490: 00000002 C1A2C9C4 F0F0C6C2 D3C1D9C7 C5404040 40404040 40404040 40404040
17:00:55 EZB5062I 0554B0: 40404040 40404040
```

Figure 55. Socket API Trace: GETCLIENTID Call

The **TrgCls** field tells us that this is a **getclientid** call. The returned data for this call is a client ID structure. The first full-word shows the protocol domain (2); the next 8 bytes shows the address space name

(AsID00FB) followed by the subtask name (LARGE), and the last 20 bytes are without interest.

```
 17:00:55 EZB7259I Sock-request called for ACB    67531840:
 17:00:55 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
 17:00:55 EZB6696I    Interrupt type: Pending message
 17:00:55 EZB6697I       Path id: 2
 17:00:55 EZB7106I       MsgId 6958553, Length 16, TrgCls: 00190000, Reply len 8, Flags 07
 17:00:55 EZB7266I IucvReceive: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958553, trgcls 00190000, bf
                   bfln1f 16, retcc 0
 17:00:55 EZB5062I 055490: 00000002 00000001 00000000 00000000
 17:00:55 EZB8251I SkTcpSoc: TCB #1001 allocated for socket 0 on path ExtInt 2 (AsID00FB LARGE   )
 17:00:55 EZB7255I SkSimpleResponse: Client AsID00FB, MsgId 6958553, retcode 0 errno 0
 17:00:55 EZB7268I IucvReply: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958553, trgcls 00190000, bfac
                   bfln2f 8, retcc 0, i
 17:00:55 EZB5062I 0556A0: 00000000 00000000
```

Figure 56. Socket API Trace: SOCKET Call

The **TrgCls** field tells us that this is a **socket** call.

The **socket** call is for a socket in the internet domain (domain 2) using a stream socket (socket type 1) and the default protocol for such a socket (protocol 0), which for the internet domain is TCP.

The socket descriptor is returned in the RETCODE field as 0.

```
 17:00:55 EZB7259I Sock-request called for ACB    67531504:
 17:00:55 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
 17:00:55 EZB6718I    Timeout: 104200.192 seconds
 17:00:55 EZB6696I    Interrupt type: Pending message
 17:00:55 EZB6697I       Path id: 2
 17:00:55 EZB7106I       MsgId 6958554, Length 16, TrgCls: 00020000, Reply len 8, Flags 07
 17:00:55 EZB7266I IucvReceive: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958554, trgcls 00020000, bf
                   bfln1f 16, retcc 0
 17:00:55 EZB5062I 0554B0: 0002270D 00000000 00000000 00000000
 17:00:55 EZB8243I AsID00FB *OLDCONN has 0 sockets
 17:00:55 EZB8243I AsID00FB LARGE has 1 sockets
 17:00:55 EZB8245I    Perm=F, AutoCli=F, Local=*~9997, TCB Q = 1
 17:00:55 EZB8246I       1001 Closed, Foreign=*~65535
 17:00:55 EZB7255I SkSimpleResponse: Client AsID00FB, MsgId 6958554, retcode 0 errno 0
 17:00:55 EZB7268I IucvReply: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958554, trgcls 00020000, bfac
                   bfln2f 8, retcc 0, i
 17:00:55 EZB5062I 055668: 00000000 00000000
```

Figure 57. Socket API Trace: BIND Call

According to the **TrgCls** field, this is a **bind** call on socket descriptor 0.

The socket is bound to an AF-INET address (2); the port number is 9997 (X'270D'), and the IP address is any IP address on this host (0).

```
17:00:55 EZB7259I Sock-request called for ACB    67531504:
17:00:55 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
17:00:55 EZB6718I    Timeout: 104200.192 seconds
17:00:55 EZB6696I    Interrupt type: Pending message
17:00:55 EZB6697I       Path id: 2
17:00:55 EZB7106I       MsgId 6958555, Length 0, TrgCls: 000D0000, Reply len 8, Flags 87
17:00:55 EZB7107I       PrmMsgHi 0, PrmMsgLo 10
17:00:55 EZB7255I SkSimpleResponse: Client AsID00FB, MsgId 6958555, retcode 0 errno 0
17:00:55 EZB7268I IucvReply: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958555, trgcls 000D0000, bfac
                  bfln2f 8, retcc 0, i
17:00:55 EZB5062I 055590: 00000000 00000000
```

Figure 58. Socket API Trace: LISTEN Call

This call is a **listen** call on socket descriptor 0.

The backlog queue size is 10, as specified on the BACKLOG parameter on the **listen** call.

```
17:00:55 EZB7259I Sock-request called for ACB    67531504:
17:00:55 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
17:00:55 EZB6718I    Timeout: 104200.192 seconds
17:00:55 EZB6696I    Interrupt type: Pending message
17:00:55 EZB6697I       Path id: 2
17:00:55 EZB7106I       MsgId 6958556, Length 0, TrgCls: 00010000, Reply len 24, Flags 87
17:00:55 EZB7107I       PrmMsgHi 0, PrmMsgLo 1
17:00:55 EZB7258I SkBlockRequest: Client AsID00FB, Msgid 6958556, Retryable T
17:01:15 EZB7259I Sock-request called for ACB    67531840:
17:01:15 EZB6707I    PrevACB: 76139288
17:01:15 EZB6708I    NextACB: 76139288
17:01:15 EZB7108I              QueueHead:76139288
17:01:15 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
17:01:15 EZB6718I    Timeout: 104200.192 seconds
17:01:15 EZB6696I    Interrupt type: Pending message
17:01:15 EZB6697I       Path id: 2
17:01:15 EZB7106I       MsgId 6958556, Length 0, TrgCls: 00010000, Reply len 24, Flags 87
17:01:15 EZB7107I       PrmMsgHi 0, PrmMsgLo 1
17:01:15 EZB7258I SkBlockRequest: Client AsID00FB, Msgid 6958556, Retryable T
17:01:15 EZB7259I Sock-request called for ACB    67531840:
17:01:15 EZB6707I    PrevACB: 76139288
17:01:15 EZB6708I    NextACB: 76139288
17:01:15 EZB7108I              QueueHead:76139288
17:01:15 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
17:01:15 EZB6718I    Timeout: 104200.192 seconds
17:01:15 EZB6696I    Interrupt type: Pending message
17:01:15 EZB6697I       Path id: 2
17:01:15 EZB7106I       MsgId 6958556, Length 0, TrgCls: 00010000, Reply len 24, Flags 87
17:01:15 EZB7107I       PrmMsgHi 0, PrmMsgLo 1
17:01:15 EZB8252I SkTcpAcc: TCB #1001 dequeued for socket 1 on path ExtInt 2 (AsID00FB LARGE   )
17:01:15 EZB7256I SkResponse: Client AsID00FB, MsgId 6958556, length 16, retcode 1 errno 0
17:01:15 EZB7271I IucvAlReply: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958556, trgcls 00010000, bf
                  bfln2f 24, retcc 0
17:01:15 EZB7272I Address list:
17:01:15 EZB5062I 055B98: 04055AB8 00000008 040558C9 00000010
17:01:15 EZB7273I Data, length = 8:
```

```
17:01:15 EZB5062I 055AB8: 00000001 00000000
17:01:15 EZB7273I Data, length = 16:
17:01:15 EZB5062I 0558C9: 00020417 09433812 00000000 00000000
```

Figure 59. Socket API Trace: ACCEPT Call

This call is an **accept** call. The caller is put into a blocked state until a connection request arrives. The call returns a new socket descriptor in the RETCODE parameter (socket descriptor 1), and the socket address structure of the connecting socket, which is an AF_INET socket (2) with port number 1047 (X'0417') and IP address 9.67.56.18 (X'09433812').

```
17:01:15 EZB7259I Sock-request called for ACB    67532288:
17:01:15 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
17:01:15 EZB6718I    Timeout: 104200.192 seconds
17:01:15 EZB6696I    Interrupt type: Pending message
17:01:15 EZB6697I       Path id: 2
17:01:15 EZB7106I       MsgId 6958598, Length 16777312, TrgCls: 00100001, Reply len 40, Flags 87
17:01:15 EZB7107I       PrmMsgHi 0, PrmMsgLo 2
17:01:15 EZB8250I SkTcpRea calls IucvAlRply: Client AsID00FB, MsgId 6958598, data length 16
17:01:15 EZB7271I IucvAlReply: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958598, trgcls 00100001, bf
                  bfln2f 40, retcc 0
17:01:15 EZB7272I Address list:
17:01:15 EZB5062I 055678:0405558C 00000008 0405553C 00000010  040FC1A9 00000010
17:01:15 EZB7273I Data, length = 8:
17:01:15 EZB5062I 05558C: 00000010 00000000
17:01:15 EZB7273I Data, length = 16:
17:01:15 EZB5062I 05553C: 00020417 09433812 00000000 00000000
17:01:15 EZB7273I Data, length = 16:
17:01:15 EZB5062I 0FC1A9: F0F0F0F0 F1404040 F0F0F0F0 F2404040
```

Figure 60. Socket API Trace: RECEIVE Peek Call

The **TrgCls** field tells us that this is a **receive** call on socket descriptor 1. The **PrmMsgLo** field indicates that this is a receive call with a flag value of 2, which means it is a MSG_PEEK call.

The peek call returns 16 bytes (X'10'). The socket address structure of the sender is returned and is equal to the socket that connected in the preceding **accept** call (AF_INET, port 1047 and IP address 9.67.56.18).

```
17:01:15 EZB7259I Sock-request called for ACB    67531616:
17:01:15 EZB6710I    IUCV interrupt -> Sock-request (from External interrupt handler)
17:01:15 EZB6718I    Timeout: 104280.734 seconds
17:01:15 EZB6696I    Interrupt type: Pending message
17:01:15 EZB6697I       Path id: 2
17:01:15 EZB7106I       MsgId 6958599, Length 580, TrgCls: 00100001, Reply len 8216, Flags 87
17:01:15 EZB7107I       PrmMsgHi 0, PrmMsgLo 0
17:01:15 EZB8250I SkTcpRea calls IucvAlRply: Client AsID00FB, MsgId 6958599, data length 536
17:01:15 EZB7271I IucvAlReply: Path ExtInt 2 (AsID00FB LARGE   ), msgid 6958599, trgcls 00100001, bf
                  bfln2f 560, retcc
17:01:15 EZB7272I Address list:
```

```
17:01:15 EZB5062I 055678: 0405558C 00000008 0405553C 00000010 040FC1A9 00000218
17:01:15 EZB7273I Data, length = 8:
17:01:15 EZB5062I 05558C: 00000218 00000000
17:01:15 EZB7273I Data, length = 16:
17:01:15 EZB5062I 05553C: 00020417 09433812 00000000 00000000
17:01:15 EZB7273I Data, length = 536:
17:01:15 EZB5062I 0FC1A9: F0F0F0F0 F1404040 F0F0F0F0 F2404040 F0F0F0F0 F3404040 F0F0F0F0 F4404040
17:01:15 EZB5062I 0FC1C9: F0F0F0F0 F5404040 F0F0F0F0 F6404040 F0F0F0F0 F7404040 F0F0F0F0 F8404040
17:01:15 EZB5062I 0FC1E9: F0F0F0F0 F9404040 F0F0F0F1 F0404040 F0F0F0F1 F1404040 F0F0F0F1 F2404040
17:01:15 EZB5062I 0FC209: F0F0F0F1 F3404040 F0F0F0F1 F4404040 F0F0F0F1 F5404040 F0F0F0F1 F6404040
17:01:15 EZB5062I 0FC229: F0F0F0F1 F7404040 F0F0F0F1 F8404040 F0F0F0F1 F9404040 F0F0F0F2 F0404040
17:01:15 EZB5062I 0FC249: F0F0F0F2 F1404040 F0F0F0F2 F2404040 F0F0F0F2 F3404040 F0F0F0F2 F4404040
17:01:15 EZB5062I 0FC269: F0F0F0F2 F5404040 F0F0F0F2 F6404040 F0F0F0F2 F7404040 F0F0F0F2 F8404040
17:01:15 EZB5062I 0FC289: F0F0F0F2 F9404040 F0F0F0F3 F0404040 F0F0F0F3 F1404040 F0F0F0F3 F2404040
17:01:15 EZB5062I 0FC2A9: F0F0F0F3 F3404040 F0F0F0F3 F4404040 F0F0F0F3 F5404040 F0F0F0F3 F6404040
17:01:15 EZB5062I 0FC2C9: F0F0F0F3 F7404040 F0F0F0F3 F8404040 F0F0F0F3 F9404040 F0F0F0F4 F0404040
17:01:15 EZB5062I 0FC2E9: F0F0F0F4 F1404040 F0F0F0F4 F2404040 F0F0F0F4 F3404040 F0F0F0F4 F4404040
17:01:15 EZB5062I 0FC309: F0F0F0F4 F5404040 F0F0F0F4 F6404040 F0F0F0F4 F7404040 F0F0F0F4 F8404040
17:01:15 EZB5062I 0FC329: F0F0F0F4 F9404040 F0F0F0F5 F0404040 F0F0F0F5 F1404040 F0F0F0F5 F2404040
17:01:15 EZB5062I 0FC349: F0F0F0F5 F3404040 F0F0F0F5 F4404040 F0F0F0F5 F5404040 F0F0F0F5 F6404040
17:01:15 EZB5062I 0FC369: F0F0F0F5 F7404040 F0F0F0F5 F8404040 F0F0F0F5 F9404040 F0F0F0F6 F0404040
17:01:15 EZB5062I 0FC389: F0F0F0F6 F1404040 F0F0F0F6 F2404040 F0F0F0F6 F3404040 F0F0F0F6 F4404040
17:01:15 EZB5062I 0FC3A9: F0F0F0F6 F5404040 F0F0F0F6 F6404040 F0F0F0F6 F7404040
```

Figure 61. Socket API Trace: RECEIVE Call

The last call we show in this example is a **receive** call. 536 bytes (X'218') is returned to the application.

If you need to analyze the socket trace in more detail, you can find more information on the IUCV interface in chapter 8 in *IBM TCP/IP for MVS: Application Programming Interface Reference*, SC31-7187.

	TrgCls			PrmMsg		
	High Order Bytes					
Call-type	Decimal	Hex	Low Order Bytes	MsgHi	MsgLo	Buffer Data i
INITAPI	0	0000	0000			Parameters passe call
ACCEPT	1	0001	ssss	0	0	Socket address s remote socket
BIND	2	0002	ssss			Socket address s to
CLOSE	3	0003	ssss	0	0	
CONNECT	4	0004	ssss			Socket address s connect to
FCNTL	5	0005	ssss	Cmd	Arg	
GETHOSTID	7	0007	0000	0	0	Host ID of this HOME IP address)
GETHOSTNAME	8	0008	0000	0	0	Host name of thi

GETPEERNAME	9	0009	ssss	0	0	Socket address s remote socket
GETSOCKNAME	10	000A	ssss	0	0	Socket address s socket
GETSOCKOPT	11	000B	ssss	level	option name	Value of option
IOCTL	12	000C	ssss			Command and argu
SELECT / SELECTX	13	000D	descrip- tor set size			Select masks
READ / READV	14	000E	ssss	0	0	Received data
RECV / RECVFROM / RECVMSG	16	0010	ssss	0	flags	Received data
LISTEN	19	0013	ssss	0	backlog queue size	
SEND / SENDMSG	20	0014	ssss			Data to be sent
SENDTO	22	0016	ssss	0	0	Flags and data t
SETSOCKOPT	23	0017	ssss	0	0	Option name and
SHUTDOWN	24	0018	ssss	0	direction	
SOCKET	25	0019	0000			Domain, type and
WRITE / WRITEV	26	001A	ssss	0	0	Data to be writt
GETCLIENTID	30	001E	0000	0	0	The client ID of
GIVESOCKET	31	001F	ssss			Client ID to giv
TAKESOCKET	32	0020	0000			Client ID to tak
Note: **ssss** denotes a socket descriptor number.						

Table 9. Important IUCV Socket Trace Entry Fields

A.0 Appendix A. Sample Datagram Socket Programs

This appendix contains the following two sets of datagram socket programs:

The first sample datagram application is written in COBOL using the Sockets Extended call API. This sample consists of a server ("Datagram Socket COBOL Server Program" in topic A.1) and a client ("Datagram Socket COBOL Client Program" in topic A.2).

The second sample datagram application is written in C. This sample consists of a server ("Datagram Socket C Server Program" in topic A.3) and a client ("Datagram Socket C Client Program" in topic A.4). This C datagram application is written so the source code can be ported between OS/2 and MVS.

A.1 Datagram Socket COBOL Server Program

```
 Identification Division.
*=========================*
*-------------------------------------------------------------*
*                                                             *
* Name:        TPIDGSRV - MVS iterative echo server using     *
*                         UDP protocols. Client is TPIDGCLN   *
*                                                             *
* Function:    This server works with datagram sockets.       *
*              It waits for incoming datagrams on port 9999.  *
*              Received datagrams are echoed back to the      *
*              client that sent them.                         *
*              If a received datagram is a close-down message,*
*              the server terminates itself.                  *
*                                                             *
* Interface:   TCP/IP address space name via EXEC PARM field. *
*                                                             *
* Logic:       1. Establish server setup                      *
*              2. Bind datagram socket to local port 9999     *
*              3. Receive datagram                            *
*                 If received datagram is a close-down message*
*                 the server terminates itself.               *
*              4. Received datagram is echoed back to UDP     *
*                 client that sent it.                        *
*                                                             *
* Returncode:  - none -                                       *
*                                                             *
* Written:     April 8, 1995 at ITSO Raleigh                  *
*                                                             *
*-------------------------------------------------------------*

 Program-id. tpidgsrv.

*======================*
 Environment Division.
*======================*

*==============*
 Data Division.
*==============*

 Working-storage Section.
*-------------------------------------------------------------*
* Socket interface function codes                             *
*-------------------------------------------------------------*
 01  soket-functions.
     02 soket-accept          pic x(16) value 'ACCEPT          '.
     02 soket-bind            pic x(16) value 'BIND            '.
     02 soket-close           pic x(16) value 'CLOSE           '.
     02 soket-connect         pic x(16) value 'CONNECT         '.
     02 soket-fcntl           pic x(16) value 'FCNTL           '.
     02 soket-getclientid     pic x(16) value 'GETCLIENTID     '.
     02 soket-gethostbyaddr   pic x(16) value 'GETHOSTBYADDR   '.
     02 soket-gethostbyname   pic x(16) value 'GETHOSTBYNAME   '.
```

```
     02 soket-gethostid       pic x(16) value 'GETHOSTID       '.
     02 soket-gethostname     pic x(16) value 'GETHOSTNAME     '.
     02 soket-getpeername     pic x(16) value 'GETPEERNAME     '.
     02 soket-getsockname     pic x(16) value 'GETSOCKNAME     '.
     02 soket-getsockopt      pic x(16) value 'GETSOCKOPT      '.
     02 soket-givesocket      pic x(16) value 'GIVESOCKET      '.
     02 soket-initapi         pic x(16) value 'INITAPI         '.
     02 soket-ioctl           pic x(16) value 'IOCTL           '.
     02 soket-listen          pic x(16) value 'LISTEN          '.
     02 soket-read            pic x(16) value 'READ            '.
     02 soket-recv            pic x(16) value 'RECV            '.
     02 soket-recvfrom        pic x(16) value 'RECVFROM        '.
     02 soket-select          pic x(16) value 'SELECT          '.
     02 soket-send            pic x(16) value 'SEND            '.
     02 soket-sendto          pic x(16) value 'SENDTO          '.
     02 soket-setsockopt      pic x(16) value 'SETSOCKOPT      '.
     02 soket-shutdown        pic x(16) value 'SHUTDOWN        '.
     02 soket-socket          pic x(16) value 'SOCKET          '.
     02 soket-takesocket      pic x(16) value 'TAKESOCKET      '.
     02 soket-termapi         pic x(16) value 'TERMAPI         '.
     02 soket-write           pic x(16) value 'WRITE           '.
*---------------------------------------------------------------*
* Work variables                                                *
*---------------------------------------------------------------*
 01  errno                          pic 9(8) binary value zero.
 01  retcode                        pic s9(8) binary value zero.
 01  client-ipaddr-dotted           pic x(15) value space.
 01  saved-message-id               pic x(8) value space.
     88  close-down-message-received  value '*CLSDWN*'.
 01  saved-message-id-len           pic 9(8) Binary value 8.
*---------------------------------------------------------------*
* Variables used for the INITAPI call                           *
*---------------------------------------------------------------*
 01  maxsoc                         pic 9(4) Binary Value 2.
 01  initapi-ident.
     05  tcpname                    pic x(8) Value space.
     05  asname                     pic x(8) Value space.
 01  subtask                        pic x(8) value space.
 01  maxsno                         pic 9(8) Binary Value 1.
*---------------------------------------------------------------*
* Variables returned by the GETCLIENTID Call                    *
*---------------------------------------------------------------*
 01  clientid.
     05  clientid-domain            pic 9(8) Binary.
     05  clientid-name              pic x(8) value space.
     05  clientid-task              pic x(8) value space.
     05  filler                     pic x(20) value low-value.
*---------------------------------------------------------------*
* Variables used for the SOCKET call                            *
*---------------------------------------------------------------*
 01  afinet                         pic 9(8) Binary Value 2.
 01  soctype-datagram               pic 9(8) Binary Value 2.
 01  proto                          pic 9(8) Binary Value zero.
 01  socket-descriptor              pic 9(4) Binary Value zero.
*---------------------------------------------------------------*
* Variables used for the BIND call                              *
*---------------------------------------------------------------*
 01  server-socket-address.
     05  server-afinet              pic 9(4) Binary Value 2.
     05  server-port                pic 9(4) Binary Value 9999.
     05  server-ipaddr              pic 9(8) Binary Value zero.
     05  filler                     pic x(8) value low-value.
```

```
*-------------------------------------------------------------*
* Variables used by the RECVFROM Call                         *
*-------------------------------------------------------------*
 01  client-socket-address.
     05  client-afinet             pic 9(4) Binary Value zero.
     05  client-port               pic 9(4) Binary Value zero.
     05  client-ipaddr             pic 9(8) Binary Value zero.
     05  filler                    pic x(8) value low-value.
*-------------------------------------------------------------*
* Buffer and length field for recvfrom and sendto operation   *
*-------------------------------------------------------------*
 01  send-request-len              pic 9(8) Binary Value zero.
 01  read-request-len              pic 9(8) Binary Value zero.
 01  read-buffer                   pic x(8192) value space.
 01  filler redefines read-buffer.
     05  message-id                pic x(8).
     05  filler                    pic x(8184).
*-------------------------------------------------------------*
* recvfrom and sendto flags                                   *
*-------------------------------------------------------------*
 01  sendto-flag                   pic 9(8) Binary value zero.
 01  recvfrom-flag                 pic 9(8) Binary value zero.
*-------------------------------------------------------------*
* Error message for socket interface errors                   *
*-------------------------------------------------------------*
 01  ezaerror-msg.
     05  filler                    pic x(9) Value 'Function='.
     05  ezaerror-function         pic x(16) Value space.
     05  filler                    pic x value ' '.
     05  filler                    pic x(8) Value 'Retcode='.
     05  ezaerror-retcode          pic ---99.
     05  filler                    pic x value ' '.
     05  filler                    pic x(9) Value 'Errorno='.
     05  ezaerror-errno            pic zzz99.
     05  filler                    pic x value ' '.
     05  ezaerror-text             pic x(50) value ' '.

 Linkage Section.
*================
 01  EXEC-parameter-field.
     05  parm-ll                   pic 9(4) Binary.
     05  parm-tcpname              pic x(8).

*=============================================*
 Procedure Division using EXEC-parameter-field.
*=============================================*

*-------------------------------------------------------------*
* Initialize socket API                                       *
*-------------------------------------------------------------*

     If parm-ll < 8 then
        Display 'Invalid or missing TCP address space name'
        Display '  in EXEC PARM field: PARM=''xxxxxxxx'' '
        Go to exit-now
     end-if.
     Move soket-initapi to ezaerror-function.
     Move parm-tcpname to tcpname.
     Call 'TPICLNID' using asname subtask.
     Call 'EZASOKET' using soket-initapi
        maxsoc
        initapi-ident
```

```
           subtask
           maxsno
           errno
           retcode.
        If retcode < 0 then
           move 'Initapi failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-now.

      *-----------------------------------------------------------------*
      * Let us see the client-id                                        *
      *-----------------------------------------------------------------*

        move soket-getclientid to ezaerror-function.
        Call 'EZASOKET' using soket-getclientid
           clientid
           errno
           retcode.
        If retcode < 0 then
           move 'Getclientid failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-term-api.
        Display 'Client ID = ' clientid-name ' ' clientid-task.

      *-----------------------------------------------------------------*
      * Get us a datagram socket descriptor                             *
      *-----------------------------------------------------------------*

        move soket-socket to ezaerror-function.
        Call 'EZASOKET' using soket-socket
           afinet
           soctype-datagram
           proto
           errno
           retcode.
        If retcode < 0 then
           move 'Socket call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-term-api.
        Move retcode to socket-descriptor.

      *-----------------------------------------------------------------*
      * Bind socket to our server port number                           *
      *-----------------------------------------------------------------*

        Move soket-bind to ezaerror-function.
        Call 'EZASOKET' using soket-bind
           socket-descriptor
           server-socket-address
           errno
           retcode.
        If retcode < 0 then
           move 'Bind call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-close-socket.

      *-----------------------------------------------------------------*
      * Loop reading and sending client datagrams until                 *
      * server receives a datagram that starts with the                 *
      * text *CLSDWN* - then we shut down.                              *
      *-----------------------------------------------------------------*
```

```
      Perform until close-down-message-received
         Display 'Entering new blocking recvfrom call'
         move soket-recvfrom to ezaerror-function
         move 8192 to read-request-len
         Call 'EZASOKET' using soket-recvfrom
            socket-descriptor
            recvfrom-flag
            read-request-len
            read-buffer
            client-socket-address
            errno
            retcode
         If retcode < 0 then
            move 'Recv-from call failed' to ezaerror-text
            perform write-ezaerror-msg thru
               write-ezaerror-msg-exit
            go to exit-close-socket
         end-if
         Call 'TPIINTOA' using client-ipaddr
            client-ipaddr-dotted
         Display 'Data from ip address ' client-ipaddr-dotted
         Display '     and port number ' client-port

         Move message-id to saved-message-id
         if not close-down-message-received then
            Call 'EZACIC05' using saved-message-id
               saved-message-id-len
         end-if

         If close-down-message-received then
            Display 'We received a shut-down message'
         else
            move soket-sendto to ezaerror-function
            move 8192 to send-request-len
            Call 'EZASOKET' using soket-sendto
               socket-descriptor
               sendto-flag
               send-request-len
               read-buffer
               client-socket-address
               errno
               retcode
            If retcode < 0 then
               move 'Sendto call failed' to ezaerror-text
               perform write-ezaerror-msg thru
                  write-ezaerror-msg-exit
               go to exit-close-socket
            end-if
         end-if
      end-perform.

   *---------------------------------------------------------------*
   * Close socket                                                  *
   *---------------------------------------------------------------*

    exit-close-socket.
      move soket-close to ezaerror-function
      Call 'EZASOKET' using soket-close
         socket-descriptor
         errno
         retcode.
      If retcode < 0 then
```

```
           move 'Close call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit.

      *-----------------------------------------------------------------*
      * Terminate socket API                                            *
      *-----------------------------------------------------------------*

       exit-term-api.
           Call 'EZASOKET' using soket-termapi.

      *-----------------------------------------------------------------*
      * Terminate program                                               *
      *-----------------------------------------------------------------*

       exit-now.
           move zero to return-code.
           Goback.

      *-----------------------------------------------------------------*
      * Subroutine                                                      *
      * ----------                                                      *
      *                                                                 *
      * Write out an error message                                      *
      *-----------------------------------------------------------------*

       write-ezaerror-msg.
           move errno to ezaerror-errno.
           move retcode to ezaerror-retcode.
           display ezaerror-msg.
       write-ezaerror-msg-exit.
           exit.
```

A.2 Datagram Socket COBOL Client Program

```
       Identification Division.
      *========================*
      *-----------------------------------------------------------------*
      *                                                                 *
      * Name:         TPIDGCLN - Client to test MVS Datagram            *
      *                          server TPIDGSRV (UDP protocols).       *
      *                                                                 *
      * Function:     Sends 8K message to server and receives reply.    *
      *               If client start option specifies CLOSE, the       *
      *               client sends a shutdown datagram to the server.   *
      *               This program uses non-blocking recvfrom calls     *
      *               in order to implement its own timeout logic       *
      *               in case the server does not respond to its        *
      *               request.                                          *
      *                                                                 *
      * Interface:    CLOSE option in EXEC PARM field                   *
      *                                                                 *
      * Logic:        1. Sends datagram to server                       *
      *               2. Reads echoed datagram from server              *
      *                                                                 *
      * Returncode:   - none -                                          *
      *                                                                 *
      * Written:      April 8, 1995 at ITSO Raleigh                     *
      *                                                                 *
      *-----------------------------------------------------------------*

       Program-id. tpidgcln.
```

```
*=====================*
 Environment Division.
*=====================*

*==============*
 Data Division.
*==============*

 Working-storage Section.
*---------------------------------------------------------------*
* Socket interface function codes                               *
*---------------------------------------------------------------*
 01  soket-functions.
     02 soket-accept          pic x(16) value 'ACCEPT          '.
     02 soket-bind            pic x(16) value 'BIND            '.
     02 soket-close           pic x(16) value 'CLOSE           '.
     02 soket-connect         pic x(16) value 'CONNECT         '.
     02 soket-fcntl           pic x(16) value 'FCNTL           '.
     02 soket-getclientid     pic x(16) value 'GETCLIENTID     '.
     02 soket-gethostbyaddr   pic x(16) value 'GETHOSTBYADDR   '.
     02 soket-gethostbyname   pic x(16) value 'GETHOSTBYNAME   '.
     02 soket-gethostid       pic x(16) value 'GETHOSTID       '.
     02 soket-gethostname     pic x(16) value 'GETHOSTNAME     '.
     02 soket-getpeername     pic x(16) value 'GETPEERNAME     '.
     02 soket-getsockname     pic x(16) value 'GETSOCKNAME     '.
     02 soket-getsockopt      pic x(16) value 'GETSOCKOPT      '.
     02 soket-givesocket      pic x(16) value 'GIVESOCKET      '.
     02 soket-initapi         pic x(16) value 'INITAPI         '.
     02 soket-ioctl           pic x(16) value 'IOCTL           '.
     02 soket-listen          pic x(16) value 'LISTEN          '.
     02 soket-read            pic x(16) value 'READ            '.
     02 soket-recv            pic x(16) value 'RECV            '.
     02 soket-recvfrom        pic x(16) value 'RECVFROM        '.
     02 soket-select          pic x(16) value 'SELECT          '.
     02 soket-send            pic x(16) value 'SEND            '.
     02 soket-sendto          pic x(16) value 'SENDTO          '.
     02 soket-setsockopt      pic x(16) value 'SETSOCKOPT      '.
     02 soket-shutdown        pic x(16) value 'SHUTDOWN        '.
     02 soket-socket          pic x(16) value 'SOCKET          '.
     02 soket-takesocket      pic x(16) value 'TAKESOCKET      '.
     02 soket-termapi         pic x(16) value 'TERMAPI         '.
     02 soket-write           pic x(16) value 'WRITE           '.
*---------------------------------------------------------------*
* Work variables                                                *
*---------------------------------------------------------------*
 01  errno                          pic 9(8) binary value zero.
 01  retcode                        pic s9(8) binary value zero.
 01  index-counter                  pic 9(8) binary value zero.
 01  buffer-element.
     05  buffer-element-nbr         pic 9(5).
     05  filler                     pic x(3) value space.
 01  server-ipaddr-dotted           pic x(15) value space.
 01  close-server                   pic 9(8) Binary value zero.
     88  close-server-down          value 1.
 01  timer-accum                    pic 9(8) Binary value zero.
 01  timer-interval                 pic 9(8) Binary value 1000.
*---------------------------------------------------------------*
* Variables used for the INITAPI call                           *
*---------------------------------------------------------------*
 01  maxsoc                         pic 9(4) Binary Value 1.
 01  initapi-ident.
```

```
     05  tcpname                    pic x(8) Value 'T18ATCP'.
     05  asname                     pic x(8) Value space.
 01  subtask                        pic x(8) value space.
 01  maxsno                         pic 9(8) Binary Value 1.
*-------------------------------------------------------------*
* Variables returned by the GETCLIENTID Call                  *
*-------------------------------------------------------------*
 01  clientid.
     05  clientid-domain            pic 9(8) Binary.
     05  clientid-name              pic x(8) value space.
     05  clientid-task              pic x(8) value space.
     05  filler                     pic x(20) value low-value.
*-------------------------------------------------------------*
* Variables used for the SOCKET call                          *
*-------------------------------------------------------------*
 01  afinet                         pic 9(8) Binary Value 2.
 01  soctype-datagram               pic 9(8) Binary Value 2.
 01  proto                          pic 9(8) Binary Value zero.
 01  socket-descriptor              pic 9(4) Binary Value zero.
*-------------------------------------------------------------*
* Variables used for the GETHOSTBYNAME Call                   *
*-------------------------------------------------------------*
 01  host-namelen                   pic 9(8) Binary Value 5.
 01  host-name                      pic x(5) Value 'mvs18'.
 01  host-entry-addr                pic 9(8) Binary Value zero.
*-------------------------------------------------------------*
* Variables used for the call to EZACIC08                     *
*-------------------------------------------------------------*
 01  host-alias-seq                 pic 9(4) Binary Value zero.
 01  host-addr-seq                  pic 9(4) Binary Value zero.
 01  host-name-length               pic 9(4) Binary Value zero.
 01  host-name-value                pic x(255) Value space.
 01  host-alias-count               pic 9(4) Binary Value zero.
 01  host-alias-length              pic 9(4) Binary Value zero.
 01  host-alias-value               pic x(255) Value space.
 01  host-addr-type                 pic 9(4) Binary Value zero.
 01  host-addr-length               pic 9(4) Binary Value zero.
 01  host-addr-count                pic 9(4) Binary Value zero.
 01  host-addr-value                pic 9(8) Binary Value zero.
 01  host-return-code               pic s9(8) Binary Value zero.
*-------------------------------------------------------------*
* Server socket address structure                             *
*-------------------------------------------------------------*
 01  server-socket-address.
     05  server-afinet              pic 9(4) Binary Value 2.
     05  server-port                pic 9(4) Binary Value 9999.
     05  server-ipaddr              pic 9(8) Binary Value zero.
     05  filler                     pic x(8) value low-value.
*-------------------------------------------------------------*
* Variables used for the IOCTL call                           *
*-------------------------------------------------------------*
 01  ioctl-command-fionbio          pic x(4).
 01  ioctl-command-string           pic x(16) value 'FIONBIO'.
 01  ioctl-reqarg-non-blocking      pic 9(8) Binary value 1.
 01  ioctl-retarg                   pic 9(8) binary value zero.
*-------------------------------------------------------------*
* Buffer and length fields for sendto operation               *
*-------------------------------------------------------------*
 01  send-request-length            pic 9(8) Binary value zero.
 01  send-buffer.
     05  send-buffer-total          pic x(8192) value space.
     05  closedown-message redefines send-buffer-total.
```

```
         10  closedown-id           pic x(8).
         10  filler                 pic x(8184).
     05  send-buffer-seq redefines send-buffer-total
                                    pic x(8) occurs 1024 times.
*-------------------------------------------------------------*
* Buffer and length fields for recvfrom operation            *
*-------------------------------------------------------------*
 01  read-request-length            pic 9(8) Binary value zero.
 01  read-buffer                    pic x(8192) value space.
*-------------------------------------------------------------*
* Other fields for sendto and reccfrom operation             *
*-------------------------------------------------------------*
 01  sendto-flag                    pic 9(8) Binary value zero.
 01  recvfrom-flag                  pic 9(8) Binary value zero.
*-------------------------------------------------------------*
* Error message for socket interface errors                  *
*-------------------------------------------------------------*
 01  ezaerror-msg.
     05  filler                     pic x(9) Value 'Function='.
     05  ezaerror-function          pic x(16) Value space.
     05  filler                     pic x value ' '.
     05  filler                     pic x(8) Value 'Retcode='.
     05  ezaerror-retcode           pic ---99.
     05  filler                     pic x value ' '.
     05  filler                     pic x(9) Value 'Errorno='.
     05  ezaerror-errno             pic zzz99.
     05  filler                     pic x value ' '.
     05  ezaerror-text              pic x(50) value ' '.

 Linkage Section.
*================
 01  EXEC-parameter-field.
     05  parm-ll                    pic 9(4) Binary.
     05  parm-close-option          pic x(5).

*=============================================*
 Procedure Division using EXEC-parameter-field.
*=============================================*

     If parm-ll = zero then
        move zero to close-server.
     If parm-ll = 5 and parm-close-option = 'CLOSE' then
        move 1 to close-server.

*-------------------------------------------------------------*
* Initialize send buffer                                     *
*-------------------------------------------------------------*

     perform varying index-counter from 0 by 1
     until index-counter > 1023
        move index-counter to buffer-element-nbr
        move buffer-element to send-buffer-seq(index-counter)
     end-perform.

*-------------------------------------------------------------*
* Initialize socket API                                      *
*-------------------------------------------------------------*

     Move soket-initapi to ezaerror-function.
     Call 'TPICLNID' using asname subtask.
     Call 'EZASOKET' using soket-initapi
        maxsoc
```

```
           initapi-ident
           subtask
           maxsno
           errno
           retcode.
        If retcode < 0 then
           move 'Initapi failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-now.

     *-----------------------------------------------------------------*
     * Let us see the client-id                                        *
     *-----------------------------------------------------------------*

        move soket-getclientid to ezaerror-function.
        Call 'EZASOKET' using soket-getclientid
           clientid
           errno
           retcode.
        If retcode < 0 then
           move 'Getclientid failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-term-api.
        Display 'Our client ID = ' clientid-name ' ' clientid-task.

     *-----------------------------------------------------------------*
     * Get us a datagram socket descriptor                             *
     *-----------------------------------------------------------------*

        move soket-socket to ezaerror-function.
        Call 'EZASOKET' using soket-socket
           afinet
           soctype-datagram
           proto
           errno
           retcode.
        If retcode < 0 then
           move 'Socket call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-term-api.
        Move retcode to socket-descriptor.

     *-----------------------------------------------------------------*
     * Get host entry structure pointer based on host name             *
     *-----------------------------------------------------------------*

        move soket-gethostbyname to ezaerror-function.
        Call 'EZASOKET' using soket-gethostbyname
           host-namelen
           host-name
           host-entry-addr
           retcode.
        If retcode < 0 then
           move 'Gethostbyname failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-close-socket.

     *-----------------------------------------------------------------*
     * Get info out of the HOSTENT structure                           *
     * As we do not know if server IP address is there, we can         *
     * only use the first returned address for our datagram.           *
     *-----------------------------------------------------------------*
```

```
      move 'EZACIC08' to ezaerror-function.
      Call 'EZACIC08' using host-entry-addr
         host-name-length
         host-name-value
         host-alias-count
         host-alias-seq
         host-alias-length
         host-alias-value
         host-addr-type
         host-addr-length
         host-addr-count
         host-addr-seq
         host-addr-value
         host-return-code.
      If host-return-code = -1 then
         move host-return-code to retcode
         move 'Host translation failed' to ezaerror-text
         perform write-ezaerror-msg thru
            write-ezaerror-msg-exit
         go to exit-close-socket
      end-if.

      Move host-addr-value to server-ipaddr.
      Call 'TPIINTOA' using server-ipaddr server-ipaddr-dotted.
      Display 'Sending datagram to ' server-ipaddr-dotted.

*-------------------------------------------------------------*
* Send datagram to server                                     *
*-------------------------------------------------------------*

      move soket-sendto to ezaerror-function.
      move 8192 to send-request-length.
      If close-server-down then
         Display 'Sending server shutdown message'
         move '*CLSDWN*' to closedown-id.
      Call 'EZASOKET' using soket-sendto
         socket-descriptor
         sendto-flag
         send-request-length
         send-buffer-total
         server-socket-address
         errno
         retcode.
      If retcode < 0 then
         move 'Write call failed' to ezaerror-text
         perform write-ezaerror-msg thru
            write-ezaerror-msg-exit
         go to exit-close-socket
      end-if.
      If close-server-down then
         go to exit-close-socket.

*-------------------------------------------------------------*
* We do not know, if the server is there, so we will not enter  *
* a blocking receive for the echoed datagram.  Instead we turn  *
* the socket into non-blocking mode, and enters a loop where we *
* issue a non-blocking recvfrom call.  If no data, we go into   *
* a one second wait and then reissue the recvfrom call.  If we  *
* have not received a reply within 30 seconds, we timeout and   *
* terminate the client.                                         *
*-------------------------------------------------------------*
```

```
      Move soket-ioctl to ezaerror-function.
      Call 'TPIIOCTL' using ioctl-command-string
         ioctl-command-fionbio.
      If return-code > zero then
         move 'Call to TPIIOCTL failed' to ezaerror-text
         perform write-ezaerror-msg thru
            write-ezaerror-msg-exit
         go to exit-close-socket
      end-if.
      Call 'EZASOKET' using soket-ioctl
         socket-descriptor
         ioctl-command-fionbio
         ioctl-reqarg-non-blocking
         ioctl-retarg
         errno
         retcode.
      If retcode < 0 then
         move 'IOCTL call failed' to ezaerror-text
         perform write-ezaerror-msg thru
            write-ezaerror-msg-exit
         go to exit-close-socket
      end-if.

      move 0 to timer-accum.
      perform until timer-accum >= 30000
         move soket-recvfrom to ezaerror-function
         move 8192 to read-request-length
         Call 'EZASOKET' using soket-recvfrom
            socket-descriptor
            recvfrom-flag
            read-request-length
            read-buffer
            server-socket-address
            errno
            retcode
         If retcode < 0 and errno not = 35 then
            move 'Recv-from call failed' to ezaerror-text
            perform write-ezaerror-msg thru
               write-ezaerror-msg-exit
            go to exit-close-socket
         end-if
         If errno = 35 then
            If timer-accum < 30000 then
               Display 'Waiting one second'
               add timer-interval to timer-accum
               Call 'TPIWAIT' using timer-interval
            else
               Display 'Timed out before server returned datagram'
            end-if
         else
            Display 'We have recieved our echoed datagram'
            Move 31000 to timer-accum
         end-if
      end-perform.

*---------------------------------------------------------------*
* Close socket                                                  *
*---------------------------------------------------------------*

 exit-close-socket.
      move soket-close to ezaerror-function
```

```
           Call 'EZASOKET' using soket-close
              socket-descriptor
              errno
              retcode.
           If retcode < 0 then
              move 'Close call failed' to ezaerror-text
              perform write-ezaerror-msg thru write-ezaerror-msg-exit.

      *-----------------------------------------------------------------*
      * Terminate socket API                                            *
      *-----------------------------------------------------------------*

       exit-term-api.
           Call 'EZASOKET' using soket-termapi.

      *-----------------------------------------------------------------*
      * Terminate program                                               *
      *-----------------------------------------------------------------*

       exit-now.
           move zero to return-code.
           Goback.

      *-----------------------------------------------------------------*
      * Subroutine.                                                     *
      * -----------                                                     *
      *                                                                 *
      * Write out an error message                                      *
      *-----------------------------------------------------------------*

       write-ezaerror-msg.
           move errno to ezaerror-errno.
           move retcode to ezaerror-retcode.
           display ezaerror-msg.
       write-ezaerror-msg-exit.
           exit.
```

A.3 Datagram Socket C Server Program

```
/* Portable UDP socket server - February 1995 */
#define WAIT

#include <stdlib.h>
#include <time.h>    /* time stamp */

#ifdef MVS
 #include <manifest.h>
 #include <bsdtypes.h>
 #include <in.h>
 #include <inet.h>
 #include <socket.h>
 #include <errno.h>
 #include <tcperrno.h>
 #include <dis.h>
#else
 /* On OS/2, use SO32DLL.LIB TCP32DLL.LIB */
 #include <types.h>
 #include <sys\socket.h>
 #include <netinet\in.h>
 #include <nerrno.h> /* sock_errno() */
 #define close soclose
```

```
 #define tcperror psock_errno
 #include "d:\rbb\dis.h"
#endif

#include <netdb.h> /* should not precede #include <manifest.h> on MVS */

#ifdef WAIT
 #ifdef MVS
  #define wait(text) printf("Hit <enter> key to continue with " #text ".\n"); getchar();
  int yesno(char * what)
  {
     char answ ;
     for (; ; ) {
        printf("Enter \'Y\' to continue, \'N\' to stop with %s:",what);
        answ =' '|getchar(); /* EBCDIC uppercase translation */
        getchar();           /* absorp enter key */
        switch (answ) {
        case 'Y': return 1; break;
        case 'N': return 0; break;
        default: ;
        } /* endswitch */
     } /* endfor */
  }
 #else
  #include <conio.h> /* getch() */
  #define wait(text) printf("Hit <any> key to continue with " #text ".\n"); getch();
  int yesno(char * what)
  {
     for (; ; ) {
        printf("Enter \'Y\' to continue, \'N\' to stop with %s\n",what);
        switch (' '|getch()) { /* ASCII lowercase translation */
        case 'y': return 1; break;
        case 'n': return 0; break;
        default: ;
        } /* endswitch */
     } /* endfor */
  }
 #endif
#else
 #define wait(text)
 #define yesno(text) once--
 int once = 1; /* this only works as there is just one yesno call in the program */
#endif

/* #define check(x,y) if (y) { psock_errno(x); exit(1); } else printf(x " OK\n"); */

#define CHECK(x,y) time(&t1) , check(x,y)

time_t  t1, t2 ;
int check(char *text, int condition) /* if TRUE, error */
{
   printf("%-8s ",text);
   if (condition) {
      tcperror("error");
#ifdef MVS
      return errno ;
#else
      return sock_errno() ;
#endif
   } else {
      time(&t2) ; /* get timestamp in seconds */
      printf("completed in %i seconds.\n",t2-t1);
```

```
      return 0 ;
   } /* endif */
}
int main(int argc,char**argv)
{
   int                  socketNumber   ;
   int                  bytesReceived  ;
   struct sockaddr_in   clientAddr     ;
   struct sockaddr_in   localAddr      ;
   unsigned long        bufferSize = 4 ;
   char               * buffer         ;
   char               * bufferChar     ;
   struct hostent     * hostEnt        ;
   unsigned short       port = 9999    ;
   time_t               ltime          ;
   int                  nameLen=sizeof(struct sockaddr_in);

   setbuf(stdout,NULL); /* don't buffer: don't loose output in case of errors */
   setbuf(stderr,NULL); /* should not be necessary ...                        */

   time(&ltime) ; /* Get timestamp in seconds */

   if (argc>1) if (*argv[1]=='?') {
      say(Parameters:\n1. port\n2. receive buffer size);
      return 0;
   } /* endif */
   if (argc>1) if (*argv[1]!='*') port = atoi(argv[1]); disint(port);
   if (argc>2) if (*argv[2]!='*') bufferSize = atoi(argv[2]); disint(bufferSize);

   if (!( buffer = (char*)malloc(bufferSize+1) )) { say(Insufficient storage to allocate receive buf

#ifndef MVS
   if (CHECK("sock_init",sock_init())) return -1;
#endif

   if (CHECK("socket",(socketNumber=socket(AF_INET,SOCK_DGRAM,0))<0)) return -1; /* create datagram

   /* bind socket to a local address with bind() call */
   localAddr.sin_family      = AF_INET     ;
   localAddr.sin_addr.s_addr = INADDR_ANY  ;
   localAddr.sin_port        = htons(port) ;
   if (CHECK("bind",bind(socketNumber,(struct sockaddr*)&localAddr,nameLen)<0)) return -1;

   /* receive data from client */
   while (yesno("RECV")) {
      say(Waiting to receive data);
      if (CHECK("recvfrom",(bytesReceived=recvfrom(socketNumber,buffer,bufferSize,0,(struct sockaddr
      printf("Received from %s port %i (%sAF_INET family).\n",
          (hostEnt=gethostbyaddr((char*)&clientAddr.sin_addr,sizeof(clientAddr.sin_addr),AF_INET))?ho
         clientAddr.sin_port,
         clientAddr.sin_family==AF_INET?"":"NOT ");
      dislong(bytesReceived);
      *(buffer+bytesReceived) = 0 ; /* for disstr */
      bufferChar = buffer ;
      while (*++bufferChar==*buffer) ; /* investigate whether all the same character */
      if (bufferChar-buffer==bytesReceived) {
         printf("All characters \'%c\' (X\'%2.2X\') received.\n",*buffer,*buffer);
      } else {
         disstr(buffer);
      } /* endif */
   } /* endwhile */
```

```
   wait(CLOSE);
   if (CHECK("close",close(socketNumber))) return -1;
   return 0 ;
}
```

A.4 Datagram Socket C Client Program

```
/* Portable UDP socket client - February 1995 */
#define WAIT

#include <stdlib.h>
#include <string.h>
#include <time.h>    /* time stamp */

#ifdef MVS
 #include <manifest.h>
 #include <bsdtypes.h>
 #include <in.h>
 #include <inet.h>
 #include <socket.h>
 #include <errno.h>
 #include <tcperrno.h>
 #include <dis.h>
#else
/* On OS/2, use SO32DLL.LIB TCP32DLL.LIB */
 #include <types.h>
 #include <sys\socket.h>
 #include <netinet\in.h>
 #include <nerrno.h> /* sock_errno() */
 #define close soclose
 #define tcperror psock_errno
 #include "d:\rbb\dis.h"
#endif

#include <netdb.h> /* should not precede #include <manifest.h> on MVS */

#ifdef WAIT
 #ifdef MVS
  #define wait(text) printf("Hit <enter> key to continue with " #text ".\n"); getchar();
  int yesno(char * what)
  {
     char answ ;
     for (; ; ) {
        printf("Enter \'Y\' to continue, \'N\' to stop with %s:",what);
        answ =' '|getchar(); /* EBCDIC uppercase translation */
        getchar();           /* absorp enter key */
        switch (answ) {
        case 'Y': return 1; break;
        case 'N': return 0; break;
        default: ;
        } /* endswitch */
     } /* endfor */
  }
 #else
  #include <conio.h> /* getch() */
  #define wait(text) printf("Hit <any> key to continue with " #text ".\n"); getch();
  int yesno(char * what)
  {
     for (; ; ) {
        printf("Enter \'Y\' to continue, \'N\' to stop with %s\n",what);
        switch (' '|getch()) { /* ASCII lowercase translation */
```

```
        case 'y': return 1; break;
        case 'n': return 0; break;
        default: ;
        } /* endswitch */
      } /* endfor */
  }
 #endif
#else
 #define wait(text)
 #define yesno(text) once--
 int once = 1; /* this only works as there is just one yesno call in the program */
#endif

/* #define check(x,y) if (y) { psock_errno(x); exit(1); } else printf(x " OK\n"); */

#define CHECK(x,y) time(&t1) , check(x,y)

time_t  t1, t2 ;
int check(char *text, int condition) /* if TRUE, error */
{
   printf("%-8s ",text);
   if (condition) {
      tcperror("error");
#ifdef MVS
      return errno ;
#else
      return sock_errno() ;
#endif
   } else {
      time(&t2) ; /* get timestamp in seconds */
      printf("completed in %i seconds.\n",t2-t1);
      return 0 ;
   } /* endif */
}
int main(int argc, char**argv )
{
   int                   socketNumber       ;
   int                   bytesSent     = 0  ;
   int                   bytesToBeSent = 12 ;
   char                * hostName           ;
   unsigned long         binaryAddress      ;
   unsigned short        serverPort = 9999  ;
   unsigned short        clientPort = 0     ;
   struct sockaddr_in    serverAddr         ;
   struct sockaddr_in    fromAddr           ;
   char                * reason             ;
   struct hostent      * hostEnt            ;
   char                * sendBuffer         ;
   char                * receiveBuffer      ;
   int                   nameLen = sizeof(struct sockaddr_in);
   time_t                ltime              ;

   setbuf(stdout,NULL); /* don't buffer: don't loose output in case of errors */
   setbuf(stderr,NULL); /* should not be necessary ...                        */

   time(&ltime) ; /* Get timestamp in seconds */

   if (argc>1) if (*argv[1]=='?') {
      say(Parameters:\n1. address server (dotted or symbolic)\n2. serverPort\n3. bytes to be sent\n4
      return 0;
   } /* endif */
```

```
   if (argc>1) if (*argv[1]!='*') hostName = argv[1] ; disstr(hostName );
   if (argc>2) if (*argv[2]!='*') serverPort = atoi(argv[2]); disint(serverPort );
   if (argc>3) if (*argv[3]!='*') bytesToBeSent = atoi(argv[3]); disint(bytesToBeSent );
   if (argc>4) if (*argv[4]!='*') clientPort = atoi(argv[4]); disint(clientPort );

#ifndef MVS
   if (CHECK("sock_init",sock_init())) return -1;
#endif

   if (( binaryAddress = inet_addr(hostName) )==-1) {
      if (!(hostEnt=gethostbyname(hostName))) {
         switch (h_errno) {
         case HOST_NOT_FOUND : reason = "host not found"  ; break;
         case TRY_AGAIN      : reason = "try again"       ; break;
         case NO_RECOVERY    : reason = "no recovery"     ; break;
         case NO_DATA        : reason = "no data/address" ; break;
      /* case NO_ADDRESS     : reason = "no address"      ; break; */
         default: disint(h_errno);reason = "?" ;
         } /* endswitch */
         printf("Gethostbyname for host \"%s\" failed, reason: %s.\n",hostName,reason);
         return 0 ;
      } /* endif */
      binaryAddress = *(unsigned long*) *hostEnt->h_addr_list ;
      printf("Host \"%s\" has address %s\n",hostName ,inet_ntoa(*(struct in_addr*)&binaryAddress));
   } /* endif */

   if (CHECK("socket",(socketNumber=socket(AF_INET,SOCK_DGRAM,0))<0)) return -1; /* create datagram

   serverAddr.sin_family      = AF_INET           ;
   serverAddr.sin_addr.s_addr = binaryAddress     ;
   serverAddr.sin_port        = htons(serverPort) ; /* disint(htons(serverAddr.sin_port)); */

   /* send message(s) */
   while (yesno("SEND")) {
      if (!( sendBuffer = (char*)malloc(bytesToBeSent) )) { say(Insufficient storage to allocate ser
      memset(sendBuffer,'A',bytesToBeSent);
      if (CHECK("sendto",(bytesSent=sendto(socketNumber,sendBuffer,bytesToBeSent,0,(struct sockaddr*
      printf("%li bytes have been sent.\n",bytesSent);
   } /* endwhile */

   wait(CLOSE);

   if (CHECK("close",close(socketNumber))) return -1; /* close socket */
   return 0 ;
}
```

B.0 Appendix B. Sample Stream Socket Programs

This appendix contains the following two sets of stream socket programs:

One set is written in COBOL using the Sockets Extended call API. This application consists of a server ("Sample Stream Socket COBOL Server" in topic B.1) and a client ("Sample Stream Socket COBOL Client" in topic B.2). The server is implemented as an iterative server running in a normal MVS address space. This server is referred to from Chapter 5, "Your First Socket Program" in topic 5.0.

Another set is written in C. This application consists of a server ("Sample Stream Socket C Server" in topic B.3) and a client ("Sample Stream Socket C Client" in topic B.4). The C source code is written so the source code can be ported between MVS and OS/2.

B.1 Sample Stream Socket COBOL Server

```
 Identification Division.
*=========================*
*-------------------------------------------------------------*
*                                                             *
* Name:        TPIIESRV - MVS iterative echo server using     *
*                         TCP protocols. Client is TPIIECLN.  *
*                                                             *
* Function:    Each client is required to start the dialog by *
*              sending a sign-on message.  Information in the *
*              sign-on message is used to verify the user and *
*              to establish a user security environment via a *
*              call to utility routine: TPIRACF.              *
*              The result of sign-on is returned to the client*
*              in a sign-on reply.                            *
*              The client then sends one or more 8K messages  *
*              to the server that are echoed back to the client.*
*              When the client closes the connection, the user*
*              security environment is reset, and the server  *
*              enters a new blocking accept call waiting for  *
*              the next client.                               *
*              A client may send a Close-down message.  If it *
*              does, the server asks RACF if the user has     *
*              authority to do so via READ access to the      *
*              RACF resource class FACILITY resource name     *
*              TPIIESRV.CLSDOWN;  if OK, the server terminates.*
*                                                             *
* Interface:   TCP address space name via EXEC PARM field     *
*                                                             *
* Logic:       1. Establish server setup and listen on        *
*                 port 9997                                   *
*              2. Accept a connection                         *
*              3. Receive sign-on message from client         *
*              4. Verify user and create task level security  *
*                 environment                                 *
*              5. Receive data message from client            *
*                 If message is close-down message and client *
*                 user is authorized to close down the server,*
*                 server terminates itself.                   *
*              6. Echo data message back to client            *
*              7. Wait for new connect                        *
*                                                             *
* Returncode:  - none -                                       *
*                                                             *
* Written:     March 8, 1995 at ITSO Raleigh                  *
*                                                             *
* Modified:                                                   *
*                                                             *
*-------------------------------------------------------------*

 Program-id. tpiiesrv.

