TCP/IP for the iRMX® Operating System

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Quick Contents

Notational Conventions

This manual uses these conventions:

- All numbers are decimal unless otherwise stated. Hexadecimal numbers include the `H` radix character (for example, `0FFH`) or a leading `0x` (for example, `0x0FF`).
- Bit 0 is the low-order bit unless otherwise stated.
- `Syntax is printed like this.`
- In interactive sessions, `computer output is printed like this` and **`user input appears like this`**.
- **System call names, command names, and processes like jobs or daemons appear in bold.**

Directory names and filenames are shown as seen from the iRMX prompt. To access files from the DOS prompt on an DOSRMX system, use a backslash (\) in pathnames rather than the forward slash (/) shown here.

Filenames are shown as they would appear on the iRMX or UNIX operating systems. On an DOSRMX system using the EDOS file driver, some filenames are truncated to match the DOS 8.3 character limits. For example, the *arpbypass* utility is installed as *arpbypas*, and its associated help file is *arpbypas.hlp*. From the iRMX prompt you can use either the truncated name or the full name to view such filenames or to invoke utilities.

This manual uses this to indicate command syntax; do not enter these characters as shown:

[ ]	Surrounds optional items
|	Separates one or more items, from which you choose one
`italic`	A variable name. Do not enter as shown; substitute the appropriate item, such as a command, value, or filename.

✏ **Note**
Notes indicate important information.

⚠ **CAUTION**
Cautions indicate situations that may damage hardware or data.

Contents

Overview of TCP/IP 1

TCP/IP programs are based on a set of protocols called Transmission Control Protocol/Internet Protocol (TCP/IP). The TCP/IP suite of networking protocols makes it possible for different brands of computers, running different operating systems, to supply resources to network users.

This manual describes how to install, use, and maintain TCP/IP networking software on your iRMX® Operating System (OS). This software allows you to communicate across a network with any other computer running TCP/IP software, regardless of its operating system.

Connecting to Network Resources

Individual computers on a computer network are called *hosts*. TCP/IP software lets you connect to various hosts on a network so that you can use their resources. The computer you use to make your original connection to the network is the *local host*. Any other computer on the network, regardless of its location, is a *remote host*.

Each host on a network is identified by a number, called an Internet address or IP address, and an official name. To access a remote host, you must specify its Internet address, official name, or a valid alias to network software.

The computer and software that originate a network command is the *client*, because they request a network service. The computer and software responding to the request is the *server*, because they provide the network service. Servers provide *sharable resources*; the network gives shared access to many users.

Host configurations and sharable resources vary with individual networks. Check with your network administrator to determine the layout of your network and the resources available to you.

Figure 1-1 on page 2 illustrates network connections and possible resources. Print Servers and File Servers have special responsibilities: they provide network printer and file storage resources. iRMX systems cannot function as print servers. The host labeled Gateway acts as a connection, or *router*, to other networks, whose resources can also be accessed.