*=====================*
 Environment Division.
```

```
*=====================*

*==============*
 Data Division.
*==============*

 Working-storage Section.
*-----------------------------------------------------------------*
* Socket interface function codes                                 *
*-----------------------------------------------------------------*
 01  soket-functions.
     02 soket-accept          pic x(16) value 'ACCEPT          '.
     02 soket-bind            pic x(16) value 'BIND            '.
     02 soket-close           pic x(16) value 'CLOSE           '.
     02 soket-connect         pic x(16) value 'CONNECT         '.
     02 soket-fcntl           pic x(16) value 'FCNTL           '.
     02 soket-getclientid     pic x(16) value 'GETCLIENTID     '.
     02 soket-gethostbyaddr   pic x(16) value 'GETHOSTBYADDR   '.
     02 soket-gethostbyname   pic x(16) value 'GETHOSTBYNAME   '.
     02 soket-gethostid       pic x(16) value 'GETHOSTID       '.
     02 soket-gethostname     pic x(16) value 'GETHOSTNAME     '.
     02 soket-getpeername     pic x(16) value 'GETPEERNAME     '.
     02 soket-getsockname     pic x(16) value 'GETSOCKNAME     '.
     02 soket-getsockopt      pic x(16) value 'GETSOCKOPT      '.
     02 soket-givesocket      pic x(16) value 'GIVESOCKET      '.
     02 soket-initapi         pic x(16) value 'INITAPI         '.
     02 soket-ioctl           pic x(16) value 'IOCTL           '.
     02 soket-listen          pic x(16) value 'LISTEN          '.
     02 soket-read            pic x(16) value 'READ            '.
     02 soket-recv            pic x(16) value 'RECV            '.
     02 soket-recvfrom        pic x(16) value 'RECVFROM        '.
     02 soket-select          pic x(16) value 'SELECT          '.
     02 soket-send            pic x(16) value 'SEND            '.
     02 soket-sendto          pic x(16) value 'SENDTO          '.
     02 soket-setsockopt      pic x(16) value 'SETSOCKOPT      '.
     02 soket-shutdown        pic x(16) value 'SHUTDOWN        '.
     02 soket-socket          pic x(16) value 'SOCKET          '.
     02 soket-takesocket      pic x(16) value 'TAKESOCKET      '.
     02 soket-termapi         pic x(16) value 'TERMAPI         '.
     02 soket-write           pic x(16) value 'WRITE           '.
*-----------------------------------------------------------------*
* Work variables                                                  *
*-----------------------------------------------------------------*
 01  errno                        pic 9(8) binary value zero.
 01  retcode                      pic s9(8) binary value zero.
 01  client-ipaddr-dotted         pic x(15) value space.
 01  client-type                  pic x    value space.
     88  client-is-ascii          value 'A'.
     88  client-is-ebcdic         value 'E'.
 01  client-status                pic 9(8) Binary value zero.
     88  client-has-closed        Value 1.
*-----------------------------------------------------------------*
* Variables used for the INITAPI call                             *
*-----------------------------------------------------------------*
 01  maxsoc                       pic 9(4) Binary Value 2.
 01  initapi-ident.
     05  tcpname                  pic x(8) Value ' '.
     05  asname                   pic x(8) Value space.
 01  subtask                      pic x(8) value space.
 01  maxsno                       pic 9(8) Binary Value zero.
*-----------------------------------------------------------------*
* Variables returned by the GETCLIENTID Call                      *
```

```
*-------------------------------------------------------------*
 01  clientid.
     05  clientid-domain           pic 9(8) Binary.
     05  clientid-name             pic x(8) value space.
     05  clientid-task             pic x(8) value space.
     05  filler                    pic x(20) value low-value.
*-------------------------------------------------------------*
* Variables used for the SOCKET call                         *
*-------------------------------------------------------------*
 01  afinet                        pic 9(8) Binary Value 2.
 01  soctype-stream                pic 9(8) Binary Value 1.
 01  proto                         pic 9(8) Binary Value zero.
 01  socket-descriptor             pic 9(4) Binary Value zero.
*-------------------------------------------------------------*
* Variables used for the BIND Call                           *
*-------------------------------------------------------------*
 01  server-socket-address.
     05  server-afinet             pic 9(4) Binary Value 2.
     05  server-port               pic 9(4) Binary Value 9997.
     05  server-ipaddr             pic 9(8) Binary Value zero.
     05  filler                    pic x(8) value low-value.
*-------------------------------------------------------------*
* Variables used by the LISTEN Call                          *
*-------------------------------------------------------------*
 01  backlog-queue                 pic 9(8) Binary Value 10.
*-------------------------------------------------------------*
* Variables used by the ACCEPT Call                          *
*-------------------------------------------------------------*
 01  client-socket-address.
     05  client-afinet             pic 9(4) Binary Value zero.
     05  client-port               pic 9(4) Binary Value zero.
     05  client-ipaddr             pic 9(8) Binary Value zero.
     05  filler                    pic x(8) value low-value.
 01  accepted-socket-descriptor    pic 9(4) Binary Value zero.
*-------------------------------------------------------------*
* Variables used by the SETSOCKOPT Linger call               *
*-------------------------------------------------------------*
 01  setsockopt-linger             pic 9(8) Binary Value 128.
 01  setsockopt-value.
     05  linger-on                 pic 9(8) Binary Value zero.
     05  linger-time               pic 9(8) Binary Value 5.
 01  setsockopt-len                pic 9(8) Binary Value 8.
*-------------------------------------------------------------*
* Peek control fields for a peeking RECV call                *
*-------------------------------------------------------------*
 01  recv-flag                     pic 9(8) Binary value zero.
 01  recv-flag-read                pic 9(8) Binary value zero.
 01  recv-flag-peek                pic 9(8) Binary value 2.
*-------------------------------------------------------------*
* Buffer and length field for read operation                 *
*-------------------------------------------------------------*
 01  read-request-len              pic 9(8) Binary Value zero.
 01  read-request-read             pic 9(8) Binary Value zero.
 01  read-request-remaining        pic 9(8) Binary Value zero.
 01  read-buffer.
     05  read-buffer-total         pic x(8192) Value space.
     05  sign-on-message redefines read-buffer-total.
         10  sign-on-id            pic x(8).
             88  message-is-signon  value '*SIGNON*'.
         10  sign-on-userid        pic x(8).
         10  sign-on-pwd           pic x(8).
         10  sign-on-new-pwd       pic x(8).
```

```
          10  sign-on-group          pic x(8).
          10  filler                 pic x(8152).
      05  close-down-message redefines read-buffer-total.
          10  close-down-id          pic x(8).
              88  message-is-closedown value '*CLSDWN*'.
          10  filler                 pic x(8184).
      05  read-buffer-byte redefines read-buffer-total
                                     pic x occurs 8192 times.
*---------------------------------------------------------------*
* Buffer and length fields for write operation                  *
*---------------------------------------------------------------*
 01  send-request-len               pic 9(8) Binary value zero.
 01  send-request-sent              pic 9(8) Binary value zero.
 01  send-request-remaining         pic 9(8) Binary value zero.
 01  send-buffer.
      05  send-buffer-total         pic x(8192) value space.
      05  sign-on-reply redefines send-buffer-total.
          10  sign-on-reply-id      pic x(8).
          10  sign-on-rc            pic 9(4).
          10  filler                pic x(8180).
      05  send-buffer-byte redefines send-buffer-total
                                     pic x occurs 8192 times.
*---------------------------------------------------------------*
* Fields used for calls to TPIAUTH                              *
*---------------------------------------------------------------*
 01  tpiiesrv-cls-resource          pic x(80)
                                    value 'TPIIESRV.CLSDOWN'.
 01  tpiauth-read                   pic x(8) value 'READ'.
*---------------------------------------------------------------*
* Fields used for calls to TPIRACF                              *
*---------------------------------------------------------------*
 01  tpiracf-request                pic 9(8) Binary value zero.
 01  tpiracf-application            pic x(8) value 'TPIIESRV'.
 01  tpiracf-rc                     pic 9(8) Binary value zero.
*---------------------------------------------------------------*
* Error message for socket interface errors                     *
*---------------------------------------------------------------*
 01  ezaerror-msg.
      05  filler                    pic x(9) Value 'Function='.
      05  ezaerror-function         pic x(16) Value space.
      05  filler                    pic x value ' '.
      05  filler                    pic x(8) Value 'Retcode='.
      05  ezaerror-retcode          pic ---99.
      05  filler                    pic x value ' '.
      05  filler                    pic x(9) Value 'Errorno='.
      05  ezaerror-errno            pic zzz99.
      05  filler                    pic x value ' '.
      05  ezaerror-text             pic x(50) value ' '.

 Linkage Section.
*================
 01  EXEC-parameter-field.
      05  parm-ll                   pic 9(4) Binary.
      05  parm-tcpname              pic x(8).

*===============================================*
 Procedure Division using EXEC-parameter-field.
*===============================================*

*---------------------------------------------------------------*
* Initialize socket API                                         *
*---------------------------------------------------------------*
```

```
     If parm-ll < 8 then
        Display 'Invalid or missing TCP address space name'
        Display '  in EXEC PARM field: PARM=''xxxxxxxx'' '
        Go to exit-now
     end-if.
     Move soket-initapi to ezaerror-function.
     Move parm-tcpname to tcpname.
     Call 'TPICLNID' using asname, subtask.
     Call 'EZASOKET' using soket-initapi
        maxsoc
        initapi-ident
        subtask
        maxsno
        errno
        retcode.
     If retcode < 0 then
        move 'Initapi failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-now.

*-----------------------------------------------------------------*
* Let us see the client ID                                        *
*-----------------------------------------------------------------*

     move soket-getclientid to ezaerror-function.
     Call 'EZASOKET' using soket-getclientid
        clientid
        errno
        retcode.
     If retcode < 0 then
        move 'Getclientid failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-term-api.
     Display 'Our client ID = ' clientid-name ' ' clientid-task.

*-----------------------------------------------------------------*
* Get us a socket descriptor                                      *
*-----------------------------------------------------------------*

     move soket-socket to ezaerror-function.
     Call 'EZASOKET' using soket-socket
        afinet
        soctype-stream
        proto
        errno
        retcode.
     If retcode < 0 then
        move 'Socket call failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-term-api.
     Move retcode to socket-descriptor.

*-----------------------------------------------------------------*
* Bind socket to our server port number                           *
*-----------------------------------------------------------------*

     Move soket-bind to ezaerror-function.
     Call 'EZASOKET' using soket-bind
        socket-descriptor
        server-socket-address
        errno
```

```
           retcode.
        If retcode < 0 then
           move 'Bind call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-close-socket.

      *-----------------------------------------------------------------*
      * Issue passive open via Listen call                              *
      *-----------------------------------------------------------------*

        move soket-listen to ezaerror-function.
        Call 'EZASOKET' using soket-listen
           socket-descriptor
           backlog-queue
           errno
           retcode.
        If retcode < 0 then
           move 'Listen call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-close-socket.

      *-----------------------------------------------------------------*
      * Start iterative server loop with a blocking Accept Call         *
      *-----------------------------------------------------------------*

       iterative-server-loop.

        move soket-accept to ezaerror-function.
        Call 'EZASOKET' using soket-accept
           socket-descriptor
           client-socket-address
           errno
           retcode.
        If retcode < 0 then
           move 'Accept call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit
           go to exit-close-socket.
        Move retcode to accepted-socket-descriptor.
        Call 'TPIINTOA' using client-ipaddr client-ipaddr-dotted.
        Display '***** New client connection *****'.
        Display 'Client IP address = ' client-ipaddr-dotted.
        Display '  and port number = ' client-port.

      *-----------------------------------------------------------------*
      * Peek at first 8 bytes of client data                            *
      *-----------------------------------------------------------------*

        Move 8 to read-request-len.
        Move recv-flag-peek to recv-flag.
        Perform read-TCP thru read-TCP-exit.
        If retcode = zero then
           Go to exit-close-a-socket.
        If message-is-signon then
           move 'E' to client-type
        else
           Call 'EZACIC05' using read-buffer
               read-request-read
           If message-is-signon then
              move 'A' to client-type
           else
              Display 'First message from client is not sign-on'
              Go to exit-close-a-socket
```

```
           end-if
        end-if.

*-----------------------------------------------------------------*
* Receive signon message and issue RACF Verify via TPIRACF       *
*-----------------------------------------------------------------*

        Move 40 to read-request-len.
        Move recv-flag-read to recv-flag.
        Perform read-TCP thru read-TCP-exit.
        If retcode = zero then
           Go to exit-close-a-socket.
        If client-is-ascii then
           Call 'EZACIC05' using read-buffer
              read-request-read
        end-if.
        Move zero to tpiracf-request.
        Call 'TPIRACF' using tpiracf-request
           sign-on-userid
           sign-on-pwd
           sign-on-new-pwd
           sign-on-group
           tpiracf-application.
        Move return-code to tpiracf-rc.
        Move '*SIGNON*' to sign-on-reply-id.
        Move tpiracf-rc to sign-on-rc.
        Move 12 to send-request-len.
        if client-is-ascii then
           Call 'EZACIC04' using send-buffer
              send-request-len
        end-if.
        Perform send-TCP thru send-TCP-exit.
        if tpiracf-rc > 0 then
           Display 'Sign-on failed for user = ' sign-on-userid
           Display '                RACF RC = ' tpiracf-rc
           Go to exit-close-a-socket
        end-if.
        Display 'Sign-on successfull for user = ' sign-on-userid.

*-----------------------------------------------------------------*
* Read 8192 block of client-data                                  *
*-----------------------------------------------------------------*

        Move 0 to client-status.
        Perform until client-has-closed
           move 8192 to read-request-len
           Perform read-TCP thru read-TCP-exit
           If retcode = 0 then
              Move 1 to client-status
           else
              Display 'Received 8K message from client'
              If client-is-ascii then
                 Call 'EZACIC05' using read-buffer
                    read-request-read
              end-if

              If message-is-closedown then
                 Display 'We recived a close-down message'
                 Call 'TPIAUTH' using tpiiesrv-cls-resource
                    tpiauth-read
                 If return-code = 0 then
                    Go to exit-close-socket
```

```
              else
                 Display 'User is not authorized to close server'
              end-if
           end-if

*-----------------------------------------------------------------*
* Echo data back to client                                        *
*-----------------------------------------------------------------*

           Move read-buffer to send-buffer
           If client-is-ascii then
              Call 'EZACIC04' using read-buffer
                 read-request-read
           end-if
           move 8192 to send-request-len
           Perform send-TCP thru send-TCP-exit
           Display 'Echoed back 8K message to client'
        end-if
     end-perform.

*-----------------------------------------------------------------*
* Delete security environment and close socket                    *
* Set 5 seconds linger time before close                          *
*-----------------------------------------------------------------*

 exit-delete-sec-env.
     Move 8 to tpiracf-request.
     Call 'TPIRACF' using tpiracf-request.
 exit-close-a-socket.
     move soket-setsockopt to ezaerror-function.
     Call 'EZASOKET' using soket-setsockopt
        accepted-socket-descriptor
        setsockopt-linger
        setsockopt-value
        setsockopt-len
        errno
        retcode.
     If retcode < 0 then
        move 'Setsockopt Linger call failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        Go to exit-close-socket.

     move soket-close to ezaerror-function
     Call 'EZASOKET' using soket-close
        accepted-socket-descriptor
        errno
        retcode.
     If retcode < 0 then
        move 'Close call failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        Go to exit-close-socket.
     Display 'Finished processing one client'.
     Go to iterative-server-loop.

*-----------------------------------------------------------------*
* Close listener socket and terminate                             *
*-----------------------------------------------------------------*

 exit-close-socket.
     move soket-close to ezaerror-function
     Call 'EZASOKET' using soket-close
        socket-descriptor
```

```
           errno
           retcode.
        If retcode < 0 then
           move 'Close call failed' to ezaerror-text
           perform write-ezaerror-msg thru write-ezaerror-msg-exit.
        Display 'Listener socket closed'.

*---------------------------------------------------------------*
* Terminate socket API                                          *
*---------------------------------------------------------------*

 exit-term-api.
     Call 'EZASOKET' using soket-termapi.

*---------------------------------------------------------------*
* Terminate program                                             *
*---------------------------------------------------------------*

 exit-now.
     move zero to return-code.
     Goback.

*---------------------------------------------------------------*
* Write out an error message                                    *
*---------------------------------------------------------------*

 write-ezaerror-msg.
     move errno to ezaerror-errno.
     move retcode to ezaerror-retcode.
     display ezaerror-msg.
 write-ezaerror-msg-exit.
     exit.

*---------------------------------------------------------------*
* Subroutine:                                                   *
* -----------                                                   *
*                                                               *
* Read data from a TCP connection                               *
*---------------------------------------------------------------*

 Read-TCP.
     move soket-recv to ezaerror-function.
     move zero to read-request-read.
     move read-request-len to read-request-remaining.
     Perform until read-request-remaining = 0
        Call 'EZASOKET' using soket-recv
           accepted-socket-descriptor
           recv-flag
           read-request-remaining
           read-buffer-byte(read-request-read + 1)
           errno
           retcode
        If retcode < 0 then
           move 'Read call failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-delete-sec-env
        end-if
        Add retcode to read-request-read
        Subtract retcode from read-request-remaining
        If retcode = 0 then
           Move zero to read-request-remaining
```

```
            Display 'Client closed socket connection'
         end-if
      end-perform.

 Read-TCP-exit.
      exit.

*-----------------------------------------------------------------*
* Subroutine:                                                     *
* -----------                                                     *
*                                                                 *
* Send data over a socket connection                              *
*-----------------------------------------------------------------*

 Send-TCP.
      move soket-write to ezaerror-function.
      move send-request-len to send-request-remaining.
      move 0 to send-request-sent.
      Perform until send-request-remaining = 0
         Call 'EZASOKET' using soket-write
            accepted-socket-descriptor
            send-request-remaining
            send-buffer-byte(send-request-sent + 1)
            errno
            retcode
         If retcode < 0 then
            move 'Write call failed' to ezaerror-text
            perform write-ezaerror-msg thru
               write-ezaerror-msg-exit
            go to exit-delete-sec-env
         end-if
         add retcode to send-request-sent
         subtract retcode from send-request-remaining
         If retcode = 0 then
            Display 'Client closed socket connection'
            Move zero to send-request-remaining
         end-if
      end-perform.

 Send-TCP-exit.
      exit.
```

B.2 Sample Stream Socket COBOL Client

```
 Identification Division.
*=========================*
*-----------------------------------------------------------------*
*                                                                 *
* Name:         TPIIECLN - Client to test MVS iterative           *
*               server TPIIESRV (TCP protocols).                  *
*                                                                 *
* Function:     This program connects to server on port 9997      *
*               and sends a sign-on message including userid,     *
*               password, optional new password and group id.     *
*               Client receives sign-on reply.  If sign-on is OK  *
*               client sends 8K messages and receives them back   *
*               from the server.                                  *
*               If client EXEC PARM startup option is CLOSE, the  *
*               client sends a server close-down message.         *
*                                                                 *
* Interface:    Optional CLOSE option in JCL EXEC PARM field.     *
```

```
*                                                               *
* Logic:       1. Connects to server                            *
*              2. Sends sign-on message to server               *
*              3. receives sign-on reply from server            *
*              4. Sends data message to server                  *
*              5. Receives data message from server             *
*              6. terminates                                    *
*                                                               *
* Returncode:  - none -                                         *
*                                                               *
* Written:     April 8, 1995 at ITSO Raleigh                    *
*                                                               *
* Modified:                                                     *
*                                                               *
*---------------------------------------------------------------*

 Program-id. tpiiecln.

*=====================*
 Environment Division.
*=====================*

*==============*
 Data Division.
*==============*

 Working-storage Section.
*---------------------------------------------------------------*
* Socket interface function codes                               *
*---------------------------------------------------------------*
 01  soket-functions.
     02 soket-accept          pic x(16) value 'ACCEPT          '.
     02 soket-bind            pic x(16) value 'BIND            '.
     02 soket-close           pic x(16) value 'CLOSE           '.
     02 soket-connect         pic x(16) value 'CONNECT         '.
     02 soket-fcntl           pic x(16) value 'FCNTL           '.
     02 soket-getclientid     pic x(16) value 'GETCLIENTID     '.
     02 soket-gethostbyaddr   pic x(16) value 'GETHOSTBYADDR   '.
     02 soket-gethostbyname   pic x(16) value 'GETHOSTBYNAME   '.
     02 soket-gethostid       pic x(16) value 'GETHOSTID       '.
     02 soket-gethostname     pic x(16) value 'GETHOSTNAME     '.
     02 soket-getpeername     pic x(16) value 'GETPEERNAME     '.
     02 soket-getsockname     pic x(16) value 'GETSOCKNAME     '.
     02 soket-getsockopt      pic x(16) value 'GETSOCKOPT      '.
     02 soket-givesocket      pic x(16) value 'GIVESOCKET      '.
     02 soket-initapi         pic x(16) value 'INITAPI         '.
     02 soket-ioctl           pic x(16) value 'IOCTL           '.
     02 soket-listen          pic x(16) value 'LISTEN          '.
     02 soket-read            pic x(16) value 'READ            '.
     02 soket-recv            pic x(16) value 'RECV            '.
     02 soket-recvfrom        pic x(16) value 'RECVFROM        '.
     02 soket-select          pic x(16) value 'SELECT          '.
     02 soket-send            pic x(16) value 'SEND            '.
     02 soket-sendto          pic x(16) value 'SENDTO          '.
     02 soket-setsockopt      pic x(16) value 'SETSOCKOPT      '.
     02 soket-shutdown        pic x(16) value 'SHUTDOWN        '.
     02 soket-socket          pic x(16) value 'SOCKET          '.
     02 soket-takesocket      pic x(16) value 'TAKESOCKET      '.
     02 soket-termapi         pic x(16) value 'TERMAPI         '.
     02 soket-write           pic x(16) value 'WRITE           '.
*---------------------------------------------------------------*
* Work variables                                                *
```

```
*-------------------------------------------------------------*
 01  errno                          pic 9(8) binary value zero.
 01  retcode                        pic s9(8) binary value zero.
 01  buffer-element.
     05  buffer-element-nbr         pic 9(5).
     05  filler                     pic x(3) value space.
 01  index-counter                  pic 9(8) binary value zero.
 01  connect-status                 pic 9(4) Binary value zero.
     88  connect-done               value 1.
 01  server-ipaddr-dotted           pic x(15) value space.
 01  close-server                   pic 9(8) Binary value zero.
     88  send-close-server          value 1.
*-------------------------------------------------------------*
* Variables used for the INITAPI call                        *
*-------------------------------------------------------------*
 01  maxsoc                         pic 9(4) Binary Value 1.
 01  initapi-ident.
     05  tcpname                    pic x(8) Value 'T18BTCP'.
     05  asname                     pic x(8) Value space.
 01  subtask                        pic x(8) value space.
 01  maxsno                         pic 9(8) Binary Value 1.
*-------------------------------------------------------------*
* Variables returned by the GETCLIENTID Call                 *
*-------------------------------------------------------------*
 01  clientid.
     05  clientid-domain            pic 9(8) Binary.
     05  clientid-name              pic x(8) value space.
     05  clientid-task              pic x(8) value space.
     05  filler                     pic x(20) value low-value.
*-------------------------------------------------------------*
* Variables used for the SOCKET call                         *
*-------------------------------------------------------------*
 01  afinet                         pic 9(8) Binary Value 2.
 01  soctype-stream                 pic 9(8) Binary Value 1.
 01  proto                          pic 9(8) Binary Value zero.
 01  socket-descriptor              pic 9(4) Binary Value zero.
*-------------------------------------------------------------*
* Variables used for the GETHOSTBYNAME Call                  *
*-------------------------------------------------------------*
 01  host-namelen                   pic 9(8) Binary Value 5.
 01  host-name                      pic x(5) Value 'mvs18'.
 01  host-entry-addr                pic 9(8) Binary Value zero.
*-------------------------------------------------------------*
* Variables used for the call to EZACIC08                    *
*-------------------------------------------------------------*
 01  host-alias-seq                 pic 9(4) Binary Value zero.
 01  host-addr-seq                  pic 9(4) Binary Value zero.
 01  host-name-length               pic 9(4) Binary Value zero.
 01  host-name-value                pic x(255) Value space.
 01  host-alias-count               pic 9(4) Binary Value zero.
 01  host-alias-length              pic 9(4) Binary Value zero.
 01  host-alias-value               pic x(255) Value space.
 01  host-addr-type                 pic 9(4) Binary Value zero.
 01  host-addr-length               pic 9(4) Binary Value zero.
 01  host-addr-count                pic 9(4) Binary Value zero.
 01  host-addr-value                pic 9(8) Binary Value zero.
 01  host-return-code               pic s9(8) Binary Value zero.
*-------------------------------------------------------------*
* Variables used for the CONNECT Call                        *
*-------------------------------------------------------------*
 01  server-socket-address.
     05  server-afinet              pic 9(4) Binary Value 2.
```

```
     05  server-port               pic 9(4) Binary Value 9997.
     05  server-ipaddr             pic 9(8) Binary Value zero.
     05  server-reserved           pic x(8) value low-value.
*---------------------------------------------------------------*
* Buffer and length field for read operation                    *
*---------------------------------------------------------------*
 01  recv-flag                     pic 9(8) Binary Value zero.
 01  read-request-len              pic 9(8) Binary Value zero.
 01  read-request-read             pic 9(8) Binary Value zero.
 01  read-request-remaining        pic 9(8) Binary Value zero.
 01  read-buffer.
     05  read-buffer-total         pic x(8192) Value space.
     05  sign-on-reply redefines read-buffer-total.
         10  sign-on-reply-id      pic x(8).
             88  message-is-reply  value '*SIGNON*'.
         10  sign-on-rc            pic 9(4).
         10  filler                pic x(8180).
     05  read-buffer-byte redefines read-buffer-total
                                   pic x occurs 8192 times.
*---------------------------------------------------------------*
* Buffer and length fields for write operation                  *
*---------------------------------------------------------------*
 01  send-request-len              pic 9(8) Binary value zero.
 01  send-request-sent             pic 9(8) Binary value zero.
 01  send-request-remaining        pic 9(8) Binary value zero.
 01  send-buffer.
     05  send-buffer-total         pic x(8192) value space.
     05  sign-on-message redefines send-buffer-total.
         10  sign-on-message-id    pic x(8).
         10  sign-on-userid        pic x(8).
         10  sign-on-pwd           pic x(8).
         10  sign-on-new-pwd       pic x(8).
         10  sign-on-group         pic x(8).
         10  filler                pic x(8152).
     05  close-down-message redefines send-buffer-total.
         10  close-down-message-id pic x(8).
         10  filler                pic x(8184).
     05  send-buffer-seq redefines send-buffer-total
                                   pic x(8) occurs 1024 times.
     05  send-buffer-byte redefines send-buffer-total
                                   pic x occurs 8192 times.
*---------------------------------------------------------------*
* Error message for socket interface errors                     *
*---------------------------------------------------------------*
 01  ezaerror-msg.
     05  filler                    pic x(9) Value 'Function='.
     05  ezaerror-function         pic x(16) Value space.
     05  filler                    pic x value ' '.
     05  filler                    pic x(8) Value 'Retcode='.
     05  ezaerror-retcode          pic ---99.
     05  filler                    pic x value ' '.
     05  filler                    pic x(9) Value 'Errorno='.
     05  ezaerror-errno            pic zzz99.
     05  filler                    pic x value ' '.
     05  ezaerror-text             pic x(50) value ' '.

 Linkage Section.
*================
 01  EXEC-parameter-field.
     05  parm-ll                   pic 9(4) Binary.
     05  parm-close-option         pic x(5).
```

```
*=============================================*
 Procedure Division using EXEC-parameter-field.
*=============================================*

     If parm-ll < 5 then
        move zero to close-server
     else
        If parm-close-option = 'CLOSE' then
           move 1 to close-server
        end-if
     end-if.

*-------------------------------------------------------------*
* Initialize socket API                                       *
*-------------------------------------------------------------*

     Move soket-initapi to ezaerror-function.
     Call 'TPICLNID' using asname subtask.
     Call 'EZASOKET' using soket-initapi
        maxsoc
        initapi-ident
        subtask
        maxsno
        errno
        retcode.
     If retcode < 0 then
        move 'Initapi failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-now.

*-------------------------------------------------------------*
* Let us see the client-id                                    *
*-------------------------------------------------------------*

     move soket-getclientid to ezaerror-function.
     Call 'EZASOKET' using soket-getclientid
        clientid
        errno
        retcode.
     If retcode < 0 then
        move 'Getclientid failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-term-api.
     Display 'Our client ID = ' clientid-name ' ' clientid-task.

*-------------------------------------------------------------*
* Get host entry structure pointer based on host name         *
*-------------------------------------------------------------*

     move soket-gethostbyname to ezaerror-function.
     Call 'EZASOKET' using soket-gethostbyname
        host-namelen
        host-name
        host-entry-addr
        retcode.
     If retcode < 0 then
        move 'Gethostbyname failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-term-api.

*-------------------------------------------------------------*
* Get IP addresses out of the HOST Entry structure.           *
```

```
*                                                               *
* Loop pulling IP addresses out of the host entry structure,    *
* getting a socket and trying to connect to IP address.         *
*                                                               *
* Loop untill the returned list of IP addresses is              *
* exhausted or a connect is succesful                           *
*---------------------------------------------------------------*

     Move zero to connect-status.
     Perform until ((host-addr-count = host-addr-seq and
        host-addr-seq > 0) or
        connect-done)
        If host-alias-seq > host-alias-count then
           subtract 1 from host-alias-seq
        end-if
        move 'EZACIC08' to ezaerror-function
        Call 'EZACIC08' using host-entry-addr
           host-name-length
           host-name-value
           host-alias-count
           host-alias-seq
           host-alias-length
           host-alias-value
           host-addr-type
           host-addr-length
           host-addr-count
           host-addr-seq
           host-addr-value
           host-return-code
        If host-return-code < 0 then
           move host-return-code to retcode
           move 'Host translation failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-close-socket
        end-if
        Move host-addr-value to server-ipaddr

*---------------------------------------------------------------*
* Get an AF_INET socket to use for connect                      *
*---------------------------------------------------------------*

        move soket-socket to ezaerror-function
        Call 'EZASOKET' using soket-socket
           afinet
           soctype-stream
           proto
           errno
           retcode
        If retcode < 0 then
           move 'Socket call failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-term-api
        end-if
        Move retcode to socket-descriptor

*---------------------------------------------------------------*
* Try to connect to iterative server on returned IP address     *
*---------------------------------------------------------------*

        If host-return-code = 0 then
```

```
            Move soket-connect to ezaerror-function
            Call 'TPIINTOA' using server-ipaddr
               server-ipaddr-dotted
            move 2 to server-afinet
            move low-value to server-reserved
            move 9997 to server-port
            Call 'EZASOKET' using soket-connect
               socket-descriptor
               server-socket-address
               errno
               retcode
            If retcode < 0 then
               Move space to ezaerror-text
               Call 'TPIINTOA' using server-ipaddr
                  ezaerror-text
               perform write-ezaerror-msg thru
                  write-ezaerror-msg-exit
               move soket-close to ezaerror-function
               Call 'EZASOKET' using soket-close
                  socket-descriptor
                  errno
                  retcode
               If retcode < 0 then
                  move 'Close call failed' to ezaerror-text
                  perform write-ezaerror-msg thru
                     write-ezaerror-msg-exit
                  Go to exit-term-api
               end-if
            else
               move 1 to connect-status
            end-if
         end-if
      end-perform.

      if not connect-done then
         move 'Connection-loop' to ezaerror-function
         move 'Connect failed' to ezaerror-text
         perform write-ezaerror-msg thru
            write-ezaerror-msg-exit
         Go to exit-term-api.

      Display 'Connected to server at ' server-ipaddr-dotted.

*---------------------------------------------------------------*
* Send sign-on message to server                                *
* In this sample code, user id and password are hardcoded.      *
* In a real application, we would prompt the client user for    *
* these values.                                                 *
*---------------------------------------------------------------*

      Move '*SIGNON*' to sign-on-message-id.
      Move 'USERXX' to sign-on-userid.
      Move '??????' to sign-on-pwd.
      Move space to sign-on-new-pwd.
      Move space to sign-on-group.
      Move 40 to send-request-len.
      Perform send-TCP thru send-TCP-exit.
      If retcode = 0 then
         Go to exit-close-socket.

*---------------------------------------------------------------*
* Receive sign-on reply from server                             *
```

```
*-------------------------------------------------------------*

     Move 12 to read-request-len.
     Perform read-TCP thru read-TCP-exit.
     If retcode = 0 then
        Go to exit-close-socket.
     If sign-on-rc not = 0 then
        Display 'Sign-on was unsuccessful'
        Go to exit-close-socket
     else
        Display 'Successful sign-on, user = ' sign-on-userid
     end-if.

*-------------------------------------------------------------*
* Initialize send buffer                                      *
*-------------------------------------------------------------*

     perform varying index-counter from 0 by 1
     until index-counter > 1023
        move index-counter to buffer-element-nbr
        move buffer-element to send-buffer-seq(index-counter)
     end-perform.

*-------------------------------------------------------------*
* If we are asked to close server down, we send a closedown   *
* message and do not expect a response.                       *
*-------------------------------------------------------------*

     If send-close-server then
        Display 'Sending close-down message to server'
        move '*CLSDWN*' to close-down-message-id
     end-if.

     move 8192 to send-request-len.

     Perform send-TCP thru send-TCP-exit.
     If send-close-server then
        Go to exit-close-socket.
     If retcode = 0 then
        Go to exit-close-socket
     else
        Display '8K Message sent to server'
     end-if.

*-------------------------------------------------------------*
* Read server response                                        *
*-------------------------------------------------------------*

     move 8192 to read-request-len.

     Perform read-TCP thru read-TCP-exit.
     If retcode = 0 then
        Go to exit-close-socket
     else
        Display 'Server returned 8K message'
     end-if.

*-------------------------------------------------------------*
* Close socket                                                *
*-------------------------------------------------------------*

 exit-close-socket.
```

```
     move soket-close to ezaerror-function
     Call 'EZASOKET' using soket-close
        socket-descriptor
        errno
        retcode.
     If retcode < 0 then
        move 'Close call failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit.

*---------------------------------------------------------------*
* Terminate socket API                                          *
*---------------------------------------------------------------*

 exit-term-api.
     Call 'EZASOKET' using soket-termapi.

*---------------------------------------------------------------*
* Terminate program                                             *
*---------------------------------------------------------------*

 exit-now.
     move zero to return-code.
     Goback.

*---------------------------------------------------------------*
* Subroutine.                                                   *
* -----------                                                   *
*                                                               *
* Write out an error message                                    *
*---------------------------------------------------------------*

 write-ezaerror-msg.
     move errno to ezaerror-errno.
     move retcode to ezaerror-retcode.
     display ezaerror-msg.
 write-ezaerror-msg-exit.
     exit.

*---------------------------------------------------------------*
* Subroutine:                                                   *
* -----------                                                   *
*                                                               *
* Read data from socket connection                              *
*---------------------------------------------------------------*

 Read-TCP.
     move soket-recv to ezaerror-function.
     move zero to read-request-read.
     move read-request-len to read-request-remaining.
     Perform until read-request-remaining = 0
        Call 'EZASOKET' using soket-recv
           socket-descriptor
           recv-flag
           read-request-remaining
           read-buffer-byte(read-request-read + 1)
           errno
           retcode
        If retcode < 0 then
           move 'Read call failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-close-socket
```

```
           end-if
           Add retcode to read-request-read
           Subtract retcode from read-request-remaining
           If retcode = 0 then
              Display 'Server closed socket connection'
              Move zero to read-request-remaining
           end-if
        end-perform.
     Read-TCP-exit.
        exit.

     *---------------------------------------------------------------*
     * Subroutine:                                                   *
     * -----------                                                   *
     *                                                               *
     * Send data over socket connection                              *
     *---------------------------------------------------------------*

      Send-TCP.
        move soket-write to ezaerror-function.
        move send-request-len to send-request-remaining.
        move 0 to send-request-sent.
        Perform until send-request-remaining = 0
           Call 'EZASOKET' using soket-write
              socket-descriptor
              send-request-remaining
              send-buffer-byte(send-request-sent + 1)
              errno
              retcode
           If retcode < 0 then
              move 'Write call failed' to ezaerror-text
              perform write-ezaerror-msg thru
                 write-ezaerror-msg-exit
              go to exit-close-socket
           end-if
           add retcode to send-request-sent
           subtract retcode from send-request-remaining
           If retcode = 0 then
              Display 'Server closed socket connection'
              Move zero to send-request-remaining
           end-if
        end-perform.
     Send-TCP-exit.
        exit.
```

B.3 Sample Stream Socket C Server

```
/* Portable socket server - (C) IBM - 1995 */
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#ifdef MVS
 #include <manifest.h>
 #include <bsdtypes.h>
 #include <in.h>
 #include <inet.h>
 #include <socket.h>
 #include <errno.h> /* required to make "errno" variable available */
 #include <tcperrno.h>
 #define tcperrno errno
```

```
#else
 /* On OS/2, use SO32DLL.LIB TCP32DLL.LIB */
 #define MAX_SEND_RECV 32767
 #include <types.h>
 #include <sys\socket.h>
 #include <netinet\in.h>
 #include <nerrno.h> /* sock_errno() */

 #define close soclose
 #define tcperror psock_errno
 #define tcperrno sock_errno()
#endif

#include <netdb.h> /* should not precede #include <manifest.h> on MVS */

int check(char *text, int condition) /* if TRUE, error */
{
   printf("%-9s ",text);
   if (condition) {
      tcperror("error");
      return tcperrno ;
   } else {
      printf("completed OK.\n");
      return 0 ;
   } /* endif */
}

int sendRecord (int socketId , char * recordBuffer , unsigned long recordLength )
{
   int    bytesSent      = 0             ;
   int    bytesToBeSent                  ;
   char * remainingData  = recordBuffer  ;
   int    remainingBytes = recordLength  ;

   while ( remainingBytes >0) {
      #ifdef MAX_SEND_RECV
       bytesToBeSent = min(remainingBytes,MAX_SEND_RECV);
      #else
       bytesToBeSent = remainingBytes ;
      #endif
      if (check("send",(bytesSent=send(socketId,remainingData,bytesToBeSent,0))<0)) return 1;
      if (!bytesSent) { printf("Connection broken while sending.\n"); return 1 ; }
      printf("%i bytes have been sent.\n",bytesSent);
      remainingBytes -= bytesSent ;
      remainingData  += bytesSent ;
   } /* endwhile */
   printf("Complete record sent.\n");
   return 0 ;
}

int receiveRecord (int socketId , char * recordBuffer , unsigned long recordLength )
{
   int    bytesReceived     = 0             ;
   int    bytesToBeReceived                 ;
   char * remainingData     = recordBuffer  ;
   int    remainingBytes    = recordLength  ;

   while ( remainingBytes >0) {
      #ifdef MAX_SEND_RECV
       bytesToBeReceived = min(remainingBytes,MAX_SEND_RECV);
      #else
```

```
       bytesToBeReceived = remainingBytes ;
      #endif
      if (check("recv",(bytesReceived=recv(socketId,remainingData,bytesToBeReceived,0))<0)) {
         return 1;
      } /* endif */
      if (!bytesReceived) { printf("Connection broken while receiving.\n"); return 1 ; }
      printf("%i bytes have been received.\n",bytesReceived);
      remainingBytes -= bytesReceived ;
      remainingData  += bytesReceived ;
   } /* endwhile */
   printf("Complete record received.\n");
   return 0 ;
}

int main(int argc,char**argv)
{
   int                  socketId          ;
   int                  newSocket         ;
   struct sockaddr_in   localAddress      ;
   struct sockaddr_in   clientAddress     ;
   char               * buffer            ;
   unsigned long        recordLength = 80 ;
   unsigned short       port=9999         ;
   struct hostent     * hostEnt           ;
   int                  namelen=sizeof(struct sockaddr_in);

   setbuf(stdout,NULL); /* don't buffer: don't loose output in case of errors */

   if (argc>1) if (*argv[1]=='?') {
      printf("Parameters:\n"
             "1. port (default 9999)\n"
             "2. expected number of bytes (default 80).\n");
      return 0;
   } /* endif */

   if (argc>1) if (*argv[1]!='*') port = atoi(argv[1]);
   if (argc>2) if (*argv[2]!='*') recordLength = atoi(argv[2]);

   printf("port          = %i\n"
          "record length = %i\n"
           , port
           , recordLength );

   if (!( buffer = (char*)malloc(recordLength+1) )) {
      printf("Insufficient storage to allocate buffer.\n");
      return 1;
   } /* endif */

#ifndef MVS
   if (check("sock_init",sock_init())) return 1;
#endif

   /* create stream socket */
   if (check("socket",(socketId=socket(AF_INET,SOCK_STREAM,0))<0)) return 1;

   /* bind socket to any local address */
   localAddress.sin_family      = AF_INET     ;
   localAddress.sin_addr.s_addr = INADDR_ANY  ;
   localAddress.sin_port        = htons(port) ;

   if (check("bind",bind(socketId,(struct sockaddr*)&localAddress,namelen)<0) ) return 1 ;
```

```
   if (check("listen",listen(socketId,1))) return 1;

   if (check("accept",(newSocket=accept(socketId,(struct sockaddr*)&clientAddress,&namelen))<0)) {
      return 1;
   } /* endif */

   printf("Client: address: %s, port: %i.\n",
      (hostEnt=
      gethostbyaddr((char*)&clientAddress.sin_addr,sizeof(clientAddress.sin_addr),AF_INET))
      ?hostEnt->h_name:inet_ntoa(clientAddress.sin_addr),
      clientAddress.sin_port);

   /* echo data to client */
   if (receiveRecord (newSocket , buffer , recordLength )) return 1;
   if (sendRecord    (newSocket , buffer , recordLength )) return 1;

   if (check("close newSocket" , close(newSocket))) return 1;
   if (check("close socketId"  , close(socketId ))) return 1;
return 0 ;
}
```

B.4 Sample Stream Socket C Client

```
/* Portable socket client - (C) IBM - 1995 */
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#ifdef MVS
 #include <manifest.h>
 #include <bsdtypes.h>
 #include <in.h>
 #include <inet.h>
 #include <socket.h>
 #include <tcperrno.h>
 #define tcperrno errno
 #include <errno.h> /* required to make "errno" variable available */

#else
 /* On OS/2, use SO32DLL.LIB TCP32DLL.LIB */
 #define MAX_SEND_RECV 32767
 #include <types.h>
 #include <sys\socket.h>
 #include <netinet\in.h>
 #include <nerrno.h> /* sock_errno() */

 #define close soclose
 #define tcperror psock_errno
 #define tcperrno sock_errno()
#endif

#include <netdb.h> /* should not precede #include <manifest.h> on MVS */

int check(char *text, int condition) /* if TRUE, error */
{
   printf("%-9s ",text);
   if (condition) {
      tcperror("error");
      return tcperrno ;
   } else {
      printf("completed OK.\n");
```

```
      return 0 ;
   } /* endif */
}

int sendRecord (int socketId , char * recordBuffer , unsigned long recordLength )
{
   int    bytesSent      = 0             ;
   int    bytesToBeSent                  ;
   char * remainingData  = recordBuffer  ;
   int    remainingBytes = recordLength  ;

   while ( remainingBytes >0) {
      #ifdef MAX_SEND_RECV
       bytesToBeSent = min(remainingBytes,MAX_SEND_RECV);
      #else
       bytesToBeSent = remainingBytes ;
      #endif
      if (check("send",(bytesSent=send(socketId,remainingData,bytesToBeSent,0))<0)) return 1;
      if (!bytesSent) { printf("Connection broken while sending.\n"); return 1 ; }
      printf("%i bytes have been sent.\n",bytesSent);
      remainingBytes -= bytesSent ;
      remainingData  += bytesSent ;
   } /* endwhile */
   printf("Complete record sent.\n");
   return 0 ;
}

int receiveRecord (int socketId , char * recordBuffer , unsigned long recordLength )
{
   int    bytesReceived     = 0             ;
   int    bytesToBeReceived                 ;
   char * remainingData     = recordBuffer  ;
   int    remainingBytes    = recordLength  ;

   while ( remainingBytes >0) {
      #ifdef MAX_SEND_RECV
       bytesToBeReceived = min(remainingBytes,MAX_SEND_RECV);
      #else
       bytesToBeReceived = remainingBytes ;
      #endif
      if (check("recv",(bytesReceived=recv(socketId,remainingData,bytesToBeReceived,0))<0)) {
         return 1;
      } /* endif */
      if (!bytesReceived) { printf("Connection broken while receiving.\n"); return 1 ; }
      printf("%i bytes have been received.\n",bytesReceived);
      remainingBytes -= bytesReceived ;
      remainingData  += bytesReceived ;
   } /* endwhile */
   printf("Complete record received.\n");
   return 0 ;
}

unsigned long * findAddresses ( char * id )
{
   unsigned long    binaryAddress   ;
   unsigned long  * binaryAddresses ;
   char           * reason          ;
   struct hostent * hostEnt         ;

   if (( binaryAddress = inet_addr(id) )==INADDR_NONE) {
      if (!(hostEnt=gethostbyname(id))) {
         switch (h_errno) {
```

```
         case HOST_NOT_FOUND : reason = "host not found"  ; break;
         case TRY_AGAIN      : reason = "try again"       ; break;
         case NO_RECOVERY    : reason = "no recovery"     ; break;
         case NO_ADDRESS     : reason = "no data/address" ; break;
         default:              reason = "?" ;
         } /* endswitch */
         printf("Gethostbyname for host \"%s\" failed, reason: %s.\n",id,reason);
         return 0 ;
      } /* endif */
      return (unsigned long*) *hostEnt->h_addr_list ;
   } else {
      binaryAddresses = (unsigned long *)calloc(2,sizeof(unsigned long));
      binaryAddresses [0] = binaryAddress ; /* second entry terminates loop */
      return binaryAddresses ;
   } /* endif */
}

int main(int argc, char**argv )
{
   int                   socketId          ;
   int                   recordLength = 80 ;
   char                * serverId          ;
   unsigned short        serverPort = 9999 ;
   struct sockaddr_in    serverAddress     ;
   unsigned long         binaryAddress     ;
   unsigned long       * binaryAddresses   ;
   struct sockaddr_in    localAddress      ;
   char                * sendBuffer        ;
   char                * receiveBuffer     ;
   int                   namelen = sizeof(localAddress);
   char                * help =
            "Parameters:\n"
            "1. address server (dotted or symbolic) (no default)\n"
            "2. serverPort (default 9999)\n3. bytes to be sent (default80).\n" ;

   setbuf(stdout,NULL); /* don't buffer: don't loose output in case of errors */

   if (argc<2) { printf(help); return 0; }
   if (argc>1) if (*argv[1]=='?') { printf(help); return 0; }

   if (argc>1) if (*argv[1]!='*') serverId = argv[1] ;
   if (argc>2) if (*argv[2]!='*') serverPort = atoi(argv[2]);
   if (argc>3) if (*argv[3]!='*') recordLength = atoi(argv[3]);

   printf("server id     = %s\n"
          "server port   = %i\n"
          "record length = %i\n"
          , serverId
          , serverPort
          , recordLength);

   if (!( sendBuffer = (char*)malloc(2*recordLength) )) {
      printf("Insufficient storage to allocate buffers.\n");
      return 1;
   } /* endif */

   receiveBuffer = sendBuffer + recordLength ;

   memset(   sendBuffer,'A',recordLength); /* we will send a record full of A's */
   memset(receiveBuffer, 0 ,recordLength); /* blank out - to prevent mistakes   */

#ifndef MVS
```

```
   if (check("sock_init",sock_init())) return 1;
#endif

   /* define fixed portion of server address */
   serverAddress.sin_family = AF_INET           ;
   serverAddress.sin_port   = htons(serverPort) ;

   if (!(binaryAddresses= findAddresses ( serverId ))) return 1 ;

   while ( binaryAddress = *binaryAddresses++ ) {

      /* get a new socket for each connect attempt */
      if (check("socket",(socketId=socket(AF_INET,SOCK_STREAM,0))<0)) return 1;
      serverAddress.sin_addr.s_addr = binaryAddress ;

      /* connect to server */
      printf("Trying to connect address %s\n",inet_ntoa(serverAddress.sin_addr));
      if (!check("connect",
      connect(socketId,(struct sockaddr*)&serverAddress,sizeof(serverAddress))<0)) break ;

      /* socket can not be reused after a failure */
      if (check("close",close(socketId))) return 1; /* close socket */

   } /* endwhile */

   if (!binaryAddress) {
      printf("All known addresses of the specified server host were tried without success.\n");
      return 1;
   } /* endif */

   /* Find out where the system bound us */
   if (check("getsockname",getsockname(socketId, (struct sockaddr *)&localAddress, &namelen))) {
      return 1;
   } /* endif */

   printf("Our own socket address: %s, port: %i.\n",
      inet_ntoa(localAddress.sin_addr),
      ntohs(localAddress.sin_port));

   /* send a message and receive echo */
   if (sendRecord    ( socketId ,    sendBuffer , recordLength )) return 1;
   if (receiveRecord ( socketId , receiveBuffer , recordLength )) return 1;

   /* verify we received the same thing we sent */
   if (memcmp(sendBuffer,receiveBuffer,recordLength)) {
      printf("Echo *NOT* correct.\n");
   } else {
      printf("Echo is correct.\n");
   } /* endif */

   if (check("close",close(socketId))) return 1;
return 0 ;
}
```

C.0 Appendix C. Sample IMS Socket Programs

This appendix contains sample IMS socket programs that are developed in COBOL.

It also contains the sample IMS listener security exit that was used in the ITSO-Raleigh installation.

C.1 Dual Purpose Implicit Mode IMS Server Program

```
 Identification Division.
*=========================*

*-----------------------------------------------------------------*
*                                                                 *
* Name:        TPIIMSDP - DI21PART database query program.        *
*                                                                 *
* Function:    Receives a part number, fetches data from the      *
*              DI21PART database and sends a message back.        *
*              Works for both MFS 3270 and implicit mode          *
*              IMS sockets.  Dual-purpose IMS MPP.                *
*                                                                 *
* Interface:   - none -                                           *
*                                                                 *
* Logic:       1. Receive input message                           *
*              2. Look up PARTROOT and STANINFO segments          *
*              3. Format output message according to              *
*                 defined layout                                  *
*              4. Insert output message and terminate             *
*                                                                 *
* Returncode:  - none -                                           *
*                                                                 *
* Written:     March 7,  1995 at ITSO Raleigh                     *
*                                                                 *
* Modified:                                                       *
*                                                                 *
*-----------------------------------------------------------------*

 Program-id. TPIIMSDP.

*======================*
 Environment Division.
*======================*

*==============*
 Data Division.
*==============*

 Working-storage Section.
*-----------------------------------------------------------------*
* Status messages                                                 *
*-----------------------------------------------------------------*
 01  partnumber-unknown             pic x(79)
     Value 'Part number is not in database'.
 01  staninfo-unknown               pic x(79)
     Value 'Only basic information is available for part number'.
 01  dli-unknown.
     05  filler                     pic x(11) Value 'DLI status='.
     05  status-dli                 pic x(2).
     05  filler                     pic x(10) Value ' Function='.
     05  status-function            pic x(4).
     05  filler                     pic x(9)  Value ' Segment='.
     05  status-segment             pic x(8).
```

```
     05  filler                     pic x(1)  Value space.
     05  status-message             pic x(34) Value space.
 01  ioerr-unknown.
     05  filler                     pic x(11) Value 'DLI status='.
     05  ioerr-dli                  pic x(2).
     05  filler                     pic x(10) Value ' Function='.
     05  ioerr-function             pic x(4).
     05  filler                     pic x(8)  Value ' Assist='.
     05  ioerr-status               pic x(6)  Value space.
     05  filler redefines ioerr-status.
         10  ioerr-char             pic x(2).
         10  filler                 pic x(4).
     05  ioerr-num redefines ioerr-status
                                    pic -99999.
     05  filler                     pic x(1)  Value space.
     05  ioerr-message              pic x(31) Value space.

*-----------------------------------------------------------------*
* Work variables                                                  *
*-----------------------------------------------------------------*
 01  dli-gu                         pic x(4) Value 'GU'.
 01  dli-isrt                       pic x(4) Value 'ISRT'.
 01  dli-gn                         pic x(4) Value 'GN'.
 01  dli-gnp                        pic x(4) Value 'GNP'.

*-----------------------------------------------------------------*
* SSA's for PARTROOT and STANINFO segments                        *
*-----------------------------------------------------------------*
 01  partroot-ssa.
     05  filler                     pic x(8) Value 'PARTROOT'.
     05  filler                     pic x(11) Value '(PARTKEY  ='.
     05  filler                     pic x(2) Value '02'.
     05  partroot-key               pic x(15) Value Space.
     05  filler                     pic x(1) Value ')'.
 01  staninfo-ssa.
     05  filler                     pic x(8) Value 'STANINFO'.
     05  filler                     pic x(1) Value ' '.

*-----------------------------------------------------------------*
* PARTROOT segment IO area                                        *
*-----------------------------------------------------------------*
 01  partroot-segment.
     05  filler                     pic x(2).
     05  partroot-partno            pic x(15).
     05  filler                     pic x(9).
     05  partroot-descr             pic x(20).
     05  filler                     pic x(4).

*-----------------------------------------------------------------*
* STANINFO segment IO area                                        *
*-----------------------------------------------------------------*
 01  staninfo-segment.
     05  staninfo-proc-code         pic x(2).
     05  staninfo-inv-code          pic x(1).
     05  staninfo-rev-number        pic x(2).
     05  filler                     pic x(24).
     05  staninfo-makedept          pic x(2).
     05  staninfo-makecost          pic x(2).
     05  filler                     pic x(2).
     05  staninfo-commodity-code    pic x(4).
     05  filler                     pic x(4).
     05  filler                     pic x(25).
```

```
*-----------------------------------------------------------------*
* Terminal segment input/output area (MID and MOD)               *
*-----------------------------------------------------------------*
 01  buffer.
     05  buffer-ll                  pic 9(4) Binary.
     05  buffer-zz                  pic 9(4) Binary.
     05  input-buffer.
         10  input-trancode         pic x(8).
         10  input-partno           pic x(15).
         10  filler                 pic x(102).
     05  output-buffer redefines input-buffer.
         10  output-partno          pic x(15).
         10  output-descr           pic x(20).
         10  output-proc-code       pic x(2).
         10  output-inv-code        pic x(1).
         10  output-revision-nbr    pic x(2).
         10  output-makedept        pic x(2).
         10  output-makecctr        pic x(2).
         10  output-commodity       pic x(2).
         10  output-status          pic x(79).

 Linkage section.
*-----------------------------------------------------------------*
* Input-Output PCB layout                                        *
*-----------------------------------------------------------------*
 01  iopcb.
     05  iopcb-lterm                pic x(8).
     05  iopcb-assist-status-bin    pic s9(4) comp.
     05  iopcb-assist-status-char redefines
         iopcb-assist-status-bin    pic x(2).
         88  iopcb-assist-aib-error   value 'EA'.
         88  iopcb-assist-buffer-full value 'EB'.
         88  iopcb-assist-tim-only    value 'EC'.
     05  iopcb-status               pic x(2).
         88  iopcb-dli-stop         value 'QC'.
         88  iopcb-dli-ok           value '  '.
         88  iopcb-assist-error     value 'ZZ'.
     05  iopcb-cdate                pic s9(7) comp-3.
     05  iopcb-ctime                pic s9(7) comp-3.
     05  iopcb-input-msgno          pic 9(8) binary.
     05  iopcb-output-mod           pic x(8).
     05  iopcb-userid               pic x(8).

 01  altpcb1.
     05  altpcb1-lterm              pic x(8).
     05  filler                     pic x(2).
     05  altpcb1-status             pic x(2).

 01  altpcb2.
     05  altpcb2-lterm              pic x(8).
     05  filler                     pic x(2).
     05  altpcb2-status             pic x(2).

*-----------------------------------------------------------------*
* DI21PART PCB layout                                            *
*-----------------------------------------------------------------*
 01  di21part-pcb.
     05  filler                     pic x(10).
     05  dbpcb-status               pic x(2).
         88  dbpcb-dli-ok           Value '  '.
         88  dbpcb-dli-not-found    Value 'GE'.
```

```
     05  filler                     pic x(8).
     05  dbpcb-segment-feedback     pic x(8).

*================================================================*
 Procedure Division using iopcb, altpcb1, altpcb2, di21part-pcb.
*================================================================*

*----------------------------------------------------------------*
* Receive one input segment.                                     *
*----------------------------------------------------------------*

 Get-unique.
     Call 'CBLADLI' using dli-gu
        iopcb
        buffer.
     If iopcb-dli-stop then
        go to exit-now.
     if not iopcb-dli-ok then
        move dli-gu to ioerr-function
        Perform io-error thru io-error-exit
        go to exit-now.

     Display 'buffer-ll      = ' buffer-ll.
     Display 'buffer-zz      = ' buffer-zz.
     Display 'input-trancode = ' input-trancode.
     Display 'input-partno   = ' input-partno.

*----------------------------------------------------------------*
* Origin of input may be determined by analyzing the             *
* buffer-zz field.  If it is zero, input has not been            *
* processed by MFS and originates from a socket client.          *
* If buffer-zz is 1,2 or 3 input has been processed by MFS       *
* and the value corresponds to the MFS option in effect.         *
*----------------------------------------------------------------*

     If buffer-zz = 0 then
        Display 'Input originates from socket client'
     else
        Display 'Input originates from 3270 terminal'.
     Display 'iopcb-lterm    = ' iopcb-lterm.
     Display 'iopcb-userid   = ' iopcb-userid.

*----------------------------------------------------------------*
* Look up info in PARTROOT                                       *
*----------------------------------------------------------------*

     move input-partno to partroot-key.
     move space to output-buffer.
     Call 'CBLADLI' using dli-gu
        di21part-pcb
        partroot-segment
        partroot-ssa.
     Display 'GU partroot status  = ' dbpcb-status.
     if dbpcb-dli-not-found then
        move partnumber-unknown to output-status
        go to isrt-output.
     if not dbpcb-dli-ok then
        move dli-gu to status-function
        perform db-error thru db-error-exit
        go to isrt-output.

*----------------------------------------------------------------*
```

```
* Look up info in STANINFO                                        *
*-----------------------------------------------------------------*

     Call 'CBLADLI' using dli-gnp
        di21part-pcb
        staninfo-segment
        staninfo-ssa.
     Display 'GNP staninfo status = ' dbpcb-status.
     if dbpcb-dli-not-found then
        move partroot-partno to output-partno
        move partroot-descr to output-descr
        move staninfo-unknown to output-status
        go to isrt-output.
     if not dbpcb-dli-ok then
        move dli-gnp to status-function
        perform db-error thru db-error-exit
        go to isrt-output.

*-----------------------------------------------------------------*
* Build output segment                                            *
*-----------------------------------------------------------------*

     move partroot-partno to output-partno.
     move partroot-descr to output-descr.
     move staninfo-proc-code to output-proc-code.
     move staninfo-rev-number to output-revision-nbr.
     move staninfo-inv-code to output-inv-code.
     move staninfo-makedept to output-makedept.
     move staninfo-makecost to output-makecctr.
     move staninfo-commodity-code to output-commodity.
     move space to output-status.

*-----------------------------------------------------------------*
* Send output segment                                             *
*-----------------------------------------------------------------*

 isrt-output.
     move 150 to buffer-ll.
     move zero to buffer-zz.

     Display 'buffer-ll      = ' buffer-ll.
     Display 'buffer-zz      = ' buffer-zz.
     Display 'output buffer  = ' output-buffer.

     Call 'CBLADLI' using dli-isrt
        iopcb
        buffer.
     Display 'ISRT output-buffer iopcb-status = ' iopcb-status.
     if not iopcb-dli-ok then
        move dli-isrt to ioerr-function
        Perform io-error thru io-error-exit
        go to exit-now.

     go to get-unique.

*-----------------------------------------------------------------*
* Handle bad DLI status from a DB call                            *
*-----------------------------------------------------------------*

 db-error.
     move dbpcb-status to status-dli.
     move dbpcb-segment-feedback to status-segment.
```

```
           move 'DLI Call failed' to status-message.
           move dli-unknown to output-status.
        db-error-exit.
           exit.

      *-----------------------------------------------------------------*
      * Handle bad DLI status from an IO call                           *
      *-----------------------------------------------------------------*

        io-error.
           move iopcb-status to ioerr-dli.
           move space to ioerr-status.
           If iopcb-assist-error then
              if iopcb-assist-status-bin < 0 then
                 move iopcb-assist-status-bin to ioerr-num
              else
                 move iopcb-assist-status-char to ioerr-char
              end-if
              move 'Socket error' to ioerr-message
           else
              move space to ioerr-char
              move 'IO PCB call failed' to ioerr-message
           end-if.
           Display ioerr-unknown.
        io-error-exit.
           exit.

      *-----------------------------------------------------------------*
      * Terminate program                                               *
      *-----------------------------------------------------------------*
        exit-now.
           Goback.
```

C.2 C Client Program to Test Dual Purpose IMS Server

```
/* TPIIMCDP - C client to test IMS dual-purpose implicit mode
   server program TPIIMSDP */
/*
/*
 * Include Files.
 */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#define lim 200
/*
#include <sys/types.h>
#include <netinet/in.h>
#include <sys/socket.h>
#include <netdb.h>
#include <stdio.h>
*/
#ifdef __OS2__
#include <types.h>
#include <netinet\in.h>
#include <sys\socket.h>
#include <nerrno.h> /* sock_errno() */
#define close soclose
#define tcperror psock_errno
```

```
#else
#include <manifest.h>
#include <bsdtypes.h>
#include <in.h>
#include <socket.h>
#endif
#include <netdb.h>
/*
 * Client Main.
 */
main(int argc, char**argv)
{
    /*
     *  Transaction Request Message (TRM)
     *  Sent by us to the IMS listener to
     *  initiate IMS transaction
     */
    struct TRM_message {
       unsigned short ll;
       unsigned short zz;
       char           trnreq [8];
       char           trancode [8];
       char           userid [8];
       char           pwd [8];
    } TRM;
    /*
     *  Request Status Message (RSM)
     *  Sent by the IMS Listener
     */
    struct RSM_message {
       unsigned short ll;
       unsigned short zz;
       char           id [8];
       unsigned long  rc;
       unsigned long  reason;
    } RSM;
    /*
     *  Completed Status Message (CSM)
     *  Sent by the assist code
     */
    struct CSM_message {
       unsigned short ll;
       unsigned short zz;
       char           csmoky [8];
    } CSM;
    /*
     *  Segment buffer for sending and receiving data
     */
    struct segment_buffer {
       unsigned short ll;
       unsigned short zz;
       char           buf [200];
    } segment;
    /*
     *  Segment buffer for input segment to IMS
     */
    struct input_segment_buffer {
       unsigned short ll;
       unsigned short zz;
       char           trancode [8];
       char           partno [15];
    } input_segment;
```

```
/*
 *  Segment buffer for output segment from IMS
 */
struct output_segment_buffer {
   unsigned short ll;
   unsigned short zz;
   char           partno [15];
   char           descr  [20];
   char           proccode [2];
   char           invcode [1];
   char           revnbr [2];
   char           makedept [2];
   char           makecctr [2];
   char           commodity [2];
   char           status [79];
} output_segment;

unsigned short port;       /* port client will connect to         */
char buf [lim];  /* send receive buffer                  */
unsigned short lenbytes;   /* Length field                        */
struct hostent *hostnm;    /* server host name information        */
struct sockaddr_in server; /* server address                      */
int s;                     /* client socket                       */
struct clientid ourclientid;  /* Client ID structure              */

/*
 * Check Arguments Passed. Should be hostname and port.
 */
if (argc != 3) {
    printf("Usage: %s hostname port\n", argv[0]);
    exit(1);
}
printf("Usage: %s hostname port\n", argv[0]);

/*
 * The host name is the first argument. Get the server address.
 */
hostnm = gethostbyname(argv[1]);
if (hostnm == (struct hostent *) 0) {
    printf("Gethostbyname failed\n");
    exit(2);
}

/*
 * The port is the second argument.
 */
port = (unsigned short) atoi(argv[2]);

/*
 * Build the TRM
 */
TRM.ll = htons(36);
TRM.zz = 0;
strcpy(TRM.trnreq,  "*TRNREQ*");
strcpy(TRM.trancode,"TCP3    ");
strcpy(TRM.userid,"USER01  ");
strcpy(TRM.pwd,"????????");

/*
 * Put the server information into the server structure.
 * The port must be put into network byte order.
 */
```

```
server.sin_family      = AF_INET;
server.sin_port        = htons(port);
server.sin_addr.s_addr = *((unsigned long *)hostnm->h_addr);

/*
 * Get a stream socket.
 */
if ((s = socket(AF_INET, SOCK_STREAM, 0)) < 0) {
    tcperror("Socket()");
    exit(3);
}
printf("Socket sd       = %d\n", s);

/*
 * Let us see our Client ID
 */
if (getclientid(AF_INET, &ourclientid) < 0) {
    tcperror("Getclientid()");
    exit(4);
}
printf("ClientID Jobname     = %s\n", ourclientid.name);
printf("ClientID Subtaskname = %s\n", ourclientid.subtaskname);

/*
 * Connect to the server and send TRM
 */
if (connect(s, (struct sockaddr*) &server, sizeof(server)) < 0) {
    tcperror("Connect()");
    exit(4);
}
printf("Connected\n");
if (send(s, (char*) &TRM, sizeof(TRM), 0) < 0) {
    tcperror("Send()");
    exit(5);
}
printf("Send of TRM complete\n");
printf("TRM trancode    = %s\n", TRM.trancode);

/*
 * Build transation input_segment and send it
 */
input_segment.ll = htons(sizeof(input_segment));
input_segment.zz = 0;
memcpy(input_segment.partno, "250794         ", 15);

if (send(s, (char*) &input_segment, sizeof(input_segment), 0) < 0) {
    tcperror("Send() of input_segment");
    exit(7);
}

printf("Send data complete\n");

/*
 * Send End of Message segment
 */
segment.ll = htons(4);
segment.zz = 0;

if (send(s, (char*) &segment, 4, 0) < 0) {
    tcperror("Send()");
    exit(7);
}
```

```
printf("EOM segment sent\n");

/*
 * Receive first segment into buffer
 */
if (recv(s, (char*) &segment, 4, MSG_PEEK) < 0) {
    tcperror("Recv() Peek for 4 bytes");
    exit(6);
}
lenbytes = ntohs( segment.ll );
printf("Bytes ready to read is %d\n", lenbytes);
if (recv(s, (char*)&segment, lenbytes, 0) < 0) {
    tcperror("Recv()");
    exit(6);
}

if (!memcmp(buf, "*REQSTS*", 8)) {
    memcpy(&RSM, &segment, ntohs( segment.ll ));
    printf("Receive of RSM complete\n");
    RSM.rc = ntohl(RSM.rc);
    RSM.reason = ntohl(RSM.reason);
    printf("RSM rc          = %d\n", RSM.rc);
    printf("RSM reason code = %d\n", RSM.reason);
    if (RSM.rc > 0) {
       printf("Negative response in RSM message - rc=%d\n", RSM.rc);
       exit(12);
    }
    if (recv(s, (char*) &segment, 4, MSG_PEEK) < 0) {
        tcperror("Recv() Peek for 4 bytes");
        exit(6);
    }
    lenbytes = ntohs( segment.ll );
    printf("Bytes ready to read is %d\n", lenbytes);
    if (recv(s, (char*) &segment, lenbytes, 0) < 0) {
        tcperror("Recv()");
        exit(6);
    }
}

printf("Full output segment is %s\n", segment.buf);
memcpy(&output_segment, &segment, ntohs( segment.ll ));
printf("Output data received\n");

printf("Partno    = %s\n", output_segment.partno);
printf("Descr     = %s\n", output_segment.descr);
printf("Proccode  = %s\n", output_segment.proccode);
printf("Invcode   = %s\n", output_segment.invcode);
printf("Revnbr    = %s\n", output_segment.revnbr);
printf("Makedept  = %s\n", output_segment.makedept);
printf("Makecctr  = %s\n", output_segment.makecctr);
printf("Commodity = %s\n", output_segment.commodity);
printf("Status    = %s\n", output_segment.status);

/*
 * Receive EOM message
 */
if (recv(s, (char*) &segment, 4, 0) < 0) {
    tcperror("Recv()");
    exit(6);
}
printf("Receive of EOM segment complete");
```

```
    /*
     * Receive CSM message
     */
    if (recv(s, (char*) &CSM, sizeof(CSM), 0) < 0) {
        tcperror("Recv()");
        exit(6);
    }
    printf("recv returned %s\n", CSM.csmoky);

    if (!memcmp(CSM.csmoky, "*CSMOKY*", 8)) {
        printf("Receive of CSM complete: %s\n", CSM.csmoky);
    }

    /*
     * Close the socket.
     */
    close(s);

    printf("Client Ended Successfully\n");
    exit(0);

}
```

C.3 Explicit Mode IMS Server Program

```
       Identification Division.
      *========================*
      *------------------------------------------------------------------*
      *                                                                  *
      * Name:        TPIIMSSE - IMS echo server, started via the         *
      *                         IMS Listener.                            *
      *                                                                  *
      * Function:    This program works as an echo server under IMS.     *
      *              The program uses TCP protocols and is coded         *
      *              in explicit mode.                                   *
      *              The client used to test both EIMSTSRI and           *
      *              TPIIMSSE is the same: EIMSTCLI.  In order to        *
      *              that, this explicit mode server uses the same       *
      *              application protocol as the IMS assist modules      *
      *              implement for an implicit mode server.              *
      *                                                                  *
      *              Input messages are preceeded by a two byte          *
      *              binary length field followed by two bytes with      *
      *              binary zeroes.                                      *
      *              The last input message is an EOM message and has    *
      *              length field of 4.                                  *
      *              llzz-message data-                                  *
      *              llzz-more message data-                             *
      *              llzz (ll=4, EOM message)                            *
      *                                                                  *
      *              Output from this server uses the same format -      *
      *              2 length bytes in front of message and signals      *
      *              end of output via an EOM segment with a length      *
      *              of four.                                            *
      *              First output message is a Request Status            *
      *              Message with an rc=0.                               *
      *              It terminates the connection by sending a           *
      *              CSM (Completed Status Message) to the client.       *
      *              llzz-RSM-                                           *
      *              llzz-message data-                                  *
      *              llzz-more message data-                             *
```

```
*              llzz (ll=4, EOM message)                          *
*              llzz-CSM-                                         *
*                                                                *
* Interface:   - none -                                         *
*                                                                *
* Logic:       1. Receive TIM from listener                      *
*              2. Initapi and takesocket with TIM info           *
*              3. Send RSM message to client                     *
*              4. Receive client messages                        *
*              5. Echo messages back to client (including        *
*                 clients own EOM message)                       *
*              6. Send CSM message to client                     *
*              7. Close socket and terminate socket API          *
*              8. Issue new IMS GU for next TIM                  *
*                                                                *
* Returncode:  - none -                                         *
*                                                                *
* Written:     June 4'th 1994 at ITSO Raleigh                    *
*                                                                *
* Modified:                                                      *
*                                                                *
*----------------------------------------------------------------*

 Program-id. TPIIMSSE.

*=====================*
 Environment Division.
*=====================*

*==============*
 Data Division.
*==============*

 Working-storage Section.
*----------------------------------------------------------------*
* Socket interface function codes                                *
*----------------------------------------------------------------*
 01  soket-functions.
     02 soket-accept          pic x(16) value 'ACCEPT          '.
     02 soket-bind            pic x(16) value 'BIND            '.
     02 soket-close           pic x(16) value 'CLOSE           '.
     02 soket-connect         pic x(16) value 'CONNECT         '.
     02 soket-fcntl           pic x(16) value 'FCNTL           '.
     02 soket-getclientid     pic x(16) value 'GETCLIENTID     '.
     02 soket-gethostbyaddr   pic x(16) value 'GETHOSTBYADDR   '.
     02 soket-gethostbyname   pic x(16) value 'GETHOSTBYNAME   '.
     02 soket-gethostid       pic x(16) value 'GETHOSTID       '.
     02 soket-gethostname     pic x(16) value 'GETHOSTNAME     '.
     02 soket-getpeername     pic x(16) value 'GETPEERNAME     '.
     02 soket-getsockname     pic x(16) value 'GETSOCKNAME     '.
     02 soket-getsockopt      pic x(16) value 'GETSOCKOPT      '.
     02 soket-givesocket      pic x(16) value 'GIVESOCKET      '.
     02 soket-initapi         pic x(16) value 'INITAPI         '.
     02 soket-ioctl           pic x(16) value 'IOCTL           '.
     02 soket-listen          pic x(16) value 'LISTEN          '.
     02 soket-read            pic x(16) value 'READ            '.
     02 soket-recv            pic x(16) value 'RECV            '.
     02 soket-recvfrom        pic x(16) value 'RECVFROM        '.
     02 soket-select          pic x(16) value 'SELECT          '.
     02 soket-send            pic x(16) value 'SEND            '.
     02 soket-sendto          pic x(16) value 'SENDTO          '.
     02 soket-setsockopt      pic x(16) value 'SETSOCKOPT      '.
```

```
     02 soket-shutdown        pic x(16) value 'SHUTDOWN        '.
     02 soket-socket          pic x(16) value 'SOCKET          '.
     02 soket-takesocket      pic x(16) value 'TAKESOCKET      '.
     02 soket-termapi         pic x(16) value 'TERMAPI         '.
     02 soket-write           pic x(16) value 'WRITE           '.
*---------------------------------------------------------------*
* Work variables                                                *
*---------------------------------------------------------------*
 01  errno                          pic 9(8) binary value zero.
 01  retcode                        pic s9(8) binary value zero.
 01  ezacic-len                     pic 9(8) Binary Value zero.
 01  dli-gu                         pic x(4) Value 'GU'.
 01  dli-isrt                       pic x(4) Value 'ISRT'.
*---------------------------------------------------------------*
* Variables used for the INITAPI call                           *
*---------------------------------------------------------------*
 01  maxsoc                         pic 9(4) Binary Value 50.
 01  apitype                        pic 9(4) Binary Value 2.
 01  initapi-ident.
     05  tcpname                    pic x(8) Value space.
     05  myjobname                  pic x(8) Value space.
 01  subtask                        pic x(8) value space.
 01  maxsno                         pic 9(8) Binary Value 1.
*---------------------------------------------------------------*
* Variables returned by the GETCLIENTID Call                    *
*---------------------------------------------------------------*
 01  clientid-area.
     05  clientid-domain            pic 9(8) Binary.
     05  clientid-name              pic x(8) value space.
     05  clientid-task              pic x(8) value space.
     05  filler                     pic x(20) value low-value.
*---------------------------------------------------------------*
* Variables used by the TAKESOCKET Call                         *
*---------------------------------------------------------------*
 01  take-from-clientid.
     05  take-from-domain           pic 9(8) Binary Value 2.
     05  take-from-name             pic x(8) value space.
     05  take-from-task             pic x(8) value space.
     05  filler                     pic x(20) value low-value.
 01  socket-descriptor              pic 9(4) Binary value zero.
*---------------------------------------------------------------*
* Transaction Initiation Message segment                        *
*---------------------------------------------------------------*
 01  TIM-message.
     05  TIM-len                    pic 9(4) Binary Value zero.
     05  filler                     pic x(2) value low-value.
     05  TIM-id                     pic x(8) value space.
     05  TIM-lstn-name              pic x(8) value space.
     05  TIM-lstn-task              pic x(8) value space.
     05  TIM-srv-name               pic x(8) value space.
     05  TIM-srv-task               pic x(8) value space.
     05  TIM-lstn-socketid          pic 9(4) Binary value zero.
     05  TIM-tcpip-name             pic x(8) value space.
     05  TIM-data-type              pic 9(4) value zero.
         88  TIM-ascii              value 0.
         88  TIM-ebcdic             value 1.
*---------------------------------------------------------------*
* Transaction Request Status message segment                    *
*---------------------------------------------------------------*
 01  RSM-message.
     05  RSM-len                    pic 9(4) Binary Value 20.
     05  filler                     pic x(2) Value low-value.
```

```
     05  RSM-oky                    pic x(8) value '*REQSTS*'.
     05  RSM-return-code            pic 9(8) Binary Value zero.
     05  RSM-reason-code            pic 9(8) Binary Value zero.
*---------------------------------------------------------------*
* Complete Status Message segment                               *
*---------------------------------------------------------------*
 01  CSM-message.
     05  CSM-len                    pic 9(4) Binary Value 12.
     05  filler                     pic x(2) Value low-value.
     05  CSM-oky                    pic x(8) value '*CSMOKY*'.
*---------------------------------------------------------------*
* Peek buffer and length fields for RECV peek call              *
*---------------------------------------------------------------*
 01  recv-flag-read                 pic 9(8) Binary value zero.
 01  recv-flag-peek                 pic 9(8) Binary value 2.
 01  recv-flag                      pic 9(8) Binary value 2.
*---------------------------------------------------------------*
* Buffer and length fields for read operation                   *
*---------------------------------------------------------------*
 01  read-request-len               pic 9(8) Binary Value zero.
 01  read-request-read              pic 9(8) Binary Value zero.
 01  read-request-remaining         pic 9(8) Binary Value zero.
 01  read-buffer.
     05  read-buffer-total          pic x(8192) Value space.
     05  read-buffer-byte redefines read-buffer-total
                                    pic x occurs 8192 times.
     05  read-buffer-segment redefines read-buffer-total.
         10  read-buffer-seg-len    pic 9(4) Binary.
             88  EOM-segment        value 4.
         10  read-buffer-seg-data   pic x(8190).
*---------------------------------------------------------------*
* Buffer and length fields for write operation                  *
*---------------------------------------------------------------*
 01  send-request-len               pic 9(8) Binary Value zero.
 01  send-request-sent              pic 9(8) Binary value zero.
 01  send-request-remaining         pic 9(8) Binary value zero.
 01  send-buffer.
     05  send-buffer-total          pic x(8192) value space.
     05  send-buffer-seq redefines send-buffer-total
                                    pic x(8) occurs 1024 times.
     05  send-buffer-byte redefines send-buffer-total
                                    pic x occurs 8192 times.
*---------------------------------------------------------------*
* Error message for socket interface errors                     *
*---------------------------------------------------------------*
 01  ezaerror-msg.
     05  filler                     pic x(9) Value 'Function='.
     05  ezaerror-function          pic x(16) Value space.
     05  filler                     pic x value ' '.
     05  filler                     pic x(8) Value 'Retcode='.
     05  ezaerror-retcode           pic ---99.
     05  filler                     pic x value ' '.
     05  filler                     pic x(9) Value 'Errorno='.
     05  ezaerror-errno             pic zzz99.
     05  filler                     pic x value ' '.
     05  filler                     pic x(11)
                                    Value 'DLI-status='.
     05  ezaerror-dli-status        pic x(2) value space.
     05  filler                     pic x value ' '.
     05  ezaerror-text              pic x(50) value ' '.

 Linkage section.
```

```
*-------------------------------------------------------------*
* Input-Output PCB layout                                     *
*-------------------------------------------------------------*
 01  iopcb.
     05  iopcb-lterm               pic x(8).
     05  filler                    pic x(2).
     05  iopcb-status              pic x(2).
     05  iopcb-cdate               pic s9(7) comp-3.
     05  iopcb-ctime               pic s9(7) comp-3.
     05  iopcb-input-msgno         pic 9(8) binary.
     05  iopcb-output-mod          pic x(8).
     05  iopcb-userid              pic x(8).

 01  altpcb1.
     05  altpcb1-lterm             pic x(8).
     05  filler                    pic x(2).
     05  altpcb1-status            pic x(2).

*=======================================*
 Procedure Division using iopcb, altpcb1.
*=======================================*

*-------------------------------------------------------------*
* Receive TIM from listener                                   *
*-------------------------------------------------------------*

 Get-unique.
     Call 'CBLTDLI' using dli-gu
        iopcb
        TIM-message.
     If iopcb-status = 'QC' then
        go to exit-now.
     if iopcb-status not equal ' ' then
        move 'IOPCB Get-Unique' to ezaerror-function
        move iopcb-status to ezaerror-dli-status
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-now.

*-------------------------------------------------------------*
* Initialize socket API with the values we got from           *
* the IMS Listener                                            *
*-------------------------------------------------------------*

     Move soket-initapi to ezaerror-function.
     Move TIM-srv-name to myjobname.
     Move TIM-srv-task to subtask.
     Move TIM-tcpip-name to tcpname.
     Display 'Initapi myjobname=' myjobname
        ' subtask=' subtask.
     Call 'EZASOKET' using soket-initapi
        maxsoc
        initapi-ident
        subtask
        maxsno
        errno
        retcode.
     If retcode < 0 then
        move 'Initapi failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-now.

*-------------------------------------------------------------*
```

```
* Issue a getclientid to take a look at the actual              *
* clientid we are running under                                 *
*---------------------------------------------------------------*

     move soket-getclientid to ezaerror-function.
     Call 'EZASOKET' using soket-getclientid
        clientid-area
        errno
        retcode.
     If retcode < 0 then
        move 'Getclientid failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-term-api.
     Display 'Getclientid returned Domain=' clientid-domain.
     Display '         Address space name=' clientid-name.
     Display '                Subtask name=' clientid-task.

*---------------------------------------------------------------*
* Issue a take-socket with the values we got from               *
* the IMS Listener                                              *
*---------------------------------------------------------------*

     move soket-takesocket to ezaerror-function.
     move TIM-lstn-name to take-from-name.
     move TIM-lstn-task to take-from-task.
     Display 'TIM-message=' TIM-message.
     Display 'Takesocket from-name=' take-from-name
        ' from-task=' take-from-task.
     Call 'EZASOKET' using soket-takesocket
        TIM-lstn-socketid
        take-from-clientid
        errno
        retcode.
     If retcode < 0 then
        move 'Takesocket failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-term-api.
     move retcode to socket-descriptor.

*---------------------------------------------------------------*
* Send an OK Request Status Message to the client.              *
* We have been started via the IMS Listener                     *
*---------------------------------------------------------------*

     If TIM-ascii then
        Move 8 to ezacic-len
        Call 'EZACIC04' using RSM-oky
           ezacic-len.
     Move RSM-message to send-buffer.
     Move RSM-len to send-request-len.
     Perform send-tcp thru send-tcp-exit.
     If send-request-sent < 0 then
        move 'Write RSM failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit
        go to exit-close-socket.

*---------------------------------------------------------------*
* Peek at first bytes of client data                            *
*---------------------------------------------------------------*

     Perform until EOM-segment
```

```
        Move 2 to read-request-len
        Move recv-flag-peek to recv-flag
        Perform read-tcp thru read-tcp-exit
        if read-request-read < 0 then
           Display 'Peek failed'
           go to exit-close-socket
        end-if

*-----------------------------------------------------------------*
* Read client data                                                *
*-----------------------------------------------------------------*

        move read-buffer-seg-len to read-request-len
        move recv-flag-read to recv-flag
        Perform read-tcp thru read-tcp-exit
        If read-request-read < 0 then
           move 'Read failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-close-socket
        end-if

*-----------------------------------------------------------------*
* Echo data back to client                                        *
*-----------------------------------------------------------------*

        move read-buffer to send-buffer
        move read-request-read to send-request-len
        Perform send-tcp thru send-tcp-exit
        If send-request-sent < 0 then
           move 'Send failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-close-socket
        end-if

     end-perform.

*-----------------------------------------------------------------*
* Send a transaction Completed Status Message to the              *
* client                                                          *
*-----------------------------------------------------------------*

     If TIM-ascii then
        Move 8 to ezacic-len
        Call 'EZACIC04' using CSM-oky
           ezacic-len.
     move CSM-len to send-request-len.
     move CSM-message to send-buffer.
     Perform send-tcp thru send-tcp-exit
     If send-request-sent < 0 then
        move 'Send CSM failed' to ezaerror-text
        perform write-ezaerror-msg thru
           write-ezaerror-msg-exit
        go to exit-close-socket.

*-----------------------------------------------------------------*
* Close the socket                                                *
*-----------------------------------------------------------------*

 exit-close-socket.
     move soket-close to ezaerror-function
```

```
     Call 'EZASOKET' using soket-close
        socket-descriptor
        errno
        retcode.
     If retcode < 0 then
        move 'Close call failed' to ezaerror-text
        perform write-ezaerror-msg thru write-ezaerror-msg-exit.

*---------------------------------------------------------------*
* Terminate socket API and request next TIM from IMS            *
*---------------------------------------------------------------*

 exit-term-api.
     Call 'EZASOKET' using soket-termapi.
     Go to get-unique.

*---------------------------------------------------------------*
* Terminate program                                             *
*---------------------------------------------------------------*

 exit-now.
     Goback.

*---------------------------------------------------------------*
* Subroutine                                                    *
* ----------                                                    *
*                                                               *
* Write out an error message                                    *
*---------------------------------------------------------------*

 write-ezaerror-msg.
     move errno to ezaerror-errno.
     move retcode to ezaerror-retcode.
     display ezaerror-msg.
 write-ezaerror-msg-exit.
     exit.

*---------------------------------------------------------------*
* Subroutine                                                    *
* ----------                                                    *
*                                                               *
* Read data from a TCP socket                                   *
*---------------------------------------------------------------*

 Read-TCP.
     move soket-recv to ezaerror-function.
     move zero to read-request-read.
     move read-request-len to read-request-remaining.
     Perform until read-request-remaining = 0
        Display 'Ready for new read'
        Display 'Number of bytes remaining='
           read-request-remaining
        Display 'Number of bytes read until now='
           read-request-read
        Call 'EZASOKET' using soket-recv
           socket-descriptor
           recv-flag
           read-request-remaining
           read-buffer-byte(read-request-read + 1)
           errno
           retcode
        Display 'Read returned rc=' retcode
```

```
            If retcode < 0 then
               move 'Read call failed' to ezaerror-text
               perform write-ezaerror-msg thru
                  write-ezaerror-msg-exit
               go to exit-close-socket
            end-if
            Display 'Number of bytes read=' retcode
            Add retcode to read-request-read
            Subtract retcode from read-request-remaining
            If retcode = 0 then
               Display 'End-of-data received too early'
               Display 'Server probably closed socket'
               Move zero to read-request-remaining
            end-if
         end-perform.
       Read-TCP-exit.
         exit.

      *---------------------------------------------------------------*
      * Subroutine                                                    *
      * ----------                                                    *
      *                                                               *
      * Send data over a TCP socket                                   *
      *---------------------------------------------------------------*

       Send-TCP.
         move soket-write to ezaerror-function.
         move send-request-len to send-request-remaining.
         move 0 to send-request-sent.
         Perform until send-request-remaining = 0
            Display 'Ready for new write'
            Display 'Number of bytes remaining='
               send-request-remaining
            Display 'Number of bytes sent until now='
               send-request-sent
            Call 'EZASOKET' using soket-write
               socket-descriptor
               send-request-remaining
               send-buffer-byte(send-request-sent + 1)
               errno
               retcode
            Display 'Write returned an rc=' retcode
            If retcode < 0 then
               move 'Write call failed' to ezaerror-text
               perform write-ezaerror-msg thru
                  write-ezaerror-msg-exit
               go to exit-close-socket
            end-if
            Display 'Number of bytes written=' retcode
            add retcode to send-request-sent
            subtract retcode from send-request-remaining
         end-perform.
       Send-TCP-exit.
         exit.
```

C.4 IMS Listener Security Exit

```
      ************************************************************************
      *                                                                      *
      *  Name:         IMSLSECX - IMS Sockets Listener security exit.       *
      *                                                                      *
```

```
*  Function:     Validate stream socket connections to IMS.          *
*                                                                    *
*  Interface:    R1 -> parameter list with eight pointers:           *
*                 +0  ->  Fullword IP Address (In)                   *
*                 +4  ->  Halfword port number (In)                  *
*                 +8  ->  8 byte IMS tranaction code name (In)       *
*                 +12 ->  Halfword datatype (0, ASCII, 1 EBCDIC) (In)*
*                 +16 ->  Fullword length of user data in TRM (In)   *
*                 +20 ->  User data (In)                             *
*                 +24 ->  Fullword return code (Out)                 *
*                 +28 ->  Fullword reason code (Out)                 *
*                                                                    *
*                Security exit interface contains user data.  User   *
*                data is installation-defined, in our case as 32     *
*                bytes with the following layout:                    *
*                8 bytes user ID                                     *
*                8 bytes password                                    *
*                8 bytes new password (optional)                     *
*                8 bytes RACF group ID (optinal)                     *
*                                                                    *
*  Logic:        1. Validates if all required parms are present.     *
*                2. Calls TPIRACF for user authentication and        *
*                   creation of task level security environment.     *
*                3. Authorizes user's access to requested IMS tran   *
*                   code via call to TPIAUTH for resource class      *
*                   FACILITY and resource TPI.IMSSOCK.trancode.       *
*                4. Deletes user security environment again and      *
*                   returns to IMS listener.                         *
*                                                                    *
*  Abends:       User abend 1001: If RACROUTE REQUEST=DELETE fails   *
*                                 and we do not know if we are       *
*                                 continueing under a user security  *
*                                 environment, we abend.             *
*                                                                    *
*  Return codes: Return and reason codes set in the IMS listener     *
*                security exit interface area.                       *
*                RC=000 Reason=000: User authenticated OK and user's *
*                                   access to tran code authorized OK.*
*                RC=008 Reason=101: UserID and password missing in TRM*
*                RC=008 Reason=102: Invalid length of userdata in TRM*
*                RC=008 Reason=103: UserID not defined to RACF       *
*                RC=008 Reason=104: Invalid password                 *
*                RC=008 Reason=105: Password has expired             *
*                RC=008 Reason=106: New password is not valid        *
*                RC=008 Reason=107: User does not belong to group    *
*                RC=008 Reason=108: User is revoked                  *
*                RC=008 Reason=109: Access to group is revoked       *
*                RC=008 Reason=110: User not authorized to IMS Sockets*
*                RC=008 Reason=111: TPIRACF internal error           *
*                RC=008 Reason=112: TPIRACF internal error           *
*                RC=008 Reason=113: User not authorized to tran code *
*                                                                    *
*                                                                    *
*  Written:      ITSO, Raleigh April 16, 1995                        *
*                                                                    *
**********************************************************************
*
INTFAREA DSECT
LSIPADDR DC    A(0)               *-> Client IP address
LSPORT   DC    A(0)               *-> Client port number
LSTRNNAM DC    A(0)               *-> IMS transaction code name
LSDATTYP DC    A(0)               *-> Datatype (0 ASCII, 1 EBCDIC)
```

```
LSDATLEN DC    A(0)               *-> Length of user data in TRM
LSUSRDAT DC    A(0)               *-> User data area
LSRETCOD DC    A(0)               *-> Return code field
LSREACOD DC    A(0)               *-> Reason code field
*
USERDATA DSECT
LSUSERID DC    CL8' '             *User ID
LSPWD    DC    CL8' '             *Password
LSNPWD   DC    CL8' '             *New Password (Optional)
LSGROUP  DC    CL8' '             *Group ID (Optional)
*
IMSLSECX INIT  'IMS Sockets Listener security exit',MODE=31
*
         LR    R11,R1             *Parameter pointer
         USING INTFAREA,R11       *Adressability of parameters
*
* ---------------------------------------------------------------------
*
* Check passed parameters and do any necessary conversion from
* ASCII to EBCDIC.
*
* ---------------------------------------------------------------------
*
         L     R2,LSDATLEN        *-> Fullword with L'userdata
         L     R9,0(R2)           *L'userdata
         C     R9,=A(16)          *User ID and Password must be there
         BL    TOFEWPRM           *Too few parameters passed
         BE    PARMOK             *Only userID and password is OK
         C     R9,=A(24)          *Exactly 24 bytes long
         BE    PARMOK             *- is OK - new password
         C     R9,=A(32)          *Or exactly 32 bytes long
         BNE   LENERR             *- is OK, if anything else: error
PARMOK   EQU   *
         L     R3,LSDATTYP        *-> Halfword with datatype
         L     R4,LSUSRDAT        *-> Userdata
         LH    R9,0(R3)           *Datatype
         LTR   R9,R9              *Is data ASCII ?
         BNZ   ISEBCDIC           *- No, data is EBCDIC
         CALL  EZACIC05,((R4),(R2)),VL *Translate ASCII to EBCDIC
ISEBCDIC EQU   *
*
* ---------------------------------------------------------------------
*
* Build TPIRACF parameters and call TPIRACF to verify user.
*
* ---------------------------------------------------------------------
*
         MVC   USERID(32),=CL32' ' *Initialize all parms to space
         MVC   REQCODE,=A(REQVER)  *Issue RACROUTE REQUEST=VERIFY
         USING USERDATA,R4         *User data area addressability
         MVC   USERID,LSUSERID     *User ID from TRM
         MVC   PWD,LSPWD           *Password from TRM
         L     R9,0(R2)            *L'userdata
         C     R9,=A(16)           *Is there a new password ?
         BNH   DOVER               *- No, all parms are set
         MVC   NPWD,LSNPWD         *New password from TRM
         C     R9,=A(24)           *Is there a group ID ?
         BNH   DOVER               *- No, all parms are set
         MVC   GROUP,LSGROUP       *Group ID from TRM
DOVER    EQU   *
         CALL  TPIRACF,            *                                  C
               (REQCODE,           *RACROUTE REQUEST=VERIFY           C
```

```
               USERID,             *                                   C
               PWD,                *                                   C
               NPWD,               *                                   C
               GROUP,              *                                   C
               APPLNAME),VL
         LTR   R15,R15             *Was VERIFY Successful?
         BNZ   VERFAIL             *- No, return error to client.
*
* ---------------------------------------------------------------------
*
* Build TPIAUTH parameters and call TPIAUTH to test if user is
* authorized to TPI.IMSSOCK.trancode in the FACILITY resource class.
*
* ---------------------------------------------------------------------
*
         L     R2,LSTRNNAM         *-> IMS Transaction code name
         MVC   RESTRNNM,0(R2)      *Move to FACILITY Class resource nm.
         CALL  TPIAUTH,            *Authorize call                     C
               (RESNAME,           *Resource name                      C
               AUTHACC),VL         *Test for read access
         ST    R15,AUTHRC          *Save RC for a little later
*
* ---------------------------------------------------------------------
*
* Delete user security environment again, so we restore address space
* security environment before we return to the IMS Listener.
*
* ---------------------------------------------------------------------
*
         MVC   PWD(24),=CL24' '    *Space out unneeded parms
         MVC   REQCODE,=A(REQDEL)  *We want to delete sec. environment
         CALL  TPIRACF,            *                                   C
               (REQCODE,           *RACROUTE REQUEST=DELETE            C
               USERID,             *                                   C
               PWD,                *Space                              C
               NPWD,               *Space                              C
               GROUP,              *Space                              C
               APPLNAME),VL
         LTR   R15,R15             *This should only give RC=0
         BZ    DELOK               *- which it did
         LR    R9,R15              *Save RC
         CVD   R15,DORD            *Convert
         OI    DORD+7,X'0F'        *- to something
         UNPK  WTODELRC,DORD       *- readable in a WTO
         WTO   MF=(E,WTODEL)       *Tell about it
         CH    R9,=AL2(253)        *Does not leave a security env.
         BE    DELOK               *- which is OK
         WTO   'IMSLSECX - User abend 1001 due to above return code'
         ABEND 1001,DUMP           *Others may leave user sec. active.
DELOK    EQU   *
         ICM   R9,B'1111',AUTHRC   *Return code from AUTH call
         BNZ   AUTHFAIL            *If not zero, auth failed.
         SR    R15,R15             *Set RC=0
         SR    R10,R10             *- and Reason code=0
         B     RETURN              *And exit
*
* ---------------------------------------------------------------------
*
* Error exit routines.  Set R15 to return code and R10 to
* reason code and go to common exit code.
*
* ---------------------------------------------------------------------
```

```
*
AUTHFAIL EQU   *                  *User is not authorized
         LA    R10,NOTAUTH        *Not authorized to tran code
         LA    R15,8              *This is an error
         B     RETURN             *And exit
VERFAIL  EQU   *                  *User did not verify successfully
         LM    R5,R7,RCBXLE       *Prepare to set reason code
RCLOOP   EQU   *
         CH    R15,0(R5)          *This TPIRACF Return code ?
         BE    SETREAS            *- Yes, set corresponding reason
         BXLE  R5,R6,RCLOOP       *We use last entry as garbage can
SETREAS  EQU   *
         LH    R10,2(R5)          *Here is corresponding reason code
         LA    R15,8              *This is an error
         B     RETURN             *And exit
TOFEWPRM EQU   *
         LA    R15,8              *This is an error
         LA    R10,PARMERR1       *To few parameters
         B     RETURN             *Exit
LENERR   EQU   *
         LA    R15,8              *This is an error
         LA    R10,PARMERR2       *Wrong length
*
RETURN   EQU   *
         L     R2,LSRETCOD        *-> Return code field
         ST    R15,0(R2)          *Pass back return code
         L     R2,LSREACOD        *-> Reason code field
         ST    R10,0(R2)          *Pass back reason code
         TERM  RC=0               *Return to IMS Listener
         LTORG
*
* ---------------------------------------------------------------------
*
* Work areas and constants.
*
* ---------------------------------------------------------------------
*
* Reason codes
*
PARMERR1 EQU   101                *At least user ID and password req.
PARMERR2 EQU   102                *Length must be 16, 24 or 32.
NOTAUTH  EQU   113                *User not authorized to trancode
*
RCBXLE   DC    A(START,4,LAST)    *TPIRACF RC to Reason code convert.
START    DC    AL2(4,103)         *User ID not defined to RACF
         DC    AL2(8,104)         *Invalid password
         DC    AL2(12,105)        *Password has expired
         DC    AL2(16,106)        *New password is not valid
         DC    AL2(20,107)        *User ID does not belong to group
         DC    AL2(24,108)        *User ID is revoked
         DC    AL2(28,109)        *Access to group is revoked
         DC    AL2(32,110)        *User ID is not authorized to appl
         DC    AL2(254,111)       *Internal error
LAST     DC    AL2(255,112)       *Some other error
*
REQCODE  DC    A(0)               *TPIRACF Request Code
REQVER   EQU   0                  *REQUEST=VERIFY
REQDEL   EQU   8                  *REQUEST=DELETE
USERID   DC    CL8' '             *User ID
PWD      DC    CL8' '             *Password
NPWD     DC    CL8' '             *New password
GROUP    DC    CL8' '             *Group ID
```

```
APPLNAME DC    CL8'IMSLSTN'        *Application name (IMSLSTN)
*
AUTHRC   DC    A(0)                *Saved RC from TPIAUTH
RESNAME  DC    C'TPI.IMSSOCK.'     *Resource TPI.IMSSOCK.trancode
RESTRNNM DC    CL8' '
         DC    CL(80-(*-RESNAME))' '
AUTHACC  DC    CL8'READ'           *We want read access
*
WTODEL   WTO   'IMSLSECX - RACROUTE REQUEST=DELETE Gave RC=xxxx',      C
               MF=L
WTODELRC EQU   WTODEL+48,4
DORD     DC    D'0'
*
         END
```

D.0 Appendix D. Sample CICS Socket Program

This appendix contains sample CICS socket programs that are developed in COBOL and C.

D.1 Stream Socket COBOL Program for CICS

```
 Identification Division.
*=========================*
*-------------------------------------------------------------------*
*                                                                   *
* Name:         TPICICSS - CICS echo server program that is         *
*                          started via the CICS Listener.           *
*                          CICS transaction code TPIE.              *
*                                                                   *
* Function:     This is a stream socket program.  The server        *
*               is started via the TPIE CICS transaction code.      *
*               It will echo back to the client any data the        *
*               client sends to it.  It will close the socket       *
*               and terminate when the client closes its socket.    *
*               If the client is quiet for more than 30 seconds,    *
*               the server will timeout and close the               *
*               connection.                                         *
*                                                                   *
* Interface:    CICS Listener Transaction Initiation Message        *
*                                                                   *
* Logic:        1. Receive TIM from CICS listener                   *
*               2. Initialize API and takesocket                    *
*               3. Enter a read/write loop where data will be       *
*                  echoed back to the client                        *
*                  Socket is set to non-blocking in order to        *
*                  control own timeout logic                        *
*               4. If no data from client within 30 seconds, the    *
*                  server closes the connection and terminates      *
*                                                                   *
* Returncode:   - none -                                            *
*                                                                   *
* Written:      March 8, 1995 at ITSO Raleigh                       *
*                                                                   *
* Modified:                                                         *
*                                                                   *
```

```
*-------------------------------------------------------------*

 Program-id. tpicicss.

*=====================*
 Environment Division.
*=====================*

*==============*
 Data Division.
*==============*

 Working-storage Section.
*-------------------------------------------------------------*
* Socket interface function codes                             *
*-------------------------------------------------------------*
 01  soket-functions.
     02 soket-accept          pic x(16) value 'ACCEPT          '.
     02 soket-bind            pic x(16) value 'BIND            '.
     02 soket-close           pic x(16) value 'CLOSE           '.
     02 soket-connect         pic x(16) value 'CONNECT         '.
     02 soket-fcntl           pic x(16) value 'FCNTL           '.
     02 soket-getclientid     pic x(16) value 'GETCLIENTID     '.
     02 soket-gethostbyaddr   pic x(16) value 'GETHOSTBYADDR   '.
     02 soket-gethostbyname   pic x(16) value 'GETHOSTBYNAME   '.
     02 soket-gethostid       pic x(16) value 'GETHOSTID       '.
     02 soket-gethostname     pic x(16) value 'GETHOSTNAME     '.
     02 soket-getpeername     pic x(16) value 'GETPEERNAME     '.
     02 soket-getsockname     pic x(16) value 'GETSOCKNAME     '.
     02 soket-getsockopt      pic x(16) value 'GETSOCKOPT      '.
     02 soket-givesocket      pic x(16) value 'GIVESOCKET      '.
     02 soket-initapi         pic x(16) value 'INITAPI         '.
     02 soket-ioctl           pic x(16) value 'IOCTL           '.
     02 soket-listen          pic x(16) value 'LISTEN          '.
     02 soket-read            pic x(16) value 'READ            '.
     02 soket-recv            pic x(16) value 'RECV            '.
     02 soket-recvfrom        pic x(16) value 'RECVFROM        '.
     02 soket-select          pic x(16) value 'SELECT          '.
     02 soket-send            pic x(16) value 'SEND            '.
     02 soket-sendto          pic x(16) value 'SENDTO          '.
     02 soket-setsockopt      pic x(16) value 'SETSOCKOPT      '.
     02 soket-shutdown        pic x(16) value 'SHUTDOWN        '.
     02 soket-socket          pic x(16) value 'SOCKET          '.
     02 soket-takesocket      pic x(16) value 'TAKESOCKET      '.
     02 soket-termapi         pic x(16) value 'TERMAPI         '.
     02 soket-write           pic x(16) value 'WRITE           '.
*-------------------------------------------------------------*
* Work variables                                              *
*-------------------------------------------------------------*
 01  errno                        pic 9(8) binary value zero.
 01  retcode                      pic s9(8) binary value zero.
 01  cleng                        pic s9(4) binary value zero.
 01  socket-to-take               pic s9(4) binary value zero.
 01  client-ipaddr-dotted         pic x(15) value space.
 01  client-status                pic 9(8) Binary value zero.
     88  client-has-closed        Value 1.
 01  timer-accum                  pic 9(8) Binary value zero.
*-------------------------------------------------------------*
* Variables used for the INITAPI call                         *
*-------------------------------------------------------------*
 01  maxsoc                       pic 9(4) Binary Value 2.
 01  initapi-ident.
```

```
     05  tcpname                    pic x(8) Value ' '.
     05  asname                     pic x(8) Value space.
 01  subtask.
     05  init-cics-task             pic 9(7).
     05  filler                     pic x    value 'I'.
 01  maxsno                         pic 9(8) Binary Value zero.
*-------------------------------------------------------------*
* Variables returned by the GETCLIENTID Call - our clientid    *
*-------------------------------------------------------------*
 01  clientid.
     05  clientid-domain            pic 9(8) Binary.
     05  clientid-name              pic x(8) value space.
     05  clientid-task              pic x(8) value space.
     05  filler                     pic x(20) value low-value.
*-------------------------------------------------------------*
* Variables used for the IOCTL call                            *
*-------------------------------------------------------------*
 01  ioctl-command-fionbio          pic x(4).
 01  ioctl-command-string           pic x(16) value 'FIONBIO'.
 01  ioctl-reqarg-non-blocking      pic 9(8) Binary value 1.
 01  ioctl-retarg                   pic 9(8) binary value zero.
*-------------------------------------------------------------*
* CICS Listener client ID used in the TAKESOCKET call          *
*-------------------------------------------------------------*
 01  clientid-lstn.
     05 cid-domain-lstn               pic 9(8) binary.
     05 cid-name-lstn                 pic x(8) value space.
     05 cid-subtask-lstn              pic x(8) value space.
     05 cid-res-lstn                  pic x(20) value low-value.
*-------------------------------------------------------------*
* Variables used for the SOCKET call                           *
*-------------------------------------------------------------*
 01  afinet                         pic 9(8) Binary Value 2.
 01  soctype-stream                 pic 9(8) Binary Value 1.
 01  proto                          pic 9(8) Binary Value zero.
 01  socket-descriptor              pic 9(4) Binary Value zero.
*-------------------------------------------------------------*
* Buffer and length fields for read operation                  *
*-------------------------------------------------------------*
 01  recv-flag                      pic 9(8) Binary value zero.
 01  read-request-len               pic 9(8) Binary Value zero.
 01  read-request-read              pic 9(8) Binary Value zero.
 01  read-request-remaining         pic 9(8) Binary Value zero.
 01  read-buffer.
     05  read-buffer-total          pic x(8192) Value space.
     05  read-buffer-byte redefines read-buffer-total
                                    pic x occurs 8192 times.
*-------------------------------------------------------------*
* Buffer and length fields for write operation                 *
*-------------------------------------------------------------*
 01  send-request-len               pic 9(8) Binary value zero.
 01  send-request-sent              pic 9(8) Binary value zero.
 01  send-request-remaining         pic 9(8) Binary value zero.
 01  send-buffer.
     05  send-buffer-total          pic x(8192) value space.
     05  send-buffer-byte redefines send-buffer-total
                                    pic x occurs 8192 times.
*-------------------------------------------------------------*
* Error message for socket interface errors                    *
*-------------------------------------------------------------*
 01  ezaerror-msg.
     05  filler                     pic x(9) Value 'Function='.
```

```
     05  ezaerror-function          pic x(16) Value space.
     05  filler                     pic x value ' '.
     05  filler                     pic x(8) Value 'Retcode='.
     05  ezaerror-retcode           pic ---99.
     05  filler                     pic x value ' '.
     05  filler                     pic x(9) Value 'Errorno='.
     05  ezaerror-errno             pic zzz99.
     05  filler                     pic x value ' '.
     05  ezaerror-text              pic x(50) value ' '.
 01  ezaerror-msg-len               pic s9(4) Binary value 105.
*---------------------------------------------------------------*
* Client ID message to CSMT                                     *
*---------------------------------------------------------------*
 01  cics-clientid-msg-area.
     05  filler                     pic x(32)
         value 'TPICICSS - client ID         '.
     05  filler                     pic x(9) value 'Asname= '.
     05  clientid-msg-asname        pic x(8).
     05  filler                     pic x(10) value ' Subtask= '.
     05  clientid-msg-subtask       pic x(8).
 01  cics-clientid-msg-len          pic 9(4) comp value 69.
*---------------------------------------------------------------*
* Startup message with TIM information to CSMT                  *
*---------------------------------------------------------------*
 01  cics-startup-msg-area.
     05  filler                     pic x(25)
         value 'CICS startup parameters: '.
     05  startup-old-socket         pic zz99.
     05  filler                     pic x value ' '.
     05  startup-lstn-asname        pic x(8) value space.
     05  filler                     pic x value ' '.
     05  startup-lstn-subtask       pic x(8) value space.
     05  filler                     pic x value ' '.
     05  startup-sin-family         pic 9999.
     05  filler                     pic x value ' '.
     05  startup-sin-port           pic 99999.
     05  filler                     pic x value ' '.
     05  startup-sin-addr           pic x(15) value space.
 01  cics-startup-msg-len           pic 9(4) comp value 72.
*---------------------------------------------------------------*
* Transaction Initiation Message from CICS listener             *
*---------------------------------------------------------------*
 01  CICS-listener-TIM.
     05 give-take-sd                pic 9(8) Binary value zero.
     05 lstn-asname                 pic x(8).
     05 lstn-subtask                pic x(8).
     05 client-in-data              pic x(35).
     05 filler                      pic x(1).
     05 sockaddr-in.
       10  sin-family               pic 9(4) Binary.
       10  sin-port                 pic 9(4) Binary.
       10  sin-addr                 pic 9(8) Binary.
       10  sin-zero                 pic x(8).

*====================
 Procedure Division.
*====================

*---------------------------------------------------------------*
* Receive TIM from the CICS Listener                            *
*---------------------------------------------------------------*
```

```
     move 72 to cleng.

     exec cics retrieve
         into(CICS-listener-TIM)
         length(cleng)
     end-exec.

     move give-take-sd to startup-old-socket.
     move lstn-asname to startup-lstn-asname.
     move lstn-subtask to startup-lstn-subtask.
     move sin-family to startup-sin-family.
     move sin-port to startup-sin-port.
     call 'TPIINTOA' using sin-addr startup-sin-addr.

     exec cics writeq td
          queue('CSMT')
          from(cics-startup-msg-area)
          length(cics-startup-msg-len)
          nohandle
     end-exec.

*-----------------------------------------------------------------*
* Initialize socket API                                          *
*-----------------------------------------------------------------*

     move space to asname.
     move eibtaskn to init-cics-task.
     Call 'EZASOKET' using soket-initapi
        maxsoc
        initapi-ident
        subtask
        maxsno
        errno
        retcode.
     if retcode <  0 then
        move 'Initapi failed' to ezaerror-text
        perform write-ezaerror-msg thru
           write-ezaerror-msg-exit.

*-----------------------------------------------------------------*
* Let us see the client-id                                       *
*-----------------------------------------------------------------*

     move soket-getclientid to ezaerror-function.
     Call 'EZASOKET' using soket-getclientid
        clientid
        errno
        retcode.
     If retcode < 0 then
        move 'Getclientid failed' to ezaerror-text
        perform write-ezaerror-msg thru
           write-ezaerror-msg-exit
        go to exit-term-api.
     move clientid-name to clientid-msg-asname.
     move clientid-task to clientid-msg-subtask.
     exec cics writeq td
          queue('CSMT')
          from(cics-clientid-msg-area)
          length(cics-clientid-msg-len)
          nohandle
     end-exec.
```

```
*-------------------------------------------------------------*
* Take the socket from the CICS Listener                      *
*-------------------------------------------------------------*

     move lstn-asname to cid-name-lstn.
     move lstn-subtask to cid-subtask-lstn.
     move sin-family to cid-domain-lstn.
     move low-value to cid-res-lstn.
     move give-take-sd to socket-to-take.
     move soket-takesocket to ezaerror-function.
     Call 'EZASOKET' using soket-takesocket
        socket-to-take
        clientid-lstn
        errno
        retcode.
     If retcode < 0 then
        move 'Takesocket failed' to ezaerror-text
        perform write-ezaerror-msg thru
           write-ezaerror-msg-exit
        go to exit-term-api.
     move retcode to socket-descriptor.

*-------------------------------------------------------------*
* Start read/write loop                                       *
*-------------------------------------------------------------*

     move zero to client-status.
     move zero to timer-accum.

     Perform until (client-has-closed or
        timer-accum > 30)

*-------------------------------------------------------------*
* First we turn the socket into non-blocking mode             *
*-------------------------------------------------------------*

        Move soket-ioctl to ezaerror-function
        Call 'TPIIOCTL' using ioctl-command-string
           ioctl-command-fionbio
        If return-code > zero then
           move 'Call to TPIIOCTL failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-close-socket
        end-if
        Call 'EZASOKET' using soket-ioctl
           socket-descriptor
           ioctl-command-fionbio
           ioctl-reqarg-non-blocking
           ioctl-retarg
           errno
           retcode
        If retcode < 0 then
           move 'IOCTL call failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-close-socket
        end-if

*-------------------------------------------------------------*
* Then we issue a read for 8192 bytes                         *
* If we receive any, we echo back what we got                 *
```

```
* If we receive none, we wait 2 seconds                          *
* We will max wait 30 seonds before we time client out           *
*----------------------------------------------------------------*

        Move 8192 to read-request-len
        Move zero to recv-flag
        Perform read-TCP thru read-TCP-exit
        If retcode = zero then
           Go to exit-close-socket
        end-if
        if read-request-read > 0 then
           move read-request-read to send-request-len
           move read-buffer to send-buffer
           Perform send-TCP thru send-TCP-exit
           move zero to timer-accum
        else
           if errno = 35 then
              add 2 to timer-accum
              exec cics delay
                  for seconds(2)
              end-exec
           else
              move 1 to client-status
           end-if
        end-if
     end-perform.

     If timer-accum > 30 then
        move '30 second timeout' to ezaerror-text
        move 'Timeout' to ezaerror-function
        perform write-ezaerror-msg thru
           write-ezaerror-msg-exit
     else
        move 'Client closed socket' to ezaerror-text
        move 'Client-close' to ezaerror-function
        perform write-ezaerror-msg thru
           write-ezaerror-msg-exit
     end-if.

*----------------------------------------------------------------*
* Close socket and terminate                                     *
*----------------------------------------------------------------*

 exit-close-socket.
     move soket-close to ezaerror-function.
     Call 'EZASOKET' using soket-close
        socket-descriptor
        errno
        retcode.
     If retcode < 0 then
        move 'Close call failed' to ezaerror-text
        perform write-ezaerror-msg thru
           write-ezaerror-msg-exit.

*----------------------------------------------------------------*
* Terminate socket API                                           *
*----------------------------------------------------------------*

 exit-term-api.
     Call 'EZASOKET' using soket-termapi.

*----------------------------------------------------------------*
```

```
* Terminate program                                                *
*-----------------------------------------------------------------*

 exit-now.
     exec cics return
     end-exec.
     Goback.