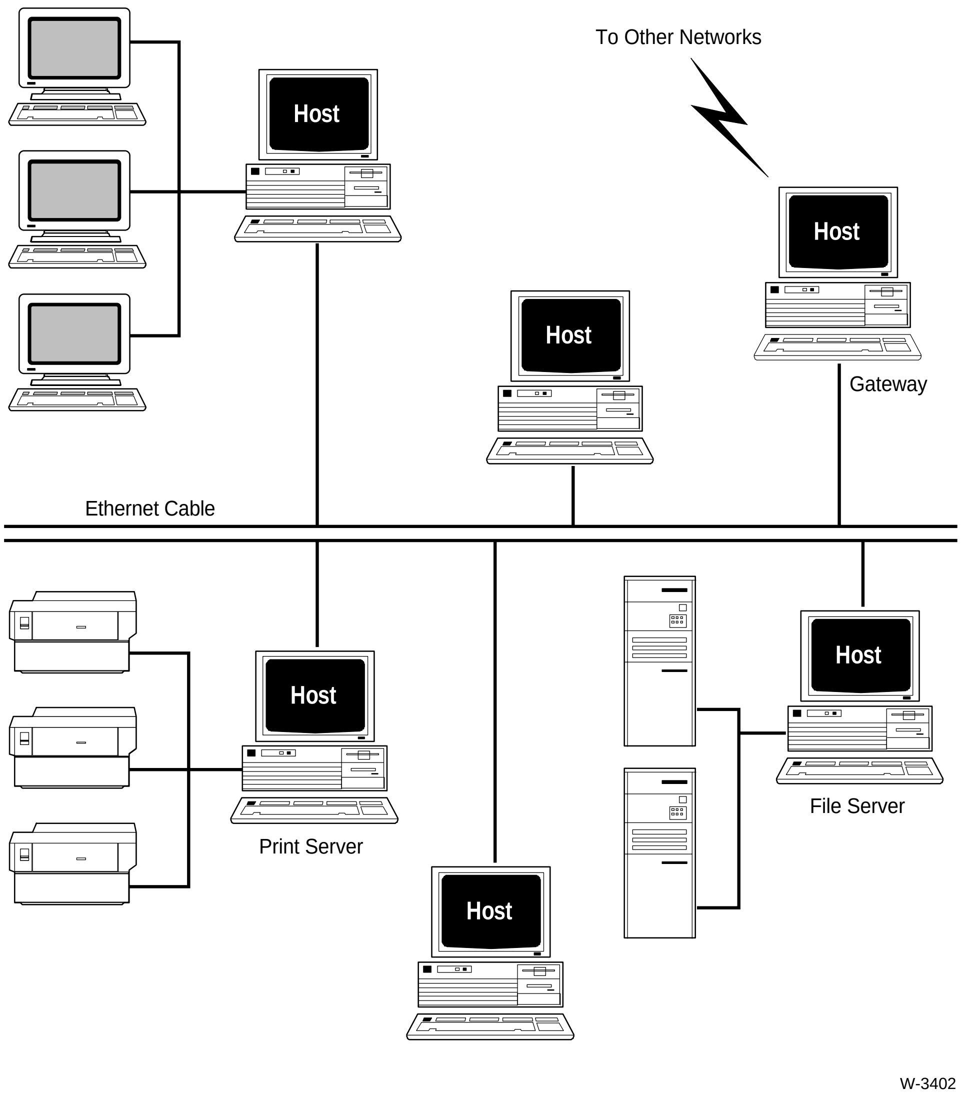


Figure 1-1. Hosts Connected on a Network

Using TCP/IP Programs and Utilities

To use TCP/IP programs and utilities, you enter network commands at the iRMX command line. After you enter a command, TCP/IP software running on the local host cooperates with TCP/IP software running on the remote host to handle your transaction.

You can use iRMX TCP/IP programs and utilities in these ways:

- Network File System (NFS) support allows you to access remote devices on hosts who use iRMX or non-iRMX operating systems.
- The **telnet** program connects to a remote host that runs a TELNET server.
- File Transfer Protocol (FTP) connects to a host that runs an FTP server and transfers files between hosts.

The TELNET service provides access to remote hosts on your network and allows you to use them as if your terminal is directly connected to the remote computers. While TELNET is running, you can submit commands to control the remote session and get information about it. To connect to a remote host, you must have the appropriate authorization and know how to use its OS.

See also: *Chapter 3, Using TELNET;*
telnet command, *Command Reference*

FTP transfers files between any two accessible network hosts supporting TCP/IP, regardless of their OSs. FTP accepts user commands to control the transfer process and perform additional operations. You don't need to know the OS on the remote host in order to use FTP. However, you must know the pathnames, filenames, and names of hosts involved in the transfer.

See also: *Chapter 4, Using File Transfer Protocols;*
ftp command, *Command Reference*

TCP/IP includes query commands such as **netstat** and **showmount**. The **netstat** command symbolically displays the contents of network-related data structures to show the status of active connections (default), configured interfaces, routing tables, network statistics, STREAMS buffer allocation failures, and packet traffic. The **showmount** command reports information on NFS-shared file systems.

See also: **netstat** and **showmount** commands, *Command Reference*

Administering TCP/IP

Chapter 2 describes a minimal configuration needed to start using TCP/IP. There are other files you can configure and special commands to control and test the configuration. If you are the network administrator or are configuring your own host machine, you should understand how to use these files and commands.

For example, one item you can configure is an FTP server. You can set it up so remote hosts can use FTP to transfer files to and from your local host.

See also: Chapter 2, Installing and Starting TCP/IP;
Chapters 6 through 9

Programming with TCP/IP

The iRMX TCP/IP implementation provides a socket interface to the software, made popular by Berkeley Unix. You can write applications that make both iRMX system calls and socket calls, or you can port existing socket applications to this interface.

See also: *Chapter 10, TCP/IP Components*

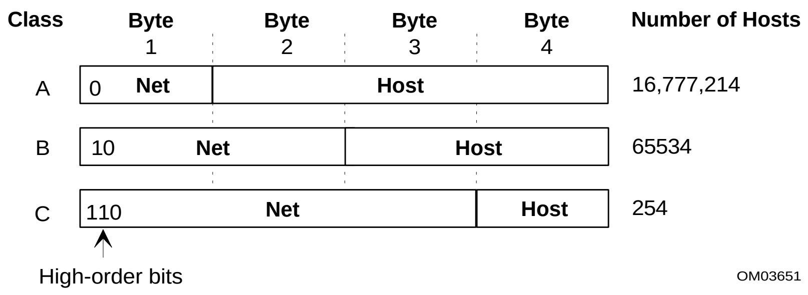
Understanding Internet Addresses

To make entries in the configuration files you need to understand the format of Internet addresses. You will also use either Internet addresses or host names (and aliases) that represent addresses when communicating with remote systems. If you already know the format of Internet addresses and names that represent them, proceed with the installation and configuration instructions in Chapter 2.