*-----------------------------------------------------------------*
* Write out an error message to CSMT                              *
*-----------------------------------------------------------------*

 write-ezaerror-msg.
     move errno to ezaerror-errno.
     move retcode to ezaerror-retcode.
     exec cics writeq td
        queue('CSMT')
        from(ezaerror-msg)
        length(ezaerror-msg-len) nohandle
     end-exec.
 write-ezaerror-msg-exit.
     exit.

*-----------------------------------------------------------------*
* Subroutine:                                                     *
* -----------                                                     *
*                                                                 *
* Read data from a TCP connection                                 *
*-----------------------------------------------------------------*

 Read-TCP.
     move soket-recv to ezaerror-function.
     move zero to read-request-read.
     move read-request-len to read-request-remaining.
     Perform until read-request-remaining = 0
        Call 'EZASOKET' using soket-recv
           socket-descriptor
           recv-flag
           read-request-remaining
           read-buffer-byte(read-request-read + 1)
           errno
           retcode
        If retcode < 0 and errno not = 35 then
           move 'Read call failed' to ezaerror-text
           perform write-ezaerror-msg thru
              write-ezaerror-msg-exit
           go to exit-close-socket
        end-if
        If retcode > 0 then
           Add retcode to read-request-read
           Subtract retcode from read-request-remaining
        end-if
        If retcode = 0 or errno = 35 then
           Move zero to read-request-remaining
        end-if
     end-perform.

 Read-TCP-exit.
     exit.

*-----------------------------------------------------------------*
* Subroutine:                                                     *
```

```
      * -----------                                                  *
      *                                                             *
      * Send data over a socket connection                          *
      *-------------------------------------------------------------*

       Send-TCP.
           move soket-write to ezaerror-function.
           move send-request-len to send-request-remaining.
           move 0 to send-request-sent.
           Perform until send-request-remaining = 0
              Call 'EZASOKET' using soket-write
                 socket-descriptor
                 send-request-remaining
                 send-buffer-byte(send-request-sent + 1)
                 errno
                 retcode
              If retcode < 0 then
                 move 'Write call failed' to ezaerror-text
                 perform write-ezaerror-msg thru
                    write-ezaerror-msg-exit
                 go to exit-close-socket
              end-if
              add retcode to send-request-sent
              subtract retcode from send-request-remaining
              If retcode = 0 then
                 Move zero to send-request-remaining
              end-if
           end-perform.

       Send-TCP-exit.
           exit.
```

D.2 C Version of EZACICSC

```
/* This is a C version of EZACICSC                                  */

#include <stdio.h>
#include <string.h>
#include <stdlib.h>

#include <manifest.h>
#include <bsdtypes.h>
#include <in.h>
#include <inet.h>
#include <socket.h>
#include <tcperrno.h>
#include <errno.h> /* required to make "errno" variable available */
#include <netdb.h> /* should not precede #include <manifest.h> on MVS */
#define recv read   /* DOCUMENTATION ERROR! */

/* "bug compatible"/ease of use correction */
#define ebcdic2ascii(buffer,length)
        ezacic04(buffer,(long*)(0x80000000|(long)&length));
#define ascii2ebcdic(buffer,length)
        ezacic05(buffer,(long*)(0x80000000|(long)&length));

long retcode ;
/* DIS.H ALTERNATIVE */
char disMsgBuffer[300];
#ifndef __stdio_h
#include <stdio.h>
```

```
#endif
#define disfloat(x) sprintf(disMsgBuffer,#x "=%lg\n" ,x); disCics()
#define disint(x)   sprintf(disMsgBuffer,#x "=%i\n" ,x); disCics()
#define disshort(x) sprintf(disMsgBuffer,#x "=%i\n" ,x); disCics()
#define dislong(x)  sprintf(disMsgBuffer,#x "=%li\n" ,x); disCics()
#define disu(x)     sprintf(disMsgBuffer,#x "=%u\n" ,x); disCics()
#define disul(x)    sprintf(disMsgBuffer,#x "=%lu\n" ,x); disCics()
#define disstr(x)   sprintf(disMsgBuffer,#x "=\"%s\"\n" ,x); disCics()
#define disstr8(x)  sprintf(disMsgBuffer,#x "=\"%8.8s\"\n" ,x); disCics()
#define dischar(x)  sprintf(disMsgBuffer,#x "='%c'\n" ,x); disCics()
#define dishex(x)   sprintf(disMsgBuffer,#x "=X'%8.8X'\n" ,x); disCics()
#define say(x)      sprintf(disMsgBuffer,#x ".\n"); disCics()

void disCics()
{
   unsigned long l ;
   l = strlen(disMsgBuffer);
   exec CICS writeq td queue("CSMT") from(disMsgBuffer) length(l) nohandle;
}

void pgmExit()
{
     if ( retcode < 0) exec CICS abend abcode("TRBB") ;

     exec CICS return  ;
}

void writeCics(char * message)
{
   char buffer[200];
   sprintf(buffer,"%s, errno=%li, retcode=%li.\n",message,errno,retcode);
   exec CICS writeq td queue("CSMT") from(buffer)
        length(strlen(buffer)) nohandle;
}

long checkEib(char * what)
{
   if (dfheiptr->eibresp||dfheiptr->eibresp2) {
      sprintf(disMsgBuffer,"%s CICS call failed, resp=%li, resp2=%li\n",
      what, dfheiptr->eibresp , dfheiptr->eibresp2);
   } else {
      sprintf(disMsgBuffer,"%s CICS call OK\n",what);
   } /* endif */
   disCics();
   return dfheiptr->eibresp ;
}

int main(int argc,char**argv)
{
   char * sendMessage ;
   unsigned long receiveBufferSize = 1000 ;
   unsigned long receivedBytes ;
   unsigned long sentBytes ;
   unsigned long messageLength  ;
   unsigned short length ;
   unsigned long sockid ;
   unsigned long ascii ;
   char * receiveBuffer ;
   int taskFlag = 1 ; /* true */
   unsigned long recvFlag = 0 ;
   char endTestField[4] ;
   char asciiEnd [4] = { 101,110,100,0 } ;
```

```
/*-------------------------------------------------------------*/
/*    program"s variables                                      */
/*-------------------------------------------------------------*/

struct clientid clientidLstn ;

struct TcpSocketParm
{
   unsigned long      giveTakeSocket       ;
   unsigned char      lstnName        [ 8] ;
   unsigned char      lstnSubtaskname [ 8] ;
   unsigned char      lstnText [ 6] ;
   unsigned char      filler   [29] ;
   unsigned char      alignchar            ;
   struct sockaddr_in socketAddress        ;
} *pTcpSocketParm ;

receiveBuffer = (char*)malloc(receiveBufferSize);

/* exec CICS handle condition not suported by CICS C support */
/*                           invreq  (invreqErrSec)          */
/*                           ioerr   (ioerrSec)              */
/*                           enddata (enddataSec)            */
/*                           lengerr (lengerrSec)            */
/*                           nospace (nospaceErrSec)         */
/*                           qiderr  (qiderrSec)             */
/*                           itemerr (itemerrSec)            */

writeCics("TRBB transaction start up");

exec CICS address eib(dfheiptr); /* Not automatic for C CICS */
checkEib("ADDRESS");

exec CICS retrieve set(pTcpSocketParm) length(length);
checkEib("RETRIEVE");
/*disshort(length); *//* is set by the call */
/*disint(pTcpSocketParm);*/

disstr8( pTcpSocketParm->lstnName );
disstr8( pTcpSocketParm->lstnSubtaskname );
disint ( pTcpSocketParm->giveTakeSocket ) ;

disint(pTcpSocketParm->socketAddress.sin_family);
disint(pTcpSocketParm->socketAddress.sin_port);
dishex(pTcpSocketParm->socketAddress.sin_addr);

/*-------------------------------------------------------------*/
/* issue "takesocket" to acquire a socket                      */
/* which was given by listen program.                          */
/*-------------------------------------------------------------*/

memset((void*)&clientidLstn,0,sizeof(clientidLstn));

clientidLstn.domain = AF_INET ;
memcpy(clientidLstn.name        , pTcpSocketParm->lstnName      ,8);
memcpy(clientidLstn.subtaskname , pTcpSocketParm->lstnSubtaskname ,8);

retcode = takesocket(&clientidLstn , pTcpSocketParm->giveTakeSocket);

if ( retcode < 0) {
   writeCics("takesocket fail");
```

```
      pgmExit();
   } else {
       writeCics("takesocket successful");
   } /* endif */

   sockid = retcode ;

   sendMessage = "Task starting thru CICS/TCPIP interface" ;
   messageLength = strlen(sendMessage) ;
   ascii = memcmp(pTcpSocketParm->lstnText,"EBCDIC",6) ;
   disstr(pTcpSocketParm->lstnText);
   disint(ascii);
   if ( ascii ) ebcdic2ascii( sendMessage ,messageLength);

   retcode = write (sockid , sendMessage , messageLength );
   if (retcode <  0) { writeCics("write socket fail"); pgmExit(); }

   sentBytes = retcode ; disint(sentBytes);

   do {
      /*-------------------------------------------------------------*/
      /*  issue "readv" socket to receive input data from client     */
      /*-------------------------------------------------------------*/

      receivedBytes = recv(sockid,receiveBuffer,receiveBufferSize,recvFlag);
      disint(receivedBytes);
      retcode = receivedBytes ;
      *(receiveBuffer+receivedBytes) = 0 ; /* disstr requirement */
      say(Before translation);
      disstr(receiveBuffer);
      if (retcode < 0) { writeCics("read socket fail"); pgmExit(); }
      if ( ascii ) ascii2ebcdic(receiveBuffer,receivedBytes);
      say(After translation);
      disstr(receiveBuffer);

      /*-------------------------------------------------------------*/
      /*   echo receiving data                                       */
      /*-------------------------------------------------------------*/

      endTestField [3] = 0 ;
      memcpy(endTestField,receiveBuffer,3);
   /* if (!strcmp(endTestField,"end")) { */
      if (!strcmp(endTestField,asciiEnd)) {
         say(end indication received);
         taskFlag = 0 ; /* false */
         sendMessage = "connection end" ;
         messageLength = strlen(sendMessage) ;
         /*if ( ascii ) ebcdic2ascii(sendMessage,messageLength);*/
         retcode = write(sockid,sendMessage,messageLength);
         if (retcode <  0) {
            writeCics("write socket fail pgm end msg");
            pgmExit();
         } /* endif */

      } /* endif */

      /* @ echo message here with "data received" text? */
#ifdef NOT
      sendMessage = "data received " ;
      messageLength = strlen(sendMessage) ;
      if ( ascii ) ebcdic2ascii(sendMessage,messageLength);
      retcode = write(sockid,sendMessage,messageLength);
```

```
#endif
      retcode = write(sockid,receiveBuffer,receivedBytes);
      if (retcode <  0)  { writeCics("Write socket fail"); pgmExit(); }
      sentBytes = retcode ;
      dislong(sentBytes) ;

   } while ( taskFlag ); /* enddo */

   /*-------------------------------------------------------------*/
   /*   close "accept descriptor"                                 */
   /*-------------------------------------------------------------*/

   retcode = close(sockid);
   writeCics("close socket");

   /*
   invreqErrSec  : writeCics("interface is not active"       ); pgmExit();
   ioerrSec      : writeCics("ioerr occurrs"                 ); pgmExit();
   lengerrSec    : writeCics("lengerr error"                 ); pgmExit();
   nospaceErrSec : writeCics("nospace condition"             ); pgmExit();
   qiderrSec     : writeCics("qiderr  condition"             ); pgmExit();
   itemerrSec    : writeCics("itemerr error"                 ); pgmExit();
   enddataSec    : writeCics("retrieve data can not be found"); pgmExit();
   */
}
```

E.0 Appendix E. Sample REXX Socket Programs

This appendix contains the following two sets of sample REXX socket programs:

1. A sample iterative server and associated client. The programs use stream sockets, and they are written in REXX.

2. A sample implementation of a NETSTAT command in NetView. The NETSTAT REXX program is invoked from the NetView operator screen, it connects to the NETSTATS REXX server that runs in a batch TSO job. The NETSTAT parameters are passed to the NETSTATS REXX that issues the actual NETSTAT command with a STACK option, collects to output lines, and transfers them back to the NETSTAT REXX client in the NetView address space.

E.1 REXX Client

```
/* REXX - Simple MVS TCP/IP Client */
if ,arg(1,'E') then do
 say 'Please specify hostname port bytesToSend'
 exit
end

parse arg hostname port bytesToSend .

service       = 'T18ATCP' /* MUST be TCP/IP jobname */
socketsetsize = 10        /* number of preallocated sockets */
```

```
subtaskid     = 'RBB'     /* any name */

"alloc f(systcpd) da('sys1.tcpparms(tcpdata)') shr"
/* Prevent message EZY1372W Dataset *.TCPIP.DATA not found */

parse value check('socketsetlist',socket('socketsetlist')) with ids
do while ids,=''
 parse var ids id ids
 parse value socket('terminate',id ) with rc .
 if rc,=0 then say 'No cleanup was needed for id=' id
end

call check 'initialize',socket('initialize',subtaskid,socketsetsize,service )

/*af_inet = 2*/ /* not required */
parse value check('socket',socket('socket',af_inet,'SOCK_STREAM','TCP')) with socket .
say 'socket id is' socket

parse value check('gethostbyname',socket('gethostbyname',hostname)) with ipaddress otheraddresses
say 'ipaddress="'ipaddress'"'
if otheraddresses,='' then say 'otheraddresses="'otheraddresses'"'

call check 'connect',socket('connect',socket,af_inet port ipaddress)

/* send a message of just 'A' characters */
parse value check('send',socket('send',socket,copies('A',bytesToSend))) with bytesSent .
left = bytesToSend-bytesSent
if left>0 then say left 'bytes left.'

call check 'close socket', socket('close',socket)
call check 'terminate'   , socket('terminate',subtaskid ) with rc .
exit

check:procedure
parse arg callname,returnstring
parse var returnstring rc rest
if rc=0 then do;say callname 'call successfull.'; return rest;end
        else do;say callname 'call failed, rc='rc', reason='rest;exit;end
```

E.2 REXX Server

```
/* REXX - Simple MVS TCP/IP Server */
if ,arg(1,'E') then do
 say 'Please specify hostname port bytesExpected .
 exit
end
parse arg hostname port bytesExpected .

service       = 'T18ATCP' /* MUST be TCP/IP jobname */
socketsetsize = 10        /* number of preallocated sockets */
subtaskid     = 'RBB'     /* any name */

"alloc f(systcpd) da('sys1.tcpparms(tcpdata)') shr"
/* Prevent message EZY1372W Dataset *.TCPIP.DATA not found */

parse value check('socketsetlist',socket('socketsetlist')) with ids
do while ids,=''
 parse var ids id ids
 parse value socket('terminate',id ) with rc .
 if rc,=0 then say 'No cleanup was needed for id=' id
end
```

```
call check 'initialize',socket('initialize',subtaskid,socketsetsize,service )

af_inet = 2
parse value check('socket',socket('socket',af_inet,'SOCK_STREAM','TCP')) with socket .
say 'socket is' socket

ipaddress = 0 /* equivalent of INADDR_ANY */
call check 'bind',socket('bind',socket,af_inet port ipaddress)

backlog = 3 ; /* or any other value you'd like */
call check 'listen',socket('listen',socket,backlog)

say 'Waiting for connection request from client.'
parse value check('socket',socket('accept',socket)) with newsocket clientdomain clientport clientadd
say 'newsocket     = "'newsocket'"'
say 'clientdomain  = "'clientdomain'"'
say 'clientaddress = "'clientaddress'"'
say 'clientport    = "'clientport'"'

parse value check('gethostbyaddr',socket('gethostbyaddr',clientaddress)) with clientname
say 'clientname    = "'clientname'"'

say 'Waiting for message to be received.'
message = ''
receivedsofar = 0
do while receivedsofar<bytesExpected
 parse value check('read',socket('read',newsocket)) with length data
 if length ,=length(data) then say 'length discrepancy.'
 message = message||data
 receivedsofar = receivedsofar + length
end

/* For test purposes, we usually send messages filled with all the same character */
/* Rather than displaying the message, we verify whether this is the case indeed */
firstchar = left(message,1)
if verify(message,firstchar)>0 then say 'received: "'message'" =' c2x(message)
else say length "characters '"firstchar"' (X'"c2x(firstchar)"') received."

call check 'close newsocket', socket('close',newsocket)
call check 'close socket'   , socket('close',socket   )
call check 'terminate'      , socket('terminate',subtaskid )
exit

check:procedure
parse arg callname,returnstring
parse var returnstring rc rest
if rc=0 then do;say callname 'call successfull.'; return rest;end
        else do;say callname 'call failed, rc='rc', reason='rest;exit;end
```

E.3 NetView NETSTAT Client REXX

```
/* REXX */
/*--------------------------------------------------------------------*/
/*                                                                    */
/* Name:       NETSTAT - NetView REXX frontend to NETSTAT server      */
/*                                                                    */
/* Function:   Accepts Netstat command parameters, passes them        */
/*             to netstat server and displays result from netstat     */
/*             server.                                                */
/*                                                                    */
```

```
/* Interface:  Same as NETSTAT command - except STACK and REPORT    */
/*                                                                  */
/* Logic:      This REXX is used as a frontend rexx to              */
/*             the TCP/IP NETSTAT command from NetView.             */
/*             1. Connects to netstat server at TCP port 6000       */
/*             2. Sends netstat parameters to server                */
/*             3. Receives response from netstat server and         */
/*                displays result lines                             */
/*                                                                  */
/* Returncode: RC = 0, processing OK                                */
/*             Everything else is non-successful returncode from    */
/*             socket interface.                                    */
/*                                                                  */
/* Written:    April 25, 1995 at ITSO Raleigh                       */
/*                                                                  */
/* Modified:                                                        */
/*                                                                  */
/*------------------------------------------------------------------*/
dotrace = 0                                 /*Controls tracing      */
                                            /*dotrace = 1 for trace */
netport = '6000'                            /*Server port number    */
netserver = 'mvs18'                         /*Server host name      */
subtaskid = opid()                          /*Subtask id = operator */
if dotrace then say 'Subtaskid = 'subtaskid
parse arg p0 p1 p2 p3 p4 p5 p6 p7 p8 p9
if dotrace then say 'Arguments passed = ' p0 p1 p2 p3 p4 p5 p6 p7 p8 p9
/*------------------------------------------------------------------*/
/*                                                                  */
/* All socket calls are performed by subroutine DoSocket            */
/*                                                                  */
/*------------------------------------------------------------------*/
sockval = DoSocket('Terminate')             /*Ensure clean interface*/
if dotrace then say 'Terminate returned: 'sockval
/*------------------------------------------------------------------*/
/*                                                                  */
/* Initialize REXX socket interface                                 */
/*                                                                  */
/*------------------------------------------------------------------*/
sockval = DoSocket('Initialize', subtaskid)
if dotrace then say 'Initialize returned: 'sockval
if sockrc <> 0 then do
   say 'Socket initialize failed, rc='sockrc
   say sockval
   exit(sockrc)
end
/*------------------------------------------------------------------*/
/*                                                                  */
/* Get IP address(es) of server host                                */
/*                                                                  */
/*------------------------------------------------------------------*/
servipaddr = DoSocket('Gethostbyname', netserver)
if dotrace then say 'Gethostbyname returned: 'servipaddr
if sockrc <> 0 then do
   say 'Gethostbyname failed, rc='sockrc
   say sockval
   x=Doclean
   exit(sockrc)
end
parse value servipaddr with s1 s2 s3 s4 s5 s6 s7 s8 s9
y=0
do i = 1 to 9
  mystring = 'sipaddr.i = s'||i
```

```
  interpret mystring
  if sipaddr.i <> '' then y=y+1
  if dotrace then say 'sipaddr.'i' = 'sipaddr.i
end
sipaddr.0 = y
if dotrace then say 'Number of IP addresses = 'sipaddr.0
/*-------------------------------------------------------------------*/
/*                                                                   */
/* Get a socket and try to connect to the server                     */
/*                                                                   */
/* If connect fails (ETIMEDOUT), we must close the socket,           */
/* get a new one and try to connect to the next IP address           */
/* in the list, we received on the gethostbyname call.               */
/*                                                                   */
/*-------------------------------------------------------------------*/
i = 1
connected = 0
do until (i > sipaddr.0 | connected)
   sockdescr = DoSocket('Socket')
   if sockrc <> 0 then do
      say 'Socket failed, rc='sockrc
      x=Doclean
      exit(sockrc)
   end
   name = 'AF_INET '||netport||' '||sipaddr.i
   sockval = DoSocket('Connect', sockdescr, name)
   if sockrc = 0 then do
      connected = 1
   end
   else do
      sockval = DoSocket('Close', sockdescr)
      if sockrc <> 0 then do
         say 'Close failed, rc='sockrc
         x=Doclean
         exit(sockrc)
      end
   end
   i = i + 1
end
if ,connected then do
   say 'Connect failed, rc='sockrc
   say sockval
   x=Doclean
   exit(sockrc)
end
netstatcmd = p0 p1 p2 p3 p4 p5 p6 p7 p8 p9
if dotrace then say 'Command='netstatcmd
/*-------------------------------------------------------------------*/
/*                                                                   */
/* Send the NETSTAT command to the NETSTAT server                    */
/*                                                                   */
/*-------------------------------------------------------------------*/
sockval = DoSocket('Write', sockdescr, netstatcmd)
if dotrace then say 'Write returned: 'sockval
if sockrc <> 0 then do
   say 'Write failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
/*-------------------------------------------------------------------*/
/*                                                                   */
/* Read the response from the NETSTAT server                         */
```

```
/* Display output lines from the netstat command                    */
/*                                                                  */
/*------------------------------------------------------------------*/
readlen = 1
resplen = 0
respdata = ''
parse upper value p0 with closedown
do until readlen = 0
   readdata = DoSocket('Read', sockdescr)
   if sockrc <> 0 then do
      say 'Read failed, rc='sockrc
      x=Doclean
      exit(sockrc)
   end
   if dotrace then say 'Server returned ' readdata
   parse value readdata with readlen readrest
   If readlen > 0 then do
      respdata = respdata||readrest
      resplen = resplen + readlen
   end
   if closedown = 'CLOSE' then readlen = 0
end
If dotrace then do
   say 'Total length = 'resplen
   say 'Total data   = 'respdata
end
If resplen > 0 then do until resplen ,> 0
   eol = pos('00'X, respdata)
   len = eol - 1
   line = substr(respdata, 1, len)
   resplen = (resplen - eol)
   respdata = substr(respdata, eol+1, resplen)
   say line
end
/*------------------------------------------------------------------*/
/*                                                                  */
/* Terminate socket interface                                       */
/*                                                                  */
/*------------------------------------------------------------------*/
sockval = DoSocket('Terminate')
if dotrace then say 'Terminate returned; 'sockval
if sockrc <> 0 then do
   say 'Socket Close failed, rc='sockrc
   say sockval
   exit(sockrc)
end
Exit(0)
/*------------------------------------------------------------------*/
/*                                                                  */
/* Doclean Procedure.                                               */
/*                                                                  */
/* If a socket call failed, and we were about to exit this          */
/* Rexx application, you should close the socket and terminate the  */
/* socket interface.                                                */
/*                                                                  */
/*------------------------------------------------------------------*/
Doclean:
  sockval = DoSocket('Close', sockdescr)
  sockval = DoSocket('Terminate')
return sockres
/*------------------------------------------------------------------*/
/*                                                                  */
```

```
/* DoSocket procedure.                                              */
/*                                                                  */
/* Do the actual socket call, and parse the return code.            */
/* Return the rest of string returned from socket call.             */
/*                                                                  */
/*------------------------------------------------------------------*/
DoSocket:
  numargs = ARG()                          /*Number of passed args */
  argstring = ''                           /*Init arg string       */
  if dotrace then do                       /*Tracepoint            */
     say 'DoSocket subroutine'             /*Trace entry to routine*/
     say ' - Number of args = 'numargs     /*Trace number of args  */
  end                                      /*                      */
  do subix=1 to numargs                    /*Build argument string */
     if dotrace then do                    /*Tracepoint            */
        say ' - arg('subix') = 'arg(subix) /*Trace each argument   */
     end                                   /*                      */
     argstring = argstring||'arg('subix')' /*for the socket call   */
     if subix<numargs then do              /*If not last argument -*/
        argstring = argstring||','         /*add a comma           */
     end                                   /*                      */
  end                                      /*                      */
  interpret 'Parse value Socket('||argstring||') with sockrc sockres'
  if dotrace then do                       /*Tracepoint            */
     say ' - return code   = 'sockrc       /*Trace returncode      */
     say ' - return string = 'sockres      /*Trace return string   */
  end                                      /*                      */
return sockres                             /*Return socket result  */
```

E.4 NETSTAT Server REXX

```
/* REXX */
/*------------------------------------------------------------------*/
/*                                                                  */
/* Name:       NETSTATS - NETSTAT server                            */
/*                                                                  */
/* Function:   REXX Socket NETSTAT server.  This is an iterative    */
/*             socket server, that serves netstat command requests  */
/*             from clients.  Clients send the netstat parameters,  */
/*             this server does the actual netstat command, picks   */
/*             up the netstat output and returns it to the client.  */
/*                                                                  */
/*             Client example is NETSTAT REXX in NetView.           */
/*                                                                  */
/* Interface:  - none -                                             */
/*                                                                  */
/* Logic:      This server binds to TCP port 6000.                  */
/*             Processing is done in a never ending loop:           */
/*             1. Accept connection request                         */
/*             2. Receive netstat parameters from client            */
/*             3. Invoke netstat command with stack option          */
/*             4. Pull out stacked netstat output lines             */
/*             5. Send lines back to client - each line terminated  */
/*                by a X'00' byte                                   */
/*             6. Go and wait for anew connection request           */
/*                                                                  */
/* Returncode: RC = 0, processing OK                                */
/*             Everything else is non-successful returncode from    */
/*             socket interface.                                    */
/*                                                                  */
/* Written:    April 25, 1995 at ITSO Raleigh                       */
```

```
/*                                                                  */
/* Modified:                                                        */
/*                                                                  */
/*------------------------------------------------------------------*/
dotrace = 0                                 /*Controls tracing      */
                                            /*dotrace = 1 for trace */
servport = '6000'                           /*Server port number    */
subtaskid = 'netstats'                      /*Subtask id            */
/*------------------------------------------------------------------*/
/*                                                                  */
/* All socket calls are performed by subroutine DoSocket            */
/*                                                                  */
/*------------------------------------------------------------------*/
sockval = DoSocket('Terminate')             /*Ensure clean interface*/
/*------------------------------------------------------------------*/
/*                                                                  */
/* Initialize REXX socket interface                                 */
/*                                                                  */
/*------------------------------------------------------------------*/
sockval = DoSocket('Initialize', subtaskid)
if sockrc <> 0 then do
   say 'Initialize failed, rc='sockrc
   exit(sockrc)
end
/*------------------------------------------------------------------*/
/*                                                                  */
/* Obtain a socket, bind it to our server port on INADDR_ANY and    */
/* issue a listen call.                                             */
/*                                                                  */
/*------------------------------------------------------------------*/
sockdescr = DoSocket('Socket')
if sockrc <> 0 then do
   say 'Socket failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
sockval = DoSocket('Bind', sockdescr, 'AF_INET' servport 0)
if sockrc <> 0 then do
   say 'Bind failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
sockval = DoSocket('Listen', sockdescr)
if sockrc <> 0 then do
   say 'Listen failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
/*------------------------------------------------------------------*/
/*                                                                  */
/* Enter iterative server loop, waiting for a connection request    */
/*                                                                  */
/*------------------------------------------------------------------*/
Do forever
   sockval = DoSocket('Accept', sockdescr)
   if sockrc <> 0 then do
      say 'Accept failed, rc='sockrc
      x=Doclean
      exit(sockrc)
   end
   parse value sockval with newsock .
/*------------------------------------------------------------------*/
```

```
/*                                                                  */
/* Read netstat parameters from client                              */
/* If client sends a CLOSE command, we will terminate the           */
/* iterative server loop.                                           */
/* We will add a stack parameter to the passed parameters.          */
/* Ensure that client did not send a stack or a report option.      */
/*                                                                  */
/*------------------------------------------------------------------*/
   sockval = DoSocket('Read', newsock)
   if sockrc <> 0 then do
      say 'Read failed, rc='sockrc
      x=Doclean2
      exit(sockrc)
   end
   parse upper value sockval with resplen netcmdi
   If substr(netcmdi,1,5) = 'CLOSE' then do
      say 'Server is terminating as result of a CLOSE command'
      retstring = 'Server Closing Down'||'00'X
      sockval = DoSocket('Write', newsock, retstring)
      sockval = DoSocket('Shutdown', newsock, read)
      sockval = DoSocket('Close', sockdescr)
      sockval = DoSocket('Terminate')
      exit(0)
   end
   if dotrace then say 'Received data = 'netcmdi
   antparms = words(netcmdi)
   netcmd = ''
   if antparms > 0 then do i=1 to antparms
      subparm = word(netcmdi,i)
      select
         when substr(subparm,1,4) = 'STAC' then nop
         when substr(subparm,1,3) = 'REP' then nop
         Otherwise netcmd = netcmd||' '||word(netcmdi,i)
      end
   end
   netcmd = 'STACK '||netcmd
   if dotrace then say 'Command = NETSTAT 'netcmd
/*------------------------------------------------------------------*/
/*                                                                  */
/* Do the actual NETSTAT command with the passed parameters         */
/* Pull out the output lines from the stack, add a line             */
/* terminating character to each line including the last and        */
/* send the full return buffer back to the client.                  */
/*                                                                  */
/*------------------------------------------------------------------*/
   msgstat=MSG()
   z=MSG("OFF")
   address tso "NETSTAT" netcmd
   xy = queued()
   If dotrace then say 'Number of lines returned='xy
   retstring = ''
   do i=1 to xy
      index = xy-i+1
      pull lin.index
   end
   do i = 1 to xy
      retstring=retstring||lin.i||'00'X
   end
   z=MSG(msgstat)
   if retstring = '' then do
      retstring = 'No response from NETSTAT command'||'00'X
   end
```

```
   sockval = DoSocket('Write', newsock, retstring)
   if dotrace then say 'Write returned: 'sockval
   if sockrc <> 0 then do
      say 'Write failed, rc='sockrc
      x=Doclean2
      exit(sockrc)
   end
/*--------------------------------------------------------------------*/
/*                                                                    */
/* Close the socket and wait for a new connection                     */
/*                                                                    */
/*--------------------------------------------------------------------*/
   sockval = DoSocket('Close', newsock)
   if sockrc <> 0 then do
      say 'Socket Close failed, rc='sockrc
      x=Doclean
      exit(sockrc)
   end
end

/*--------------------------------------------------------------------*/
/*                                                                    */
/* Doclean Procedure.                                                 */
/*                                                                    */
/* If a socket call failed, and we are about to exit this             */
/* Rexx application, close the socket and terminate the               */
/* socket interface.                                                  */
/*                                                                    */
/*--------------------------------------------------------------------*/
Doclean:
   if dotrace then do
      say 'Cleaning up socket descriptor = 'sockdescr
   end
   sockval = DoSocket('Close', sockdescr)
   sockval = DoSocket('Terminate')
return sockres
Doclean2:
   if dotrace then do
      say 'Cleaning up socket descriptor = 'sockdescr
      say '         and socket descriptor = 'newsock
   end
   sockval = DoSocket('Close', sockdescr)
   sockval = DoSocket('Close', newsock)
   sockval = DoSocket('Terminate')
return sockres

/*--------------------------------------------------------------------*/
/*                                                                    */
/* DoSocket procedure.                                                */
/*                                                                    */
/* Do the actual socket call, and parse the return code.              */
/* Return rest of string returned from socket call.                   */
/*                                                                    */
/*--------------------------------------------------------------------*/
DoSocket:
  numargs = ARG()                          /*Number of passed args */
  argstring = ''                           /*Init arg string       */
  if dotrace then do                       /*Tracepoint            */
     say 'DoSocket subroutine'             /*Trace entry to routine*/
     say ' - Number of args = 'numargs     /*Trace number of args  */
  end                                      /*                      */
  do subix=1 to numargs                    /*Build argument string */
```

```
      if dotrace then do                      /*Tracepoint            */
         say ' - arg('subix') = 'arg(subix)   /*Trace each argument   */
      end                                     /*                      */
      argstring = argstring||'arg('subix')'   /*for the socket call   */
      if subix<numargs then do                /*If not last argument -*/
         argstring = argstring||','           /*add a comma           */
      end                                     /*                      */
    end                                       /*                      */
    msgstat = msg()                           /*Save message status   */
    z = msg("OFF")                            /*Turn messages off     */
    interpret 'Parse value Socket('||argstring||') with sockrc sockres'
    z = msg(msgstat)                          /*Restore message status*/
    if dotrace then do                        /*Tracepoint            */
       say ' - return code   = 'sockrc        /*Trace returncode      */
       say ' - return string = 'sockres       /*Trace return string   */
    end                                       /*                      */
  return sockres                              /*Return socket result  */
```

F.0 Appendix F. Sample PLI Socket Programs

This appendix contains a sample iterative PL/I server and associated client. The programs use stream sockets, and they are written in PL/I.

F.1 PL/I Server

```
/* PL/I Stream Socket Server */
pserver: proc(parm)options(main);

 /* The extended sockets API routine */
 dcl ezasoket entry options(retcode,asm,inter) ext;
 dcl function char(16) ;

 /* Regular C routines to convert Internet addresses */
 dcl inet_addr entry(char(16)    ) options(retcode,asm,inter)         ext('INET@ADD');
 dcl inet_ntoa entry(fixed(31)bin) options(retcode,asm,inter,byvalue) ext('INET@NTA');

 /*********************************************************************/
 /*                                                                   */
 /* Subroutines                                                       */
 /*                                                                   */
 /*********************************************************************/

 /* Routine to parse the parameterlist */
 word:procedure(string,wordno)returns(char(255)var);
  dcl string char(*)var;
  dcl wordno fixed(31)bin;
  dcl i      fixed(31)bin;
  dcl p1     fixed(31)bin;
  dcl p2     fixed(31)bin init(0);
  do i=1 to wordno;
   if p2>length(string) then return('');
   p1=verify(substr(string,p2+1),' ');
   if p1=0 then return('');
   p1=p1+p2;
   p2=index(substr(string,p1),' ');
   if p2=0 then p2=length(string)+1;else p2=p2+p1-1;
```

```
 end;
 return(substr(string,p1,p2-p1));
end word;

/* Routine to check parameter validity */
numeric:procedure(num_string)returns(bit(1));
 dcl num_string char(100)var;
 return(verify(num_string,'0123456789')=0);
end numeric ;

/* Routines to convert strings */
z2var : procedure(zstring)returns(char(255)var);
 dcl zstring char(256);
 dcl p fixed(31)bin;
 p=index(zstring,low(1));
 if p=0 then return(zstring);
        else return(substr(zstring,1,p-1));
end z2var ;
var2z : procedure(varstring)returns(char(256));
 dcl varstring char(255)var;
 return(varstring||low(1));
end var2z ;

/*********************************************************************/
/*                                                                   */
/* Subroutine to check results of all socket API calls               */
/*                                                                   */
/*********************************************************************/

sock_check:procedure(function,errno,retcode) returns(bit(1));
 dcl function char(16)       ; /* function name */
 dcl retcode  fixed bin(31) ; /* return code   */
 dcl errno    fixed bin(31) ; /* error number  */
 put skip edit(function) (a);
 if retcode >=0 then do;
  put edit(' completed OK.')(A) ;
  return('0'B);
 end; else do;
  put edit(' failed, errno=',errno) (a,f(9)) ;
  return('1'B);
 end;
end sock_check;

/* Routine to send records */
sendRecord : procedure (socket , recordBuffer , recordLength )
 returns(bit(1));

 /* parameter declarations */
 dcl socket         fixed(15)bin ;
 dcl recordBuffer   char(*)      ;
 dcl recordLength   fixed(31)bin ;

 /* internal variable declarations */
 dcl bytesSent      fixed(31)bin init(0) ;
 dcl bytesToBeSent  fixed(31)bin         ;
 dcl remainingBytes fixed(31)bin init(recordLength);

 function = 'WRITE' ;
 sendloop : do while ( remainingBytes >0);
  bytesToBeSent = remainingBytes ;
  call ezasoket(
   function                      ,
```

```
   socket                          ,
   bytesToBeSent                   ,
   substr(recordBuffer,bytesSent+1) ,
   errno                           ,
   retcode);
  if sock_check(function,errno,retcode) then stop ;
  bytesSent = retcode ;
  if bytesSent=0 then do ;
   put skip list('Connection broken while sending.');
   return ('1'b) ;
  end ;
  put skip edit(bytesSent,' bytes have been sent.')(f(9),a);
  remainingBytes = remainingBytes - bytesSent ;
 end sendloop ;
 put skip list('Complete record sent.');
 return ('0'b);
end sendRecord ;

/* Routine to receive records */
receiveRecord : procedure (socket , recordBuffer , recordLength )
 returns(fixed(31)bin);

 /* parameter declarations */
 dcl socket            fixed(15)bin ;
 dcl recordBuffer      char(*)      ;
 dcl recordLength      fixed(31)bin ;

 /* internal variable declarations */
 dcl bytesReceived     fixed(31)bin init(0);
 dcl bytesReceivedNow  fixed(31)bin;
 dcl bytesToBeReceived fixed(31)bin ;
 dcl remainingBytes    fixed(31)bin init(recordLength) ;

 begin;
  dcl receiveBuffer    char(recordLength) ;
  function = 'READ' ;
  receiveloop : do while ( remainingBytes >0);
   bytesToBeReceived = remainingBytes ;
   call ezasoket(
    function          ,
    socket            ,
    bytesToBeReceived ,
    receiveBuffer     ,
    errno             ,
    retcode);
   if sock_check(function,errno,retcode) then stop ;
   bytesReceivedNow = retcode ;
   put skip edit(bytesReceivedNow,' bytes have been received.')(f(9),a);
   if bytesReceivedNow=0 then do ;
    put skip list('Connection broken while receiving.');
    return ('1'b) ;
   end ;
   substr(recordBuffer,bytesReceived+1,bytesReceivedNow) = receiveBuffer;
   remainingBytes = remainingBytes - bytesReceivedNow ;
   bytesReceived  = bytesReceived  + bytesReceivedNow ;
  end receiveloop ;
  put skip list('Complete record received.');
  return ('0'b);
 end;
end receiveRecord ;

/*********************************************************************/
```

```
/*                                                                   */
/* Obtain information from JCL parameterlist (PARM=)                 */
/*                                                                   */
/*********************************************************************/

dcl parm        char(100)var; /* passed in JCL */
dcl tcpipjobname char(8) ; /* T18ATCP in Raleigh, ZTCPIP in La Hulpe */
dcl ownport     fixed(15)bin init(0);
dcl recordlen   fixed(31)bin init(0);
dcl crecordlen  char(100)var;
dcl cownport    char(100)var;

tcpipjobname = word(parm,1);
cownport     = word(parm,2);
crecordlen   = word(parm,3);
if tcpipjobname=' '|,numeric(cownport)|,numeric(crecordlen) then do;
 put skip list('Usage: parm=''/tcp/ip-jobname ownport recordlength''');
 call pliretc(4);
 return ;
end;
ownport    = cownport   ;
recordlen  = crecordlen ;
put skip data(ownport);
put skip data(recordlen);

/*********************************************************************/
/*                                                                   */
/* INITAPI call defines TCP/IP subsystem in this MVS to be used      */
/* NOTE: "tcpname" should be your TCP/IP's jobname                   */
/*                                                                   */
/*********************************************************************/

dcl maxsoc fixed bin(15) init(255);     /* largest socket # checked  */
dcl 1 id                            ,  /*                           */
    2 tcpname char(8)               ,  /* TCP/IP jobname            */
    2 adsname char(8) init('       ');  /* local address space       */
dcl subtask char(8) init('SUBTASK');    /* task/path identifier      */
dcl maxsno  fixed bin(31) init(0);      /* max descriptor assigned   */
dcl retcode fixed bin(31) init(0);      /* return code               */
dcl errno   fixed bin(31) init(0);      /* error number              */

id.tcpname = tcpipjobname ;

function = 'INITAPI' ;
call ezasoket(function, maxsoc, id, subtask, maxsno, errno, retcode);
if sock_check(function,errno,retcode) then stop ;

/*********************************************************************/
/*                                                                   */
/* SOCKET call obtains a "socket" descriptor, no comms yet.          */
/*                                                                   */
/*********************************************************************/

function = 'SOCKET' ;
dcl af_inet     fixed bin(31) init(2);    /* internet domain         */
dcl type_stream fixed bin(31) init(1);    /* two-way byte stream     */
dcl proto       fixed bin(31) init(0);    /* prototype default       */
call ezasoket(function, af_inet, type_stream, proto, errno, retcode);
if sock_check(function,errno,retcode) then stop ;
dcl socket      fixed bin(15);            /* socket descriptor       */
socket = retcode;
```

```
/*********************************************************************/
/*                                                                   */
/* Execute BIND call                                                 */
/*                                                                   */
/*********************************************************************/

function = 'BIND' ;
dcl 1 local_address,                      /* our socket address     */
    2 family  fixed bin(15) init(2) ,     /* AF_INET = TCP/IP       */
    2 port    fixed bin(15)         ,     /* our own port           */
    2 address fixed bin(31) init(0) ,     /* accept any address     */
    2 reserved char(8);                   /* reserved               */
local_address.port = cownport ;           /* can not through init   */
call ezasoket(function, socket, local_address, errno, retcode);
if sock_check(function,errno,retcode) then stop ;

/*********************************************************************/
/*                                                                   */
/* Execute LISTEN call                                               */
/*                                                                   */
/*********************************************************************/

function = 'LISTEN' ;
dcl backlog fixed bin(31) init(5) ;   /* max length of pending queue */
call ezasoket(function, socket, backlog, errno, retcode);
if sock_check(function,errno,retcode) then stop ;

/*********************************************************************/
/*                                                                   */
/* Execute ACCEPT call                                               */
/*                                                                   */
/*********************************************************************/

function = 'ACCEPT' ;
dcl 1 client_address like local_address ;  /* our socket address     */
call ezasoket(function, socket, client_address, errno, retcode);
if sock_check(function,errno,retcode) then stop ;
dcl newsocket fixed bin(15);           /* new socket               */
newsocket = retcode;

/*********************************************************************/
/*                                                                   */
/*   Who is our client?                                              */
/*                                                                   */
/*********************************************************************/

call inet_ntoa(client_address.address); /* call C inet_ntoa routine */
dcl dotted_address char(16) based(dotted_address_pointer);
unspec(dotted_address_pointer) = unspec(pliretv());
put skip edit('Our client''s TCP/IP address "',
z2var(dotted_address),'" - port',client_address.port)
(a,a,a,f(5));
if client_address.family,=2 then put skip list('Not AF_INET family.'); /* very unlikely */

/*********************************************************************/
/*                                                                   */
/*   Exchange a record                                               */
/*                                                                   */
/*********************************************************************/

begin;
```

```
 dcl record char(recordlen);

 if receiveRecord(newsocket,record,recordlen) then put skip list('receive failed.');
 if sendRecord   (newsocket,record,recordlen) then put skip list('send failed.');

end;

/*********************************************************************/
/*                                                                   */
/* Issue CLOSE calls for both sockets                                */
/*                                                                   */
/*********************************************************************/

function = 'CLOSE' ;
call ezasoket(function, newsocket, errno, retcode);
if sock_check(function,errno,retcode) then stop ;

call ezasoket(function, socket, errno, retcode);
if sock_check(function,errno,retcode) then stop ;

/*********************************************************************/
/*                                                                   */
/* TERMAPI call terminates the connection between this address space */
/* and the TCP/IP address space chosen by INITAPI                    */
/*                                                                   */
/*********************************************************************/

function = 'TERMAPI' ;
call ezasoket(function);

call pliretc(0);

end pserver;
```

F.2 PL/I Server

```
/* PL/I Stream Socket Client */
pclient: proc(parm)options(main);

 /* The extended sockets API routine */
 dcl ezasoket entry options(retcode,asm,inter) ext;
 dcl function char(16) ;

 /* Regular C routines to convert Internet addresses */
 dcl inet_addr entry(char(16)    ) options(retcode,asm,inter)         ext('INET@ADD');
 dcl inet_ntoa entry(fixed(31)bin) options(retcode,asm,inter,byvalue) ext('INET@NTA');

 /*********************************************************************/
 /*                                                                   */
 /* Subroutines                                                       */
 /*                                                                   */
 /*********************************************************************/

 /* Routine to parse the parameterlist */
 word:procedure(string,wordno)returns(char(255)var);
  dcl string char(*)var;
  dcl wordno fixed(31)bin;
  dcl i      fixed(31)bin;
  dcl p1     fixed(31)bin;
  dcl p2     fixed(31)bin init(0);
  do i=1 to wordno;
```

```
  if p2>length(string) then return('');
  p1=verify(substr(string,p2+1),' ');
  if p1=0 then return('');
  p1=p1+p2;
  p2=index(substr(string,p1),' ');
  if p2=0 then p2=length(string)+1;else p2=p2+p1-1;
 end;
 return(substr(string,p1,p2-p1));
end word;

/* Routine to check parameter validity */
numeric:procedure(num_string)returns(bit(1));
 dcl num_string char(100)var;
 return(verify(num_string,'0123456789')=0);
end numeric ;

/* Routines to convert strings */
z2var : procedure(zstring)returns(char(255)var);
 dcl zstring char(256);
 dcl p fixed(31)bin;
 p=index(zstring,low(1));
 if p=0 then return(zstring);
        else return(substr(zstring,1,p-1));
end z2var ;
var2z : procedure(varstring)returns(char(256));
 dcl varstring char(255)var;
 return(varstring||low(1));
end var2z ;

/*********************************************************************/
/*                                                                   */
/* Subroutine to check results of all socket API calls               */
/*                                                                   */
/*********************************************************************/

sock_check:procedure(function,errno,retcode) returns(bit(1));
 dcl function char(16)      ; /* function name */
 dcl retcode  fixed bin(31) ; /* return code   */
 dcl errno    fixed bin(31) ; /* error number  */
 put skip edit(function) (a);
 if retcode >=0 then do;
  put edit(' completed OK.')(A) ;
  return('0'B);
 end; else do;
  put edit(' failed, errno=',errno) (a,f(9)) ;
  return('1'B);
 end;
end sock_check;

/* Routine to send records */
sendRecord : procedure (socket , recordBuffer , recordLength )
 returns(bit(1));

 /* parameter declarations */
 dcl socket         fixed(15)bin ;
 dcl recordBuffer   char(*)      ;
 dcl recordLength   fixed(31)bin ;

 /* internal variable declarations */
 dcl bytesSent      fixed(31)bin init(0) ;
 dcl bytesToBeSent  fixed(31)bin         ;
 dcl remainingBytes fixed(31)bin init(recordLength);
```

```
 function = 'WRITE' ;
 sendloop : do while ( remainingBytes >0);
  bytesToBeSent = remainingBytes ;
  call ezasoket(
   function                        ,
   socket                          ,
   bytesToBeSent                   ,
   substr(recordBuffer,bytesSent+1) ,
   errno                           ,
   retcode);
  if sock_check(function,errno,retcode) then stop ;
  bytesSent = retcode ;
  if bytesSent=0 then do ;
   put skip list('Connection broken while sending.');
   return ('1'b) ;
  end ;
  put skip edit(bytesSent,' bytes have been sent.')(f(9),a);
  remainingBytes = remainingBytes - bytesSent ;
 end sendloop ;
 put skip list('Complete record sent.');
 return ('0'b);
end sendRecord ;

/* Routine to receive records */
receiveRecord : procedure (socket , recordBuffer , recordLength )
 returns(fixed(31)bin);

 /* parameter declarations */
 dcl socket            fixed(15)bin ;
 dcl recordBuffer      char(*)      ;
 dcl recordLength      fixed(31)bin ;

 /* internal variable declarations */
 dcl bytesReceived     fixed(31)bin init(0);
 dcl bytesReceivedNow  fixed(31)bin;
 dcl bytesToBeReceived fixed(31)bin ;
 dcl remainingBytes    fixed(31)bin init(recordLength) ;

 begin;
  dcl receiveBuffer    char(recordLength) ;
  function = 'READ' ;
  receiveloop : do while ( remainingBytes >0);
   bytesToBeReceived = remainingBytes ;
   call ezasoket(
    function          ,
    socket            ,
    bytesToBeReceived ,
    receiveBuffer     ,
    errno             ,
    retcode);
   if sock_check(function,errno,retcode) then stop ;
   bytesReceivedNow = retcode ;
   put skip edit(bytesReceivedNow,' bytes have been received.')(f(9),a);
   if bytesReceivedNow=0 then do ;
    put skip list('Connection broken while receiving.');
    return ('1'b) ;
   end ;
   substr(recordBuffer,bytesReceived+1,bytesReceivedNow) = receiveBuffer;
   remainingBytes = remainingBytes - bytesReceivedNow ;
   bytesReceived  = bytesReceived  + bytesReceivedNow ;
  end receiveloop ;
```

```
  put skip list('Complete record received.');
  return ('0'b);
 end;
end receiveRecord ;

/*********************************************************************/
/*                                                                   */
/* Obtain information from JCL parameterlist (PARM=)                 */
/*                                                                   */
/*********************************************************************/

dcl parm        char(100)var; /* passed in JCL */
dcl tcpipjobname char(8) ; /* T18ATCP in Raleigh, ZTCPIP in La Hulpe */
dcl servername  char(100);
dcl serverport  fixed(15)bin init(0);
dcl namelen     fixed(31)bin init(0);
dcl recordlen   fixed(31)bin init(0);
dcl crecordlen  char(100)var;
dcl cserverport char(100)var;

tcpipjobname = word(parm,1);
servername   = word(parm,2); namelen=length(servername);
cserverport  = word(parm,3);
crecordlen   = word(parm,4);
if tcpipjobname=' '|servername=' '|,numeric(cserverport)|,numeric(crecordlen) then do;
 put skip list('Usage: parm=''/tcp/ip-jobname servername serverport recordlength''');
 call pliretc(4);
 return ;
end;
serverport = cserverport ;
recordlen  = crecordlen  ;
put skip data(servername);
put skip data(serverport);
put skip data(recordlen );

/*********************************************************************/
/*                                                                   */
/* INITAPI call defines TCP/IP subsystem in this MVS to be used      */
/* NOTE: "tcpname" should be your TCP/IP's jobname                   */
/*                                                                   */
/*********************************************************************/

dcl maxsoc fixed bin(15) init(255)   ;  /* largest socket # checked  */
dcl 1 id                             ,  /*                           */
    2 tcpname char(8)                ,  /* TCP/IP jobname            */
    2 adsname char(8) init('       ');  /* local address space       */
dcl subtask char(8) init('SUBTASK');    /* task/path identifier      */
dcl maxsno  fixed bin(31) init(0);      /* max descriptor assigned   */
dcl retcode fixed bin(31) init(0);      /* return code               */
dcl errno   fixed bin(31) init(0);      /* error number              */

id.tcpname = tcpipjobname ;

function = 'INITAPI' ;
call ezasoket(function, maxsoc, id, subtask, maxsno, errno, retcode);
if sock_check(function,errno,retcode) then stop ;

/*********************************************************************/
/*                                                                   */
/* SOCKET call obtains a "socket" descriptor, no comms yet.          */
/*                                                                   */
/*********************************************************************/
```

```
function = 'SOCKET' ;
dcl af_inet     fixed bin(31) init(2);    /* internet domain         */
dcl type_stream fixed bin(31) init(1);    /* two-way byte stream     */
dcl proto       fixed bin(31) init(0);    /* prototype default       */
call ezasoket(function, af_inet, type_stream, proto, errno, retcode);
if sock_check(function,errno,retcode) then stop ;
dcl socket      fixed bin(15);            /* socket descriptor       */
socket = retcode;

/*********************************************************************/
/*                                                                   */
/* Prepare for CONNECT - common part                                 */
/*                                                                   */
/*********************************************************************/

dcl 1 name_id,                          /* server address in reqd. fmt.*/
    2 family  fixed bin(15) init(2),    /* AF_INET: TCP/IP             */
    2 port    fixed bin(15)        ,    /* port    ) of the server     */
    2 address fixed bin(31)        ,    /* address ) to be contacted   */
    2 reserved char(8);                 /* reserved                    */

name_id.port = serverport ;

/*********************************************************************/
/*                                                                   */
/* Find out how the server address is specified: either/or:          */
/* 1. as a "dotted decimal" address                                  */
/* 2. as a symbolic address                                          */
/*                                                                   */
/*********************************************************************/

dcl hostaddr fixed(31)bin;
call inet_addr(var2z(servername));
hostaddr = pliretv();
if hostaddr = -1 then do;  /* this means the address was symbolic */

 /*******************************************************************/
 /*                                                                 */
 /* Find server address by means of GETHOSTBYNAME                   */
 /*                                                                 */
 /*******************************************************************/

 dcl 1 hostent based(hostentptr) ,
     2 nameptr      ptr          ,
     2 aliaslist    ptr          ,
     2 family       fixed(31)bin ,
     2 hostaddrlen  fixed(31)bin ,
     2 hostaddrlist ptr          ;
 function = 'GETHOSTBYNAME' ;
 call ezasoket(function, namelen, servername, hostentptr, retcode);
 if sock_check(function,errno,retcode) then stop ;

 dcl hostname         char(256)    based(hostent.nameptr);
 dcl alias            char(256)    based;
 dcl aliasptr    (99) ptr          based(hostent.aliaslist);
 dcl hostaddrptr (99) ptr          based(hostent.hostaddrlist);
 dcl hostaddrn        fixed(31)bin based;
 put skip edit('Full name of server host: "',z2var(hostname),'"')(a,a,a);

 /*******************************************************************/
 /*                                                                 */
```

```
 /* CONNECT call connects to the server                              */
 /*                                                                  */
 /********************************************************************/

 function = 'CONNECT' ;
 dcl addressIndex fixed(31)bin ;
 dcl dotted_address char(16) based(dotted_address_pointer);
 do addressIndex = 1 by 1 while (unspec(hostaddrptr(addressIndex)),=0) ;
  name_id.address = hostaddrptr(addressIndex)->hostaddrn ;
  call inet_ntoa(name_id.address);      /* call C inet_ntoa routine */
  unspec(dotted_address_pointer) = unspec(pliretv());
  put skip edit('Trying to contact TCP/IP address "',z2var(dotted_address),'"')(a,a,a);
  call ezasoket(function, socket, name_id, errno, retcode);
  if ,sock_check(function,errno,retcode) then leave ;
 end ;

 if unspec(hostaddrptr(addressIndex))=0 then do;
  put skip list('Unable to contact any of the addresses of the specified server.');
  stop;
 end;
end;else do;

 /********************************************************************/
 /*                                                                  */
 /* CONNECT call connects to the server                              */
 /*                                                                  */
 /********************************************************************/

 function = 'CONNECT' ;
 name_id.address = hostaddr ;
 call ezasoket(function, socket, name_id, errno, retcode);
 if sock_check(function,errno,retcode) then stop ;
end;

/********************************************************************/
/*                                                                  */
/*   Find our local address and ("ephemeral") port                  */
/*                                                                  */
/********************************************************************/

dcl 1 local_address like name_id ;    /* to get our local address    */
function = 'GETSOCKNAME' ;
call ezasoket(function, socket, local_address, errno, retcode);
if ,sock_check(function,errno,retcode) then do;
 call inet_ntoa(local_address.address); /* call C inet_ntoa routine */
 unspec(dotted_address_pointer) = unspec(pliretv());
 put skip edit('Our local TCP/IP address "',z2var(dotted_address),'" - port',local_address.port)
 (a,a,a,f(5));
 if local_address.family,=2 then put skip list('Not AF_INET family.'); /* very unlikely */
end;

/********************************************************************/
/*                                                                  */
/*   Exchange a record with the server and check whether            */
/*   thew echo is identical - as it should be.                      */
/*                                                                  */
/********************************************************************/

begin;

 dcl echoRecord char(recordlen);
 dcl recordSent char(recordlen);
```

```
 recordSent=repeat('A',recordlen-1);

 if sendRecord   (socket,recordSent,recordlen) then put skip list('send failed.');
 if receiveRecord(socket,echoRecord,recordlen) then put skip list('receive failed.');

 if recordSent=echoRecord then put skip list('Echoed record identical.');
                          else put skip list('Echoed record *not* identical.');
end;

/*********************************************************************/
/*                                                                   */
/* SHUTDOWN call terminates the connection with the server           */
/*                                                                   */
/*********************************************************************/

function = 'CLOSE' ;
call ezasoket(function, socket, errno, retcode);
if sock_check(function,errno,retcode) then stop ;

/*********************************************************************/
/*                                                                   */
/* TERMAPI call terminates the connection between this address space */
/* and the TCP/IP address space chosen by INITAPI                    */
/*                                                                   */
/*********************************************************************/

function = 'TERMAPI' ;
call ezasoket(function);

call pliretc(0);

end pclient;
```

G.0 Appendix G. Socket Utilities for Sockets Extended Programs

This appendix contains a number of handy utility programs that were developed during the creation of this book. We document them here because they may come in handy when you begin to develop your own Sockets Extended programs.

G.1 TPICLNID Obtain Values for TCP/IP Client ID

```
*********************************************************************
*                                                                   *
* Name:       TPICLNID                                              *
*                                                                   *
* Function:   Return address space name and TCB address as two      *
*             8-character fields.                                   *
*                                                                   *
```

```
* Interface:  R1 -> parameter list                                    *
*                   +0  Pointer to address space name field (Out)     *
*                   +4  Pointer to TCB address name field   (Out)     *
*                                                                     *
* Logic:      Find address space name via ASCB and TCB address via    *
*             CVT.  Format TCB address into 8 bytes character field,  *
*             and return address space name and TCB address.          *
*                                                                     *
* Returncode: - none -                                                *
*                                                                     *
* Written:    March 27'th 1994 at ITSO Raleigh                        *
*                                                                     *
* Modified:                                                           *
*                                                                     *
***********************************************************************
         PRINT NOGEN
         IHAASCB                  *ASCB layout
TPIWORK  DSECT
         DC    18F'0'             *Save Area
DORD     DC    D'0'               *Decimal work word
*
ASNAMED  DSECT
ASNAME   DC    CL8' '             *Address space name
TCBNAMED DSECT
TCBNAME  DC    CL8' '             *TCB address
*
TPICLNID INIT  'Find Address space name and TCB address',RENT=YES,     C
               WORKLEN=256,MODE=31
*
         USING TPIWORK,R13
         L     R9,0(R1)           *-> Address space name return field
         USING ASNAMED,R9
         L     R10,4(R1)          *-> TCB address name return field
         USING TCBNAMED,R10
         L     R3,X'10'           *-> CVT
         L     R3,0(R3)           *-> TCB Words
         L     R15,12(R3)         *-> Current ASCB (My ASCB)
         USING ASCB,R15
         L     R3,4(R3)           *-> Current TCB (My TCB)
         SR    R2,R2              *Make ready for double shift
         SLDL  R2,4               *0000000x xxxxxxx0
         STM   R2,R3,DORD         *Store for Unpack
         UNPK  TCBNAME,DORD       *Unpack
         NC    TCBNAME,=8X'0F'    *Remove F's
         TR    TCBNAME,TRHEX      *Translate to EBCDIC
         ICM   R14,15,ASCBJBNI    *-> Jobname if initiated
         BNZ   INITJBN            *If not zero, pointer is OK
         ICM   R14,15,ASCBJBNS    *-> Jobname if start/logon
         BNZ   INITJBN            *If not zero, pointer is OK
         MVC   ASNAME,=CL8' '     *We did not find a jobname
         B     INITJOBS           *Job name is initialized
INITJBN  EQU   *
         MVC   ASNAME,0(R14)      *Move in job name
INITJOBS EQU   *
         TERM  RC=0               *And out we go
         LTORG
TRHEX    DC    C'0123456789ABCDEF' *Hex to char translation
         END
```

G.2 TPIINTOA Convert IP Address to Character String

```
*********************************************************************
*                                                                   *
* Name:       TPIINTOA                                              *
*                                                                   *
* Function:   Convert an IP address from a fullword network byte    *
*             order to 15 characters dotted decimal notation.       *
*                                                                   *
* Interface:  R1 -> parameter list with two pointers:               *
*             +0  -> fullword with IP address in network byte format*
*             +4  -> 15 character return area, where IP address will*
*                    be returned in dotted decimal format.          *
*                                                                   *
* Logic:      This module is called from whenever another module needs*
*             to convert an IP address to dotted decimal format.    *
*             Output is returned in the format a human would type   *
*             it in.  No leading zeroes if a part of the address is *
*             less than 3 characters in length (a value above 99).  *
*                                                                   *
*             Example:                                              *
*               Input:  X'09180221'                                 *
*               Output: CL15'9.24.2.33'                             *
*                                                                   *
* Abends:     - none -                                              *
*                                                                   *
* Returncode: - none -                                              *
*                                                                   *
* Written:    May 28'th 1994 at ITSO Raleigh                        *
*                                                                   *
* Modified:                                                         *
*                                                                   *
*********************************************************************
*
WORKAREA DSECT
         DC    18F'0'              *Save area
DORD     DC    D'0'
WORK     DC    CL4' '
INITSTR  DC    CL15' '             *Init string
DOTSTR   DC    CL15'   .   .   .   '
WORKSTR  DC    CL15' '
*
TPIINTOA INIT  'Build dotted string from fullword IP address',         C
               RENT=YES,WORKLEN=512
*
         USING WORKAREA,R13
*
*-------------------------------------------------------------------*
*                                                                   *
* Start by converting the fullword to a fixed character format:     *
* xxx.xxx.xxx.xxx - where each part includes leading zeroes         *
*                                                                   *
*-------------------------------------------------------------------*
*
         L     R9,0(R1)            *-> Fullword with IP address
         L     R10,4(R1)           *-> 15 character string
*
         MVC   INITSTR,=CL15' '    *Initial string of spaces
         MVC   DOTSTR,=CL15'   .   .   .   '  *Initial dotted string
         MVC   0(L'INITSTR,R10),INITSTR *Initialize to space
         MVC   WORKSTR,DOTSTR      *Initialize workstring
*
         LA    R2,WORKSTR          *-> First part goes here
         LR    R3,R9               *-> First byte of fullword
```

```
         LA    R4,1
         LR    R5,R3
         LA    R5,3(R5)            *-> Last byte of fullword
BLDSTR   EQU   *
         SR    R1,R1               *Clear workreg
         IC    R1,0(R3)            *This byte to work with
         CVD   R1,DORD             *To decimal
         OI    DORD+7,X'0F'        *Nice zone
         MVC   WORK,=XL4'40202120' *Edit mask
         ED    WORK,DORD+6         *The three last digits
         MVC   0(3,R2),WORK+1      *In place it goes.
         LA    R2,4(R2)            *Next part goes here
         BXLE  R3,R4,BLDSTR        *Take all four bytes
*
*-------------------------------------------------------------------*
*                                                                   *
* Reduce the intermidiate result, so leading zeroes are             *
* removed:                                                          *
* 00x.0xx.xxx.0xx => x.xx.xxx.xx                                    *
*                                                                   *
*-------------------------------------------------------------------*
*
         LA    R2,WORKSTR          *-> Start of workstring
         LA    R3,L'WORKSTR        *Full length of workstring
         LR    R6,R2               *We need to calculate a pointer
         AR    R6,R3               *- to the last character
         BCTR  R6,0                *- in the workstring.
SPCLOOK  EQU   *
         CLI   0(R2),C' '          *Is this a space?
         BNE   SPCADV              *- No, just advance
         BCTR  R3,0                *New length
         LTR   R3,R3               *Any length left?
         BZ    SPCEND              *- No, we are finished
         LR    R4,R3               *Current length
         BCTR  R4,0                *And now ready for execute
         EX    R4,MVCSTR           *Move up string
         MVI   0(R6),C' '          *Move in a space as last char
         BCTR  R6,0                *Ready for next move up
         B     SPCLOOK             *- Yes, look for more moves
SPCADV   EQU   *
         LA    R2,1(R2)            *Advance string pointer
         BCTR  R3,0                *Reduce length
         CH    R3,=AL2(0)          *Any length left?
         BH    SPCLOOK             *- Yes, look for more moves
SPCEND   EQU   *
         MVC   0(L'WORKSTR,R10),WORKSTR *Move back to caller
         TERM  RC=0
MVCSTR   MVC   0(*-*,R2),1(R2)     *Move up string
         END
```

G.3 TPIIADDR Convert IP Address Character String to Full-word

```
*********************************************************************
*                                                                   *
* Name:       TPIIADDR                                              *
*                                                                   *
* Function:   Convert an IP address from a 15 character dotted      *
*             decimal format to a fullword network byte format.     *
*                                                                   *
* Interface:  R1 -> parameter list with two pointers:               *
*             +0  -> 15 character area with IP address in dotted    *
```

```
*                    decimal format.                                  *
*             +4  -> fullword return area for IP address in network   *
*                    byte format.                                     *
*                                                                     *
* Logic:      This module is called from other TPI modules            *
*             to convert an IP address from dotted decimal format to  *
*             a fullword network byte format.                         *
*                                                                     *
*             Example:                                                *
*               Input:  CL15'9.24.2.33'                               *
*               Output: X'09180221'                                   *
*                                                                     *
* Abends:     - none -                                                *
*                                                                     *
* Returncode: RC = 00: Conversion OK                                  *
*             RC = 08: A part is longer than 3 characters             *
*                      (9.1234.2.3)                                   *
*             RC = 12: A part has a zero length (9..2.3)              *
*             RC = 16: Non numeric data (9.A.B.2)                     *
*             RC = 20: A part has a value greater than 255            *
*                      (9.340.2.1)                                    *
*             RC = 24: The IP address has more than four parts        *
*                      (9.2.3.2.4)                                    *
*             RC = 28: The IP address has less than four parts        *
*                      (9.2.3)                                        *
*                                                                     *
*             When the return code is 0, a valid IP address is        *
*             returned. When the return code > 0, a return field      *
*             of binary zero is returned.                             *
*                                                                     *
* Written:    May 28'th 1994 at ITSO Raleigh                          *
*                                                                     *
* Modified:                                                           *
*                                                                     *
***********************************************************************
WORKAREA DSECT
         DC    18F'0'              *Save area
DORD     DC    D'0'                *Work
STARTOUT DC    A(0)                *Work
WORK     DC    CL4' '              *Work
NUMTEST  DC    CL4' '              *Work
*
TPIIADDR INIT  'Convert IP address from text to fullword',            C
               RENT=YES,WORKLEN=64
*
         USING WORKAREA,R13
         L     R9,0(R1)            *-> 15 bytes text string IP addr
         L     R10,4(R1)           *-> Fullword return field
         ST    R10,STARTOUT        *Save start of return field
         LR    R2,R9               *Passed string starts here
         LR    R8,R9
         LA    R8,15(R8)           *First byte after string
         LR    R3,R2               *Our advance pointer
NEXTCHAR EQU   *
         CLI   0(R3),C'.'          *A separator ?
         BE    SEPFND              *- Yes, we found one
         CLI   0(R3),C' '          *A separator (The last one) ?
         BE    SEPFND              *- Yes, process element
CONTLOOP EQU   *
         LA    R3,1(R3)            *Advance one byte
         CR    R3,R8               *Still inside string ?
         BL    NEXTCHAR            *- Yes, look on
```

```
SEPFND   EQU   *                  *- No, treat as separator found
         LR    R4,R3               *Do not destroy advance pointer
         SR    R4,R2               *Where we started = length
         CH    R4,=AL2(3)          *Max 3 is allowed
         BH    SETRC8              *If more - RC=8
         LTR   R4,R4               *But must also be > 0
         BNP   SETRC12             *If not - RC=12
         MVC   WORK,=4C'0'         *Initialize work field
         LA    R7,WORK             *-> Start of work field
         LA    R15,4               *Length of work field
         SR    R15,R4              *Offset into work field
         AR    R7,R15              *-> Here to move into workfield
         BCTR  R4,0                *Length of bytes for Execute
         EX    R4,MVCBYTES         *Move bytes to work field
         XC    NUMTEST,NUMTEST     *Make ready for MVZ
         MVZ   NUMTEST,WORK        *Let us see zones
         CLC   NUMTEST,=4X'F0'     *Are we numeric ?
         BNE   SETRC16             *- No - RC=16
         PACK  DORD,WORK           *Pack to decimal
         CVB   R1,DORD             *Into binary form.
         CH    R1,=AL2(255)        *Max value
         BH    SETRC20             *If higher - RC=20
         STCM  R1,B'0001',0(R10)   *Return byte
         LA    R10,1(R10)          *-> Next return byte
         CLI   0(R3),C' '          *Any more data?
         BE    SETRC0              *- No, we are done
         LA    R3,1(R3)            *-> Start of next string part
         LR    R2,R3               *New start base
         CR    R3,R8               *Are we still inside ?
         BNL   SETRC0              *- No, consider end of string
         L     R14,STARTOUT        *-> First return byte
         LA    R14,4(R14)          *-> first byte after return field
         CR    R10,R14             *We will only return 4 bytes
         BL    NEXTCHAR            *- OK, we are not there yet
         B     SETRC24             *- We will not return 5 !!
*
SETRC0   EQU   *
         L     R14,STARTOUT        *-> First return byte
         LA    R14,4(R14)          *-> first byte after return field
         CR    R10,R14             *Did we return exact 4 bytes?
         BNE   SETRC28             *- No, set RC=28
         SR    R15,R15
         B     RETURNDT            *Go and return valid data
SETRC8   EQU   *
         LA    R15,8               *One part > 3 characters
         B     GETOUT
SETRC12  EQU   *                  *Zero length part
         LA    R15,12
         B     GETOUT
SETRC16  EQU   *                  *Part is not numeric
         LA    R15,16
         B     GETOUT
SETRC20  EQU   *                  *Part value > 255
         LA    R15,20
         B     GETOUT
SETRC24  EQU   *                  *More than 4 parts
         LA    R15,24
         B     GETOUT
SETRC28  EQU   *                  *Less than 4 parts
         LA    R15,28
GETOUT   EQU   *
         L     R1,STARTOUT         *-> Return field
```

```
         XC    0(4,R1),0(R1)       *Return zero value when rc<>0
RETURNDT EQU   *
         TERM RC=R15
         LTORG
MVCBYTES MVC   0(*-*,R7),0(R2)     *Move bytes to workfield
         END
```

G.4 TPIIOCTL Convert IOCTL Command Name to Command

```
*********************************************************************
*                                                                   *
* Name:       TPIIOCTL                                              *
*                                                                   *
* Function:   Build COMMAND parameter for IOCTL call                *
*             COBOL has some problems with the command bitstrings.  *
*                                                                   *
* Interface:  R1 -> parameter list with two pointers:               *
*             +0  -> 16 char command string name      (In)          *
*             +0  -> ioctl command fullword value     (Out)         *
*                                                                   *
* Logic:      Build ioctl command based on command string           *
*                                                                   *
* Abends:     - none -                                              *
*                                                                   *
* Returncode: - none -                                              *
*                                                                   *
* Written:    April 8'th 1995 at ITSO Raleigh                       *
*                                                                   *
* Modified:                                                         *
*                                                                   *
*********************************************************************
*
WORKAREA DSECT
         DC    18F'0'              *Save area
*
TPIIOCTL INIT  'Build IOCTL command code',                          C
               RENT=YES
*
         USING WORKAREA,R13
*
         L     R2,0(R1)            *-> 16 char command string
         L     R3,4(R1)            *-> 4 byte return area
         LM    R5,R7,CMDBXLE
LOOP     EQU   *
         CLC   0(16,R2),0(R5)      *This command ?
         BE    FOUNDIT             *- Yes
         BXLE  R5,R6,LOOP          *Look them all
         LA    R15,8               *Set RC=8
         B     GETBACK             *And return to caller
FOUNDIT  EQU   *
         MVC   0(4,R3),16(R5)      *Move back command value
         SR    R15,R15             *Set RC=0
GETBACK  EQU   *
         TERM  RC=R15              *Use value in R15 as RC
         LTORG
CMDBXLE  DC    A(FIRST,20,LAST)
FIRST    DC    CL16'FIONBIO        ',X'8004A77E'
         DC    CL16'FIONREAD       ',X'4004A77F'
         DC    CL16'SIOCADDRT      ',X'8030A70A'
         DC    CL16'SIOCATMARK     ',X'4004A707'
         DC    CL16'SIOCDELRT      ',X'8030A70B'
```

```
         DC    CL16'SIOCGIFADDR    ',X'C020A70D'
         DC    CL16'SIOCGIFBRDADDR ',X'C008A714'
LAST     DC    CL16'SIOCGIFDSTADDR ',X'C020A70F'
         END
```

G.5 TPIWAIT Place Calling Process in Wait

```
*********************************************************************
*                                                                   *
* Name:       TPIWAIT                                               *
*                                                                   *
* Function:   Wait a specified amount of time.                      *
*                                                                   *
* Interface:  R1 -> parameter list with one pointer:                *
*             +0  -> fullword with waittime in milliseconds         *
*                                                                   *
* Logic:      Wait the requested amount of time and return.         *
*                                                                   *
* Abends:     - none -                                              *
*                                                                   *
* Returncode: - none -                                              *
*                                                                   *
* Written:    April 8'th 1995 at ITSO Raleigh                       *
*                                                                   *
* Modified:                                                         *
*                                                                   *
*********************************************************************
*
WORKAREA DSECT
         DC    18F'0'              *Save area
WAITTIME DC    A(0)                *Wait interval
*
TPIWAIT  INIT  'Wait a specified amount of time',                    C
               RENT=YES,WORKLEN=256
*
         USING WORKAREA,R13
*
         L     R9,0(R1)            *-> Fullword with waittime in msec
         L     R7,0(R9)            *Milliseconds
         SR    R6,R6               *Prepare for division
         D     R6,=A(10)           *To get in 1/100 seconds
         ST    R7,WAITTIME         *Store for STIMER
         LA    R2,WAITTIME         *-> fullword with 1/100 seconds
         STIMER WAIT,              *Wait                             C
               BINTVL=(R2)
*
         TERM  RC=0
         LTORG
         END
```

G.6 TPIRACF Interface to RACROUTE REQUEST=VERIFY User SVC

```
*********************************************************************
*                                                                   *
* Name:       TPIRACF                                               *
*                                                                   *
* Function:   Interface routine to user SVC 236 for verification of *
*             user and construction of task level security          *
*             environment.                                          *
```

```
*                                                                     *
* Interface:  R1 -> Parameter list with 6 pointers:                   *
*              +0 -> 4 byte request kode    (In)                      *
*                      0: Verify user and establish task level        *
*                         security environment                        *
*                      4: Verify user; do not establish task level    *
*                         security environment                        *
*                      8: Reset security environment for this task to *
*                         address space environment                   *
*              +4 -> 8 byte userid          (In)                      *
*              +8 -> 8 byte password        (In)                      *
*              +12-> 8 byte new password    (In)                      *
*              +16-> 8 byte RACF group      (In)                      *
*              +20-> 8 byte application     (In)                      *
*                                                                     *
*              New password, RACF group and application must be       *
*              be passed as space if they are not relevant for this   *
*              call.                                                  *
*                                                                     *
*              Password and new password must be passed in clear.     *
*                                                                     *
* Logic:      1. Validate parameters                                  *
*             2. Build TPIRACFA area                                  *
*             3. Issue SVC236 with R1 pointing to TPIRACFA            *
*             4. Convert return codes to something understandable     *
*             5. Return to caller                                     *
*                                                                     *
* Abend:      none                                                    *
*                                                                     *
* Returncode:  0  : Everything is OK                                  *
*              4  : Userid is not defined to RACF                     *
*              8  : Password is invalid                               *
*             12  : Password is expired - new password required       *
*             16  : New password not a valid password                 *
*             20  : Userid is not part of the passed group            *
*             24  : Userid is revoked                                 *
*             28  : Access to group is revoked                        *
*             32  : Userid is not authorized to application           *
*            252  : Caller not authorized to use SVC 236              *
*            253  : There is no task level env. to delete             *
*            254  : Error in passed parameters                        *
*            255  : Request in error - of other reasons.              *
*                                                                     *
* Written:    April 7'th, 1995 - ITSO Raleigh                         *
*                                                                     *
***********************************************************************
*
*
TPIWORK  DSECT
         DS    104X'00'               *Save Area
MACWORK  DC    XL128'00'              *Macro work area
PARMPTR  DC    A(0)                   *Parameter pointer at entry
TPIRACFA TPIRACFA                     *Interface area to SVC 236
WTOWORK  DS    0F                     *WTO Message build area
         DC    XL4'00',C'TPIRACF - '  *Placeholder
         DC    C'Function='           *Placeholder
RACREQ   DC    CL4' '                 *Request kode
         DC    C' User='              *Placeholder
RACUID   DC    CL8' '                 *Userid
         DC    C' Group='             *Placeholder
RACGRP   DC    CL8' '                 *Group
         DC    C' Appl='              *Placeholder
```

```
RACAPP   DC    CL8' '                  *Application
         DC    C' SAF RC='             *Placeholder
RACSAF   DC    CL4' '                  *SAF RC
         DC    C' RACF RC='            *Placeholder
RACRC    DC    CL4' '                  *RACF RC
         DC    C' RACF Reason='        *Placeholder
RACREAS  DC    CL4' '                  *RACF Reason
         DC    C' TPIRACF RC='         *Placeholder
RACMYRC  DC    CL4' '                  *Return code from TPIRACF
         DC    XL4'00'                 *Placeholder
DORD     DC    D'0'                    *For work
WORKRC   DC    A(0)                    *For work
*
TPIRACF  INIT  'TPI - RACF interface',RENT=YES,WORKLEN=512,           C
               MODE=31
*
         USING TPIWORK,R13
         ST    R1,PARMPTR
         LR    R11,R1                  *Save parms pointer
*
         MVC   TPIRACFA(TPIRACFL),=XL(TPIRACFL)'00'
         MVC   TPIREYEC,=CL8'TPIRACFA' *Eyecatacher
         MVC   WTOWORK(WTOLISTL),WTOLIST *Init WTO area
*
* ------------------------------------------------------------------
*
*  Check all parameters and build TPIRACFA area
*
* ------------------------------------------------------------------
*
         L     R2,0(R1)                *-> request code
         L     R2,0(R2)                *Request code
         MVC   RACREQ,=CL4'CRE'        *Create
         CH    R2,=AL2(0)              *Code = 0 is OK
         BE    REQOK
         MVC   RACREQ,=CL4'TEST'       *Just test
         CH    R2,=AL2(4)              *Code = 4 is OK
         BE    REQCRE
         MVC   RACREQ,=CL4'N/A'        *Unknown code
         CH    R2,=AL2(8)              *Code = 8 is OK
         BNE   BADPARMS
         MVC   RACREQ,=CL4'DELE'       *Delete task level env.
         B     REQOK
REQCRE   EQU   *
         SR    R2,R2                   *TEST starts with a create
REQOK    EQU   *
         ST    R2,TPIRREQ              *Request code for interface
         CH    R2,=AL2(8)              *ENVIR=DELETE?
         BE    PARMSOK                 *No further parms needed
         L     R2,4(R1)                *-> 8 bytes userid
         MVC   TPIRUID,0(R2)           *Userid
         MVC   RACUID,0(R2)            *Trace line
         LA    R2,TPIRUIDL
         BAL   R14,CALLEN              *Get l'userid
         L     R2,8(R1)                *-> 8 bytes password
         MVC   TPIRPWD,0(R2)           *Password
         LA    R2,TPIRPWDL
         BAL   R14,CALLEN              *Get l'password
         L     R2,12(R1)               *-> 8 bytes new password
         MVC   TPIRNPW,0(R2)           *New password
         LA    R2,TPIRNPWL
         BAL   R14,CALLEN              *Get l'new password
```

```
         L     R2,16(R1)               *-> 8 bytes group
         MVC   TPIRGRP,0(R2)           *Group
         MVC   RACGRP,0(R2)            *Trace line
         LA    R2,TPIRGRPL
         BAL   R14,CALLEN              *Get l'group
         L     R2,20(R1)               *-> 8 bytes application name
         MVC   TPIRAPP,0(R2)           *Application name
         MVC   RACAPP,0(R2)            *Trace line
         LA    R2,TPIRAPPL
         BAL   R14,CALLEN              *Get l'application
*
         CLC   TPIRREQ,=A(4)           *0 and 4 require certain parms
         BH    PARMSOK                 *8 requires no special parms
         CLI   TPIRUIDL,0              *We must have a user ID
         BE    BADPARMS
         CLI   TPIRPWDL,0              *And a password
         BE    BADPARMS
PARMSOK  EQU   *
*
* ---------------------------------------------------------------------
*
*  Issue SVC call with R1 pointing to TPIRACFA
*  Create trace line after return from user SVC 236
*
* ---------------------------------------------------------------------
*
         LA    R1,TPIRACFA             *-> TPIRACFA interface area
         SVC   236                     *User SVC 236
*
RCTEST   EQU   *
         CH    R15,=AL2(250)           *Is it our own RC?
         BH    SETRCOWN                *- Yes, pass it back
         LR    R2,R15                  *Save it for later use
         TPIHEX TPIRSAF+2,RACSAF       *SAF returncode
         TPIHEX TPIRRC+2,RACRC         *RACF returncode
         TPIHEX TPIRREAS+2,RACREAS     *RACF reasoncode
         LR    R15,R2                  *SVC236 R15
*
* ---------------------------------------------------------------------
*
*  Analyze returncodes from SAF and RACF; and set returncode from this
*  routine
*
* ---------------------------------------------------------------------
*
         CLC   TPIRSAF,=A(0)           *RC=0 from SAF is OK
         BE    SETRC0                  *OK
         CLC   TPIRSAF,=A(4)           *SAF RC=4 ?
         BNE   TSAF08                  *- no, test for SAF RC=8
         CLC   TPIRRC,=A(4)            *RACF RC=4 ?
         BE    SETRC4                  *User is unknown
         B     SETRC255                *Garbage can
TSAF08   EQU   *
         CLC   TPIRSAF,=A(8)           *SAF RC=8 ?
         BNE   SETRC255                *- No, Garbage can
         CLC   TPIRRC,=A(8)            *RACF RC=8
         BE    SETRC8                  *- Yes, Password invalid
         CLC   TPIRRC,=A(12)           *RACF RC=12 X'0C'
         BE    SETRC12                 *- Yes, Password expired
         CLC   TPIRRC,=A(16)           *RACF RC=16 X'10'
         BE    SETRC16                 *- Yes, New password invalid
         CLC   TPIRRC,=A(20)           *RACF RC=20 X'14'
```

```
         BE    SETRC20                 *- Yes, User not in group
         CLC   TPIRRC,=A(28)           *RACF RC=28 X'1C'
         BE    SETRC24                 *- Yes, User is revoked
         CLC   TPIRRC,=A(36)           *RACF RC=36 X'24'
         BE    SETRC28                 *- Yes, access to group rev.
         CLC   TPIRRC,=A(52)           *RACF RC=52 X'34'
         BE    SETRC32                 *- Yes, Access to appl. not all.
         B     SETRC255                *Rest for garbage can
*
* ---------------------------------------------------------------------
*
*  Subroutine for calculation of length byte in interface
*  to RACROUTE
*
* ---------------------------------------------------------------------
*
CALLEN   EQU   *
         LA    R3,1(R2)                *-Start field
         LA    R4,8                    *Max length
CALLOOP  EQU   *
         CLI   0(R3),0                 *X'00' terminates
         BE    CALEND
         CLI   0(R3),X'40'             *X'40' terminates also
         BE    CALEND
         LA    R3,1(R3)                *Advance pointer
         BCT   R4,CALLOOP
CALEND   EQU   *
         LA    R3,8                    *max length
         SR    R3,R4                   *no. loops=length
         STC   R3,0(R2)                *Length field in here
         BR    R14                     *back to mainline
*
* ---------------------------------------------------------------------
*
*  Returncode settings
*
* ---------------------------------------------------------------------
*
SETRC0   EQU   *
         LA    R6,0                    *OK
         CLC   RACREQ,=CL4'TEST'       *If call was for test
         BNE   RETUR
         CLC   TPIRREQ,=AL4(TPIRALL)   *and we did a CREATE
         BNE   RETUR
         MVC   TPIRREQ,=AL4(TPIRDEL)   *Then we must delete it again
         MVI   TPIRUIDL,0              *No user ID
         MVI   TPIRPWDL,0              *No password
         MVI   TPIRNPWL,0              *No new password
         MVI   TPIRGRPL,0              *No group id
         MVI   TPIRAPPL,0              *No appl id
         LA    R1,TPIRACFA             *-> TPIRACFA interface area
         SVC   236                     *User SVC 236
         LTR   R15,R15                 *Should only be OK?
         BZ    RETUR                   *- Yes, it is
         B     RCTEST                  *Redrive return code testing
SETRC4   EQU   *
         LA    R6,4                    *User unknown
         B     RETUR
SETRC8   EQU   *
         LA    R6,8                    *password invalid
         B     RETUR
SETRC12  EQU   *
```

```
         LA    R6,12                   *password expired
         B     RETUR
SETRC16  EQU   *
         LA    R6,16                   *new password invalid
         B     RETUR
SETRC20  EQU   *
         LA    R6,20                   *user not in group
         B     RETUR
SETRC24  EQU   *
         LA    R6,24                   *user revoked
         B     RETUR
SETRC28  EQU   *
         LA    R6,28                   *access to group revoked
         B     RETUR
SETRC32  EQU   *
         LA    R6,32                   *not auth. to appl.
         B     RETUR
SETRCOWN EQU   *
         LR    R6,R15                  *Pass unchanged back to caller
         B     RETUR
SETRC255 EQU   *
         LA    R6,255                  *garbage can returkode
         B     RETUR
BADPARMS EQU   *
         LA    R6,254                  *Error in passed params
         B     RETUR
RETUR    EQU   *
         ST    R6,WORKRC               *Just for formatting
         TPIHEX WORKRC+2,RACMYRC       *RC from TPIRACF
         WTO   MF=(E,WTOWORK)          *Put out a WTO
         TERM  RC=R6                   *Return with RC as set in R6
         LTORG
WTOLIST  WTO   'TPIRACF - Function=n/a  User=n/a      Group=n/a      ApC
               pl=n/a      SAF RC=n/a  RACF RC=n/a  RACF Reason=n/a  TPC
               IRACF RC=n/a ',MF=L
WTOLISTL EQU   *-WTOLIST
         END

         MACRO
&NAME TPIRACFA &TYPE=CSECT
         AIF   ('&TYPE' EQ 'DSECT').DSECT
&NAME DS   0F                        *TPIRACFA section
         AGO   .GENCODE
.DSECT ANOP
&NAME DSECT                          *TPIRACFA section
.GENCODE ANOP
TPIREYEC DC    CL8'TPIRACFA'             *Eye catcher
TPIRSAF  DC    AL4(0)                    *SAF RC
TPIRRC   DC    AL4(0)                    *RACF RC
TPIRREAS DC    AL4(0)                    *RACF Reason code
TPIRREQ  DC    F'0'                      *Request code
TPIRALL  EQU   0                         *Verify and build sec. env
TPIRDEL  EQU   8                         *Delete sec env.
TPIRUIDL DC    AL1(0)                    *L'userid
TPIRUID  DC    CL8' '                    *Userid
TPIRPWDL DC    AL1(0)                    *L'password
TPIRPWD  DC    CL8' '                    *password
TPIRNPWL DC    AL1(0)                    *L'new password
TPIRNPW  DC    CL8' '                    *new password
TPIRGRPL DC    AL1(0)                    *L'groupid
TPIRGRP  DC    CL8' '                    *groupid
TPIRAPPL DC    AL1(0)                    *L'application
```

```
TPIRAPP  DC    CL8' '                  *application
TPIRACFL EQU   *-&NAME
         MEND
```

G.7 User SVC for RACROUTE REQUEST=VERIFY

```
*********************************************************************
*                                                                   *
* Name:       IGC00236 - SVC 236 - IGC0023F                         *
*                                                                   *
* Function:   User SVC 236 type 4 - Do RACROUTE REQUEST=VERIFY      *
*             for verification of userid/pw and creation of a       *
*             task level security environment.                      *
*             Address space user ID of calling task must be         *
*             authorized to use this SVC by having read access to   *
*             FACILITY resource TPI.RACINIT                         *
*                                                                   *
* Interface:  R1 ->  Interface area, mapped with macro TPIRACFA.    *
*                    Area has been constructed by interface module  *
*                    TPIRACF, which issues the SVC 236.             *
*             R3 ->  CVT                                            *
*             R4 ->  TCB for calling task                           *
*             R5 ->  SVRB                                           *
*             R6 ->  Entry Point address                            *
*             R7 ->  ASCB                                           *
*             R14 -> Return address                                 *
*                                                                   *
*             Register contents has been saved before entry to      *
*             this SVC routine.                                     *
*             R2-R14 will be restored by MVS before control is      *
*             passed back to program that issued the SVC 236.       *
*                                                                   *
* Logic:      1. Verify that R1 points to a valid TPIRACFA control  *
*                block and that caller has access to it.            *
*             2. Copy TPIRACFA control to our getmained storage     *
*             3. Issue RACROUTE REQUEST=AUTH to see if calling      *
*                address space user ID has read access to           *
*                FACILITY resource TPI.RACINIT                      *
*             4. Initialize SAFP parameter list with the passed     *
*                values for userid, password etc.                   *
*                TPIRACF has verified that the needed parameters    *
*                for the request is included in TPIRACFA.           *
*             5. Issue RACROUTE REQUEST=VERIFY                      *
*             6. Set key to callers key and store RACROUTE return   *
*                codes back into callers TPIRACFA                   *
*             7. Return to caller                                   *
*                                                                   *
* Abends:     none (hopefully!)                                     *
*                                                                   *
* Returncode: 0-250: Return code from SAF                           *
*               252: Calling address space user is not authorized to*
*                    use this user SVC.                             *
*               253: No task level security environment to delete.  *
*               254: R1 does not point to a valid TPIRACFA control  *
*                    block on entry to SVC routine.                 *
*                                                                   *
* Written:    ITSO Raleigh April 10, 1995.                          *
*                                                                   *
*********************************************************************
*
         PRINT NOGEN
```

```
         ICHSAFP                       *SAF Parameter list
         CVT   DSECT=YES               *CVT
         IHAPSA                        *PSA
         IHARB                         *RB
         IKJTCB                        *TCB
         IHAASCB                       *ASCB
         IHAASXB                       *ASXB
*
TPIRACFA TPIRACFA TYPE=DSECT
*
TPIWORK  DSECT
MACWORK  DC    256X'00'               *Macro work area
GETMADR  DC    A(0)                   *Getmained storage address
GETMLEN  DC    A(0)                   *Getmained storage length
PARMPTR  DC    A(0)                   *-> passed user parmlist
PARMCOPY DC    (TPIRACFL)X'00'        *Copy of user parmlist
SAFWORK  DC    512X'00'               *SAF router workarea
WORKLEN  EQU   *-TPIWORK              *Length to getmain
*
IGC00236 TITLE 'ITSO User type 4 SVC number 236 - RACROUTE VERIFY'
IGC00236 CSECT
IGC00236 AMODE 31
IGC00236 RMODE ANY
*
* GENERAL PURPOSE REGISTER EQUATES
*
R0       EQU   0
R1       EQU   1
R2       EQU   2
R3       EQU   3
R4       EQU   4
R5       EQU   5
R6       EQU   6
R7       EQU   7
R8       EQU   8
R9       EQU   9
R10      EQU   10
R11      EQU   11
R12      EQU   12
R13      EQU   13
R14      EQU   14
R15      EQU   15
*
         LR    R12,R6                  *Entry point address
         USING IGC00236,R12            *Addressability
         LR    R8,R14                  *Save return address ptr.
         USING CVT,R3                  *Comm. Vector Table
         USING TCB,R4                  *Task Control Block
         USING RBBASIC,R5              *Request Block common part
         USING ASCB,R7                 *Address Space Control Block
         LR    R9,R1                   *-> TPIRACFA interface area
         LA    R0,WORKLEN              *L'Workarea
         GETMAIN R,LV=(0)              *Getmain workarea storage
         LR    R11,R1                  *Here it is
         USING TPIWORK,R11             *Workarea adressability
         ST    R11,GETMADR             *For later freemain
         ST    R0,GETMLEN              *-do-
*
* --------------------------------------------------------------------
*
* To be sure that caller does not pass a pointer to storage that he/she
* has no access to, we use modeset to set key to user key before we
```

```
* reference all bytes in the passed area.
* We then switch back to our own key and copy the parameter area into
* our own getmained storage, so the caller is not able to modify them
* on the fly.
*
* If interface area does not have a valid eyecatcher, we return
* to the caller with RC=254
*
* ---------------------------------------------------------------------
*
         PRINT GEN
         ST    R9,PARMPTR              *Save pointer to user parmlist
         MODESET EXTKEY=RBT234,        *Ensure proper fetch protect    C
               WORKREG=2
         MVC   0(TPIRACFL,R9),0(R9)    *Copy to itself for byte ref.
         MODESET EXTKEY=ZERO,          *Back to SVC key                C
               WORKREG=2
         PRINT NOGEN
         MVC   PARMCOPY(TPIRACFL),0(R9) *Copy interface area to us
         LA    R9,PARMCOPY             *-> Copy of interface area
         USING TPIRACFA,R9             *Hereafter we access our copy
         CLC   TPIREYEC,=CL8'TPIRACFA' *Valid Eyecatcher?
         BNE   RETUR254                *- No, return with RC=254
*
* ---------------------------------------------------------------------
*
* To control who is using this SVC, we ask RACF if address space
* user ID has READ access to FACILITY class resource TPI.RACINIT
*
* If AS user is not authorized or no AS ACEE exists, we return
* to caller with RC=252
*
* ---------------------------------------------------------------------
*
INTFOK   EQU   *
         L     R2,ASCBASXB             *-> ASCB Extension
         USING ASXB,R2                 *ASXB
         ICM   R2,15,ASXBSENV          *-> Address Space ACEE
         BZ    RETUR252                *No AS ACEE exists, RC=252
         MVC   MACWORK(AUTHPL),AUTHP   *RACROUTE AUTH Parm list
         LA    R10,MACWORK             *-> SAFP
         USING SAFP,R10                *Adressability RACROUTE parms
         RACROUTE REQUEST=AUTH,        *Authorization request          C
               ATTR=READ,              *We want READ access to         C
               ENTITYX=TPIRES,         *TPI.RACINIT                    C
               ACEE=(R2),              *Check against AS user          C
               LOGSTR=LOGSTR,          *For logging purposes           C
               WORKA=SAFWORK,          *512 bytes work area            C
               RELEASE=1.9,            *Required for ENTITYX keyword   C
               MF=(E,MACWORK)          *Use prebuilt parmlist
         LTR   R15,R15                 *We will only accept SAF RC=0
         BNZ   RETUR252                *Else return with RC=252
*
* ---------------------------------------------------------------------
*
* Build parameter list for RACROUTE REQUEST=VERIFY call based
* on the passed values in the interface area from the caller.
*
* ---------------------------------------------------------------------
*
         CLC   TPIRREQ,=A(TPIRDEL)     *Delete request?
         BNE   NOTDEL                  *- No
```

```
         ICM   R14,15,TCBSENV          *Do we have a TCB ACEE ?
         BZ    RETUR253               *- No, return with RC=253
NOTDEL   EQU   *
         MVC   MACWORK(VERPL),VERP    *VERIFY parameter list
         CLI   TPIRUIDL,0             *Do we have user ID?
         BE    NOUID                  *- No, no user ID passed
         RACROUTE REQUEST=VERIFY,     *                              C
               USERID=TPIRUIDL,       *Put in user ID                C
               MF=(M,MACWORK)         *
NOUID    EQU   *
         CLI   TPIRPWDL,0             *Do we have a password ?
         BE    NOPWD                  *- No, no password passed
         RACROUTE REQUEST=VERIFY,     *                              C
               PASSWRD=TPIRPWDL,      *Put in password               C
               MF=(M,MACWORK)         *
NOPWD    EQU   *
         CLI   TPIRNPWL,0             *Do we have new password?
         BE    NONPW                  *- No, no new password passed
         RACROUTE REQUEST=VERIFY,     *                              C
               NEWPASS=TPIRNPWL,      *Put in new password           C
               MF=(M,MACWORK)         *
NONPW    EQU   *
         CLI   TPIRGRPL,0             *Do we have a group ID
         BE    NOGRP                  *- No, no group id passed
         RACROUTE REQUEST=VERIFY,     *                              C
               GROUP=TPIRGRPL,        *Put in group id               C
               MF=(M,MACWORK)         *
NOGRP    EQU   *
         CLI   TPIRAPPL,0             *Do we have an appl name?
         BE    NOAPP                  *- No, no appl name passed
         RACROUTE REQUEST=VERIFY,     *                              C
               APPL=TPIRAPPL,         *Put in application name       C
               MF=(M,MACWORK)         *
NOAPP    EQU   *
         CLC   TPIRREQ,=A(TPIRALL)    *ENVIR=CREATE?
         BNE   NOTCREAT               *- No.
         RACROUTE REQUEST=VERIFY,     *                              C
               ENVIR=CREATE,          *Put in CREATE                 C
               MF=(M,MACWORK)         *
         B     DORAC
NOTCREAT EQU   *
         RACROUTE REQUEST=VERIFY,     *                              C
               ENVIR=DELETE,          *Put in DELETE                 C
               MF=(M,MACWORK)         *
*
* ---------------------------------------------------------------------
*
* Issue the RACROUTE REQUEST=VERIFY call.
* Use modeset to set key to callers key, before we store return
* code values back into the caller's interface area.
*
* ---------------------------------------------------------------------
*
DORAC    EQU   *
         RACROUTE REQUEST=VERIFY,     *Do VERIFY request             C
               LOGSTR=LOGSTR,         *Identify us as caller         C
               WORKA=SAFWORK,         *Work area                     C
               RELEASE=1.9,           *SAF release                   C
               MF=(E,MACWORK)         *
         LR    R7,R15                 *Save SAF RC
         L     R9,PARMPTR             *Restore pointer to user parms
         MODESET EXTKEY=RBT234,       *Ensure proper store protect   C
```

```
               WORKREG=2              *
          STCM  R7,B'1111',TPIRSAF     *SAF RC
          MVC   TPIRRC,SAFPRRET        *RACF RC
          MVC   TPIRREAS,SAFPRREA      *RACF Reason kode
          MODESET EXTKEY=ZERO,         *Reset to SVC key               C
               WORKREG=2               *
          B     FREESTOR               *Go to freemain
RETUR252  EQU   *                      *Not authorized to use SVC
          LA    R7,252                 *RC=252
          B     FREESTOR               *Go to freemain
RETUR253  EQU   *                      *No task level env. to delete
          LA    R7,253                 *RC=253
          B     FREESTOR               *Go to freemain
RETUR254  EQU   *                      *Invalid eyecatcher
          LA    R7,254                 *RC=254
FREESTOR  EQU   *
          L     R1,GETMADR             *This to freemain
          L     R0,GETMLEN             *Length to freemain
          FREEMAIN R,A=(R1),LV=(R0)    *Freemain storage
          LR    R15,R7                 *Return code to R15
          LR    R14,R8                 *Restore return address ptr.
          BR    R14                    *Get back.
          LTORG
VERP      RACROUTE REQUEST=VERIFY,MF=L
VERPL     EQU   *-VERP
AUTHP     RACROUTE REQUEST=AUTH,CLASS='FACILITY',MF=L
AUTHPL    EQU   *-AUTHP
LOGSTR    DC    AL1(L'LOGTXT)
LOGTXT    DC    C'TPI Routines - RACROUTE VERIFY'
          DS    0F
TPIRES    DC    AL2(20,0),CL20'TPI.RACINIT'
          END
```

G.8 TPIAUTH Issue RACROUTE REQUEST=AUTH for FACILITY Class

```
*********************************************************************
*                                                                   *
* Name:       TPIAUTH                                               *
*                                                                   *
* Function:   Issue a RACROUTE REQUEST=AUTH for a FACILITY class    *
*             resource                                              *
*                                                                   *
* Interface:  R1 -> parameter list                                  *
*                   +0  Pointer to 80 char resource name (In)       *
*                   +4  Pointer to 8 char access intent (In)        *
*                                                                   *
* Logic:      Issue a RACROUTE REQUEST=AUTH for the resource name   *
*             passed.  Authorization will be done via std. ACEE     *
*             search order: Use TCBSENV if it is non-zero.  If      *
*             TCBSENV is zero, use address space security environment.*
*                                                                   *
* Returncode: 0:  Access is allowed                                 *
*             4:  Access is not allowed                             *
*                                                                   *
* Written:    March 27'th 1994 at ITSO Raleigh                      *
*                                                                   *
* Modified:                                                         *
*                                                                   *
*********************************************************************
*
PARMS     DSECT
```

```
PNAME    DC    A(0)                *-> 80 char resource name
PACCESS  DC    A(0)                *-> 8 char access intent
*
TPIWORK  DSECT
         DC    18F'0'              *Save area
RACLWORK RACROUTE REQUEST=AUTH,    *RACROUTE Macro expansion          C
               ENTITY=(0),                                            C
               CLASS='FACILITY',                                      C
               ATTR=READ,                                             C
               WORKA=0,                                               C
               RELEASE=2.1,                                           C
               MF=L
WTOWORK  WTO   'TPIAUTH SAF RC=xxxx RACF RC=xxxx RACF Reason=xxxx',    C
               MF=L
WTOSAFRC EQU   WTOWORK+19,4        *SAF RC in WTO line
WTORACRC EQU   WTOWORK+32,4        *RACF RC in WTO line
WTORACRS EQU   WTOWORK+49,4        *RACF Reason in WTO line
DORD     DC    D'0'                *Unpack and edit work
RACFWORK DC    512X'00'            *SAF work area
ENTITYBF DC    AL2(80,0)           *ENTITYX buffer
ENTITYNM DC    CL80' '             *Resource name
*
TPIAUTH  INIT  'Issue RACROUTE REQUEST=AUTH for a FACILITY resource', C
               MODE=31,RENT=YES,WORKLEN=1024

         USING TPIWORK,R13         *Adressability work areas
         LR    R2,R1               *Save parm pointer
         USING PARMS,R2            *Adressability parameters
         L     R3,PACCESS          *-> 8 char access intent
         LM    R7,R9,BXLEINT       *Access intent table
INTLOOP  EQU   *
         CLC   0(8,R3),0(R7)       *This access intent ?
         BE    GOTINT              *- Yes.
         BXLE  R7,R8,INTLOOP       *Look through them all
         LA    R7,INTST            *Use READ as default
GOTINT   EQU   *
         SR    R3,R3
         IC    R3,8(R7)            *Access intent code
         L     R4,PNAME            *-> resource name
         MVC   ENTITYBF(4),=AL2(80,0) *Initialize buffer header
         MVC   ENTITYNM,0(R4)      *Move name to 80 byte buffer
*
         MVC   RACLWORK(RACLISTL),RACLIST
         RACROUTE REQUEST=AUTH,    *Authorize request                 C
               ENTITYX=ENTITYBF,   *Resource name                     C
               ATTR=(R3),          *Access intent                     C
               WORKA=RACFWORK,     *SAF Work area                     C
               RELEASE=2.1,        *                                  C
               MF=(E,RACLWORK)     *
*
         LR    R11,R15             *Save return code from SAF
         MVC   WTOWORK(WTOLEN),WTOLIST
         LR    R7,R11              *Prepare for double shift
         SR    R6,R6               *Make ready for double shift
         SLDL  R6,4                *0000000x xxxxxxx0
         STM   R6,R7,DORD          *Store for Unpack
         UNPK  WTOSAFRC,DORD       *Unpack
         NC    WTOSAFRC,=4X'0F'    *Remove F's
         TR    WTOSAFRC,TRHEX      *Translate to EBCDIC
         L     R7,RACLIST          *RACF RC
         SR    R6,R6               *Make ready for double shift
         SLDL  R6,4                *0000000x xxxxxxx0
```

```
         STM   R6,R7,DORD          *Store for Unpack
         UNPK  WTORACRC,DORD       *Unpack
         NC    WTORACRC,=4X'0F'    *Remove F's
         TR    WTORACRC,TRHEX      *Translate to EBCDIC
         L     R7,RACLIST+4        *RACF reason code
         SR    R6,R6               *Make ready for double shift
         SLDL  R6,4                *0000000x xxxxxxx0
         STM   R6,R7,DORD          *Store for Unpack
         UNPK  WTORACRS,DORD       *Unpack
         NC    WTORACRS,=4X'0F'    *Remove F's
         TR    WTORACRS,TRHEX      *Translate to EBCDIC
         WTO   MF=(E,WTOWORK)      *Write out result to syslog
         TERM  RC=R11              *And out we go with SAF RC
         LTORG
*
RACLIST  RACROUTE REQUEST=AUTH,                                      C
               ENTITY=(0),                                           C
               CLASS='FACILITY',                                     C
               ATTR=READ,                                            C
               WORKA=0,                                              C
               RELEASE=2.1,                                          C
               MF=L
RACLISTL EQU   *-RACLIST
*
WTOLIST  WTO   'TPIAUTH SAF RC=xxxx RACF RC=xxxx RACF Reason=xxxx',   C
               MF=L
WTOLEN   EQU   *-WTOLIST
*
TRHEX    DC    C'0123456789ABCDEF'
*
BXLEINT  DC    A(INTST,9,INTLAST)
INTST    DC    CL8'READ',XL1'02'
         DC    CL8'UPDATE',XL1'04'
         DC    CL8'CONTROL',XL1'08'
INTLAST  DC    CL8'ALTER',XL1'80'
         END
```

H.0 Appendix H. Sample MVS Concurrent Server

This appendix contains a description of a sample socket application that was developed during the creation of this book.

The application is called TCP/IP Programming Interfaces (TPI) and consists of the following components:

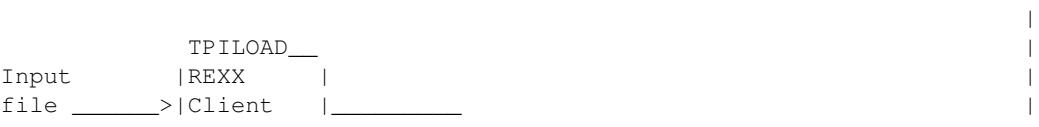
1. A concurrent server implemented in an MVS address space and based on the Sockets Extended assembler macro interface

2. A REXX client using REXX sockets

3. A CICS client written in COBOL using Sockets Extended call interface

4. An IMS client written in COBOL using Sockets Extended call interface

5. A REXX client using REXX socket used to load the database



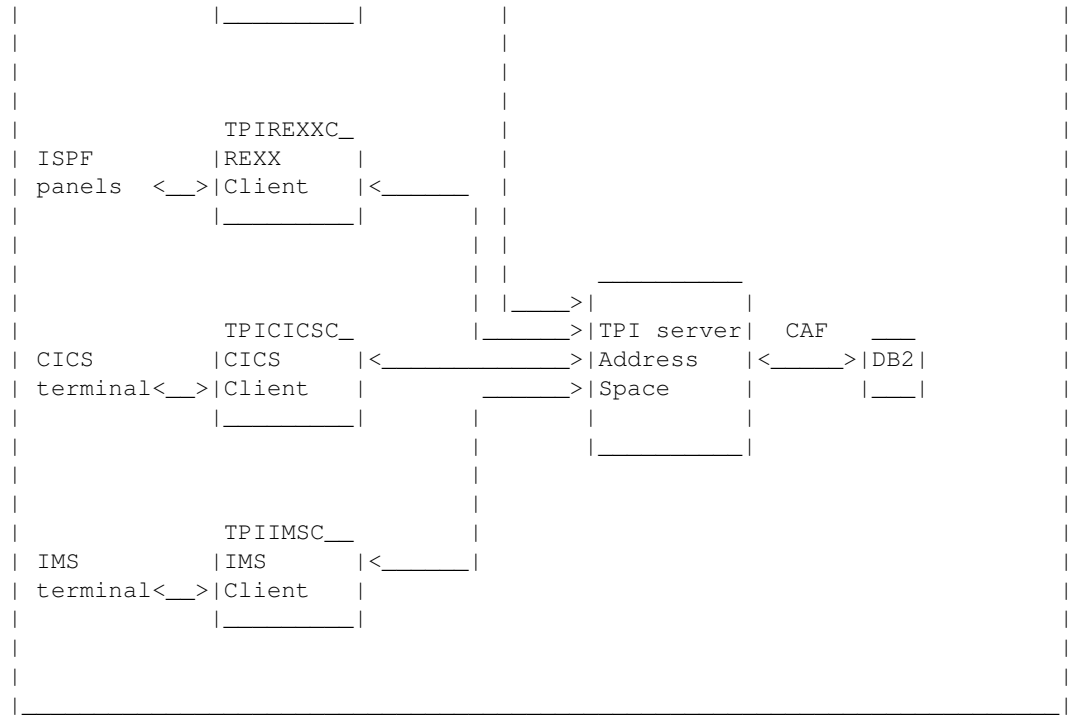


Figure 62. TPI Application Components

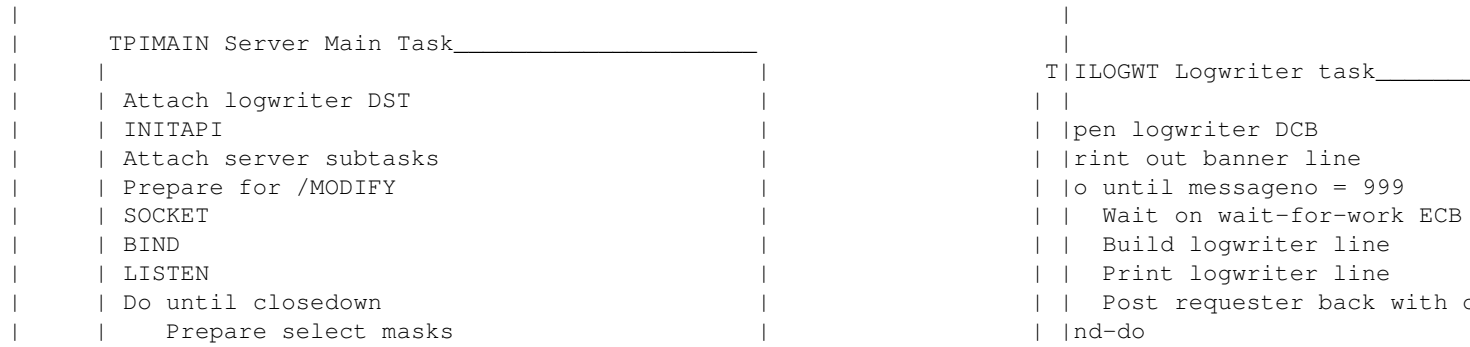
The purpose of the application was to illustrate as many of the new IBM TCP/IP Version 3 Release 1 for MVS programming interfaces as possible.

The server maintains a DB2 table called *tpidata* with administrative information related to TCP/IP hosts in the ITSO-Raleigh environment. The REXX client uses ISPF panels as user interface, and connects to the server address space for add, query, update or delete requests of DB2 data.

The IMS and CICS clients are query only clients.

H.1 TPI Concurrent MVS Server

The concurrent TPI server is implemented in an MVS address space (started task or batch job). It is based on the Sockets Extended assembler macro programming interface.



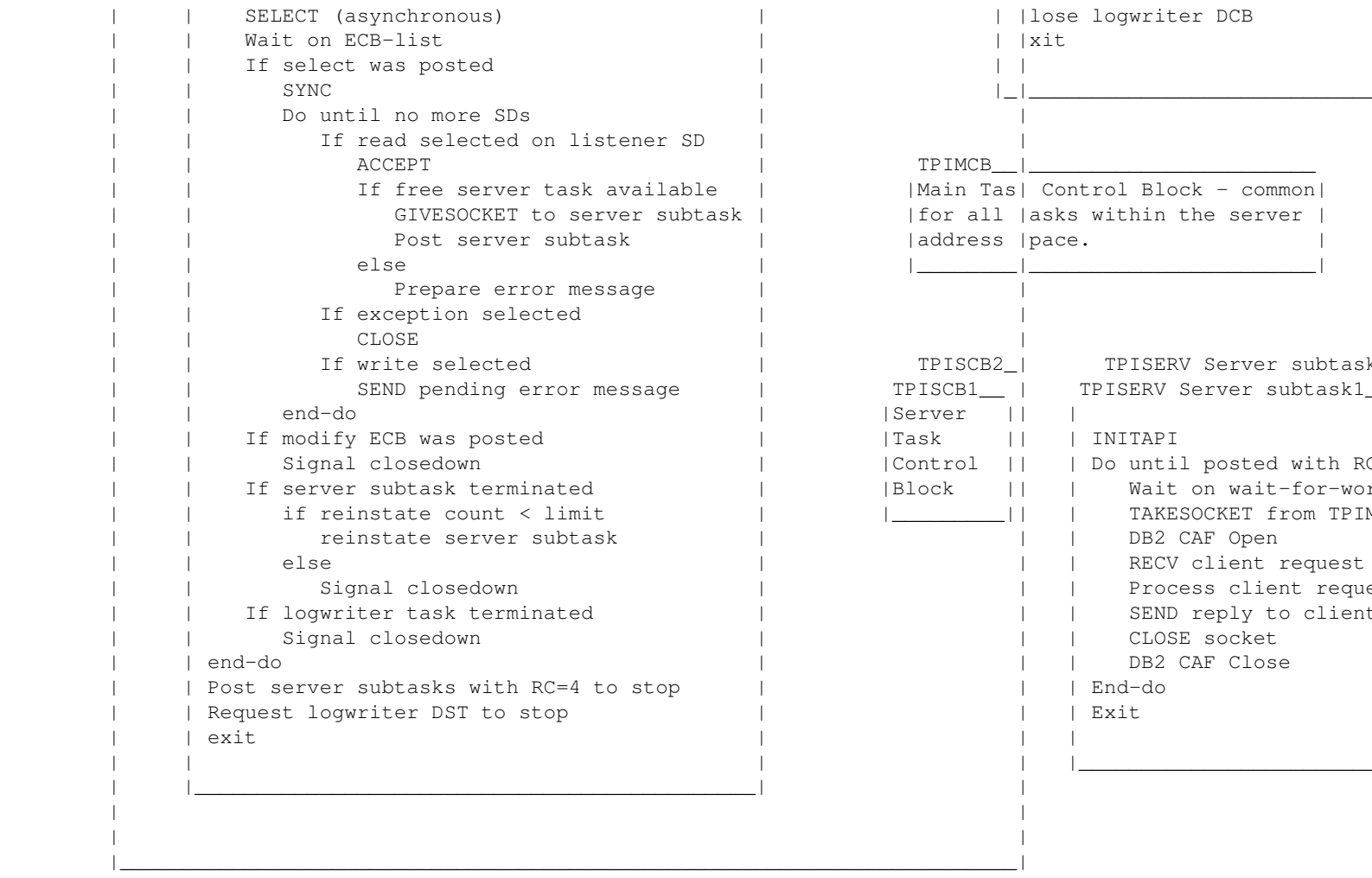


Figure 63. TPI Server Address Space Logic

H.1.1 TPIMAIN Concurrent Server Main Process

```
**********************************************************************
*                                                                    *
* Name:       TPIMAIN                                                *
*                                                                    *
* Function:   TCP/IP Programming Interfaces sample ITSO application  *
*             main module.                                           *
*                                                                    *
* Interface:  - none -                                               *
```

```
*                                                                     *
* Logic:      This module is the main task module in the TPI          *
*             Server application.                                     *
*             It is started either as a normal batch job or as a      *
*             started task.                                           *
*             The main logic is as follows:                           *
*             1.  Initialize Main task Control Block (TPIMCB)         *
*             2.  Establish EZA Global Work Area addressability       *
*             3.  Getmain storage for Server task Control Blocks      *
*                 (TPISCB)                                            *
*             4.  Attach Log Writer Task                              *
*             5.  Initialize socket environment via the INITAPI       *
*                 function and fetch our own TCP/IP Client id         *
*             6.  Getmain storage for Main task SOcket descriptor     *
*                 table (TPIMSO) and initialize entries.              *
*             7.  Attach server subtasks and initialize TIPSCBs       *
*             8.  Set up, so operator can issue a /P command to       *
*                 stop server address space                           *
*             9.  Get a socket to be used for listen                  *
*             10. Bind the socket to the TPI Server application       *
*                 port number                                         *
*             11. Issue a Listen on the socket                        *
*             12. Here starts Main task loop:                         *
*                 Build bit masks for select command and issue an     *
*                 asynchronous select (with an ECB keyword)           *
*             13. Wait on an ECBlist including:                       *
*                 - select ECB                                        *
*                 - operator modify ECB                               *
*                 - log writer subtask termination ECB                *
*                 - server subtask termination ECBs                   *
*             14. When wait comes through, analyze event:             *
*                 Select: a. Issue a socket SYNC call to synchronize  *
*                            with socket interface.                   *
*                            Analyze all returned bits in the select  *
*                            bitmasks.                                *
*                         b. If read selected: Issue an accept,       *
*                            a givesocket, and post a free server     *
*                            subtask.                                 *
*                         c. If exception selected: Issue a close     *
*                            socket (Server subtask has taken socket  *
*                            with a takesocket call).                 *
*                         d. If write selected: Write out any pending *
*                            error message and close socket.          *
*                 Modify: Request all subtasks to terminate and       *
*                         close down.                                 *
*                 Subtask termination: If it is log writer task,      *
*                         treat it as a shutdown request. If it is    *
*                         a server subtask, reinstate the subtask     *
*                         (keeping track of number of reinstates in   *
*                         order to avoid abend loops).                *
*             15. Continue with item no. 12 above.                    *
*                                                                     *
* Abends:     U1000: Could not find posted ECB after Wait on ECBLIST  *
*                                                                     *
* Returncode: - none -                                                *
*                                                                     *
* Written:    May 28'th 1994 at ITSO Raleigh                          *
*                                                                     *
* Modified:                                                           *
*                                                                     *
***********************************************************************
         PRINT NOGEN
```

```
COMMAREA DSECT                    *For EXTRACT macro
         IEZCOM
CIBAREA  DSECT                    *For QEDIT
         IEZCIB
         IHAASCB                  *ASCB layout
         PRINT GEN
TPISCB   TPISCB                   *Server task Control Block dsect
TPIMSO   TPIMSO                   *Main task socket descriptor table
TPIMAIN  INIT  'TPI Main Task',RENT=NO,MODE=24,BASE=(12,11,10)
*-------------------------------------------------------------------*
*                                                                   *
* Initialize default runtime parameters                             *
*                                                                   *
*-------------------------------------------------------------------*
         MVC   TPIMDB2,=CL4'DSNI'  *DB2 subsystem name
         MVC   TPIMTCPI,=CL8'T18ATCP' *TCPIP AS name
         MVC   TPIMPORT,=AL2(9999) *Port number
         MVC   TPIMNOST,=AL2(2)    *Start 2 server tasks
         MVC   TPIMMAXS,=AL2(50)   *Max 50 sockets
         MVC   TPIMMAXD,=AL4(50)   *Max 50 socket descriptors
         L     R3,X'10'            *-> CVT
         L     R3,0(R3)            *-> TCB Words
         L     R15,12(R3)          *-> Current ASCB (My ASCB)
         L     R3,4(R3)            *-> Current TCB (My TCB)
         SR    R2,R2               *Make ready for double shift
         SLDL  R2,4                *0000000x xxxxxxx0
         STM   R2,R3,DORD          *Store for Unpack
         UNPK  TPIMTCBE,DORD       *Unpack
         NC    TPIMTCBE,=8X'0F'    *Remove F's
         TR    TPIMTCBE,TRHEX      *Translate to EBCDIC
         USING ASCB,R15
         ICM   R14,15,ASCBJBNI     *-> Jobname if initiated
         BNZ   INITJBN             *If not zero, pointer is OK
         ICM   R14,15,ASCBJBNS     *-> Jobname if start/logon
         BNZ   INITJBN             *If not zero, pointer is OK
         MVC   IDENTJOB,=CL8' '    *We did not find a jobname
         B     INITJOBS            *Job name is initialized
INITJBN  EQU   *
         MVC   IDENTJOB,0(R14)     *Move in job name
         DROP  R15
INITJOBS EQU   *
         LA    R15,MAINGLOB        *-> EZA Global work area
         ST    R15,TPIMGLOB        *Subtasks will need it
         TPITRC TYPE=INIT,         *Enable trace points               C
               TRACE=YES,          *                                  C
               MOD=TPIMAIN         *Tracing module is TPIMAIN
*-------------------------------------------------------------------*
*                                                                   *
* Getmain storage for server task control blocks (TPISCB)           *
*                                                                   *
*-------------------------------------------------------------------*
         LH    R2,TPIMNOST         *Number of server tasks
         MH    R2,=AL2(TPISCBLN)   *Multiply by TPISCB length
         STORAGE OBTAIN,           *Getmain for pool of               C
               LENGTH=(R2),        *- Server task Control             C
               LOC=BELOW           *- Blocks
         ST    R1,TPIMSCBB         *-> First TPISCB
         MVC   TPIMSCBB+4(4),=A(TPISCBLN) *L'TPISCB Entry
         LH    R2,TPIMNOST         *Number of TPISCB entries
         BCTR  R2,0                *The last number
         MH    R2,=AL2(TPISCBLN)   *Times length per entry
         AR    R2,R1               *-> Last TPISCB entry
```

```
         ST    R2,TPIMSCBB+8       *Ready for BXLE
*------------------------------------------------------------------*
*                                                                  *
* Start up our Log writer task.                                    *
* It will wait for work on ECB: TPIMLECB                           *
*                                                                  *
*------------------------------------------------------------------*
         XC    TPIMLDON,TPIMLDON   *Clear for wait
         ATTACH EP=TPILOGWT,       *Module name: TPILOGWT             C
               PARAM=(TPIMCB),     *Pass Main task Control Block      C
               ECB=ECBTLOGW        *Termination ECB
         ST    R1,TPIMLTCB         *-> Log writer TCB
         WAIT  ECB=TPIMLDON        *LOGWT will post, when init done.
         XC    TPIMLDON,TPIMLDON   *Clean up
*------------------------------------------------------------------*
*                                                                  *
* Initialize socket API                                            *
*                                                                  *
* Get our client id and log it to the log file                     *
*                                                                  *
*------------------------------------------------------------------*
         MVC   IDENTTCP,TPIMTCPI   *TCP/IP Address space name
         MVC   TRCMLFUN,=CL8'INITAPI'
         EZASMI TYPE=INITAPI,      *Initialize socket interface       C
               MAXSOC=TPIMMAXS,    *So many concurrent sockets        C
               SUBTASK=TPIMTCBE,   *My TCB address in EBCDIC          C
               IDENT=IDENTSTR,     *TCP/IP AS name and my AS name     C
               MAXSNO=TPIMMAXD,    *Max. no of socket descriptors     C
               ERRNO=ERRNO,                                           C
               RETCODE=RETCODE,                                       C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *Initapi OK
         BM    EZAERROR            *- No.
         MVC   TRCMLFUN,=CL8'GETCLNID'
         EZASMI TYPE=GETCLIENTID,  *Get our own client id             C
               CLIENT=TPIMCLNI,    *Store it in Main task Control bl. C
               ERRNO=ERRNO,                                           C
               RETCODE=RETCODE,                                       C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *Was it OK
         BM    EZAERROR            *- No, stop now.
         L     R15,TPIMCDOM        *Addressing Family
         CVD   R15,DORD            *From binary to decimal
         OI    DORD+7,X'0F'        *A nice sign.
         UNPK  CLNLOGAF,DORD       *Into logging line
         MVC   CLNLOGAS,TPIMCNAM   *Address Space Name
         MVC   CLNLOGST,TPIMCTSK   *Subtask Name
         TPILOG TEXT=CLNLOGLN,     *Log client id                     C
               MSGNO=1,            *Text is prebuilt                  C
               MOD=TPIMAIN         *Main is logging the message
*------------------------------------------------------------------*
*                                                                  *
* Getmain storage for Main task socket descriptor table.           *
* Initialize socket descriptor table.                              *
*                                                                  *
*------------------------------------------------------------------*
         L     R2,TPIMMAXD         *Max. number of socket descriptors
         MH    R2,=AL2(TPIMSOLN)   *Multiply by TPIMSO length
         STORAGE OBTAIN,           *Getmain for pool of socket        C
               LENGTH=(R2),        *- descriptor control              C
               LOC=BELOW           *- blocks
         ST    R1,TPIMSOTB         *-> First TPIMSO
```

```
         MVC   TPIMSOTB+4(4),=A(TPIMSOLN) *L'TPIMSO Entry
         LH    R2,TPIMMAXS         *Number of TPIMSO entries
         BCTR  R2,0                *The last number
         MH    R2,=AL2(TPIMSOLN)   *Times length per entry
         AR    R2,R1               *-> Last TPIMSO entry
         ST    R2,TPIMSOTB+8       *Ready for BXLE
         LM    R1,R3,TPIMSOTB      *TPIMSO BXLE addresses
         SR    R4,R4               *Socket counter
         USING TPIMSO,R1
INITMSO  EQU   *
         XC    TPIMSO(TPIMSOLN),TPIMSO *Clear TPIMSO entry
         MVC   TPIMSEYE,=CL8'TPIMSO' *Move in eyecatcher
         STH   R4,TPIMSNO          *Socket number
         LA    R4,1(R4)            *Advance
         BXLE  R1,R2,INITMSO       *Do them all
         DROP  R1
*------------------------------------------------------------------*
*                                                                  *
* Start Server subtasks and initialize TPISCB entries              *
*                                                                  *
*------------------------------------------------------------------*
         LA    R6,ECBPSTS          *First Subtask Term. ECB pointer
         LM    R3,R5,TPIMSCBB      *Loop addresses for TPISCBs
         USING TPISCB,R3
INITSCB  EQU   *
         XC    TPISCB(TPISCBLN),TPISCB *Clear storage
         MVC   TPISEYE,=CL8'TPISCB' *Move in eyecatcher
         MVC   TPISMCB,=A(TPIMCB)  *-> TPIMCB
         LA    R8,TPISTECB         *-> Term. ECB
         ATTACH EP=TPISERV,        *Server subtask main module         C
               PARAM=((R3)),       *Pass TPISCB as only parameter      C
               ECB=(R8)            *Termination ECB
         ST    R1,TPISTCB          *-> TCB of subtask
         WAIT  ECB=TPISIECB        *Wait for subtask initialization
         LA    R1,TPISTECB         *-> Subtask termination ECB
         ST    R1,0(R6)            *Put it into ECB List
         LA    R6,4(R6)            *Next one goes here
         BXLE  R3,R4,INITSCB       *Start them all
         S     R6,=A(4)            *This was last ECB Pointer
         OI    0(R6),BIT0          *Close ECB List
         DROP  R3
*------------------------------------------------------------------*
*                                                                  *
* Set up, so we can receive Modify commands from MVS operator      *
*                                                                  *
* We will actually never analyze input, but terminate as soon as   *
* the Modify ECB is posted                                         *
*                                                                  *
*------------------------------------------------------------------*
         LA    R2,COMMADDR         *-> Communications Area pointer
         EXTRACT (R2),FIELDS=COMM
         L     R2,COMMADDR         *-> Communications Area
         USING COMMAREA,R2
         QEDIT ORIGIN=COMCIBPT,CIBCTR=1 *Only one Modify accepted
         L     R3,COMECBPT         *-> Modify ECB
         ST    R3,ECBPMODI         *Add to our Wait ECB-list
         DROP  R2
*------------------------------------------------------------------*
*                                                                  *
* We are now ready to get a SOCKET, BIND it to our port and issue  *
* a LISTEN command.                                                *
*                                                                  *
```

```
*-------------------------------------------------------------------*
         MVC   TRCMLFUN,=CL8'SOCKET'
         EZASMI TYPE=SOCKET,       *Get a socket                    C
               AF='INET',          *In the INET addressing family   C
               SOCTYPE='STREAM',   *Of type stream                  C
               ERRNO=ERRNO,                                         C
               RETCODE=RETCODE,                                     C
               ERROR=EZAERROR
         ICM   R2,15,RETCODE       *If Retcode < zero it is
         BM    EZAERROR            *- an error - else it is socketdescr
         TPITRC 'Socket descriptor from SOCKET Call',               C
               REG=R2              *Trace new socket descriptor
         LM    R3,R5,TPIMSOTB      *Our socket table
         USING TPIMSO,R3
SOCKLLOP EQU   *
         CH    R2,TPIMSNO          *This socket descriptor?
         BE    SOCKLLOK            *- Yes this is our listener socket.
         BXLE  R3,R4,SOCKLLOP      *Loop thrugh them all
         TPILOG MOD=TPIMAIN,       *If error here, nothing will work  C
               MSGNO=10
         B     CLOSEDWN            *Fatal error
SOCKLLOK EQU   *
         OI    TPIMSBIT,TPIMSACT+TPIMSREA+TPIMSLIS
         ST    R2,TPIMSOCK         *Just so we have it.
         LH    R1,TPIMPORT         *Our port number
         STH   R1,SSTRPORT         *Into socket structure for bind
         MVC   TRCMLFUN,=CL8'BIND'
         TPITRC 'Issuing BIND with socket descriptor',              C
               WORD=TPIMSOCK       *Trace entry to Bind
         EZASMI TYPE=BIND,         *Bind socket to our port         C
               S=TPIMSOCK,         *Our listener socket descriptor  C
               NAME=SOCSTRUC,      *Port and INADDR_ANY IP address  C
               ERRNO=ERRNO,                                         C
               RETCODE=RETCODE,                                     C
               ERROR=EZAERROR
         ICM   R2,15,RETCODE       *If Retcode < zero it is
         BM    EZAERROR            *- an error
         MVC   TPIMSSOC,SOCSTRUC   *This is listener socket struc.
         DROP  R3
         MVC   TRCMLFUN,=CL8'LISTEN'
         TPITRC 'Issuing LISTEN with socket descriptor',           C
               WORD=TPIMSOCK       *Trace entry to Listen
         EZASMI TYPE=LISTEN,       *Issue listen call               C
               S=TPIMSOCK,         *On our listener socket          C
               BACKLOG=10,         *Max 10 in the backlog queue     C
               ERRNO=ERRNO,                                         C
               RETCODE=RETCODE,                                     C
               ERROR=EZAERROR
         ICM   R2,15,RETCODE       *If Retcode < zero it is
         BM    EZAERROR            *- an error
*-------------------------------------------------------------------*
*                                                                   *
* Here our main loop starts.                                        *
*                                                                   *
* Based on our socket descriptor table, build the three bit strings to*
* be used in a SELECT call, and issue the SELECT call.              *
*                                                                   *
*-------------------------------------------------------------------*
DOSELECT EQU   *
         LM    R3,R5,TPIMSOTB      *BXLE addresses for socket table
         USING TPIMSO,R3
         XC    SELMASKS(SELMASKL),SELMASKS *Clear them all
```

```
SELMSOLP EQU   *
         TM    TPIMSBIT,TPIMSACT   *Do we work with it?
         BZ    SELMSONX            *- No, try next one
         TPIMASK SET,              *Set Exception bit for all          C
               MASK=ESNDMASK,      *- our active                       C
               SD=TPIMSNO          *- socket descriptors
         TM    TPIMSBIT,TPIMSREA   *Set read bit?
         BZ    SELMSONR            *- No, no test for read
         TPIMASK SET,              *Set read bit for                   C
               MASK=RSNDMASK,      *- for our                          C
               SD=TPIMSNO          *- listener socket descriptor
SELMSONR EQU   *
         TM    TPIMSBIT,TPIMSWRT   *Set write bit?
         BZ    SELMSONX            *- No, no test for write
         TPIMASK SET,              *Set write bit for socket           C
               MASK=WSNDMASK,      *- descriptor if we have a          C
               SD=TPIMSNO          *- pending error message for it.
SELMSONX EQU   *
         BXLE  R3,R4,SELMSOLP      *Loop through all sock descr.
         DROP  R3
         MVC   TRCMLFUN,=CL8'SELECT'
         TPITRC 'Issuing SELECT with MAXSOC',                          C
               WORD=TPIMMAXD       *Trace entry to select
         XC    ECBSELE,ECBSELE     *Clean up ECB
         EZASMI TYPE=SELECT,       *Select call                        C
               MAXSOC=TPIMMAXD,    *Max. this many descr. to test      C
               TIMEOUT=SELTIMEO,   *One hour timeout value             C
               RSNDMSK=RSNDMASK,   *Read mask                          C
               RRETMSK=RRETMASK,   *Returned read mask                 C
               WSNDMSK=WSNDMASK,   *Write mask                         C
               WRETMSK=WRETMASK,   *Returned write mask                C
               ESNDMSK=ESNDMASK,   *Exception mask                     C
               ERETMSK=ERETMASK,   *Returned exception mask            C
               ECB=ECBSELE,        *Post this ECB when activity occurs C
               ERRNO=ERRNO,        *- ECB points to an ECB plus 100    C
               RETCODE=RETCODE,    *- bytes of workarea for socket     C
               ERROR=EZAERROR      *- interface to use.
         ICM   R2,15,RETCODE       *If Retcode < zero it is
         BM    EZAERROR            *- an error
*--------------------------------------------------------------------*
*                                                                    *
* Wait for something to happen, which can be one of the following    *
* events:                                                            *
* 1. SELECT was posted                                               *
* 2. Modify was issued from MVS operator: close down                 *
* 3. Log Writer Task terminated unexpected: close down               *
* 4. A subtask ended prematurely                                     *
*                                                                    *
*--------------------------------------------------------------------*
DOMWAIT  EQU   *
         WAIT  1,ECBLIST=ECBLIST   *Wait for something
         L     R14,ECBPMODI        *-> Modify ECB
         TM    0(R14),BIT1         *Was modify used?
         BZ    POSTNMOD            *- No, it was not modify
         TPILOG MOD=TPIMAIN,       *Message from TPIMAIN               C
               MSGNO=11            *We are modified to Stop
         WTO   'TPIMAIN Modified to STOP - Closing Down'
         B     CLOSEDWN            *Close down the server address space
POSTNMOD EQU   *
         TM    ECBSELE,BIT1        *Was Select posted?
         BO    SELPOSTE            *- Yes, process select
         TM    ECBTLOGW,BIT1       *Did Logtask terminate?
```

```
         BZ    NOTLOGT             *- No, test for server subtasks
         TPILOG MOD=TPIMAIN,       *Message from TPIMAIN              C
               MSGNO=12            *Log writer task terminated
         B     CLOSEDWN            *Treat as closedown
*-------------------------------------------------------------------*
*                                                                   *
* Test for terminated server subtask.  If a server subtask ended    *
* print out the task termination code on the log file.              *
* We allow up to 2 times number of subtasks reinstates.             *
* If reinstate counter is not exeeded, we attach the server subtasks *
* again, and continue processing.                                   *
*                                                                   *
*-------------------------------------------------------------------*
NOTLOGT  EQU   *
         LM    R3,R5,TPIMSCBB      *BXLE addresses for TPISCBs
         USING TPISCB,R3
TSERTERL EQU   *
         TM    TPISTECB,BIT1       *Did Server subtask terminate?
         BZ    TSERTERN            *- No, test next subtask
         L     R1,TPISTECB         *Termination ECB Contents 00xxxxxx
         SLL   R1,8                *Remove wait and xxxxxx00
         SRL   R1,4                *- post bits 0xxxxxx0
         XC    DORD,DORD           *Clear work area
         ST    R1,DORD+4           *Store as lower half of doubleword
         UNPK  TERMCODE,DORD       *Unpack it
         NC    TERMCODE,=6X'0F'    *Remove zones
         TR    TERMCODE,TRHEX      *Translate to text
         LA    R2,TERMTEXT         *-> Termination message
         TPILOG MOD=TPIMAIN,       *Message from TPIMAIN              C
               TEXT=(R2),          *R2 points to 80 character message  C
               MSGNO=1             *Msgno=1 means prebuilt text
         L     R1,TPIMREIN         *So many reinstates until now
         LH    R2,TPIMNOST         *So many server subtasks
         SLL   R2,1                *Multiply by two
         CR    R1,R2               *We allow 2*n'subtask resinstates
         BL    TSERTREI            *- We are under, so do reinstate
         TPILOG MOD=TPIMAIN,       *Message from TPIMAIN              C
               MSGNO=13            *Reinstate limit is exceeded
         B     CLOSEDWN            *Do a close down
TSERTREI EQU   *
         LA    R1,1(R1)            *Increment reinstate count
         ST    R1,TPIMREIN         *Keep track of it..
         XC    TPISTECB,TPISTECB   *Clear ECB
         LA    R8,TPISTECB         *-> Server task Term. ECB
         ATTACH EP=TPISERV,        *Server subtask main module        C
               PARAM=((R3)),       *Pass TPISCB as only parameter     C
               ECB=(R8)            *Termination ECB
         ST    R1,TPISTCB          *-> TCB of subtask
         SR    R8,R8               *Make ready for double shift
         LR    R9,R1               *TCB address
         SLDL  R8,4                *0000000x xxxxxxx0
         STM   R8,R9,DORD          *Store for Unpack
         UNPK  TPISTCBE,DORD       *Unpack
         NC    TPISTCBE,=8X'0F'    *Remove F's
         TR    TPISTCBE,TRHEX      *Translate to EBCDIC
         WAIT  ECB=TPISIECB        *Wait for subtask initialization
         TPILOG MOD=TPIMAIN,       *Message from TPIMAIN              C
               MSGNO=15            *We have reinstated a server task
         B     DOMWAIT             *Go into a new wait on ECBLIST
TSERTERN EQU   *
         BXLE  R3,R4,TSERTERL      *Look for server task termination
         TPITRC 'Wait completed - no ECBs posted',                   C
```

```
               W=ECBLIST,MOD=TPIMAIN
          ABEND 1000,DUMP           *This is a SNO error (!)
*-------------------------------------------------------------------*
*                                                                   *
* Select was posted.                                                *
*                                                                   *
* First thing we must do is to synchronize our module with the      *
* socket interface via the SYNC socket call. Return info from select *
* will be placed in our parameters when we issue the SYNC call (this *
* includes return codes and return masks from select).              *
*                                                                   *
* If SYNC is successfull, the RETCODE holds the number of selected  *
* socket descriptors. We must remember to process ALL selected      *
* socket descriptors; a socket descriptor will only be marked as    *
* selected one time for a given activity.                           *
*                                                                   *
*-------------------------------------------------------------------*
SELPOSTE EQU   *
          EZASMI TYPE=SYNC,         *Synchronize function              C
               ECB=ECBSELE,         *Select ECB plus 100 bytes workarea C
               ERRNO=ERRNO,                                            C
               RETCODE=RETCODE,                                        C
               ERROR=EZAERROR
          ICM   R15,15,RETCODE      *Was everything OK
          BM    EZAERROR            *- No, some error
          ST    R15,NOSELCD         *Number of sd's selected
          TPITRC 'SYNC completed - number of SDs returned',           C
               W=NOSELCD            *Trace number of selected sd's
          LM    R3,R5,TPIMSOTB      *Socket descr. table
          USING TPIMSO,R3
SPMSOLP   EQU   *
          TPIMASK TEST,             *Test a bit                        C
               MASK=RRETMASK,       *- in the returned read mask       C
               SD=TPIMSNO           *- for this socket descriptor
          BNE   SPMSONRD            *No read pending on this one
          L     R15,NOSELCD         *Decrement number of
          BCTR  R15,0               *- selected socket descriptors
          ST    R15,NOSELCD         *- by one.
          TM    TPIMSBIT,TPIMSLIS   *Is it our listener socket?
          BO    SPDOACC             *- Yes, do an accept
          TPITRC 'Unexpected read returned', *We only expect read     C
               H=TPIMSNO            *- on our listener socket
          B     SPECLOSE            *Just close it
SPMSONRD EQU   *
          TPIMASK TEST,             *Test a bit in the                 C
               MASK=ERETMASK,       *- returned exception mask         C
               SD=TPIMSNO           *- for this seocket descriptor
          BNE   SPMSONEX            *No exception pending in this one
          L     R15,NOSELCD         *Decrement number of
          BCTR  R15,0               *- selected socket descriptors
          ST    R15,NOSELCD         *- by one.
          TM    TPIMSBIT,TPIMSEXP   *Did we expect it?
          BO    SPECLOSE            *- Yes, server has taken socket.
          TPITRC 'Unexpected exception returned', *We only expect     C
               H=TPIMSNO            *- exception, when takesocket is OK
          B     SPECLOSE            *For everything else, just close it
SPMSONEX EQU   *
          TPIMASK TEST,             *Test a bit in the                 C
               MASK=WRETMASK,       *- returned write mask             C
               SD=TPIMSNO           *- for this socket descriptor
          BNE   SPMSONXT            *No write pending
          L     R15,NOSELCD         *Decrement number of
```

```
         BCTR  R15,0               *- selected socket descriptors
         ST    R15,NOSELCD         *- by one.
         TM    TPIMSBIT,TPIMSWRT   *Did we expect it?
         BO    SPWRITE             *- Yes, write out message
         TPITRC 'Unexpected Write returned', *We only expect write     C
               H=TPIMSNO           *- for pending error message
         B     SPECLOSE            *Close it
SPMSONXT EQU   *
         BXLE  R3,R4,SPMSOLP       *Someone must be ready
         CLC   NOSELCD,=A(0)       *Should be zero now
         BE    DOSELECT            *- It is, do new select
         TPILOG MSGNO=14,          *Not all selected sd's found. This  C
               MOD=TPIMAIN         *- is an SNO error, but we will
         B     DOSELECT            *- continue with new select.
*-------------------------------------------------------------------*
*                                                                   *
* Write selected.                                                   *
* Write out pending message to client                               *
*                                                                   *
*-------------------------------------------------------------------*
SPWRITE  EQU   *
         MVC   TRCMLFUN,=CL8'WRITE'
         TPITRC 'Write no-server message', *Trace write call          C
               H=TPIMSNO           *- on this socket descriptor
         LA    R2,TPIMSNO          *Socket descriptor
         MVC   REQLEN,MSGNOLEN     *We want to send full message
         XC    ACTLEN,ACTLEN       *Clean before call
         MVC   SENDFLAG,=A(SENDDATA) *We want to send the data
         MVC   TRCMLFUN,=CL8'SEND' *For EZAERROR routine
         CALL  TPISEND,(MAINGLOB,  *EZA Global workarea               C
               MAINTASK,           *EZA Task work area               C
               (R2),               *Socket descriptor                C
               MSGNOSRV,           *Output buffer                    C
               REQLEN,             *Requested length                 C
               ACTLEN,             *Returned actual length           C
               SENDFLAG,           *SEND flag = Send data            C
               RETCODE,            *EZA Retcode                      C
               ERRNO),VL           *EZA Error number
         LTR   R15,R15             *Was send successfull ?
         BZ    SENDOK              *- Yes, buffer has been sent
         CH    R15,=AL2(4)         *Did peer close socket?
         BE    SPECLOSE            *- Yes, we close as well
         B     EZAERROR            *Others means EZA error code
SENDOK   EQU   *
         TPITRC 'Sent so many bytes', *Trace the send call            C
               W=ACTLEN
         B     SPECLOSE            *And close the socket
*-------------------------------------------------------------------*
*                                                                   *
* Close a socket and free socket descriptor entry                   *
*                                                                   *
*-------------------------------------------------------------------*
SPECLOSE EQU   *
         TPITRC 'Closing down socket', *Trace close call              C
               H=TPIMSNO           *For this socket descriptor
         MVC   TRCMLFUN,=CL8'CLOSE'
         EZASMI TYPE=CLOSE,        *Close socket                     C
               S=TPIMSNO,          *This socket descriptor           C
               ERRNO=ERRNO,                                          C
               RETCODE=RETCODE,                                      C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *OK?
```

```
         BM    EZAERROR            *- No..
         MVI   TPIMSBIT,0          *Clear out in-use flag
         B     SPMSONXT            *Test next sd after select post
         DROP  R3
*-------------------------------------------------------------------*
*                                                                   *
* Read selected on Listener socket; issue an ACCEPT                 *
* R3 points to listener socket descriptor entry                     *
*                                                                   *
*-------------------------------------------------------------------*
SPDOACC  EQU   *
         USING TPIMSO,R3
         MVC   TRCMLFUN,=CL8'ACCEPT'
         TPITRC 'Issuing ACCEPT',  *Trace accept call                C
               H=TPIMSNO           *- on this socket descriptor
         EZASMI TYPE=ACCEPT,       *Accept new connection            C
               S=TPIMSNO,          *On listener socket descriptor    C
               NAME=SOCSTRUC,      *Returned client socket structure C
               ERRNO=ERRNO,                                          C
               RETCODE=RETCODE,                                      C
               ERROR=EZAERROR
         ICM   R2,15,RETCODE       *OK?
         BM    EZAERROR            *- No, error indicated
         TPITRC 'ACCEPT returned new socket descriptor', *Trace      C
               REG=R2              *- new socket descriptor
         LR    R15,R2              *We need it later
         MH    R2,=AL2(TPIMSOLN)   *Offset into socket table
         A     R2,TPIMSOTB         *+ start gives new entry
         DROP  R3                  *Drop listener socket descr. base
         USING TPIMSO,R2           *Base for the new descriptor no.
         XC    TPIMSO(TPIMSOLN),TPIMSO *Clear entry
         STH   R15,TPIMSNO         *Descriptor number
         OI    TPIMSBIT,TPIMSACT   *Socket descriptor temp. active
         MVC   TPIMSSOC,SOCSTRUC   *Socket structure
*-------------------------------------------------------------------*
*                                                                   *
* Find an available server subtask, issue a GIVESOCKET              *
* and POST server task.                                             *
*                                                                   *
* If no server subtask is available, we mark the new socket         *
* descriptor for write pending and includes it in a new select.     *
* When write is selected, we write out an error message about no    *
* available server.                                                 *
*                                                                   *
*-------------------------------------------------------------------*
         LM    R7,R9,TPIMSCBB      *Subtask BXLE addresses
         USING TPISCB,R7
ACCSUBLP EQU   *
         TM    TPISECB,BIT0        *Is this one waiting for work?
         BO    ACCFREST            *- Yes, we found a free server task
         BXLE  R7,R8,ACCSUBLP      *Look through them all
         MVC   TPIMSENO,=AL2(1)    *Indicate no server
         OI    TPIMSBIT,TPIMSWRT   *We want to write
         B     SPMSONXT            *Test next sd after select
ACCFREST EQU   *
         MVC   CLNNAME,TPIMCNAM    *Our Client ID Address Space Name
         MVC   CLNTASK,TPISTCBE    *To this subtask
         L     R15,CLNFAM          *Addressing Family
         CVD   R15,DORD            *From binary to decimal
         OI    DORD+7,X'0F'        *A nice sign.
         UNPK  GIVLOGAF,DORD       *Into logging line
         LH    R15,TPIMSNO         *Socket descr. to give
```

```
         CVD   R15,DORD            *From binary to decimal
         OI    DORD+7,X'0F'        *A nice sign.
         UNPK  GIVLOGSD,DORD       *Into logging line
         MVC   GIVLOGAS,CLNNAME    *Address Space Name
         MVC   GIVLOGST,CLNTASK    *Subtask Name
         TPILOG TEXT=GIVLOGLN,     *Log client id to give sd to        C
               MSGNO=1,            *Text is prebuilt                  C
               MOD=TPIMAIN         *Main is logging the message
         MVC   TRCMLFUN,=CL8'GIVESOCK'
         EZASMI TYPE=GIVESOCKET,   *Givesocket                        C
               S=TPIMSNO,          *Give this socket descriptor       C
               CLIENT=CLNSTRUC,    *- to an available server task     C
               ERRNO=ERRNO,                                           C
               RETCODE=RETCODE,                                       C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *OK ?
         BM    EZAERROR            *- No, tell about it.
         MVC   TPISSOD,TPIMSNO     *Main task sockdesr. for takesocket
         POST  TPISECB,0           *Wake up server task
         OI    TPIMSBIT,TPIMSEXP   *We expect an except. aft. takesock.
         DROP  R2,R7               *Drop work base register
         USING TPIMSO,R3           *Back to listener socket descriptor
         B     SPMSONXT            *Test next socket after select
*-------------------------------------------------------------------*
*                                                                   *
* Here we come if non-successfull EZASMI macro call                 *
* Write out message to log file, and terminate.                     *
*                                                                   *
*-------------------------------------------------------------------*
EZAERROR EQU   *
         TPILOG MOD=TPIMAIN,       *TPIMAIN is logging message        C
               FUNC=TRCMLFUN,      *This socket function              C
               ERRNO=ERRNO,        *Socket error number               C
               RETCODE=RETCODE,    *Socket return code                C
               MSGNO=0             *Construct socket error message
*-------------------------------------------------------------------*
*                                                                   *
* Closedown                                                         *
*                                                                   *
* Try to post server subtask for orderly shutdown - followed        *
* by detach.                                                        *
*                                                                   *
* Msgno=999 instructs the log writer task to close its logfile      *
* DCB and to terminate. Allow both server subtasks and log writer   *
* task time to do proper termination.                               *
*                                                                   *
*-------------------------------------------------------------------*
CLOSEDWN EQU   *
         LM    R3,R5,TPIMSCBB      *SCB bxle
         USING TPISCB,R3
CLSLOOP  EQU   *
         CLC   TPISTCB,=4X'00'     *Is the task attached ?
         BE    CLSNODET            *- No, so do not detach it.
         TM    TPISECB,BIT0        *Is it waiting for work?
         BO    CLSSWAIT            *- Yes, ask it to terminate.
         STIMER WAIT,              *Wait 500 msec for                 C
               BINTVL=MSEC500      *- it to finish work.
         B     CLSDET              *- and then just detach it.
CLSSWAIT EQU   *
         POST  TPISECB,4           *Post with RC=4 for terminate
         STIMER WAIT,              *Wait 500 msec for                 C
               BINTVL=MSEC500      *- it to terminate
```

```
CLSDET   EQU   *                  *- and then just detach it.
         LA    R2,TPISTCB         *-> Server TCB address
         DETACH (R2)              *Just go away now...
CLSNODET EQU   *
         BXLE  R3,R4,CLSLOOP      *Kill them all
         DROP  R3
         TPILOG MOD=TPIMAIN,      *Tell Log Writer Task to close      C
               MSGNO=999          *- log file and terminate
         STIMER WAIT,             *Allow time to close the            C
               BINTVL=MSEC500     *- logfile and terminate
         LA    R2,TPIMLTCB        *-> Log writer TCB address
         DETACH (R2)              *Kill Log Writer task
         EZASMI TYPE=TERMAPI      *Terminate socket API
         TERM  RC=0               *And out we go
         LTORG
*-------------------------------------------------------------------*
*                                                                   *
* Select masks used by the socket select call and select control    *
* variables                                                         *
*                                                                   *
*-------------------------------------------------------------------*
         DS    0F
         DC    CL16'SELECT MASKS'  *Eyecatcher
SELMASKS DS    0F
RSNDMASK DC    XL8'00000000'       *Read mask
RRETMASK DC    XL8'00000000'       *Returned read mask
WSNDMASK DC    XL8'00000000'       *Write mask
WRETMASK DC    XL8'00000000'       *Returned write mask
ESNDMASK DC    XL8'00000000'       *Exception mask
ERETMASK DC    XL8'00000000'       *Returned exception mask
SELMASKL EQU   *-SELMASKS
*
NOSELCD  DC    A(0)                *Keep track of selected sd's
SELTIMEO DC    A(3600,0)           *One hour timeout
ECBSELE  DC    A(0)                *Select ECB
         DC    100X'00'            *Required by EZASMI !!
*-------------------------------------------------------------------*
*                                                                   *
* No available server error message                                 *
*                                                                   *
*-------------------------------------------------------------------*
MSGNOSRV DC    C'B',C'TPI',C'0007'
         DC    CL80'No server is currently available - try again later'
MSGNOLEN DC    A(*-MSGNOSRV)       *L'message
*-------------------------------------------------------------------*
*                                                                   *
* Socket interface variables and structures                         *
*                                                                   *
*-------------------------------------------------------------------*
TRCMLFUN DC    CL8' '              *Current socket function
ERRNO    DC    A(0)                *Errorno from EZASMI
RETCODE  DC    A(0)                *Returncode from EZASMI
*
IDENTSTR DS    0F                  *INITAPI: Ident structure
IDENTTCP DC    CL8' '              *TCP/IP Address space name
IDENTJOB DC    CL8' '              *My Address space name
*
SOCSTRUC DS    0F                  *BIND and ACCEPT: Socket structure
SSTRFAM  DC    AL2(2)              *TCP/IP Addressing family
SSTRPORT DC    AL2(0)              *Port number
SSTRADDR DC    AL4(0)              *IP Address (=X'00' is INADDR_ANY)
SSTRRESV DC    8X'00'              *Reserved
```

```
*
CLNSTRUC DS    0F                  *GIVESOCKET: Client structure
CLNFAM   DC    A(2)                *TCP/IP Adressing family
CLNNAME  DC    CL8' '              *Address space name of target
CLNTASK  DC    CL8' '              *Subtask id of target
CLNRESV  DC    XL20'00'            *Reserved
*-------------------------------------------------------------------*
*                                                                   *
* TPIRECV and TPISEND Communication fields                          *
*                                                                   *
*-------------------------------------------------------------------*
REQLEN   DC    A(0)                *Requested receive/send length
ACTLEN   DC    A(0)                *Actually received/sent length
SENDFLAG DC    A(0)                *SEND flags
SENDDATA EQU   0                   *Send data
*-------------------------------------------------------------------*
*                                                                   *
* Main task Control Block                                           *
*                                                                   *
*-------------------------------------------------------------------*
TPIMCB   TPIMCB TYPE=CSECT         *Main Control Block
*-------------------------------------------------------------------*
*                                                                   *
* ECBlist for wait                                                  *
*                                                                   *
*-------------------------------------------------------------------*
ECBLIST  DS    0F
ECBPMODI DC    A(0)                *-> Modify ECB
         DC    A(ECBSELE)          *-> Select ECB
         DC    A(ECBTLOGW)         *-> Logwriter termination ECB
ECBPSTS  DC    10A(0)              *Max 10 subtasks term. ECB's
*-------------------------------------------------------------------*
*                                                                   *
* Subtask termination log message                                   *
*                                                                   *
*-------------------------------------------------------------------*
TERMTEXT DC    0CL80' '
TERMCODE DC    CL6' ',CL1' '       *Completion code
         DC    CL(80-(*-TERMTEXT))'Subtask prematurely terminated'
*-------------------------------------------------------------------*
*                                                                   *
* Logging line for client id                                        *
*                                                                   *
*-------------------------------------------------------------------*
CLNLOGLN DC    0CL80' '
         DC    C'TPIMAIN Client ID '
         DC    C'Family='
CLNLOGAF DC    CL4' ',CL1' '       *Addressing Family
         DC    C'Address Space='
CLNLOGAS DC    CL8' ',CL1' '       *Address Space Name
         DC    C'Subtask='
CLNLOGST DC    CL8' '              *Subtask Name
         DC    CL(80-(*-CLNLOGLN))' '
*-------------------------------------------------------------------*
*                                                                   *
* Logging line client id on givesocket                              *
*                                                                   *
*-------------------------------------------------------------------*
GIVLOGLN DC    0CL80' '
         DC    C'Givesocket SD='
GIVLOGSD DC    CL4' ',CL1' '
         DC    C'Family='
```

```
GIVLOGAF DC    CL4' ',CL1' '       *Addressing Family
         DC    C'Address Space='
GIVLOGAS DC    CL8' ',CL1' '       *Address Space Name
         DC    C'Subtask='
GIVLOGST DC    CL8' '              *Subtask Name
         DC    CL(80-(*-GIVLOGLN))' '
*-------------------------------------------------------------------*
*                                                                   *
* Various work fields                                               *
*                                                                   *
*-------------------------------------------------------------------*
COMMADDR DC    A(0)                *-> Communications Area for Modify
ECBTLOGW DC    A(0)                *Log writer termination ECB
DORD     DC    D'0'                *For unpack/pack
TRHEX    DC    C'0123456789ABCDEF' *Hex to text translate table
*-------------------------------------------------------------------*
*                                                                   *
* Socket API - Global workarea                                      *
*                                                                   *
*-------------------------------------------------------------------*
MAINGLOB EZASMI TYPE=GLOBAL,       *Global work area is              C
               STORAGE=CSECT       *- located here
*-------------------------------------------------------------------*
*                                                                   *
* Socket API - Main Task workarea                                   *
*                                                                   *
*-------------------------------------------------------------------*
MAINTASK EZASMI TYPE=TASK,         *Main task work area is           C
               STORAGE=CSECT       *- located here
         END
```

H.1.2 TPILOGWT Logwriter Data Services Task

```
*********************************************************************
*                                                                   *
* Name:       TPILOGWT                                              *
*                                                                   *
* Function:   Log writer Data Services Task in the TPI server       *
*             application.                                          *
*                                                                   *
* Interface:  R1 -> parameter list with one pointer:                *
*             +0  -> TPI Main task Control Block, which holds the   *
*                    parameters required by TPILOGWT to write out   *
*                    a message to the log file on DD stmt TPILOG.   *
*                                                                   *
* Logic:      This program executes as an independent subtask attached*
*             by TPIMAIN as part of initialization.                 *
*             During startup, it will open a DCB for the TPILOG     *
*             dataset. TPIMAIN waits for TPILOGWT to initialize on  *
*             TPIMLDON ECB in the Main task Control Block, which    *
*             TPILOGWT posts when initialization is done.           *
*             Requests to print a message are initiated from other  *
*             tasks via the TPILOG macro. Combined processing of    *
*             TPILOG Macro and TPILOGWT is:                         *
*                                                                   *
*             1. TPILOG macro enqueues on TPI, TPILOGWT to          *
*                serialize use of the Log Writer interface          *
*                fields in the Main task Control Block.             *
*             2. When TPILOG macro gets its enqueue, it builds      *
*                TPILOGWT parameters in the Main task Control       *
*                Block.                                             *
```

```
*             3. TPILOG macro posts TPIMLECB, which TPILOGWT is       *
*                waiting on for work.                                 *
*             4. TPILOG macro then issues a wait on TPIMLDON.         *
*             5. TPILOGWT wakes up and processes the log request      *
*                writing a message to log file                        *
*             6. When TPILOGWT has finished processing this           *
*                request it posts TPIMLDON, which TPILOG macro is     *
*                waiting on. TPILOGWT then issues a new wait on       *
*                TPIMLECB - waiting for a new log request.            *
*             7. The TPILOG macro dequeues from TPI, TPILOGWT and     *
*                exits from the macro expansion code.                 *
*                                                                     *
*             If TPILOGWT receives a message number of 999, it        *
*             will close the log file DCB and terminate.              *
*                                                                     *
* Abends:     - none -                                                *
*                                                                     *
* Returncode: - none -                                                *
*                                                                     *
* Written:    May 28'th 1994 at ITSO Raleigh                          *
*                                                                     *
* Modified:                                                           *
*                                                                     *
***********************************************************************
*---------------------------------------------------------------------*
*                                                                     *
* Instream macro for formatting numbers                               *
*                                                                     *
*---------------------------------------------------------------------*
         MACRO
         FORMNUM &FROM,&TO
         L     R15,&FROM
         CVD   R15,DWORD
         OI    DWORD+7,X'0F'
         UNPK  &TO.,DWORD
         MEND
*---------------------------------------------------------------------*
*                                                                     *
* Instream macroe for generating message table entry                  *
*                                                                     *
*---------------------------------------------------------------------*
         MACRO
         MSG   &NO,&TEXT
         DC    A(&NO.),CL80&TEXT.
         MEND
*
TPIMCB   TPIMCB TYPE=DSECT         *Main task Control Block
*
TPILOGWT INIT  'Log data set writer task',MODE=24
*---------------------------------------------------------------------*
*                                                                     *
* Initialize - open DCB and put out greeting message on log file.     *
*                                                                     *
*---------------------------------------------------------------------*
         L     R9,0(R1)             *-> Main task Control Block (TPIMCB)
         USING TPIMCB,R9            *Address it
         OPEN  (TPILOG,(OUTPUT))    *Open our log writer DCB
         PUT   TPILOG,HD1           *Print our header line
*---------------------------------------------------------------------*
*                                                                     *
* For each request, post back when done - as requester is waiting     *
* for us to complete work on TPIMLDON in the main task Control        *
```

```
* Block.                                                              *
*                                                                     *
* Then issue a wait on TPIMLECB also in the Main task Control Block   *
* for a new work request.                                             *
*                                                                     *
*---------------------------------------------------------------------*
WAITWORK EQU   *
         POST  TPIMLDON,0          *Tell requester, we are done.
         XC    TPIMLECB,TPIMLECB   *Clear our ECB
         WAIT  ECB=TPIMLECB        *Wait for next work request
         CLC   TPIMLMNO,=A(999)    *Means close down
         BE    GETOUT              *- So just close DCB and exit.
         TIME  DEC,                *Let us see the current time        C
               TIMENOW,            *- when we were woken up            C
               LINKAGE=SYSTEM
*---------------------------------------------------------------------*
*                                                                     *
* Build fixed part of each trace line: timestamp, module and message  *
* number                                                              *
*                                                                     *
*---------------------------------------------------------------------*
         MVI   LIN,C' '            *Initialize output line
         MVC   LIN+1(L'LIN-1),LIN  *- with spaces
         MVC   EDWORK,EDMASK       *Time edit mask
         LM    R2,R3,TIMENOW       *hhmmssth xxxx0000
         SRDL  R2,28               *Shift out so 00000h hmmssthx
         STM   R2,R3,DWORD         *Treat as decimal
         OI    DWORD+7,X'0F'       *Put in a sign
         ED    EDWORK,DWORD+3      *Edit time as hh:mm:ss.th
         MVC   TIMESTMP,EDWORK+1   *Time to output line
         MVC   MODULE,TPIMLMOD     *Name of calling module
         FORMNUM TPIMLMNO,MSGNO    *Format message number to line
*---------------------------------------------------------------------*
*                                                                     *
* Do message code specific processing:                                *
* Msgno = 0 means we must format Socket interface return info         *
* Msgno = 1 means that a prebuilt text string has been passed         *
*           as message text, and we just put it out                   *
*                                                                     *
* For all other message numbers passed, a corresponding text is       *
* found in the message table, which is part of this module.           *
*                                                                     *
*---------------------------------------------------------------------*
         L     R2,TPIMLMNO         *Passed message number
         LTR   R2,R2               *MSGNO=0 means EZASMI returninfo
         BZ    EZAINFO             *Go and format socket return info
         C     R2,=A(1)            *MSGNO=1 means passed text string
         BE    TEXTOUT             *Just put out the passed string
         LM    R3,R5,MSGTABBX      *Search message table
MSGLOOP  EQU   *
         CLC   TPIMLMNO,0(R3)      *This message ?
         BE    FOUNDMSG            *- Yes, print it
         BXLE  R3,R4,MSGLOOP       *Look through them all
         LA    R3,DUMMYMSG         *If not found, use a dummy text
FOUNDMSG EQU   *
         MVC   TEXT,4(R3)          *Print table message text
         PUT   TPILOG,LIN          *Print it
         B     WAITWORK            *Wait for next request
TEXTOUT  EQU   *
         MVC   TEXT,TPIMLTXT       *Print passed text string
         PUT   TPILOG,LIN          *Print it
         B     WAITWORK            *Wait for next request
```

```
EZAINFO  EQU   *
         MVC   EZAFUN,=C'EZASMI Function='
         MVC   EZAERR,=C'ErrNo='
         MVC   EZARET,=C'RetCode='
         MVC   EZAFUNCD,TPIMLFUN   *Socket function
         FORMNUM TPIMLERR,EZAERRNO *Socket error number
         FORMNUM TPIMLRET,EZARETCD *Socket return code
         PUT   TPILOG,LIN          *Print it
         B     WAITWORK            *Wait for next request
*-------------------------------------------------------------------*
*                                                                   *
* When we recive msgno=999, we close the log file DCB and           *
* terminate                                                         *
*                                                                   *
*-------------------------------------------------------------------*
GETOUT   EQU   *
         CLOSE (TPILOG)            *Close log file DCB
         POST  TPIMLDON,0          *Tell requester, we are done.
         TERM  RC=0                *No reason for anything else.
         LTORG
*-------------------------------------------------------------------*
*                                                                   *
* Formatting work fields                                            *
*                                                                   *
*-------------------------------------------------------------------*
EDWORK   DC    CL12' '
EDMASK   DC    XL12'2120207A20207A20204B2020'
DWORD    DC    D'0'
TIMENOW  DC    XL16'00'
*-------------------------------------------------------------------*
*                                                                   *
* Header line and detail line layout                                *
*                                                                   *
*-------------------------------------------------------------------*
HD1      DC    CL130'1TPI Log Writer Task has started'
*
LIN      DS    0CL130' '
         DC    C' '
TIMESTMP DC    CL11' ',CL1' '
MODULE   DC    CL8' ',CL1' '
MSGNO    DC    CL3' ',CL1' '
EZAFUN   DC    C'EZASMI Function='
EZAFUNCD DC    CL8' ',CL1' '
EZAERR   DC    C'ErrNo='
EZAERRNO DC    CL5' ',CL1' '
EZARET   DC    C'RetCode='
EZARETCD DC    CL4' ',CL1' '
         ORG   EZAFUN
TEXT     DC    CL80' '
         DC    CL(130-(*-LIN))' '
*-------------------------------------------------------------------*
*                                                                   *
* Log file DCB                                                      *
*                                                                   *
*-------------------------------------------------------------------*
TPILOG   DCB   DDNAME=TPILOG,MACRF=(PM),RECFM=FBA,LRECL=130,          C
               DSORG=PS,BLKSIZE=1300
*-------------------------------------------------------------------*
*                                                                   *
* Message text table - key is message number                        *
*                                                                   *
*-------------------------------------------------------------------*
```

```
MSGTABBX DC    A(MSGTAB,84,MSGTABSL-84)
MSGTAB   DS    0C
         MSG   10,'Returned socket descriptor is not in TPIMSO table.'
         MSG   11,'TPIMAIN Modified to STOP - we close down.'
         MSG   12,'Log Writer Task terminated - we close down.'
         MSG   13,'Server subtask reinstate limit exceeded - we close dC
               own.'
         MSG   14,'Not all selected socket descriptors were found - we C
               will continue with new select.'
         MSG   15,'Server subtask has been reinstated.'
MSGTABSL EQU   *
DUMMYMSG DC    A(998),CL80'Error code missing in error code table.'
         END
```

H.1.3 TPISERV Concurrent Server Subtask

```
*********************************************************************
*                                                                   *
* Name:       TPISERV                                               *
*                                                                   *
* Function:   This module is the main module in each TPI server     *
*             subtask                                               *
*                                                                   *
* Interface:  R1 -> parameter list with one pointer:                *
*             +0  -> TPISCB TPI Server task Control Block           *
*                    Pointers to the TPI Main task Control Block and *
*                    to the socket global workarea are picked up from *
*                    the Server task Control Block.                 *
*                                                                   *
* Logic:      This module receives control as the main module when  *
*             the main task issue an Attach to start a new server   *
*             subtask.                                              *
*             1. Pointers to the Main task Control Block and to the *
*                EZA Global Workarea are established.               *
*             2. Pointer to the task level EZA Work Area is set up. *
*             3. When the task has finished initialization, it posts *
*                TPISIECB in the Server task Control Block, which   *
*                the main task is waiting on.                       *
*             4. The module then enters a loop, where it waits for  *
*                work on TPISECB in the Server task Control Block,  *
*                which will be posted by the main task, when a new  *
*                connection arrives from the network.               *
*                If the main task posts with an RC=0 it means work. *
*                If the main task posts with an RC=4 it means       *
*                shutdown.                                          *
*             5. When work arrives, a Takesocket is issued to take  *
*                the socket given by the main task. The main task   *
*                passes the socket descriptor in the Server task    *
*                Control Block and the main task client id in the   *
*                Main task Control Block.                           *
*             6. DB2 connection is established and a DB2 plan is    *
*                opened.                                            *
*             7. Data is received over the socket interface into a  *
*                buffer.                                            *
*             8. The buffer is passed to TPISERVD, which will do the *
*                required processing on it.                         *
*             9. When control returns from TPISERVD, the input buffer *
*                has been replaced by an output buffer, which is sent *
*                over the socket interface.                         *
*            10. The socket is closed.                              *
*            11. The connection with DB2 is closed.                 *
```

```
*            12. Processing continues at item no. 4 above.           *
*                                                                    *
* Abends:     - none -                                               *
*                                                                    *
* Returncode: - none -                                               *
*                                                                    *
* Written:    May 28'th 1994 at ITSO Raleigh                         *
*                                                                    *
* Modified:                                                          *
*                                                                    *
**********************************************************************
         PRINT GEN
TPIMCB   TPIMCB TYPE=DSECT         *Main task Control block dsect
TPISCB   TPISCB TYPE=DSECT         *Server task Control Block dsect
TPIREC   TPIREC TYPE=DSECT         *TPI input and output record dsect
         PRINT NOGEN
EZAGLOB  EZASMI TYPE=GLOBAL,       *EZA Global work Area dsect         C
               STORAGE=DSECT
*
TPISERV  INIT  'TPI Server task',RENT=NO,MODE=24,BASE=(12,11)
*--------------------------------------------------------------------*
*                                                                    *
* Pointer for Server task Control Block (TPISCB) is passed from      *
* the main task on the attach call.                                  *
* Addressability to the Main task Control Block (TPIMCB) and the     *
* main task EZA Global Work Area is established.                     *
* Addressability to task level EZA Work area is established.         *
*                                                                    *
* Subtask client ID is built, and a socket INITAPI call              *
* is issued.                                                         *
*                                                                    *
* Main task waits for server subtask to initialize on TPISIECB.      *
*                                                                    *
*--------------------------------------------------------------------*
         L     R10,0(R1)           *-> Server task Control Block
         USING TPISCB,R10          *Server task Control Block
         L     R9,TPISMCB          *-> Main task Control Block
         USING TPIMCB,R9           *Main task Control Block
         TPITRC TYPE=INIT,         *Enable trace points               C
               MOD=TPISERV,        *Tracing module is TPISERV         C
               TRACE=YES
         TPITRC 'TPISERV entered',                                    C
               REG=R10             *Address of TPISCB
         L     R8,TPIMGLOB         *-> EZA Global work area
         USING EZAGLOB,R8          *EZA Global work area
         LA    R1,EZATASK          *-> EZA task work area
         ST    R1,TPISTASK         *Just so we have it.
         L     R3,X'10'            *-> CVT
         L     R3,0(R3)            *-> TCB Words
         L     R3,4(R3)            *-> Current TCB (My TCB)
         SR    R2,R2               *Make ready for double shift
         SLDL  R2,4                *0000000x xxxxxxx0
         STM   R2,R3,DORD          *Store for Unpack
         UNPK  TPISTCBE,DORD       *Unpack
         NC    TPISTCBE,=8X'0F'    *Remove F's
         TR    TPISTCBE,TRHEX      *Translate to EBCDIC
         MVC   TRCMLFUN,=CL8'INITAPI'
         MVC   IAPITCP,TPIMTCPI    *TCP/IP address space name
         MVC   IAPIAS,TPIMCNAM     *Our address space name
         EZASMI TYPE=INITAPI,      *Initialize socket API             C
               MAXSOC=IAPISOCC,    *This many sockets                 C
               SUBTASK=TPISTCBE,   *My TCB address in EBCDIC          C
```

```
              IDENT=IAPIIDEN,     *TCP/IP AS name and my AS name      C
              MAXSNO=IAPISNO,     *This many socket descriptors       C
              ERRNO=ERRNO,                                            C
              RETCODE=RETCODE
         ICM  R15,15,RETCODE      *Did we do well ?
         BM   EZAERROR            *- No, deal with it.
         MVC  TRCMLFUN,=CL8'GETCLNID'
         EZASMI TYPE=GETCLIENTID, *Get our own client id              C
              CLIENT=TPISCLNI,    *Store it in Server task Control B. C
              ERRNO=ERRNO,                                            C
              RETCODE=RETCODE,                                        C
              ERROR=EZAERROR
         ICM  R15,15,RETCODE      *Was it OK
         BM   EZAERROR            *- No, stop now.
         L    R15,TPISCDOM        *Addressing Family
         CVD  R15,DORD            *From binary to decimal
         OI   DORD+7,X'0F'        *A nice sign.
         UNPK CLNLOGAF,DORD       *Into logging line
         MVC  CLNLOGAS,TPISCNAM   *Address Space Name
         MVC  CLNLOGST,TPISCTSK   *Subtask Name
         TPILOG TEXT=CLNLOGLN,    *Log client id                     C
              MSGNO=1,            *Text is prebuilt                  C
              MOD=TPISERV         *Main is logging the message
         POST TPISIECB,0          *OK, we have initialized
*-------------------------------------------------------------------*
*                                                                   *
* Wait-for-Work loop starts here. Main task will post TPISECB,      *
* when there is work to be done.                                    *
*                                                                   *
* RC=0 means work to do.                                            *
* RC=4 means shutdown.                                              *
*                                                                   *
*-------------------------------------------------------------------*
WAITLOOP EQU  *
         TPITRC 'TPISERV Going to sleep.',                          C
              REG=R10             *Address of TPISCB
         XC   TPISECB,TPISECB     *Clean up
         WAIT ECB=TPISECB         *Wait for work
         TPITRC 'TPISERV Woke up',                                  C
              W=TPISECB           *ECB in trace
         L    R2,TPISECB          *Let us see the RC
         SLL  R2,8                *Get rid of
         SRL  R2,8                *- post and wait bits
         LTR  R2,R2               *RC=0 means work
         BNZ  GETOUT              *Anything else means shutdown
*-------------------------------------------------------------------*
*                                                                   *
* Main task socket descriptor is passed in TPISCB as TPISSOD.       *
* Main task client id is in TPIMCB as TPIMCLNI.                     *
* On Takesocket, we must point to the socket descriptor and the     *
* client id from the task that issued Givesocket.                   *
*                                                                   *
* Takesocket returns a new socket descriptor, which will be used    *
* in this subtask for further communication.                        *
*                                                                   *
*-------------------------------------------------------------------*
         MVC  TRCMLFUN,=CL8'TAKESOCK'
         TPITRC 'Takesocket With old descriptor',                   C
              H=TPISSOD           *Trace old socket descr.
         EZASMI TYPE=TAKESOCKET,  *Takesocket                       C
              CLIENT=TPIMCLNI,    *Main task client id structure     C
              SOCRECV=TPISSOD,    *Main task socket descriptor       C
```

```
               ERRNO=ERRNO,                                            C
               RETCODE=RETCODE,                                        C
               ERROR=EZAERROR
          ICM  R15,15,RETCODE      *Did we do well ?
          BM   EZAERROR            *- No, deal with it.
          STH  R15,TPISNSOD        *Server task socket descr.no
          TPITRC 'Takesocket returned new descriptor',                 C
               REG=R15             *Trace new socket descriptor
*--------------------------------------------------------------------*
*                                                                    *
* Issue a Getpeername call to obtain socket address structure of     *
* client.  Format and print it on log file.                          *
*                                                                    *
*--------------------------------------------------------------------*
          MVC  TRCMLFUN,=CL8'GETPEERN'
          EZASMI TYPE=GETPEERNAME,  *Getpeername                      C
               S=TPISNSOD,          *Of connected client              C
               NAME=PEERNAME,       *Return socket address struc here C
               ERRNO=ERRNO,                                           C
               RETCODE=RETCODE,                                       C
               ERROR=EZAERROR
          ICM  R15,15,RETCODE      *Did we do well ?
          BM   EZAERROR            *- No, deal with it.
          LH   R2,PEERFAM          *Addressing family of peer
          CVD  R2,DORD             *To decimal
          OI   DORD+7,X'0F'        *Put in sign
          UNPK PERLOGAF,DORD       *Into logging line
          LH   R2,PEERPORT         *Port number of peer
          CVD  R2,DORD             *To decimal
          OI   DORD+7,X'0F'        *Put in sign
          UNPK PERLOGPO,DORD       *Into logging line
          CALL TPIINTOA,(PEERIP,   *Convert from 4 bytes network order C
               PERLOGIP),VL        *- to 15 char text.
          TPILOG TEXT=PERLOGLN,    *Log peers socket address          C
               MSGNO=1,            *Text is prebuilt                  C
               MOD=TPISERV         *From TPISERV
*--------------------------------------------------------------------*
*                                                                    *
* Open our DB2 plan, and let CAF issue an implicit DB2 connection.   *
* The DB2 subsystem id is picked up from the Main task Control Block.*
*                                                                    *
*--------------------------------------------------------------------*
          MVC  CAFFUNC,=CL12'OPEN' *Open a PLAN
          MVC  CAFSSNM,TPIMDB2     *DB2 subsystem name
          MVC  CAFPLAN,=CL8'TPISERV' *DB2 plan name
          CALL DSNALI,(CAFFUNC,    *Function=OPEN                     C
               CAFSSNM,            *Subsystem name                    C
               CAFPLAN,            *Plan name=TPISERV                 C
               CAFRC,              *CAF Return code                   C
               CAFREAS),VL         *CAF Reason code
          CLC  CAFRC,=A(0)         *Was it OK?
          BE   CAFOPNOK            *- Yes, we have a connection
          TPITRC 'CAF Open Return Code', *Trace the bad               C
               W=CAFRC             *- CAF Return code
          TPITRC 'CAF Open Reason Code', *Trace the bad               C
               W=CAFREAS           *- CAF Reason code
          B    CLOSESOK            *And give up this socket.
*--------------------------------------------------------------------*
*                                                                    *
* Use TPIRECV for the actual socket RECV call.                       *
*                                                                    *
* Start with a peek at the first 5 bytes.                            *
```

```
*                                                                     *
* The first byte in the received data is                              *
* a record code we use to decide how many bytes we must read to have  *
* a full record. The next 4 bytes is used to decide wether the        *
* received data is ASCII or EBCDIC. The fixed text in our application *
* is 4 bytes with the value 'TPI '.                                   *
*                                                                     *
* Based on the decision about the number of bytes and bytes read, we  *
* call TPIRECV again for an actual read of the number of bytes we     *
* now know should be there.                                           *
*                                                                     *
*---------------------------------------------------------------------*
CAFOPNOK EQU   *
         LA    R6,BUFFER           *Begin to read into
         LA    R5,TPISNSOD         *Socket descriptor
         MVC   REQLEN,=A(5)        *We want to see first 5 bytes
         MVC   RECVFLAG,=A(RECVPEEK) *We just want to peek.
         MVC   TRCMLFUN,=CL8'RECV' *For EZAERROR routine
         CALL  TPIRECV,((R8),      *EZA Global workarea                C
               EZATASK,            *EZA Task work area                 C
               (R5),               *Socket descriptor                  C
               (R6),               *Input buffer                       C
               REQLEN,             *Requested length                   C
               ACTLEN,             *Returned actual length             C
               RECVFLAG,           *RECV flag = Peek at data           C
               RETCODE,            *EZA Retcode                        C
               ERRNO),VL           *EZA Error number
         LTR   R15,R15             *Successfull ?
         BZ    PEEKOK              *- Yes, buffer has first 5 bytes
         CH    R15,=AL2(4)         *Did peer close socket?
         BE    CLOSESOK            *- Yes, we close as well
         B     EZAERROR            *Others means EZA error code
PEEKOK   EQU   *
         TPITRC 'Peek returned so many bytes',                       C
               W=ACTLEN
         LM    R1,R3,RECIDBXL      *BXLE for record IDs
READFID  EQU   *
         CLC   0(1,R1),BUFFER      *First byte is record ID
         BE    GOTANID             *This is it
         BXLE  R1,R2,READFID       *If not fond - error message back:
         LA    R6,BUFFER           *-> Input buffer
         USING TPIREC,R6           *Let us see if it is ascii/ebcdic
         MVI   TPISCTYP,TPISEBCD   *Default client is EBCDIC
         CLC   IIDENT,=CL4'TPI'    *Is client in EBCDIC?
         BE    RESP3EBC            *- Yes, flag is correct: EBCDIC
         MVI   TPISCTYP,TPISASCI   *- No, set client flag: ASCII
RESP3EBC EQU   *
         MVI   IRECID,IRESP        *Build error response with
         MVC   ICODE,=CL4'0003'    *- errorcode = 0003 (invalid recid)
         B     PREPSEND            *Go and send it.
         DROP  R6                  *Was only temporary for error 0003.
GOTANID  EQU   *
         LH    R2,1(R1)            *Length of this record type
         ST    R2,REQLEN           *So long is pending message
         XC    ACTLEN,ACTLEN       *Just clean it before call
         LA    R6,BUFFER           *-> Input data
         LA    R5,TPISNSOD         *Socket descriptor
         MVC   RECVFLAG,=A(RECVREAD) *We want to read the data now
         MVC   TRCMLFUN,=CL8'RECV' *For EZAERROR routine
         CALL  TPIRECV,((R8),      *EZA Global workarea                C
               EZATASK,            *EZA Task work area                 C
               (R5),               *Socket descriptor                  C
```

```
               (R6),               *Input buffer                      C
               REQLEN,             *Requested length                  C
               ACTLEN,             *Returned actual length            C
               RECVFLAG,           *RECV flag = Peek at data          C
               RETCODE,            *EZA Retcode                       C
               ERRNO),VL           *EZA Error number
         LTR   R15,R15             *Successfull ?
         BZ    READOK              *- Yes, buffer has full message
         CH    R15,=AL2(4)         *Did peer close socket?
         BE    CLOSESOK            *- Yes, we close as well
         B     EZAERROR            *Others mean EZA error code
*-------------------------------------------------------------------*
*                                                                   *
* If input data is in ASCII, we translate the whole string into     *
* EBCDIC, and set a switch so we remember to translate output       *
* data from EBCDIC to ASCII before we send it.                      *
*                                                                   *
* The buffer is then passed to TPISERVD, which will do whatever     *
* processing is needed and build output data in the buffer area.    *
*                                                                   *
*-------------------------------------------------------------------*
READOK   EQU   *
         USING TPIREC,R6           *Let us work on it.
         TPITRC 'Receive returned so many bytes',                   C
               W=ACTLEN
         MVI   TPISCTYP,TPISEBCD   *Default client is EBCDIC
         CLC   IIDENT,=CL4'TPI'    *Do we need ASCII translate
         BE    RECINEBC            *- No, it is in EBCDIC
         CALL  EZACIC05,((R6),     *Translate from ASCII to           C
               ACTLEN),VL          *EBCDIC
         MVI   TPISCTYP,TPISASCI   *Client is ASCII
RECINEBC EQU   *
         CALL  TPISERVD,((R10),    *-> Server task Control Block      C
               BUFFER,             *Input buffer                      C
               RECLEN),VL          *L'input buffer
*-------------------------------------------------------------------*
*                                                                   *
* On return from TPISERVD, the buffer holds a partly completed      *
* output record.                                                    *
* If the request to TPISERVD was to fetch an existing DB2 record,   *
* the buffer is complete and we need find out just how many bytes   *
* to send to the client.                                            *
*                                                                   *
* If output is a message indicating successfull or unsuccessfull    *
* processing, we find a suitable message text to pass back.         *
*                                                                   *
*-------------------------------------------------------------------*
PREPSEND EQU   *
         LM    R1,R3,RECIDBXL      *BXLE for record IDs
SENDFID  EQU   *
         CLC   IRECID,0(R1)        *First byte is record ID
         BE    SENDID              *This is it
         BXLE  R1,R2,SENDFID       *Look for it
         MVC   ICODE,=CL4'0003'    *Invalid record id (err in TPISERVD)
         MVI   IRECID,IRESP        *Response
         B     PREPSEND            *Redrive BXLE
SENDID   EQU   *
         LH    R2,1(R1)            *Length of this record type
         ST    R2,RECLEN           *So long is current record
         CLI   IRECID,IQRESP       *Is it a query response record?
         BE    SENDNRSP            *- Yes, buffer is complete.
         CLC   ICODE,=CL4'0006'    *SQL Error message is complete.
```

```
         BE    SENDNRSP            *Do not modify DSNTIAR text
         LM    R1,R3,MSGBXLE       *BXLE addresses for msgtext
SENDMLOP EQU   *
         CLC   ICODE,0(R1)         *This message code?
         BE    SENDMFND            *- Yes, message found
         BXLE  R1,R2,SENDMLOP      *Look through them all
         MVC   IMESSAGE,=CL80'No message text found'
         B     SENDNRSP            *Default has been set
SENDMFND EQU   *
         MVC   IMESSAGE,4(R1)      *Return this message
*-------------------------------------------------------------------*
*                                                                   *
* If received data was ASCII, the client most likely wants the      *
* response in ASCII again.                                          *
*                                                                   *
*-------------------------------------------------------------------*
SENDNRSP EQU   *
         TM    TPISCTYP,TPISASCI   *Is Client ASCII ?
         BZ    SENDIT              *- No, just send data
         CALL  EZACIC04,(BUFFER,   *Translate data from EBCDIC         C
               RECLEN),VL          *- to ASCII
*-------------------------------------------------------------------*
*                                                                   *
* Send data to client, close socket, close DB2 connection and go    *
* and wait for more work.                                           *
*                                                                   *
*-------------------------------------------------------------------*
SENDIT   EQU   *
         LA    R5,TPISNSOD         *Socket descriptor
         MVC   REQLEN,RECLEN       *We want to send full message
         XC    ACTLEN,ACTLEN       *Clean before call
         MVC   SENDFLAG,=A(SENDDATA) *We want to send the data
         MVC   TRCMLFUN,=CL8'SEND' *For EZAERROR routine
         CALL  TPISEND,((R8),      *EZA Global workarea                C
               EZATASK,            *EZA Task work area                 C
               (R5),               *Socket descriptor                  C
               BUFFER,             *Output buffer                      C
               REQLEN,             *Requested length                   C
               ACTLEN,             *Returned actual length             C
               SENDFLAG,           *SEND flag = Send data              C
               RETCODE,            *EZA Retcode                        C
               ERRNO),VL           *EZA Error number
         LTR   R15,R15             *Was send successfull ?
         BZ    SENDOK              *- Yes, buffer has been sent
         CH    R15,=AL2(4)         *Did peer close socket?
         BE    CLOSESOK            *- Yes, we close as well
         B     EZAERROR            *Others means EZA error code
SENDOK   EQU   *
         TPITRC 'Sent so many bytes', *Trace the send call           C
               W=ACTLEN
CLOSESOK EQU   *
         MVC   TRCMLFUN,=CL8'CLOSE'
         EZASMI TYPE=CLOSE,        *Close the socket                 C
               S=TPISNSOD,         *Subtask socket descriptor        C
               ERRNO=ERRNO,                                          C
               RETCODE=RETCODE,                                      C
               ERROR=EZAERROR
         ICM   R15,15,RETCODE      *Was close socket done ?
         BM    EZAERROR            *- No, some error
         TPITRC 'Close done',      *Trace the close call             C
               REG=R15
         MVC   CAFFUNC,=CL12'CLOSE'
```

```
         CALL  DSNALI,(CAFFUNC,     *Function=CLOSE                    C
               CAFTERMO,            *Termination options: Commit       C
               CAFRC,               *CAF Return code                   C
               CAFREAS),VL          *CAF Reason code
         CLC   CAFRC,=A(0)          *Was CAF Close OK ?
         BE    WAITLOOP             *- Yes, wait for more work
         TPITRC 'CAF Close Return Code', *Trace the bad                C
               W=CAFRC              *- CAF Return code
         TPITRC 'CAF Close Reason Code', *Trace the bad                C
               W=CAFREAS            *- CAF Reason code
         B     WAITLOOP             *Wait for work
*-------------------------------------------------------------------*
*                                                                   *
* If we receive an unexpected error code from the socket interface,  *
* we write out diagnostic info to the log data set and close the     *
* socket before we go and wait for new work.                         *
*                                                                   *
*-------------------------------------------------------------------*
EZAERROR EQU   *
         TPILOG MOD=TPISERV,        *TPISERV module is logging         C
               FUNC=TRCMLFUN,       *This was the socket function      C
               ERRNO=ERRNO,         *- that gave this error code       C
               RETCODE=RETCODE,     *- with this retcode.              C
               MSGNO=0              *No message passed - build it.
         EZASMI TYPE=CLOSE,         *Close the socket                  C
               S=TPISNSOD,          *Subtask socket descriptor         C
               ERRNO=ERRNO,         *We really do not care about       C
               RETCODE=RETCODE      *- these, but for the sake of it.
         B     WAITLOOP             *Just wait for another client
*-------------------------------------------------------------------*
*                                                                   *
* Terminate subtask.                                                *
*                                                                   *
*-------------------------------------------------------------------*
*
GETOUT   EQU   *
         EZASMI TYPE=TERMAPI        *Terminate socket API
         TPITRC 'TPISERV is shutting down',                         C
               W=TPISECB            *Trace the ECB
         TERM  RC=0                 *No reason for anything else
         LTORG
TRHEX    DC    C'0123456789ABCDEF' *Hex translate table
*-------------------------------------------------------------------*
*                                                                   *
* CAF Call Attachment Facility interface parameters                  *
*                                                                   *
*-------------------------------------------------------------------*
CAFFUNC  DC    CL12' '             *CAF Function code
CAFSSNM  DC    CL4' '              *DB2 subsystem name
CAFPLAN  DC    CL8' '              *DB2 Plan name
CAFRC    DC    A(0)                *CAF Return code
CAFREAS  DC    A(0)                *CAF Reason code
CAFTERMO DC    CL4'SYNC'           *CAF Termination option
*-------------------------------------------------------------------*
*                                                                   *
* Initapi call parameters                                           *
*                                                                   *
*-------------------------------------------------------------------*
IAPISOCC DC    AL2(10)             *Max socc
IAPIIDEN DS    0C
IAPITCP  DC    CL8' '              *TCP/IP Address space name
IAPIAS   DC    CL8' '              *My address space name
```

```
IAPISNO  DC    AL4(10)             *Max sno
IAPITYPE DC    AL2(2)              *Api type
*-------------------------------------------------------------------*
*                                                                   *
* Getpeername call parameters                                       *
*                                                                   *
*-------------------------------------------------------------------*
PEERNAME DS    0C                  *Returned socket address structure
PEERFAM  DC    AL2(0)              *Addressing family
PEERPORT DC    AL2(0)              *Port number
PEERIP   DC    AL4(0)              *IP address
         DC    8X'00'              *Reserved
*-------------------------------------------------------------------*
*                                                                   *
* TPIRECV and TPISEND Communication fields                          *
*                                                                   *
*-------------------------------------------------------------------*
REQLEN   DC    A(0)                *Requested receive/send length
ACTLEN   DC    A(0)                *Actually received/sent length
RECVFLAG DC    A(0)                *RECV flags
RECVREAD EQU   0                   *Read data
RECVPEEK EQU   2                   *Peek at data
SENDFLAG DC    A(0)                *SEND flags
SENDDATA EQU   0                   *Send data
*-------------------------------------------------------------------*
*                                                                   *
* Socket call error status information                              *
*                                                                   *
*-------------------------------------------------------------------*
TRCMLFUN DC    CL8' '              *Socket function for errorlog
ERRNO    DC    A(0)                *Socket error code
RETCODE  DC    A(0)                *Socket return code
MSGCODE  DC    AL2(0)              *Message code to be returned
*-------------------------------------------------------------------*
*                                                                   *
* Table over valid record id's and length of records                *
*                                                                   *
*-------------------------------------------------------------------*
RECIDBXL DC    A(RECIDST,3,RECIDSL-3)
RECIDST  EQU   *                   *Record id and lenght table
         DC    C'1',AL2(230)       *Add new record
         DC    X'31',AL2(230)      *Add new record ASCII 1
         DC    C'2',AL2(230)       *Update existing record
         DC    X'32',AL2(230)      *Update existing record ASCII 2
         DC    C'3',AL2(24)        *Query existing record
         DC    X'33',AL2(24)       *Query existing record ASCII 3
         DC    C'4',AL2(24)        *Delete existing record
         DC    X'34',AL2(24)       *Delete existing record ASCII 4
         DC    C'A',AL2(230)       *Query response with data
         DC    C'a',AL2(230)       *Query response with data
         DC    X'41',AL2(230)      *Query response with data ASCII A
         DC    X'61',AL2(230)      *Query response with data ASCII a
         DC    C'B',AL2(89)        *Response with text
         DC    C'b',AL2(89)        *Response with text
         DC    X'42',AL2(89)       *Response with text ASCII B
         DC    X'62',AL2(89)       *Response with text ASCII b
RECIDSL  EQU   *
*-------------------------------------------------------------------*
*                                                                   *
* EZA Task level work area and buffer with control fields           *
*                                                                   *
*-------------------------------------------------------------------*
```

```
         PRINT GEN
EZATASK  EZASMI TYPE=TASK,         *Task EZA Work area                C
               STORAGE=CSECT
BUFFER   DC    XL255'00'           *Enough for our purpose
READLN   DC    A(0)                *So many bytes were read
BUFLEN   DC    A(*-BUFFER)         *L'BUFFER
RECLEN   DC    A(0)                *L'current input record
*-------------------------------------------------------------------*
*                                                                   *
* Logging line for client id                                        *
*                                                                   *
*-------------------------------------------------------------------*
DORD     DC    D'0'                *Work field for unpack
CLNLOGLN DC    0CL80' '
         DC    C'TPISERV Client ID '
         DC    C'Family='
CLNLOGAF DC    CL4' ',CL1' '       *Addressing Family
         DC    C'Address Space='
CLNLOGAS DC    CL8' ',CL1' '       *Address Space Name
         DC    C'Subtask='
CLNLOGST DC    CL8' '              *Subtask Name
         DC    CL(80-(*-CLNLOGLN))' '
*-------------------------------------------------------------------*
*                                                                   *
* Logging line for peer socket address                              *
*                                                                   *
*-------------------------------------------------------------------*
PERLOGLN DC    0CL80' '
         DC    C'Peer socket address - '
         DC    C'Family='
PERLOGAF DC    CL4' ',CL1' '       *Addressing Family
         DC    C'Port number='
PERLOGPO DC    CL5' ',CL1' '       *Port number
         DC    C'IP address='
PERLOGIP DC    CL15' '             *IP address
         DC    CL(80-(*-PERLOGLN))' '
*-------------------------------------------------------------------*
*                                                                   *
* Table with possible error codes and messages, that can be         *
* returned to the client in a response message.                     *
*                                                                   *
*-------------------------------------------------------------------*
MSGBXLE  DC    A(MSGST,84,MSGSL-84)
MSGST    EQU   *
         DC    CL4'0000',CL80'Processing completed successfully'
         DC    CL4'0001',CL80'No DB2 record exists for specified IP addC
               ress'
         DC    CL4'0002',CL80'DB2 record not added, specified IP addresC
               s already exists'
         DC    CL4'0003',CL80'Invalid record id received from client'
         DC    CL4'0004',CL80'Invalid Function code in request'
         DC    CL4'0005',CL80'Invalid IP address - syntax error'
         DC    CL4'0006',CL80'SQL error message'
         DC    CL4'0007',CL80'No Server is currently available - try agC
               ain later'
MSGSL    EQU   *
WTORREPL DC    CL2' '
WTORECB  DC    F'0'
         END
```

H.1.4 TPISERVD Concurrent Server DB2 Access

```
*********************************************************************
*                                                                   *
* Name:       TPISERVD                                              *
*                                                                   *
* Function:   This module processes the transactions received from  *
*             a TPI client.                                         *
*             The module is called from TPISERV when an input buffer*
*             has been received.                                    *
*                                                                   *
* Interface:  R1 -> parameter list with three pointers:             *
*             +0  -> TPISCB TPI Server task Control Block.          *
*             +4  -> Buffer holding input record and in which       *
*                    output record will be built.                   *
*             +8  -> Fullword with lenght of input record.          *
*                                                                   *
* Logic:      The input record is analyzed for a function code,     *
*             that identifies which processing is required by this  *
*             module.                                               *
*                                                                   *
*             Four basic functions are supported:                   *
*             A: Add a row to DB2. The passed buffer contains all   *
*                data required to build the SQL variables to be     *
*                inserted into DB2.                                 *
*             U: Update a row in DB2. The passed buffer contains all*
*                data of all columns in the row. All columns are    *
*                updated.                                           *
*             D: Delete a row in DB2. The passed buffer contains    *
*                the primary key: The IP address.                   *
*             Q: Query a row in DB2. The passed buffer contains the *
*                primary key: The IP address.  An output buffer will*
*                be constructed with data from all columns in the   *
*                row.                                               *
*                                                                   *
*             The following response codes can be returned from this*
*             module in a response record to the client:            *
*                                                                   *
*             0000 Successfull processing. If it was a query the    *
*                  rest of the record holds the fetched data.       *
*             0001 Requested row does not exist                     *
*             0002 Record not added - IP address already defined    *
*             0003 (Not returned by TPISERVD, but by TPISERV)       *
*             0004 Invalid function code in input record            *
*             0005 Invalid IP address - syntax error                *
*             0006 Undefined SQL error - SQLCode and first line     *
*                  of DSNTIAR message is returned                   *
*                                                                   *
* Abends:     - none -                                              *
*                                                                   *
* Returncode: - none -                                              *
*                                                                   *
* Written:    May 28'th 1994 at ITSO Raleigh                        *
*                                                                   *
* Modified:                                                         *
*                                                                   *
*********************************************************************
         PRINT GEN
TPISCB   TPISCB TYPE=DSECT         *Server task Control Block dsect
TPIMCB   TPIMCB TYPE=DSECT         *Main task Control Block dsect
         PUSH  PRINT
         EXEC SQL INCLUDE TPIREC
         POP   PRINT
```

```
TPIREC   TPIREC TYPE=DSECT         *TPI input and output record dsect
*
TPISERVD INIT  'TPI Server database access module',MODE=24,RENT=NO,    C
               BASE=(12,11)
*-------------------------------------------------------------------*
*                                                                   *
* Establish addressability to both Server task and Main task        *
* Control Blocks.                                                   *
*                                                                   *
* Pick up pointer to input buffer.  Data is in EBCDIC at this point *
* in time.                                                          *
*                                                                   *
* Acquire storege for SQL work area.                                *
*                                                                   *
*-------------------------------------------------------------------*
         L     R10,0(R1)           *-> Server task Control Block
         USING TPISCB,R10
         L     R9,TPISMCB          *-> Main task Control Block
         USING TPIMCB,R9
         L     R8,4(R1)            *-> Buffer holding input record
         USING TPIREC,R8
         TPITRC TYPE=INIT,         *Enable trace points               C
               TRACE=YES,                                            C
               MOD=TPISERVD        *Tracing module is TPISERVD
         L     R7,SQLDSIZ          *Length of SQL work area
         STORAGE OBTAIN,           *Getmain SQL                      C
               LENGTH=(R7),        *- Work area                      C
               LOC=BELOW
         LR    R7,R1               *-> SQL work area
         USING SQLDSECT,R7
*-------------------------------------------------------------------*
*                                                                   *
* IP address is presented to the user as max 15 character text      *
* string in dotted decimal notation.  The key in DB2 is a           *
* fullword in network byte order.                                   *
* Module TPIIADDR will convert from dotted decimal format to        *
* network byte order format.                                        *
*                                                                   *
*-------------------------------------------------------------------*
         LA    R2,IIPADDR          *-> 15 char ip address
         CALL  TPIIADDR,((R2),     *R2 point to dotted decimal value C
               HIPADDR),VL         *Convert to fullword
         LTR   R15,R15             *Was IP address OK ?
         BE    RECIAOK             *- Yes, it translated to fullword
         MVC   MSGCODE,=AL2(5)     *Invalid IP address format
         B     WRITEMSG            *Write back error message
*-------------------------------------------------------------------*
*                                                                   *
* Test for function code in received buffer and pass control to     *
* function specific parts of this module.                           *
*                                                                   *
*-------------------------------------------------------------------*
RECIAOK  EQU   *
         CLI   IRECID,IRECADD      *Is it Add ?
         BE    ADDREC              - Yes, do it.
         CLI   IRECID,IRECUPD      *Is it Update ?
         BE    UPDREC              - Yes, do it.
         CLI   IRECID,IRECQUE      *Is it Query ?
         BE    QUEREC              - Yes, do it.
         CLI   IRECID,IRECDEL      *Is it Delete ?
         BE    DELREC              - Yes, do it.
         MVC   MSGCODE,=AL2(4)     *Invalid function requested.
```

```
         B     WRITEMSG            *Return status message
*-------------------------------------------------------------------*
*                                                                   *
* Add a row to DB2 - key is IP address in network byte order.       *
* There is a unique index over the IP address column, so an         *
* attempt to insert an IP address, that already exists will give    *
* an SQL code = -803.                                               *
*                                                                   *
*-------------------------------------------------------------------*
ADDREC   EQU   *
         EXEC SQL INSERT INTO TPIDATA                              C
               VALUES(                                             C
               :HIPADDR,                                           C
               :IHOSTNM,                                           C
               :IADDNM,                                            C
               :IROOM,                                             C
               :IOWNER,                                            C
               :IOWNERPH,                                          C
               :IEQUIP,                                            C
               :IOPERSYS,                                          C
               :ITEXT)
         MVC   MSGCODE,=AL2(0)     *Anticipate record was added.
         CLC   SQLCODE,=A(0)       *Was insert succesfull?
         BE    WRITEMSG            *- Yes, OK response is set
         B     BADSQL              *Else send back SQL message
*-------------------------------------------------------------------*
*                                                                   *
* Select a row from DB2. As we only select on a unique key,         *
* the select can only return a single row, so we do not need to     *
* bother with cursors.                                              *
*                                                                   *
* If the select was successfull, the fetched IP address os          *
* converted from fullword format to dotted decimal format by        *
* module TPIINTOA, and a complete output buffer is built.           *
*                                                                   *
*-------------------------------------------------------------------*
QUEREC   EQU   *
         EXEC SQL SELECT * INTO                                    C
               :HIPADDR,                                           C
               :IHOSTNM,                                           C
               :IADDNM,                                            C
               :IROOM,                                             C
               :IOWNER,                                            C
               :IOWNERPH,                                          C
               :IEQUIP,                                            C
               :IOPERSYS,                                          C
               :ITEXT                                              C
               FROM TPIDATA                                        C
               WHERE IPADDR = :HIPADDR
         CLC   SQLCODE,=A(0)       *Was Query succesfull?
         BNE   BADSQL              *- No, send back SQL message
         LA    R2,IIPADDR          *Character IP address
         CALL  TPIINTOA,(HIPADDR,  *Fullword format                  C
               (R2)),VL            *- Convert to string
         MVC   ICODE,=CL4'0000'    *OK Message number
         MVI   IRECID,IQRESP       *Query response
         B     RETURN              *Everything OK for return
*-------------------------------------------------------------------*
*                                                                   *
* Update a row in DB2.  For reasons of simplicty, we expect that    *
* the input record contains values for all columns in the row, that *
* is updated.  A client would first issue a query to get the current *
```

```
* contents of the row - make the required modifications and return    *
* the full record in an update request.                               *
*                                                                     *
*---------------------------------------------------------------------*
UPDREC   EQU   *
         EXEC SQL UPDATE TPIDATA                                     C
               SET                                                   C
               IPADDR = :HIPADDR,                                    C
               HOSTNM = :IHOSTNM,                                    C
               ADDNM = :IADDNM,                                      C
               ROOM = :IROOM,                                        C
               OWNER = :IOWNER,                                      C
               OWNERPH = :IOWNERPH,                                  C
               EQUIP = :IEQUIP,                                      C
               OPERSYS = :IOPERSYS,                                  C
               TEXT = :ITEXT                                         C
               WHERE IPADDR = :HIPADDR
         CLC   SQLCODE,=A(0)       *Was update succesfull?
         BNE   BADSQL              *- No, send SQL message
         MVC   MSGCODE,=AL2(0)     *OK, Record was updated
         B     WRITEMSG            *Write back OK message
*---------------------------------------------------------------------*
*                                                                     *
* Delete a row in DB2.                                                *
*                                                                     *
*---------------------------------------------------------------------*
DELREC   EQU   *
         EXEC SQL DELETE FROM TPIDATA                                C
               WHERE IPADDR = :HIPADDR
         CLC   SQLCODE,=A(0)       *Was delete succesfull?
         BNE   BADSQL              *- No, send SQL message
         MVC   MSGCODE,=AL2(0)     *OK Record was deleted
         B     WRITEMSG            *Send OK message back
*---------------------------------------------------------------------*
*                                                                     *
* Build response header with response record id and code              *
* TPISERV will find a message based in the code and put that into     *
* output record, before it is sent.                                   *
*                                                                     *
*---------------------------------------------------------------------*
WRITEMSG EQU   *
         LH    R2,MSGCODE          *This message code to return
         CVD   R2,DORD             *We like character data..
         OI    DORD+7,X'0F'        *Reads nice and clear
         UNPK  ICODE,DORD          *Number into buffer
         MVI   IRECID,IRESP        *This is response message record id
         B     RETURN              *Return to TPISERV
*---------------------------------------------------------------------*
*                                                                     *
* If SQLcode <> 0, we come here.                                      *
*                                                                     *
* SQLCode = 100 is OK and means: Row not found - we return a          *
*               response code 0001 to the client.                     *
* SQLCode = -803 is also OK and means: You tried to insert an IP      *
*               address, that already existed - we return a           *
*               response code 0002 to the client.                     *
*                                                                     *
* Other SQLCodes are handed over to DSNTIAR for translation into      *
* some text. The full DSNTIAR Message is logged on the log file,      *
* the SQL Code and the first 75 bytes of the DSNTIAR message buffer   *
* are returned to the client as message text.                         *
*                                                                     *
```

```
*-------------------------------------------------------------------*
BADSQL   EQU   *
         CLC   SQLCODE,=F'100'     *Record not found?
         BE    SQLNOFND            *- Yes, we take care of this one
         CLC   SQLCODE,=F'-803'    *Duplicate record ID?
         BNE   SQLERR              *- No.
         MVC   MSGCODE,=AL2(2)     *This one we handle
         B     WRITEMSG            *Treat as normal response
SQLNOFND EQU   *
         MVC   MSGCODE,=AL2(1)     *We handle this one
         B     WRITEMSG            *Treat as normal response
SQLERR   EQU   *
         TPITRC 'Bad SQL Return Code',                              C
               W=SQLCODE           *Trace the SQLCode
         CALL  DSNTIAR,(SQLCA,     *SQL Communications Area         C
               DSNTIARA,           *DSNTIAR Return area             C
               DSNTIARP),VL        *L'DSNTIAR output lines
         LA    R3,DSNTIARA+2       *First line
         L     R4,DSNTIARP         *L'each line
         LR    R5,R3
         AH    R5,DSNTIARA         *First byte after area
         S     R5,DSNTIARP         *-> Last possible line
BADSQLLP EQU   *
         CLC   0(80,R3),=CL80' '   *Empty line=>no more
         BE    BADSQLNM            *We are done
         TPILOG MOD=TPISERV,       *Log the full                    C
               MSGNO=1,            *- DSNTIAR Message buffer        C
               TEXT=(R3)           *- on the log file
         BXLE  R3,R4,BADSQLLP      *Put them out all
BADSQLNM EQU   *
         MVC   IMESSAGE,=CL80' '   *Clear message area
         MVC   ICODE,=CL4'0006'    *SQL Error
         MVI   IRECID,IRESP        *Response record
         L     R2,SQLCODE          *This was the SQLCode
         LTR   R2,R2               *Was it negative?
         BP    BADSQLPO            *- No, it is positive
         LPR   R2,R2               *Ensure it is positive
         MVI   IMESSAGE,C'-'       *Show it was negative
BADSQLPO EQU   *
         CVD   R2,DORD
         OI    DORD+7,X'0F'
         UNPK  IMESSAGE+1(3),DORD  *Put it into message
         MVC   IMESSAGE+5(75),DSNTIARA+2 *First 75 bytes from DSNTIAR
*-------------------------------------------------------------------*
*                                                                   *
* Return to TPISERV, Output buffer has been built.                  *
*                                                                   *
*-------------------------------------------------------------------*
RETURN   EQU   *
         TERM RC=0
         LTORG
*-------------------------------------------------------------------*
*                                                                   *
* IP address transformation work areas and message code information  *
*                                                                   *
*-------------------------------------------------------------------*
HIPADDR  DC    F'0'               *Hexadecimal IP Address
HIPADDRT DC    CL15' '            *Character IP address
MSGCODE  DC    H'0'               *Return message code
DORD     DC    D'0'
*-------------------------------------------------------------------*
*                                                                   *
```

```
* SQL communications area and DSNTIAR message buffer                  *
*                                                                     *
*---------------------------------------------------------------------*
         EXEC SQL INCLUDE SQLCA
DSNTIARP DC    A(80)
DSNTIARA DS    0C
DSNTIARL DC    AL2(8*80)
         DC    8CL80' '
         END
```

H.1.5 TPISEND Send Data Over a Stream Socket

```
**********************************************************************
*                                                                    *
* Name:       TPISEND                                                *
*                                                                    *
* Function:   Issue SEND socket calls to send a specified            *
*             number of bytes.                                       *
*                                                                    *
* Interface:  R1 -> parameter list with the following pointers:      *
*             +0  -> EZA Global work area (In)                       *
*             +4  -> EZA Task work area (In)                         *
*             +8  -> Halfword woth socket descriptor (In)            *
*             +C  -> Buffer (In)                                     *
*             +10 -> Fullword with requested length (In)             *
*             +14 -> Fullword for actual length (Out)                *
*             +18 -> Fullword with SEND flags (In)                   *
*             +1C -> Fullword for SEND Retcode (Out)                 *
*             +20 -> Fullword for SEND Error code (Out)              *
*                                                                    *
* Logic:      This module is to send data from a buffer              *
*             to a socket.                                           *
*             The routine will repeat the send operation until       *
*             either the requested length has been sent or send      *
*             returns a length of zero (peer closed socket)          *
*                                                                    *
* Abends:     - none -                                               *
*                                                                    *
* Returncode: RC = 0  Everything OK                                  *
*             RC = 4  Peer closed the socket                         *
*             RC = 8  Examine Retcode and Errorcode for details      *
*                                                                    *
* Written:    June 18'th 1994 at ITSO Raleigh                        *
*                                                                    *
* Modified:                                                          *
*                                                                    *
**********************************************************************
PARMS    DSECT
PEZAGLOB DC    A(0)               *-> EZA Global workarea
PEZATASK DC    A(0)               *-> EZA Task workarea
PSD      DC    A(0)               *-> Socket descriptor
PBUFFER  DC    A(0)               *-> Send buffer
PREQLEN  DC    A(0)               *-> Word with requested length
PACTLEN  DC    A(0)               *-> Word to return actual length
PSENDFLG DC    A(0)               *-> Word with SEND flags
PRETCODE DC    A(0)               *-> Retcode to return
PERRNO   DC    A(0)               *-> Error no to return
*
         PRINT NOGEN
EZAGLOB  EZASMI TYPE=GLOBAL,       *EZA Global workarea              C
               STORAGE=DSECT
```

```
EZATASK  EZASMI TYPE=TASK,          *EZA Task workarea                 C
               STORAGE=DSECT
*
TPISEND  INIT  'TPI Send data over a socket',RENT=NO,                  C
               BASE=(12),MODE=24
*
         LR    R10,R1               *So we wont destroy it
         USING PARMS,R10            *Here we have them all
         L     R2,PSD               *-> Socket descriptor
         MVC   SD,0(R2)             *Now we have it
         L     R2,PREQLEN           *-> Requested length
         MVC   REQLEN,0(R2)         *Now we have it
         MVC   REMLEN,0(R2)         *Remaining length := requested len.
         L     R2,PBUFFER           *-> Buffer
         ST    R2,BUFNEXT           *Here to fetch first byte
         L     R2,PSENDFLG          *-> Send flags
         MVC   SENDFLAG,0(R2)       *Copy to us self
         L     R8,PEZAGLOB          *-> EZA Global workarea
         USING EZAGLOB,R8           *Addressability
         L     R9,PEZATASK          *-> EZA Task workarea
         USING EZATASK,R9           *Adressability
         XC    RC,RC                *RC = 0
         XC    RETCODE,RETCODE      *RETCODE = 0
         XC    ERRNO,ERRNO          *ERRNO = 0
         XC    ACTLEN,ACTLEN        *ACTLEN = 0
*
DOSEND   EQU   *
         L     R2,BUFNEXT           *-> Here to fetch data
         EZASMI TYPE=SEND,          *Send call                         C
               S=SD,                *From this socket descriptor       C
               NBYTE=REMLEN,        *Request remaining length          C
               BUF=(R2),            *-> Read data into buffer          C
               FLAGS=SENDFLAG,      *Send flags                        C
               ERRNO=ERRNO,         *Put error here                    C
               RETCODE=RETCODE      *Retcode/length here
         ICM   R15,15,RETCODE       *Let us have a look
         BM    EZAERROR             * < 0 Something seriously wrong
         BZ    SDCLOSED             * = 0 Means peer closed socket
         A     R15,ACTLEN           *Add to actual until now
         ST    R15,ACTLEN           *Update it
         L     R15,REMLEN           *Original remaining length
         S     R15,RETCODE          *Minus what we got now
         ST    R15,REMLEN           *New remaining length
         L     R2,BUFNEXT           *Here we started to fetch
         A     R2,RETCODE           *If more, fetch from here
         ICM   R15,15,REMLEN        *Is there more to send ?
         BNZ   DOSEND               *- Yes, do a new send
         B     RETURN               *- No, we have sent all
*
SDCLOSED EQU   *
         MVC   RC,=A(4)             *Set RC=4 for socket closed
         B     RETURN               *And return current status
EZAERROR EQU   *
         MVC   RC,=A(8)             *Set RC=8 for EZA error codes
         L     R2,PRETCODE          *-> Callers RETCODE
         MVC   0(L'RETCODE,R2),RETCODE *Return RETCODE to Caller
         L     R2,PERRNO            *-> Callers ERRNO
         MVC   0(L'ERRNO,R2),ERRNO *Return ERRNO to Caller
RETURN   EQU   *
         L     R2,PACTLEN           *-> Callers ACTLEN
         MVC   0(L'ACTLEN,R2),ACTLEN *Return actual length
         L     R15,RC               *Return code
```

```
         TERM  RC=R15
         LTORG
*
SD       DC    AL2(0)              *Socket descriptor
REQLEN   DC    A(0)                *Requested length
ACTLEN   DC    A(0)                *Sent so far
REMLEN   DC    A(0)                *Remaining length
BUFNEXT  DC    A(0)                *-> Where to fetch next byte
SENDFLAG DC    A(0)                *Send flags
RETCODE  DC    A(0)                *EZASMI Returncode
ERRNO    DC    A(0)                *EZASMI Error code
RC       DC    A(0)                *TPISEND Return code
*
         END
```

H.1.6 TPIRECV Receive Data Over a Stream Socket

```
*********************************************************************
*                                                                   *
* Name:       TPIRECV                                               *
*                                                                   *
* Function:   Issue RECV socket calls to receive a specified        *
*             number of bytes.                                      *
*                                                                   *
* Interface:  R1 -> parameter list with the following pointers:     *
*             +0  -> EZA Global work area (In)                      *
*             +4  -> EZA Task work area (In)                        *
*             +8  -> Halfword woth socket descriptor (In)           *
*             +C  -> Buffer (Out)                                   *
*             +10 -> Fullword with requested length (In)            *
*             +14 -> Fullword for actual length (Out)               *
*             +18 -> Fullword with RECV flags (In)                  *
*             +1C -> Fullword for RECV Retcode (Out)                *
*             +20 -> Fullword for RECV Error code (Out)             *
*                                                                   *
* Logic:      This module is to read data from a socket into a      *
*             program buffer.                                       *
*             The routine will repeat the RECV operation until      *
*             either the requested length has been read or RECV     *
*             returns a length of zero (peer closed socket)         *
*                                                                   *
* Abends:     - none -                                              *
*                                                                   *
* Returncode: RC = 0  Everything OK                                 *
*             RC = 4  Peer closed the socket                        *
*             RC = 8  Examine Retcode and Errorcode for details     *
*                                                                   *
* Written:    June 18'th 1994 at ITSO Raleigh                       *
*                                                                   *
* Modified:                                                         *
*                                                                   *
*********************************************************************
PARMS    DSECT
PEZAGLOB DC    A(0)                *-> EZA Global workarea
PEZATASK DC    A(0)                *-> EZA Task workarea
PSD      DC    A(0)                *-> Socket descriptor
PBUFFER  DC    A(0)                *-> Read buffer
PREQLEN  DC    A(0)                *-> Word with requested length
PACTLEN  DC    A(0)                *-> Word to return actual length
PRECVFLG DC    A(0)                *-> Word with RECV flags
PRETCODE DC    A(0)                *-> Retcode to return
```

```
PERRNO   DC    A(0)                *-> Error no to return
*
         PRINT NOGEN
EZAGLOB  EZASMI TYPE=GLOBAL,        *EZA Global workarea               C
               STORAGE=DSECT
EZATASK  EZASMI TYPE=TASK,          *EZA Task workarea                 C
               STORAGE=DSECT
*
TPIRECV  INIT  'TPI Receive data over a socket',RENT=NO,               C
               BASE=(12),MODE=24
*
         LR    R10,R1               *So we wont destroy it
         USING PARMS,R10            *Here we have them all
         L     R2,PSD               *-> Socket descriptor
         MVC   SD,0(R2)             *Now we have it
         L     R2,PREQLEN           *-> Requested length
         MVC   REQLEN,0(R2)         *Now we have it
         MVC   REMLEN,0(R2)         *Remaining length := requested len.
         L     R2,PBUFFER           *-> Buffer
         ST    R2,BUFNEXT           *Here to store first byte
         L     R2,PRECVFLG          *-> Receive flags
         MVC   RECVFLAG,0(R2)       *Copy to us self
         L     R8,PEZAGLOB          *-> EZA Global workarea
         USING EZAGLOB,R8           *Addressability
         L     R9,PEZATASK          *-> EZA Task workarea
         USING EZATASK,R9           *Adressability
         XC    RC,RC                *RC = 0
         XC    RETCODE,RETCODE      *RETCODE = 0
         XC    ERRNO,ERRNO          *ERRNO = 0
         XC    ACTLEN,ACTLEN        *ACTLEN = 0
*
DORECV   EQU   *
         L     R2,BUFNEXT           *-> Here to store data
         EZASMI TYPE=RECV,          *Receive call                      C
               S=SD,                *From this socket descriptor       C
               NBYTE=REMLEN,        *Request remaining length          C
               BUF=(R2),            *-> Read data into buffer          C
               FLAGS=RECVFLAG,      *Receive falgs                     C
               ERRNO=ERRNO,         *Put error here                    C
               RETCODE=RETCODE      *Retcode/length here
         ICM   R15,15,RETCODE       *Let us have a look
         BM    EZAERROR             * < 0 Something seriously wrong
         BZ    SDCLOSED             * = 0 Means peer closed socket
         A     R15,ACTLEN           *Add to actual until now
         ST    R15,ACTLEN           *Update it
         L     R15,REMLEN           *Original remaining length
         S     R15,RETCODE          *Minus what we got now
         ST    R15,REMLEN           *New remaining length
         L     R2,BUFNEXT           *Here we started to store
         A     R2,RETCODE           *If more, it goes here
         ICM   R15,15,REMLEN        *Is there more to receive ?
         BNZ   DORECV               *- Yes, do a new receive
         B     RETURN               *- No, we have it.
*
SDCLOSED EQU   *
         MVC   RC,=A(4)             *Set RC=4 for socket closed
         B     RETURN               *And return current status
EZAERROR EQU   *
         MVC   RC,=A(8)             *Set RC=8 for EZA error codes
         L     R2,PRETCODE          *-> Callers RETCODE
         MVC   0(L'RETCODE,R2),RETCODE *Return RETCODE to Caller
         L     R2,PERRNO            *-> Callers ERRNO
```

```
         MVC   0(L'ERRNO,R2),ERRNO *Return ERRNO to Caller
RETURN   EQU   *
         L     R2,PACTLEN          *-> Callers ACTLEN
         MVC   0(L'ACTLEN,R2),ACTLEN *Return actual length
         L     R15,RC              *Return code
         TERM  RC=R15
         LTORG
*
SD       DC    AL2(0)              *Socket descriptor
REQLEN   DC    A(0)                *Requested length
ACTLEN   DC    A(0)                *Read so far
REMLEN   DC    A(0)                *Remaining length
BUFNEXT  DC    A(0)                *-> Where to store next byte
RECVFLAG DC    A(0)                *Receive flags
RETCODE  DC    A(0)                *EZASMI Returncode
ERRNO    DC    A(0)                *EZASMI Error code
RC       DC    A(0)                *TPIRECV Return code
*
         END
```

H.1.7 TPIMCB Macro Main Task Control Block

```
         MACRO
&NAME TPIMCB &TYPE=DSECT
         PUSH  PRINT
         PRINT GEN
         AIF   ('&TYPE' EQ 'DSECT').DSEC
&NAME DS   0F
         AGO   .HDOK
.DSEC ANOP
&NAME DSECT
.HDOK ANOP
*********************************************************************
*                                                                   *
* TPI Main Control Block (TPIMCB).                                  *
*                                                                   *
*********************************************************************
TPIMEYE  DC    CL8'TPIMCB'         *Eyecatcher
TPIMGLOB DC    A(0)                *-> EZA Global workarea
TPIMDB2  DC    CL4' '              *DB2 Subsystem name to use
TPIMTCPI DC    CL8' '              *TCPIP Address space name
TPIMPORT DC    AL2(0)              *Listen port number
TPIMNOST DC    AL2(0)              *Number of server subtasks
TPIMMAXS DC    AL2(0)              *Maximum number of sockets
         DC    AL2(0)              *Reserved
TPIMMAXD DC    AL4(0)              *Maximum descriptor number
TPIMTCBE DC    CL8' '              *TCB Address in EBCDIC
TPIMSCBB DC    3A(0)               *TPISCB Table BXLE addresses
TPIMSOTB DC    3A(0)               *TPIMSO Table BXLE addresses
TPIMSOCK DC    A(0)                *Listen socket number
TPIMREIN DC    A(0)                *Times server reinstated
TPIMECBP DC    A(0)                *-> Main Wait ECBList
TPIMFECB DC    A(0)                *Modify ECB
TPIMECBS DC    A(0)                *Select ECB
TPIMCLNI DS    0C                  *Main task client id
TPIMCDOM DC    A(0)                *Domain: AF-INET
TPIMCNAM DC    CL8' '              *Our address space name
TPIMCTSK DC    CL8' '              *Our task id
         DC    20X'00'             *Reserved (part of clientid)
TPIMLQNM DC    CL8'TPI'            *TPI Log writer Qname
TPIMLRNM DC    CL8'TPILOGWT'       *TPI Log writer Rname
```

```
TPIMLDON DC    A(0)               *ECB for LOGWT to post, when done.
TPIMLECB DC    A(0)               *Log task wait-for-work ECB
TPIMLTCB DC    A(0)               *Log task TCB address
TPIMLMOD DC    CL8' '             *Module requesting log
TPIMLFUN DC    CL8' '             *EZASMI Function for log
TPIMLERR DC    A(0)               *EZASMI Error Number to be logged
TPIMLRET DC    A(0)               *EZASMI Return code to be logged
TPIMLMNO DC    A(0)               *Message number to be logged
TPIMLTXT DC    CL80' '            *Free message text to be logged
*
TPIMCBLN EQU   *-&NAME
         POP   PRINT
         MEND
```

H.1.8 TPISCB Macro Subtask Control Block

```
         MACRO
&NAME TPISCB &TYPE=DSECT
         AIF   ('&TYPE' EQ 'DSECT').DSEC
&NAME DS   0F
         AGO   .HDOK
.DSEC ANOP
&NAME DSECT
.HDOK ANOP
*********************************************************************
*                                                                   *
* TPI Server Control Block (TPISCB).                                *
*                                                                   *
*********************************************************************
TPISEYE  DC    CL8'TPISCB'        *Eyecatcher
TPISTASK DC    A(0)               *-> EZA Task workarea
TPISMCB  DC    A(0)               *-> TPIMCB
TPISTCB  DC    A(0)               *-> Subtask TCB
TPISTCBE DC    CL8' '             *Subtask TCB address in EBCDIC
TPISECB  DC    A(0)               *Subtask wait-for-work ECB
TPISTECB DC    A(0)               *Subtask termination ECB
TPISIECB DC    A(0)               *Subtask initialization ECB
TPISSOD  DC    AL2(0)             *Parent socket descr. no.
TPISNSOD DC    AL2(0)             *Subtask socket descr. no.
TPISCLNI DS    0C                 *Server task client id
TPISCDOM DC    A(0)               *Adressing Family
TPISCNAM DC    CL8' '             *Address space name
TPISCTSK DC    CL8' '             *Subtask name
         DC    20X'00'            *Reserver - part of clientid
TPISCTYP DC    X'00'              *Current Client option
TPISASCI EQU   BIT0               *- Client is ASCII based
TPISEBCD EQU   BIT1               *- Client is EBCDIC based
         DC    XL3'00'            *Reserved
*
TPISCBLN EQU   *-&NAME
         MEND
```

H.1.9 TPILOG Macro Issue Logwriter Request

```
         MACRO
         TPILOG &MOD=TPIMAIN,                                  C
               &FUNC=,                                         C
               &ERRNO=,                                        C
               &RETCODE=,                                      C
```

```
               &MSGNO=0,                                              C
               &TEXT='No text'
          GBLB  &TPILOGSW
          AIF   (&TPILOGSW).NOTFRST
          B     TPIA&SYSNDX.
MSEC200   DC    F'20'
MSEC500   DC    F'50'
TPILOGR2  DC    A(0)
TPILOGEQ  EQU   *
          LA    R14,TPIMLQNM
          LA    R15,TPIMLRNM
          ENQ   ((R14),(R15),E,8,STEP)
          BR    R2
TPILOGDQ  EQU   *
          LA    R14,TPIMLQNM
          LA    R15,TPIMLRNM
          DEQ   ((R14),(R15),8,STEP)
          BR    R2
&TPILOGSW SETB  1
TPIA&SYSNDX. EQU *
.NOTFRST  ANOP
          ST    R2,TPILOGR2         *Save work register
          BAL   R2,TPILOGEQ         *Do enqueue
          TM    TPIMLECB,BIT0       *Is he waiting
          BO    TPIL&SYSNDX.
          STIMER WAIT,BINTVL=MSEC500
          TM    TPIMLECB,BIT0       *Is he waiting
          BO    TPIO&SYSNDX.    *Drop it..
TPIL&SYSNDX. EQU *
          MVC   TPIMLMOD,=CL8'&MOD.'
          AIF   (T'&FUNC EQ 'O').NOFUNC
          AIF   ('&FUNC'(1,1) EQ '''').FUNSTR
          MVC   TPIMLFUN,&FUNC.
          AGO   .NOFUNC
.FUNSTR   ANOP
          MVC   TPIMLFUN,=CL8&FUNC.
.NOFUNC   ANOP
          XC    TPIMLERR,TPIMLERR
          AIF   (T'&ERRNO EQ 'O').NOERRNO
          MVC   TPIMLERR,&ERRNO
.NOERRNO  ANOP
          XC    TPIMLRET,TPIMLRET
          AIF   (T'&RETCODE EQ 'O').NORETC
          MVC   TPIMLRET,&RETCODE
.NORETC   ANOP
          LA    R15,&MSGNO
          ST    R15,TPIMLMNO
          AIF   (T'&TEXT EQ 'O').NOTEXT
          MVI   TPIMLTXT,C' '
          MVC   TPIMLTXT+1(L'TPIMLTXT-1),TPIMLTXT
          AIF   ('&TEXT'(1,1) EQ '''').TEXTSTR
          AIF   ('&TEXT'(1,1) EQ '(').REGADR
          MVC   TPIMLTXT(L'&TEXT),&TEXT.
          AGO   .NOTEXT
.REGADR   ANOP
          MVC   TPIMLTXT,0&TEXT.
          AGO   .NOTEXT
.TEXTSTR  ANOP
          LCLA  &NBYTES
&NBYTES   SETA  K'&TEXT
&NBYTES   SETA  &NBYTES-2
          MVC   TPIMLTXT(&NBYTES.),=C&TEXT.
```

```
.NOTEXT ANOP
         XC    TPIMLDON,TPIMLDON
         POST  TPIMLECB,0          *Wake him up
         WAIT  ECB=TPIMLDON        *Wait for him to do it
TPIO&SYSNDX. EQU *
         BAL   R2,TPILOGDQ         *Do dequeue
         L     R2,TPILOGR2         *Restore work register
         MEND
```

H.1.10 TPITRC Macro Issue Trace Request

```
         MACRO
         TPITRC &TXT,&REG=,&WORD=,&H=,&W=,&MOD=, C
               &TYPE=TRACE,&TRACE=YES
         GBLB  &TRCSW
         GBLB  &TPITRC
         GBLC  &TPITRCM
         AIF   (&TRCSW).NOTFRST
         B     TRCA&SYSNDX.
TPITRCTX DS    0CL80
TPITRCHX DC    CL8' ',CL1' '
TPITRCT  DC    CL71' '
TRCHEX   DC    C'0123456789ABCDEF'
TRCDWORD DC    D'0'
         DS    0F
TRCA&SYSNDX. EQU *
&TRCSW SETB 1
&TPITRC SETB 1
.NOTFRST ANOP
         AIF   (&TPITRC).TRON
         MEXIT
.TRON ANOP
         AIF   ('&TYPE' EQ 'TRACE').DOTRCE
         AIF   ('&TRACE' EQ 'YES').TRYES
&TPITRC SETB 0
         MEXIT
.TRYES ANOP
&TPITRCM SETC '&MOD.'
         MEXIT
.DOTRCE ANOP
         AIF   (T'&REG EQ 'O').NOREG
         LR    R15,&REG
         AGO   .COMM
.NOREG ANOP
         AIF   (T'&WORD EQ 'O').NOWORD
         L     R15,&WORD
         AGO   .COMM
.NOWORD ANOP
         AIF   (T'&W EQ 'O').NOW
         L     R15,&W
         AGO   .COMM
.NOW ANOP
         AIF   (T'&H EQ 'O').NOH
         LH    R15,&H
         AGO   .COMM
.NOH ANOP
.COMM ANOP
         SR    R14,R14
         SLDL  R14,4
         STM   R14,R15,TRCDWORD
         UNPK  TPITRCHX,TRCDWORD
```

```
         NC    TPITRCHX,=8X'0F'
         TR    TPITRCHX,TRCHEX
         AIF   (T'&TXT NE 'O').TEXTOK
         MVC   TPITRCT,=CL71'Trace entry'
         AGO   .DOLOG
.TEXTOK ANOP
         MVI   TPITRCT,C' '        *Clear the text field
         MVC   TPITRCT+1(L'TPITRCT-1),TPITRCT
         LCLA  &NBYTES
&NBYTES SETA K'&TXT
&NBYTES SETA &NBYTES-2
         MVC   TPITRCT(&NBYTES.),=C&TXT.
.DOLOG ANOP
         TPILOG MOD=&TPITRCM.,MSGNO=1,TEXT=TPITRCTX
         MEND
```

H.1.11 TPIMASK Macro Set and Test Bits in Select Mask

```
         MACRO
         TPIMASK &TYPE,&MASK=,&SD=
         SR    R14,R14             *Nullify
         AIF   ('&SD'(1,1) EQ '(').SDREG
         LH    R15,&SD             *Socket descriptor
         AGO   .SDOK
.SDREG ANOP
         LR    R15,&SD             *Socket descriptor
.SDOK ANOP
         D     R14,=A(32)              *Divide by 32
         SLL   R15,2                   *Multiply offset with word length
         AIF   ('&MASK'(1,1) EQ '(').MASKREG
         LA    R1,&MASK            *Here mask starts
         AGO   .MASKOK
.MASKREG ANOP
         LR    R1,&MASK            *Here mask starts
.MASKOK ANOP
         AR    R15,R1                  *Here our word starts
         LA    R1,1                    *Rightmost bit on
         SLL   R1,0(R14)               *Shift left rest from division
         O     R1,0(R15)               *Or bits from mask
         AIF   ('&TYPE' EQ 'SET').DOSET
         C     R1,0(R15)               *If equal, bit was on
         MEXIT
.DOSET ANOP
         ST    R1,0(R15)               *New mask
         MEND
```

H.1.12 TPIREC Macro DB2 Row Layout

```
         MACRO
&NAME TPIREC &TYPE=DSECT
         PUSH  PRINT
         PRINT GEN
         AIF   ('&TYPE' EQ 'DSECT').DSEC
&NAME DS   0F
         AGO   .HDOK
.DSEC ANOP
&NAME DSECT
.HDOK ANOP
*********************************************************************
```

```
*                                                                     *
* TPI Input or Output recprd                                          *
*                                                                     *
***********************************************************************
IRECID   DC    CL1'0'              *Record ident
IRECADD  EQU   C'1'                *Add a record
IRECUPD  EQU   C'2'                *Update a record
IRECQUE  EQU   C'3'                *Query a record
IRECDEL  EQU   C'4'                *Delete a record
IQRESP   EQU   C'A'                *OK Response to query Incl. data
IRESP    EQU   C'B'                *Response
IIDENT   DC    CL4'TPI '           *Fixed text (ASCII/EBCDIC)
ICODE    DC    CL4' '              *Return code
*
IIPADDR  DC    CL15' '             *IP Addr. in text
IHOSTNM  DC    CL18' '             *Host name (with domorigin)
IADDNM   DC    CL18' '             *Additional name ident
IROOM    DC    CL10' '             *ITSO Room number
IOWNER   DC    CL32' '             *Owners name
IOWNERPH DC    CL16' '             *Owners phone number
IEQUIP   DC    CL16' '             *Equipment type
IOPERSYS DC    CL16' '             *Operating system
ITEXT    DC    CL80' '             *Additional text
*
         ORG   IIPADDR
IMESSAGE DC    CL80' '             *Status message
         ORG
IRECLEN  EQU   *-&NAME.
         MEND
```

H.1.13 TPIMSO Macro Socket Descriptor Table

```
         MACRO
&NAME TPIMSO &TYPE=DSECT
         AIF   ('&TYPE' EQ 'DSECT').DSEC
&NAME DS   0F
         AGO   .HDOK
.DSEC ANOP
&NAME DSECT
.HDOK ANOP
***********************************************************************
*                                                                     *
* TPI Main task Socket Descriptor Table Entry (TPIMSO)                *
*                                                                     *
***********************************************************************
TPIMSEYE DC    CL8'TPIMSO'         *Eye catcher
TPIMSNO  DC    AL2(0)              *Main task socket number
TPIMSBIT DC    X'00'               *Status bits
TPIMSACT EQU   BIT0                *This socket is in use
TPIMSLIS EQU   BIT1                *This is main listen socket
TPIMSREA EQU   BIT2                *Read OK (only Listen socket)
TPIMSWRT EQU   BIT3                *Write OK if TPIMSENO<>0
TPIMSEXP EQU   BIT4                *Exception expected (Takesocket)
         DC    X'00'               *Reserved
TPIMSENO DC    AL2(0)              *Pending Error number
TPIMSSOC DS    0C                  *Socket structure
TPIMSFAM DC    AL2(0)              *Addressing family
TPIMSPOR DC    AL2(0)              *Peer port number
TPIMSADR DC    AL4(0)              *Peer IP address
         DC    XL8'00'             *Reserved
*
```

```
TPIMSOLN EQU   *-&NAME
         MEND
```

H.2 TPI REXX Client Application

The TPI REXX client consists of a REXX program, an ISPF panel and an ISPF message definition member.

H.2.1 TPI REXX Client

```
/* REXX */
/*--------------------------------------------------------------------*/
/*                                                                    */
/* Name:       TPIREXXC - TPI Demo application REXX Client            */
/*                                                                    */
/* Function:   Controls user interface for update and query of        */
/*             TPI data. User interface is ISPF panel. Communication*/
/*             with TPI server is via REXX Socket interface.          */
/*                                                                    */
/* Interface:  - none -                                               */
/*                                                                    */
/* Logic:      This REXX controls a user dialog, where the user       */
/*             uses ISPF panels to interface to the TPI server. The */
/*             REXX pgm. builds a transaction, which is sent to the */
/*             TPI server over a socket connection, receives the      */
/*             response and displays it to the user.                  */
/*                                                                    */
/* Returncode: RC = 0, processing OK                                  */
/*             Everything else is non-successful returncode from      */
/*             socket interface.                                      */
/*                                                                    */
/* Written:    April 13, 1995 at ITSO Raleigh                         */
/*                                                                    */
/* Modified:                                                          */
/*                                                                    */
/*--------------------------------------------------------------------*/
dotrace = 0                                 /*Controls tracing      */
                                            /*dotrace = 1 for trace */
tpiport = '9999'                            /*Server port number    */
tpiserver = 'mvs18'                         /*Server host name      */
subtaskid = 'tpirexxc'                      /*Subtask id            */
/*--------------------------------------------------------------------*/
/*                                                                    */
/* All socket calls are performed by subroutine DoSocket              */
/*                                                                    */
/*--------------------------------------------------------------------*/
sockval = DoSocket('Terminate')             /*Ensure clean interface*/
/*--------------------------------------------------------------------*/
/*                                                                    */
/* Initialize REXX socket interface                                   */
/* and get our own TCP/IP Client id.                                  */
/*                                                                    */
/*--------------------------------------------------------------------*/
Address TSO "ALLOC FI(SYSTCPD) DA('SYS1.TCPPARMS(TCPDATA)') SHR"
sockval = DoSocket('Initialize', subtaskid)
```

```
if sockrc <> 0 then do
   say 'Initialize failed, rc='sockrc
   exit(sockrc)
end
sockval = DoSocket('Getclientid')
if sockrc <> 0 then do
   say 'Getclientid failed, rc='sockrc
   exit(sockrc)
end
servipaddr = DoSocket('Gethostbyname', tpiserver)
if sockrc <> 0 then do
   say 'Gethostbyname failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
numips = words(servipaddr)
parse value servipaddr with s1 s2 s3 s4 s5 s6 s7 s8 s9
do i = 1 to numips
  sipaddr.i = word(servipaddr, i)
  if dotrace then say 'sipaddr.'i' = 'sipaddr.i
end
sipaddr.0 = numips
if dotrace then say 'Number of IP addresses = 'sipaddr.0
/*--------------------------------------------------------------------*/
/*                                                                    */
/* Initialize REXX and ISPF variables                                 */
/*                                                                    */
/*--------------------------------------------------------------------*/
ispfloop = 0
tpiact = 'Q'
tpiip = ''
tpihost = ''
tpiaddnm = ''
tpiroom = ''
tpiowner = ''
tpiphone = ''
tpiequip = ''
tpios = ''
tpitext = ''
tpimsg = ''
/*--------------------------------------------------------------------*/
/*                                                                    */
/* Display dataentry panel, process input until user presses PF3      */
/*                                                                    */
/*--------------------------------------------------------------------*/
Do until ispfloop
  address ispexec "Display panel(tpi)"
  if rc > 0 then do
    ispfloop = 1
    iterate
  end
  if tpiact = 'A' | tpiact = 'U' then do
    /*----------------------------------------------------------------*/
    /*                                                                */
    /* If user wants to add or update TPI information, build a        */
    /* TPI ADD or UPDATE transaction string.                          */
    /*                                                                */
    /*----------------------------------------------------------------*/
    recident = 'TPI '
    reccode = '0000'
    recipaddr = substr(tpiip,1,15)
    rechostnm = substr(tpihost,1,18)
```

```
  recaddnm = substr(tpiaddnm,1,18)
  recroom = substr(tpiroom,1,10)
  recowner = substr(tpiowner,1,32)
  recownerph = substr(tpiphone,1,16)
  recequip = substr(tpiequip,1,16)
  recopersys = substr(tpios,1,16)
  rectext = substr(tpitext,1,80)
  if tpiact = 'A' then recid = '1'
  if tpiact = 'U' then recid = '2'
  record = recid||recident||reccode||recipaddr||rechostnm||recaddnm
  record = record||recroom||recowner||recownerph||recequip||recopersys
  record = record||rectext
end
else do
  /*-----------------------------------------------------------------*/
  /*                                                                 */
  /* If user wants to delete or query TPI information, build a       */
  /* TPI DELETE or QUERY transaction string.                         */
  /*                                                                 */
  /*-----------------------------------------------------------------*/
  recident = 'TPI '
  reccode = '0000'
  recipaddr = substr(tpiip,1,15)
  if tpiact = 'Q' then recid = '3'
  if tpiact = 'D' then recid = '4'
  record = recid||recident||reccode||recipaddr
end
/*-------------------------------------------------------------------*/
/*                                                                   */
/* Get a socket and try to connect to the server                     */
/*                                                                   */
/* If connect fails (ETIMEDOUT), we must close the socket,           */
/* get a new one and try to connect to the next IP address           */
/* in the list we received on the gethostbyname call.                */
/*                                                                   */
/*-------------------------------------------------------------------*/
i = 1
connected = 0
do until (i > sipaddr.0 | connected)
   sockdescr = DoSocket('Socket')
   if sockrc <> 0 then do
      say 'Socket failed, rc='sockrc
      x=Doclean
      exit(sockrc)
   end
   name = 'AF_INET '||tpiport||' '||sipaddr.i
   sockval = DoSocket('Connect', sockdescr, name)
   if sockrc = 0 then do
      connected = 1
   end
   else do
      parse value respdata with resplen response
      sockval = DoSocket('Close', sockdescr)
      if sockrc <> 0 then do
         say 'Close failed, rc='sockrc
         x=Doclean
         exit(sockrc)
      end
   end
   i = i + 1
end
if ,connected then do
```

```
   say 'Connect failed, rc='sockrc
   say sockval
   x=Doclean
   exit(sockrc)
end
/*-------------------------------------------------------------------*/
/*                                                                   */
/* Send the TPI transaction to the TPI server                        */
/*                                                                   */
/*-------------------------------------------------------------------*/
sockval = DoSocket('Write', sockdescr, record)
if dotrace then say 'Write returned: 'sockval
if sockrc <> 0 then do
   say 'Write failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
/*-------------------------------------------------------------------*/
/*                                                                   */
/* Read the response from the TPI Server                             */
/*                                                                   */
/*-------------------------------------------------------------------*/
respdata = DoSocket('Read', sockdescr)
if sockrc <> 0 then do
   say 'Read failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
/*-------------------------------------------------------------------*/
/*                                                                   */
/* Close the socket                                                  */
/*                                                                   */
/*-------------------------------------------------------------------*/
parse value respdata with resplen response
sockval = DoSocket('Close', sockdescr)
if sockrc <> 0 then do
   say 'Socket Close failed, rc='sockrc
   x=Doclean
   exit(sockrc)
end
if substr(response,1,1) = 'A' then do
  /*-----------------------------------------------------------------*/
  /*                                                                 */
  /* If it is a query response, the returned string is a             */
  /* complete TPI record, which will be unpacked into the            */
  /* corresponding REXX variables.                                   */
  /*                                                                 */
  /*-----------------------------------------------------------------*/
  tpiip = substr(response,10,15)
  tpihost = substr(response,25,18)
  tpiaddnm = substr(response,43,18)
  tpiroom = substr(response,61,10)
  tpiowner = substr(response,71,32)
  tpiphone = substr(response,103,16)
  tpiequip = substr(response,119,16)
  tpios = substr(response,135,16)
  tpitext = substr(response,151,80)
 end
else do
  /*-----------------------------------------------------------------*/
  /*                                                                 */
  /* If it is non-query response, the returned string holds          */
```

```
    /* a TPI response code and optionally a return message.         */
    /*                                                              */
    /* Response code = 0000 means succesfull completion.            */
    /*                                                              */
    /*--------------------------------------------------------------*/
    if substr(response,6,4) = '0000' then do
       tpimsg = ' '
       address ispexec "setmsg msg(tpi004)"
     end
    else do
      /*------------------------------------------------------------*/
      /*                                                            */
      /* Response code = 0003 means no data found on a query        */
      /* request.                                                   */
      /*                                                            */
      /* Clear out all variables.                                   */
      /*                                                            */
      /*------------------------------------------------------------*/
      tpimsg = substr(response,10,80)
      tpirespc = substr(response,6,4)
      address ispexec "setmsg msg(tpi003)"
      if tpirespc = '0001' then do
         address ispexec "setmsg msg(tpi005)"
         tpimsg = ' '
         tpihost = ''
         tpiaddnm = ''
         tpiroom = ''
         tpiowner = ''
         tpiphone = ''
         tpiequip = ''
         tpios = ''
         tpitext = ''
      end
      /*------------------------------------------------------------*/
      /*                                                            */
      /* Response code = 0002 means data was not added - TPI        */
      /* data for specified IP address already existed.             */
      /*                                                            */
      /*------------------------------------------------------------*/
      if tpirespc = '0002' then do
         address ispexec "setmsg msg(tpi006)"
         tpimsg = ' '
      end
    end
  end
end
/*----------------------------------------------------------------*/
/*                                                                */
/* Terminate socket interface                                     */
/*                                                                */
/*----------------------------------------------------------------*/
sockval = DoSocket('Terminate')
if sockrc <> 0 then do
   say 'Socket Close failed, rc='sockrc
   exit(sockrc)
end
Exit(0)

/*----------------------------------------------------------------*/
/*                                                                */
/* Doclean Procedure.                                             */
/*                                                                */
```

```
/* If a socket call failed and we are about to exit this           */
/* Rexx application, close the socket and terminate the            */
/* socket interface.                                               */
/*                                                                 */
/*-----------------------------------------------------------------*/
Doclean:
   if dotrace then do
      say 'Cleaning up socket descriptor = 'sockdescr
   end
   sockval = DoSocket('Close', sockdescr)
   sockval = DoSocket('Terminate')
return sockres

/*-----------------------------------------------------------------*/
/*                                                                 */
/* DoSocket procedure.                                             */
/*                                                                 */
/* Do the actual socket call, and parse the return code.           */
/* Return rest of string returned from socket call.                */
/*                                                                 */
/*-----------------------------------------------------------------*/
DoSocket:
  numargs = ARG()                          /*Number of passed args */
  argstring = ''                           /*Init arg string       */
  if dotrace then do                       /*Tracepoint            */
     say 'DoSocket subroutine'             /*Trace entry to routine*/
     say ' - Number of args = 'numargs     /*Trace number of args  */
  end                                      /*                      */
  do subix=1 to numargs                    /*Build argument string */
     if dotrace then do                    /*Tracepoint            */
        say ' - arg('subix') = 'arg(subix) /*Trace each argument   */
     end                                   /*                      */
     argstring = argstring||'arg('subix')' /*for the socket call   */
     if subix<numargs then do              /*If not last argument -*/
        argstring = argstring||','         /*add a comma           */
     end                                   /*                      */
  end                                      /*                      */
  msgstat = msg()                          /*Save message status   */
  z = msg("OFF")                           /*Turn messages off     */
  interpret 'Parse value Socket('||argstring||') with sockrc sockres'
  z = msg(msgstat)                         /*Restore message status*/
  if dotrace then do                       /*Tracepoint            */
     say ' - return code   = 'sockrc       /*Trace returncode      */
     say ' - return string = 'sockres      /*Trace return string   */
  end                                      /*                      */
return sockres                             /*Return socket result  */
```

H.2.2 TPI REXX Client ISPF Panel Definition

```
)ATTR
@ type(text) intens(high) color(turq)   /*hilite(reverse)*/
$ type(text) intens(high) color(green)  /*hilite(reverse)*/
% type(text) intens(high) color(red)    /*hilite(reverse)*/
+ type(text) intens(high) color(white)  /*hilite(reverse)*/
! type(text) intens(high) color(turq)   /*hilite(reverse)*/
? type(text) intens(high) color(yellow) /*hilite(reverse)*/
_ type(input) intens(high) color(turq) caps(on)
? type(input) intens(high) color(turq) caps(off)
)body
!-----------------  TCP/IP MVS Programming Interfaces  -----------------------
$OPTION  ===>_ZCMD
```

```
%
$
$  Function  . . . .%==>_Z+ (+A$Add,+D$Delete,+Q$Query or+U$Update)
$
!IP Host information:
$  IP address  . . .%==>_TPIIP          $    In dotted decimal form
$  Hostname  . . . .%==>?TPIHOST           $ Hostname without domain origin
$  Additional name .%==>?TPIADDNM          $ MAC address or SNA PU name
$  Room number . . .%==>?TPIROOM  $          Room number xx-nnn
$  Owner name  . . .%==>?TPIOWNER                      $
$  Owners phone no .%==>?TPIPHONE        $
$  Equipment type  .%==>?TPIEQUIP        $
$  Operating system %==>?TPIOS           $   Operating system name and version
$  Additional text .%==>?TPITEXT
                        %
$
$  &TPIMSG                                                                  $
$
$Enter%END$command to terminate TPI Application
$
%
)INIT
 .ZVARS= '(TPIACT)'
)PROC
 Ver (&tpiact,list,A,D,Q,U,msg=tpi001)
 Ver (&tpiip,nonblank,msg=tpi002)
)END
```

H.2.3 TPI REXX Client ISPF Message Definitions

```
TPI001   'Invalid action code     ' .TYPE=ACTION
'TPI001E: Action code &tpiact. is invalid.  You may choose '+
'between A for Add, U for Update, D for Delete or Q for Query.' +
'Use a Query before you do an Update.'
TPI002   'IP address is required  ' .TYPE=ACTION
'TPI002E: You must type in an IP address for all request types.'
TPI003   'Error response received ' .TYPE=WARNING
'TPI003E: Server returned a negative response with code=&tpirespc.'
TPI004   'Processing successfull  ' .TYPE=WARNING
'TPI004I: Request processed successfully.'
TPI005   'No record found         ' .TYPE=ACTION
'TPI005E: No DB2 record exists for specified IP address.'
TPI006   'Duplicate IP address    ' .TYPE=ACTION
'TPI006E: Specified IP Address already exists in DB2.'
```

H.3 TPI DB2 Table Definition

```
create table tpidata (ipaddr int not null,
                      hostnm char(18),
                      addnm char(18),
                      room char(10),
                      owner char(32),
                      ownerph char(16),
                      equip char(16),
                      opersys char(16),
                      text char(80),
                      primary key(ipaddr));
create unique index tpiindex on tpidata (ipaddr);
commit;
```

H.4 Sample Log from TPI Server Execution

The following is an example of logwriter output from an execution of the TPI concurrent server. Two server subtasks are started, and one client connection is processed before the server is modified to close down.

```
TPI Log Writer Task has started
13:11:11.16 TPIMAIN  001 TPIMAIN Client ID Family=0002 Address Space=T18ATPI  Subtask=008FDA28
13:11:11.90 TPISERV  001 00005EF8 TPISERV entered
13:11:12.20 TPISERV  001 TPISERV Client ID Family=0002 Address Space=T18ATPI  Subtask=008F0BF8
13:11:12.20 TPISERV  001 00005EF8 TPISERV Going to sleep.
13:11:12.52 TPISERV  001 00005F50 TPISERV entered
13:11:12.53 TPISERV  001 TPISERV Client ID Family=0002 Address Space=T18ATPI  Subtask=008F0968
13:11:12.54 TPISERV  001 00005F50 TPISERV Going to sleep.
13:11:12.54 TPIMAIN  001 00000000 Socket descriptor from SOCKET Call
13:11:12.54 TPIMAIN  001 00000000 Issuing BIND with socket descriptor
13:11:12.54 TPIMAIN  001 00000000 Issuing LISTEN with socket descriptor
13:11:12.55 TPIMAIN  001 00000031 Issuing SELECT with MAXSOC
13:12:28.49 TPIMAIN  001 00000001 SYNC completed - number of SDs returned  1
13:12:28.50 TPIMAIN  001 00000000 Issuing ACCEPT  2
13:12:28.50 TPIMAIN  001 00000001 ACCEPT returned new socket descriptor
13:12:28.50 TPIMAIN  001 Givesocket SD=0001 Family=0002 Address Space=T18ATPI  Subtask=008F0BF8  3
13:12:28.51 TPIMAIN  001 00000031 Issuing SELECT with MAXSOC  4
13:12:28.51 TPISERV  001 40000000 TPISERV Woke up  5
13:12:28.51 TPISERV  001 00000001 Takesocket With old descriptor  5
13:12:28.52 TPISERV  001 00000000 Takesocket returned new descriptor  5
13:12:28.52 TPIMAIN  001 00000001 SYNC completed - number of SDs returned  6
13:12:28.52 TPISERV  001 Peer socket address - Family=0002 Port number=01024 IP address=9.67.56.81
13:12:28.52 TPIMAIN  001 00000001 Closing down socket  7
13:12:28.53 TPIMAIN  001 00000031 Issuing SELECT with MAXSOC  8
13:12:29.90 TPISERV  001 00000005 Peek returned so many bytes  9
13:12:29.93 TPISERV  001 00000018 Receive returned so many bytes
13:12:31.68 TPISERV  001 000000E6 Sent so many bytes
13:12:31.69 TPISERV  001 00000000 Close done
13:12:31.72 TPISERV  001 00005EF8 TPISERV Going to sleep.
13:15:25.29 TPIMAIN  011 TPIMAIN Modified to STOP - we close down.
13:15:25.35 TPISERV  001 40000004 TPISERV Woke up
13:15:25.36 TPISERV  001 40000004 TPISERV is shutting down
13:15:25.85 TPISERV  001 40000004 TPISERV Woke up
13:15:25.85 TPISERV  001 40000004 TPISERV is shutting down
```

The first column is a timestamp column. The second column is the name of the module that requested the line printed on the log. Third column is an internal message number. The remaining part of a log line is free format.

Note the sequence of events around the client connection:

1. Main task is posted in its **select**.
2. Main task issues **accept**.
3. Main task issues **givesocket** and posts subtask to start processing.
4. Main task enters a new **select**.
5. Subtask wakes up and issues a **takesocket**.
6. Main task is again posted in its **select**
7. Main task closes the socket it gave to the subtask.
8. Main task issues a new **select**.
9. Subtask goes on processing the client request.

I.0 Appendix I. Sample Compile and Link JCL Procedures

This appendix contains the compilation and link procedures that were used to compile and link the sample programs in this book.

The procedures use an ITSO utility program called JCLTEST. This program compares two comma-separated strings that are passed in the PARM field. If the strings are equal, it returns a return code of zero. We used this program to set return codes to be used by the conditional JCL statements. Using this technique, we avoided maintaining four different procedures per language; but we were able to package all combinations of SQL, CICS and code without SQL or CICS into one procedure per language.

I.1 Assemble JCL Procedure

```
//TCPASM  PROC MEMBER=TEMPNAME,
//             USER=TCPIP,
//             MLQ=ITSC,
//             SUFFIX=1$,
//             WSPC=500,
//             DB2=,
//             TCPMLQ=V3R1M0,
//             OUTC='*',
//             WORK=SYSDA,
//             ASMPARM='OBJECT,NODECK,NOXREF'
//*****************************************************************
//*                                                               *
//* TCP/IP MVS V3R1 - ITSO, Raleigh                               *
//*                                                               *
//* Assemble an Assembler module                                  *
//* ----------------------------                                  *
//*                                                               *
//* Input:        user.mlq.ASM(member)                            *
//* Macroes:      user.mlq.ASM                                    *
//* Object deck:  user.mlq.OBJ(member)                            *
//*                                                               *
//* MEMBER        Module member name                              *
//* USER          HLQ for source, object and list datasets        *
//* MLQ           MLQ for source, object and list datasets        *
//* DB2           Specify DB2=YES if source includes SQL stmt's   *
//* CICS          Specify CICS=YES if source includes CICS stmt's *
//* TCPMLQ        TCPIP dataset MLQ                               *
//* SUFFIX        CICS translator module suffix                   *
//* ASMPARM       Assembler parameters                            *
//* OUTC          Output class for SYSOUT                         *
//* WORK          Work UNIT                                       *
//*                                                               *
//*****************************************************************
//*
//DB2TEST EXEC PGM=JCLTEST,PARM='YES,&DB2.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
// IF (DB2TEST.RC=0) THEN       *** Include DB2 Precompile ***
//*
//DB2PRE  EXEC PGM=DSNHPC,PARM='HOST(ASM),TWOPASS',REGION=4096K
//DBRMLIB  DD  DSN=&USER..&MLQ..DBRMLIB.DATA(&MEMBER),DISP=SHR
//STEPLIB  DD  DSN=SYS1.DSN230.DSNEXIT,DISP=SHR
//         DD  DSN=SYS1.DSN230.DSNLOAD,DISP=SHR
```

```
//SYSCIN   DD  DSN=&&DSNHOUT,DISP=(MOD,PASS),UNIT=&WORK.,
//             SPACE=(800,(&WSPC,&WSPC))
//SYSLIB   DD  DSN=&USER..&MLQ..ASM,DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSTERM  DD  SYSOUT=&OUTC.
//SYSUDUMP DD  SYSOUT=&OUTC.
//SYSUT1   DD  SPACE=(800,(&WSPC,&WSPC),,,ROUND),UNIT=&WORK.
//SYSIN    DD  DSN=&USER..&MLQ..ASM(&MEMBER.),DISP=SHR
//*
// ELSE                *** No DB2 precompile, copy input ***
//*
//DB2NO   EXEC PGM=IEBGENER
//SYSIN    DD  DUMMY
//SYSUT1   DD  DSN=&USER..&MLQ..ASM(&MEMBER.),DISP=SHR
//SYSUT2   DD  DSN=&&DSNHOUT,DISP=(MOD,PASS),UNIT=&WORK.,
//             SPACE=(800,(&WSPC,&WSPC))
//SYSPRINT DD  DUMMY
//*
// ENDIF               *** End of DB2 section
//*
//CICSTEST EXEC PGM=JCLTEST,PARM='YES,&CICS.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
// IF (CICSTEST.RC = 0) THEN *** CICS Translation ***
//*
//CICSTRN EXEC PGM=DFHEAP&SUFFIX,
//             REGION=4096K
//STEPLIB  DD  DSN=CICS.SDFHLOAD,DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC
//SYSPUNCH DD  DSN=&&SYSCIN,
//             DISP=(NEW,PASS),UNIT=&WORK,
//             DCB=BLKSIZE=400,
//             SPACE=(400,(400,100))
//SYSIN    DD  DSN=&&DSNHOUT,DISP=(OLD,DELETE)
//*
// ELSE                *** No CICS Translation, copy input ***
//*
//CICSCOPY EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=&&DSNHOUT,DISP=(OLD,DELETE)
//SYSUT2   DD  DSN=&&SYSCIN,
//             DISP=(NEW,PASS),UNIT=&WORK,
//             DCB=BLKSIZE=400,
//             SPACE=(400,(400,100))
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
// ENDIF               *** End of CICS Translation section ***
//*
//* Assemble source into an object deck.
//*
//ASM     EXEC PGM=ASMA90,PARM='&ASMPARM.',COND=(4,LT),REGION=4096K
//SYSIN    DD  DSN=&&SYSCIN,DISP=(OLD,DELETE)
//SYSLIB   DD  DSN=SYS1.MACLIB,DISP=SHR
//         DD  DSN=SYS1.AMODGEN,DISP=SHR
//         DD  DSN=&USER..&MLQ..ASM,DISP=SHR
//         DD  DSN=TCPIP.&TCPMLQ..SEZACMAC,DISP=SHR
//         DD  DSN=CICS.SDFHMAC,DISP=SHR
//SYSLIN   DD  DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSTERM  DD  SYSOUT=&OUTC.
//SYSUT1   DD  SPACE=(CYL,(5,2),,,ROUND),UNIT=&WORK.
//*
```

```
//* MVS Binder step without resolving external references
//*
//LKEDOBJ EXEC PGM=IEWL,REGION=4096K,
//            PARM='NCAL,LET'
//SYSLMOD  DD  DSN=&USER..&MLQ..LOAD(&MEMBER.),DISP=SHR
//SYSUT1   DD  UNIT=&WORK,DCB=BLKSIZE=1024,
//             SPACE=(1024,(200,20))
//SYSPRINT DD  SYSOUT=&OUTC
//SYSLIN   DD  DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//        PEND
```

I.2 COBOL Compile JCL Procedure

```
//TCPCOB   PROC SUFFIX=1$,
//             DB2=,
//             CICS=,
//             MEMBER=,
//             USER=TCPIP,
//             MLQ=ITSC,
//             WSPC=500,
//             OUTC='*',
//             WORK=SYSDA
//*****************************************************************
//*                                                               *
//* TCP/IP MVS V3R1 - ITSO, Raleigh                               *
//*                                                               *
//* Compile a COBOL source module                                 *
//* -----------------------------                                 *
//*                                                               *
//* Input:        user.mlq.COBOL(member)                          *
//* Object deck:  user.mlq.OBJ(member)                            *
//*                                                               *
//* MEMBER        Module member name                              *
//* USER          HLQ for source, object and list datasets        *
//* MLQ           MLQ for source, object and list datasets        *
//* DB2           Specify DB2=YES if source includes SQL stmt's   *
//* CICS          Specify CICS=YES if source is for CICS          *
//* OUTC          Output class for SYSOUT                         *
//* WORK          Work UNIT                                       *
//* SUFFIX        CICS translator module suffix                   *
//*                                                               *
//*****************************************************************
//*
//DB2TEST EXEC PGM=JCLTEST,PARM='YES,&DB2.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
// IF (DB2TEST.RC=0) THEN  *** DB2 Precompile ***
//*
//DB2PRE  EXEC PGM=DSNHPC,PARM='HOST(COB2),APOST',REGION=4096K
//DBRMLIB  DD  DSN=&USER..&MLQ..DBRMLIB.DATA(&MEMBER.),
//             DISP=SHR
//STEPLIB  DD  DSN=SYS1.DSN230.DSNEXIT,DISP=SHR
//         DD  DSN=SYS1.DSN230.DSNLOAD,DISP=SHR
//SYSCIN   DD  DSN=&&DSNHOUT,DISP=(NEW,PASS),UNIT=&WORK.,
//             SPACE=(800,(&WSPC,&WSPC))
//SYSLIB   DD  DSN=&USER..&MLQ..SRCLIB.DATA,DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSTERM  DD  SYSOUT=&OUTC.
//SYSUDUMP DD  SYSOUT=&OUTC.
//SYSUT1   DD  SPACE=(800,(&WSPC,&WSPC),,,ROUND),UNIT=&WORK.
//SYSUT2   DD  SPACE=(800,(&WSPC,&WSPC),,,ROUND),UNIT=&WORK.
```

```
//SYSIN    DD  DSN=&USER..&MLQ..COBOL(&MEMBER.),DISP=SHR
//*
// ELSE                *** No DB2 Precompile, copy input ***
//*
//DB2COPY EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=&USER..&MLQ..COBOL(&MEMBER.),DISP=SHR
//SYSUT2   DD  DSN=&&DSNHOUT,DISP=(NEW,PASS),UNIT=&WORK.,
//             SPACE=(800,(&WSPC,&WSPC))
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
// ENDIF               *** End of DB2 Precompile section ***
//*
//CICSTEST EXEC PGM=JCLTEST,PARM='YES,&CICS.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
// IF (CICSTEST.RC = 0) THEN *** CICS Translation ***
//*
//CICSTRN EXEC PGM=DFHECP&SUFFIX,
//             PARM='COBOL2',
//             REGION=4096K
//STEPLIB  DD  DSN=CICS.SDFHLOAD,DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC
//SYSPUNCH DD  DSN=&&SYSCIN,
//             DISP=(NEW,PASS),UNIT=&WORK,
//             DCB=BLKSIZE=400,
//             SPACE=(400,(400,100))
//SYSIN    DD  DSN=&&DSNHOUT,DISP=(OLD,DELETE)
//*
// ELSE                *** No CICS Translation, copy input ***
//*
//CICSCOPY EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=&&DSNHOUT,DISP=(OLD,DELETE)
//SYSUT2   DD  DSN=&&SYSCIN,
//             DISP=(NEW,PASS),UNIT=&WORK,
//             DCB=BLKSIZE=400,
//             SPACE=(400,(400,100))
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
// ENDIF               *** End of CICS Translation section ***
//*
//* COBOL2 Compile source module into an object deck.
//*
//COBII   EXEC PGM=IGYCRCTL,REGION=4096K,
//             PARM='NODYNAM,LIB,OBJECT,RENT,RES,APOST'
//STEPLIB  DD  DSN=COB2.COB2COMP,DISP=SHR
//SYSLIB   DD  DSN=CICS.SDFHCOB,DISP=SHR
//         DD  DSN=CICS.USER.SDFHLOAD,DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSTERM  DD  SYSOUT=&OUTC.
//SYSIN    DD  DSN=&&SYSCIN,DISP=(OLD,DELETE)
//SYSLIN   DD  DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//SYSUT1   DD  UNIT=&WORK,SPACE=(460,(350,100))
//SYSUT2   DD  UNIT=&WORK,SPACE=(460,(350,100))
//SYSUT3   DD  UNIT=&WORK,SPACE=(460,(350,100))
//SYSUT4   DD  UNIT=&WORK,SPACE=(460,(350,100))
//SYSUT5   DD  UNIT=&WORK,SPACE=(460,(350,100))
//SYSUT6   DD  UNIT=&WORK,SPACE=(460,(350,100))
//SYSUT7   DD  UNIT=&WORK,SPACE=(460,(350,100))
//SYSUT8   DD  UNIT=&WORK,SPACE=(460,(350,100))
//*
```

```
//* MVS Binder step without resolving external references
//*
//LKEDOBJ EXEC PGM=IEWL,REGION=4096K,
//            PARM='NCAL,LET'
//SYSLMOD  DD  DSN=&USER..&MLQ..LOAD(&MEMBER.),DISP=SHR
//SYSUT1   DD  UNIT=&WORK,DCB=BLKSIZE=1024,
//             SPACE=(1024,(200,20))
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSLIN   DD  DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//        PEND
```

I.3 C/370 Compile JCL Procedure

```
//TCPC370 PROC MEMBER=,
//             USER=TCPIP,
//             MLQ=ITSC,
//             SUFFIX=1$,
//             DB2=,
//             CICS=,
//             WORK=SYSDA,
//             C370MLQ=V2R1M0,
//             PLIMLQ=V2R3M0,
//             TCPMLQ=V3R1M0,
//             CPARM='DEF(MVS),SOURCE',
//             WSPC=500,
//             OUTC='*'
//*****************************************************************
//*                                                               *
//* TCP/IP MVS V3R1 - ITSO, Raleigh                               *
//*                                                               *
//* Compile a C source module                                     *
//* -------------------------                                     *
//*                                                               *
//* Input:        user.mlq.C(member)                              *
//* Header files: user.mlq.H                                      *
//* Object deck:  user.mlq.OBJ(member)                            *
//*                                                               *
//* MEMBER        Module member name                              *
//* USER          HLQ for source, object and list datasets        *
//* MLQ           MLQ for source, object and list datasets        *
//* TCPMLQ        TCPIP dataset MLQ                               *
//* C370MLQ       C/370 dataset MLQ                               *
//* PLIMLQ        PL/I dataset MLQ                                *
//* CPARM         C Compiler parameter options                    *
//* DB2           Specify DB2=YES if source includes SQL stmt's.  *
//* CICS          Specify CICS=YES if source is for CICS          *
//* SUFFIX        CICS translator module suffix                   *
//* OUTC          Output class for SYOUTC                         *
//* WORK          Work UNIT                                       *
//*                                                               *
//*****************************************************************
//*
//DB2TEST EXEC PGM=JCLTEST,PARM='YES,&DB2.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
// IF (DB2TEST.RC=0) THEN  *** DB2 Precompile ***
//*
//DB2PRE  EXEC PGM=DSNHPC,PARM='HOST(C)',REGION=4096K
//DBRMLIB  DD  DSN=&USER..&MLQ..DBRMLIB.DATA(&MEMBER.),
//             DISP=SHR
//STEPLIB  DD  DSN=SYS1.DSN230.DSNEXIT,DISP=SHR
```

```
//         DD  DSN=SYS1.DSN230.DSNLOAD,DISP=SHR
//SYSCIN   DD  DSN=&&DSNHOUT,DISP=(NEW,PASS),UNIT=&WORK.,
//             SPACE=(800,(&WSPC,&WSPC))
//SYSLIB   DD  DSN=&USER..&MLQ..SRCLIB.DATA,DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSTERM  DD  SYSOUT=&OUTC.
//SYSUDUMP DD  SYSOUT=&OUTC.
//SYSUT1   DD  SPACE=(800,(&WSPC,&WSPC),,,ROUND),UNIT=&WORK.
//SYSUT2   DD  SPACE=(800,(&WSPC,&WSPC),,,ROUND),UNIT=&WORK.
//SYSIN    DD  DSN=&USER..&MLQ..C(&MEMBER.),DISP=SHR
//*
// ELSE                *** No DB2 Precompile, copy input ***
//*
//DB2COPY EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=&USER..&MLQ..C(&MEMBER.),DISP=SHR
//SYSUT2   DD  DSN=&&DSNHOUT,DISP=(NEW,PASS),UNIT=&WORK.,
//             SPACE=(800,(&WSPC,&WSPC))
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
// ENDIF               *** End of DB2 Precompile section ***
//*
//CICSTEST EXEC PGM=JCLTEST,PARM='YES,&CICS.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
// IF (CICSTEST.RC = 0) THEN *** CICS Translation ***
//*
//CICSTRN EXEC PGM=DFHEDP&SUFFIX,
//             REGION=4096K
//STEPLIB  DD  DSN=CICS.SDFHLOAD,DISP=SHR
//SYSPRINT DD  SYSOUT=&OUTC
//SYSPUNCH DD  DSN=&&SYSCIN,
//             DISP=(NEW,PASS),UNIT=&WORK,
//             DCB=BLKSIZE=400,
//             SPACE=(400,(400,100))
//SYSIN    DD  DSN=&&DSNHOUT,DISP=(OLD,DELETE)
//*
// ELSE                *** No CICS Translation, copy input ***
//*
//CICSCOPY EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=&&DSNHOUT,DISP=(OLD,DELETE)
//SYSUT2   DD  DSN=&&SYSCIN,
//             DISP=(NEW,PASS),UNIT=&WORK,
//             DCB=BLKSIZE=400,
//             SPACE=(400,(400,100))
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
// ENDIF               *** End of CICS Translation section ***
//*
//* Compile a C module into an object deck
//*
//COMPILE EXEC PGM=EDCCOMP,
//        PARM=('&CPARM'),
//        REGION=4096K
//STEPLIB   DD DSN=C370.&C370MLQ..SEDCLINK,DISP=SHR
//          DD DSN=PLI.&PLIMLQ..SIBMLINK,DISP=SHR
//          DD DSN=C370.&C370MLQ..SEDCCOMP,DISP=SHR
//SYSLIB    DD DSN=TCPIP.&TCPMLQ..SEZACMAC,DISP=SHR
//          DD DSN=C370.&C370MLQ..SEDCHDRS,DISP=SHR,DCB=(BLKSIZE=3120)
//USERLIB   DD DSN=&USER..&MLQ..H,DISP=SHR
//SYSIN     DD DSN=&&SYSCIN,DISP=SHR
```

```
//SYSLIN    DD DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//SYSMSGS   DD DSN=C370.&C370MLQ..SEDCMSGS(EDCMSGE),DISP=SHR
//SYSPRINT  DD SYSOUT=&OUTC.
//SYSCPRT   DD SYSOUT=&OUTC.
//SYSTERM   DD DUMMY
//SYSUT1    DD DSN=&&SYSUT1,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT2    DD SYSOUT=&OUTC
//SYSUT4    DD DSN=&&SYSUT4,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT5    DD DSN=&&SYSUT5,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT6    DD DSN=&&SYSUT6,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT7    DD DSN=&&SYSUT7,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT8    DD DSN=&&SYSUT8,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT9    DD DSN=&&SYSUT9,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//SYSUT10   DD DSN=&&SYSUT10,DISP=(,PASS),UNIT=&WORK.,
//             SPACE=(32000,(30,20)),
//             DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
//*
//* MVS Binder step without resolving external references
//*
//LKEDOBJ EXEC PGM=IEWL,REGION=4096K,
//             PARM='NCAL,LET'
//SYSLMOD  DD  DSN=&USER..&MLQ..LOAD(&MEMBER.),DISP=SHR
//SYSUT1   DD  UNIT=&WORK,DCB=BLKSIZE=1024,
//             SPACE=(1024,(200,20))
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSLIN   DD  DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//       PEND
```

I.4 Link/Edit JCL Procedure

```
//TCPLINK PROC MEMBER=,
//             USER=TCPIP,
//             MLQ=ITSC,
//             DB2=,
//             CICS=,
//             IMS=,
//             COBOL=,
//             ASM=,
//             C370=,
//             TCPMLQ=V3R1M0,
//             PLIMLQ=V2R3M0,
//             C370MLQ=V2R1M0,
//             OUTC='*',
//             LNKPARM='XREF,LIST',
//             WORK=SYSDA
//*************************************************************
//*                                                           *
```

```
//* TCP/IP MVS V3R1 - ITSO, Raleigh                                  *
//*                                                                  *
//* Bind (Link/Edit) a program                                       *
//* --------------------------                                       *
//*                                                                  *
//* Syslib:       user.mlq.OBJ                                       *
//* Load module:  user.mlq.LOAD(member)                              *
//*                                                                  *
//* MEMBER        Module member name                                 *
//* USER          HLQ for source, object and list datasets           *
//* MLQ           MLQ for source, object and list datasets           *
//* DB2           Specify DB2=YES if program uses SQL                *
//* CICS          Specify CICS=YES if program runs in CICS           *
//* IMS           Specify IMS=YES if program runs in IMS             *
//* COBOL         Specify COBOL=YESL if program includes COBOL       *
//* ASM           Specify ASM=YES if program includes ASM            *
//* C370          Specify C370=YES if program includes C/370         *
//* TCPMLQ        TCPIP dataset MLQ                                  *
//* LNKPARM       Linkage editor parameters                          *
//* OUTC          Output class for SYSOUT                            *
//* WORK          Work UNIT                                          *
//*                                                                  *
//* If you need to pass SYSLIN input to the Binder, override         *
//* SYSIN with stepname LKEDCICS for CICS and LKEDBAT for            *
//* non-CICS link jobs                                               *
//*                                                                  *
//* //LKEDCICS.SYSIN DD *  - for CICS links                          *
//*      or                                                          *
//* //LKEDBAT.SYSIN  DD *  - for non-CICS links                      *
//*                                                                  *
//*******************************************************************
//*
//ALLOCW  EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=NULLFILE,DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//SYSUT2   DD  DSN=&&WORKDS,DISP=(,PASS),UNIT=&WORK,
//             SPACE=(TRK,(2,1)),
//             DCB=(RECFM=FB,LRECL=80)
//SYSIN    DD  DUMMY
//SYSPRINT DD  SYSOUT=*
//*
//* Test for program conditions - set RC's for later logic
//*
//TESTCICS EXEC PGM=JCLTEST,PARM='YES,&CICS.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
//TESTCOB  EXEC PGM=JCLTEST,PARM='YES,&COBOL.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
//TESTC370 EXEC PGM=JCLTEST,PARM='YES,&C370.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
//TESTDB2  EXEC PGM=JCLTEST,PARM='YES,&DB2.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
//TESTASM  EXEC PGM=JCLTEST,PARM='YES,&ASM.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
//TESTIMS  EXEC PGM=JCLTEST,PARM='YES,&IMS.'
//STEPLIB  DD  DSN=TCPIP.ITSC.LOAD,DISP=SHR
//*
//* If this is a CICS program, we need language dependent
//* CICS stubs for both CICS and socket interface
```

```
//*
// IF (TESTCICS.RC = 0) THEN
//   IF (TESTC370.RC = 0) THEN
//*
//CICSC370 EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=CICS.SDFHC370(DFHEILID),DISP=SHR
//         DD  DSN=TCPIP.ITSC.CNTL(EZACIC07),DISP=SHR
//SYSUT2   DD  DSN=&&WORKDS,DISP=(MOD,PASS)
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
//   ENDIF
//   IF (TESTCOB.RC = 0) THEN
//*
//CICSCOB EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=CICS.SDFHCOB(DFHEILIC),DISP=SHR
//         DD  DSN=TCPIP.ITSC.CNTL(EZACICAL),DISP=SHR
//SYSUT2   DD  DSN=&&WORKDS,DISP=(MOD,PASS)
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
//   ENDIF
//   IF (TESTASM.RC = 0) THEN
//*
//CICSASM EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=CICS.SDFHMAC(DFHEILIA),DISP=SHR
//         DD  DSN=TCPIP.ITSC.CNTL(EZACICAL),DISP=SHR
//SYSUT2   DD  DSN=&&WORKDS,DISP=(MOD,PASS)
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
//   ENDIF
// ENDIF
//*
//* If Program includes SQL calls, we need language dependent
//* DB2 stubs
//*
// IF (TESTDB2.RC = 0) THEN
//   IF (TESTC370.RC = 0) THEN
//*
//DB2C370 EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=TCPIP.ITSC.CNTL(DSNDLI),DISP=SHR
//SYSUT2   DD  DSN=&&WORKDS,DISP=(MOD,PASS)
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
//   ENDIF
//   IF (TESTCOB.RC = 0) THEN
//*
//DB2COB  EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=TCPIP.ITSC.CNTL(DSNCLI),DISP=SHR
//SYSUT2   DD  DSN=&&WORKDS,DISP=(MOD,PASS)
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
//   ENDIF
//   IF (TESTASM.RC = 0) THEN
//*
//DB2ASM  EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=TCPIP.ITSC.CNTL(DSNALI),DISP=SHR
//SYSUT2   DD  DSN=&&WORKDS,DISP=(MOD,PASS)
//SYSIN    DD  DUMMY
```

```
//SYSPRINT DD  DUMMY
//*
//   ENDIF
// ENDIF
//*
//* If program includes DL/I calls, we need a language
//* independent stub
//*
// IF (TESTIMS.RC = 0) THEN
//*
//COPYIMS EXEC PGM=IEBGENER
//SYSUT1   DD  DSN=TCPIP.ITSC.CNTL(DFSLI000),DISP=SHR
//SYSUT2   DD  DSN=&&WORKDS,DISP=(MOD,PASS)
//SYSIN    DD  DUMMY
//SYSPRINT DD  DUMMY
//*
// ENDIF
//*
//* We need different SYSLIB setup for CICS and non-CICS
//* environments.
//*
// IF (TESTCICS.RC = 0) THEN
//*
//LKEDCICS EXEC PGM=IEWL,REGION=4096K,
//             PARM='&LNKPARM.'
//SYSLIB   DD  DSN=&USER..&MLQ..LOAD,DISP=SHR
//         DD  DSN=TCPIP.&TCPMLQ..SEZACMTX,DISP=SHR
//         DD  DSN=TCPIP.&TCPMLQ..SEZATCP,DISP=SHR
//         DD  DSN=SYS1.TCPIP.&TCPMLQ..SEZALINK,DISP=SHR
//         DD  DSN=C370.&C370MLQ..SEDCBASE,DISP=SHR
//         DD  DSN=PLI.&PLIMLQ..SIBMBASE,DISP=SHR
//         DD  DSN=CICS.SDFHLOAD,DISP=SHR
//         DD  DSN=COB2.COB2CICS,DISP=SHR
//         DD  DSN=COB2.COB2LIB,DISP=SHR
//         DD  DSN=SYS1.DSN230.DSNLOAD,DISP=SHR
//         DD  DSN=IMS.RESLIB,DISP=SHR
//SYSLMOD  DD  DSN=&USER..&MLQ..LOAD(&MEMBER.),DISP=SHR
//SYSUT1   DD  UNIT=&WORK,DCB=BLKSIZE=1024,
//             SPACE=(1024,(200,20))
//SYSPRINT DD  SYSOUT=&OUTC.
//SYSLIN   DD  DSN=&&WORKDS,DISP=(OLD,DELETE)
//         DD  DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//         DD  DDNAME=SYSIN
//SYSIN    DD  DUMMY
//*
// ELSE
//*
//LKEDBAT EXEC PGM=IEWL,REGION=4096K,
//             PARM='&LNKPARM.'
//SYSLIB   DD  DSN=C370.&C370MLQ..SEDCBASE,DISP=SHR
//         DD  DSN=PLI.&PLIMLQ..SIBMBASE,DISP=SHR
//         DD  DSN=TCPIP.&TCPMLQ..SEZACMTX,DISP=SHR
//         DD  DSN=TCPIP.&TCPMLQ..SEZATCP,DISP=SHR
//         DD  DSN=SYS1.TCPIP.&TCPMLQ..SEZALINK,DISP=SHR
//         DD  DSN=&USER..&MLQ..LOAD,DISP=SHR
//         DD  DSN=COB2.COB2LIB,DISP=SHR
//         DD  DSN=SYS1.DSN230.DSNLOAD,DISP=SHR
//         DD  DSN=IMS.RESLIB,DISP=SHR
//SYSLMOD  DD  DSN=&USER..&MLQ..LOAD(&MEMBER.),DISP=SHR
//SYSUT1   DD  UNIT=&WORK,DCB=BLKSIZE=1024,
//             SPACE=(1024,(200,20))
//SYSPRINT DD  SYSOUT=&OUTC.
```

```
//SYSLIN   DD  DSN=&USER..&MLQ..OBJ(&MEMBER.),DISP=SHR
//         DD  DSN=&&WORKDS,DISP=(OLD,DELETE)
//         DD  DDNAME=SYSIN
//SYSIN    DD  DUMMY
//*
// ENDIF
//*
//        PEND
```

The link/edit procedure uses a number of SYSLIN files:

DFHEILID C/370 CICS language stub

```
INCLUDE SYSLIB(DFHELII)
```

EZACIC07 C-sockets library routines

```
INCLUDE SYSLIB(EZACIC07)
```

DFHEILIC COBOL CICS language stub

```
INCLUDE SYSLIB(DFHECI)
```

EZACICAL Sockets Extended CICS interface stub

```
INCLUDE SYSLIB(EZACICAL)
```

DFHEILIA Assembler CICS language stub

```
INCLUDE SYSLIB(DFHEAI)
```

DSNDLI C/370 SQL language stub

```
INCLUDE SYSLIB(DSNDLI)
```

DSNCLI COBOL SQL language stub

```
INCLUDE SYSLIB(DSNCLI)
```

DSNALI Assembler SQL language stub

```
INCLUDE SYSLIB(DSNALI)
```

DFSLI000 DL/I Language stub

```
INCLUDE SYSLIB(DFSLI000)
```

ABBREVIATIONS List of Abbreviations

Abbreviation	**Meaning**
ACEE	Accessor Environment Element
ACK	Acknowledgement Segment (TCP)
AF_INET	Addressing Family Internet
AF_IUCV	Addressing Family IUCV
AF_UNIX	Addressing Family UNIX

AIX	Advanced Interactive Executive
APF	Authorized Program Facility
API	Application Programming Interface
APPC	Advanced Program to Program Communication
ARP	Address Resolution Protocol
AS	Address Space
BMP	Batch Message Program (IMS)
BMS	Basic Mapping Support (CICS)
BSD	Berkeley Software Distribution
CICS	Customer Information Control System
CPI-C	Common Programming Interface - Communications
CSM	Completed Status Message
DCE	Distributed Computing Environment
DDM	Distributed Data Management
DLI	Data Language One (IMS)
DNS	Domain Name System
DPI	Distributed Programming Interface
DPL	Distributed Program Link (CICS)
DRDA	Distributed Relational Data Access
DST	Data Services Task
DTP	Distributed Transaction Processing (CICS)
ECB	Event Control Block
EIB	Execute Interface Block (CICS)
EOM	End Of Message
FIN	Finish Segment (TCP)
FTP	File Transfer Protocol
GLBD	Global Location Broker Daemon (server)
GTF	Generalized Trace Facility
IC	Interval Control (CICS)
ICMP	Internet Control Message Protocol
IDL	Interface Definition Language

IMS	Information Management System
IP	Internet Protocol
IPCS	Interactive Problem Control System
ISN	Initial Sequence Number
ITSO	International Technical Support Organisation
IUCV	Inter-User Communication Vehicle
JES	Job Entry Subsystem
LAN	Local Area Network
LFS	Logical File System (OpenEdition/MVS)
LLBD	Local Location Broker Daemon (server)
LPD	Line Printer Deamon (server)
MFS	Message Formatting Services (IMS)
MIB	Management Information Base
MID	Message Input Descriptor (IMS)
MOD	Message Output Descriptor (IMS)
MPP	Message Processing Program (IMS)
MPR	Message Processing Region (IMS)
MQI	Message Queueing Interface
MQM	Message Queue Manager
MSS	Maximum Segment Size
MTU	Maximum Transmission Unit
NCK	Network Computing Kernel
NCS	Network Computing System
NDB	Network Data Base
NFS	Network File System
NIDL	Network Interface Definition Language
NRGLBD	Non Replicated Global Location Broker Daemon (server)
ONC	Open Network Computing
OSF	Open Software Foundation
PCB	Program Communication Block (IMS)
PCT	Program Control Table (CICS)

PFS	Physical File System (OpenEdition/MVS)
PDU	Protocol Data Unit
PPT	Processing Program Table (CICS)
PSB	Program Specification Block (IMS)
RACF	Resource Access Control Facility
RARP	Reverse Address Resolution Protocol
RCT	Resource Control Table (CICS)
RDW	Record Descriptor Word
RFC	Request for Comments
RIP	Routing Information Protocol
RPC	Remote Procedure Call
RSH	Remote Shell Protocol
RSM	Request Status Message
SAF	Security Access Facility
SBCS	Single Byte Character Set
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SNA	System Network Architecture
SQL	Structured Query Language
SYN	Synchronize Segment (TCP)
TCB	Task Control Block
TCP	Transmission Control Protocol
TD	Transient Data (CICS)
TFTP	Trivial File Transfer Protocol
TIM	Transaction Initiation Message
TRM	Transaction Request Message
TRUE	Task Related User Exit (CICS)
UDP	User Data Protocol
UUID	Universal Unique Identifier
VMCF	VM Communication Facility
VTAM	Virtual Telecomunication Access Method

WFI	Wait For Input (IMS)
XDR	External Data Representation Standard
XTI	X/Open Transport Interface

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