The Defense Advanced Research Projects Agency (DARPA) Internet protocol family is a collection of protocols that utilize the Internet address format. This family includes the Transmission Control Protocol (TCP), Internet Protocol (IP), Internet Control Message Protocol (ICMP), and User Datagram Protocol (UDP). A raw interface is also provided to IP and ICMP.

Internet addresses are also called IP addresses; they use the IP routing protocol. An IP address is a 4-byte quantity. It is a (*net*,*host*) pair, where *net* identifies a network and *host* identifies a host on that network. There are three basic classes of address, as distinguished by the high-order bits of the address. Class A addresses use an 8-bit *net* and a 24-bit *host*; the high-order bit is 0. Class B addresses use a 16-bit *net* and a 16-bit *host*; the high-order bits are 10. Class C addresses use a 24-bit *net* and an 8-bit *host*; the high-order bits are 110.

Because of the size of the host part of an address, the different classes of address correspond to networks of varying size. The format of the addresses is shown below, along with the number of hosts possible in each class:



The dot notation form of an Internet address consists of one to four numbers separated by dots (.). Each number can be expressed in decimal, octal (leading `0`), or hexadecimal (leading `0x`).

The most common format is a four-part address (*a.b.c.d*), consisting of four 8-bit decimal numbers in the range 0-255. This is called dotted-decimal notation. The four parts are assigned, in order, to the four bytes in the Internet address.

See also: **inet** function, Chapter 11, for more information about dot notation

You can distinguish between the classes of address by the first number of a dotted-decimal address. Class A addresses begin with numbers in the range 1-126. (Value 127 is a special case used for the loopback device, described later in this manual.) Class B addresses begin with numbers in the range 128-191. Class C addresses begin with numbers in the range 192-223 (there are other special classes of network in the range 224-255).

Once you know the class of an address, you can tell which part of the address specifies the network and which specifies the host. For example, in a Class A address, the first byte is the network number and the last three bytes specify the host. In the address 89.3.240.9, the network is number 89, and the host is number 3.240.9 on that network. The host address is 89.3.240.9, because it must be specified in terms of its network. The network address is 89.0.0.0.

See also: *hosts* and *networks* files, Chapter 9

Note
iRMX TCP/IP does not currently support IP multicast addressing (or IP multicasting or multicast addressing).

Subnet Addresses

Sites may implement subnet addressing to accommodate a cluster of local networks. Subnet addressing further divides the local host portion of the address into a subnet part and a host part. Within the local cluster, each subnet appears to be an individual network; externally, the entire cluster appears to be a single network. In the example address 89.3.240.9, you might choose to use one byte of the host part to designate subnets. In that case, you would interpret the host to be number 240.9 on subnet 3 of network 89.

You enable subnet addressing by specifying a subnet mask for a network interface and by using the subnet mask when setting up the routes to each subnet.

See also: **Tunable Parameters**, Chapter 8

Special Addresses

Addresses of all 0s or all 1s are special cases and are not assigned to hosts. The address 0.0.0.0 means the local host. The address 255.255.255.255 broadcasts to all hosts on the network to which you are directly connected. An address with the host part set to all 1s broadcasts to all hosts on a specific network.

In a program, use the local address INADDR_ANY to do wildcard matching on incoming messages and to mean the local host on outgoing messages. Use the distinguished address INADDR_BROADCAST to broadcast on the primary network interface if it supports broadcast. These and other Internet-specific data types are defined in the include (header) file <netinet/in.h>. This file is normally installed in the /intel/include directory.

Specifying Domain Names

You often use an alias to specify a host, not an IP address. The *:config:hosts* file is one method used to translate between names and addresses. The iRMX TCP/IP software does not include a Domain Name Service (DNS) server, which is another method used to translate the names. However, it does include a DNS client. The client contacts any DNS servers running on other hosts on the network and uses their name translation services. This section briefly describes the format of domain names, which is the naming convention generally used for TCP/IP.

The Internet authorities maintain several domains, including:

arpa	used by ARPANET
com	commercial organizations
edu	educational institutions
mil	military groups

Within the major domains, Internet authorities assign subdomains for use by organizations. Local authorities in the organizations then assign machine names and possibly further subdomains.

You specify domain names with dotted notation; *myhost.mydept.mycompany.com* is an example. In this name, *myhost* is the name of the host computer, *mydept* is a subdomain assigned by a company, *mycompany* is a subdomain assigned to that company, and it is in the *com* domain because it is a commercial organization. This is an example of a fully-qualified name, beginning with the host name and ending with the Internet domain. The name *myhost* is qualified by its domain *mydept.mycompany.com*. Each name must be unique within its domain; there cannot be two *mydept* names (of either a host or subdomain) within *mycompany*.

In a local network you need only a host name to communicate between systems. However, to communicate by name with hosts on the Internet, you may want to specify the complete domain names as their official names in your *:config:hosts* file.

Request For Comment (RFC) Reports

The Internet community uses RFCs to discuss and define TCP/IP. This manual refers to certain RFCs by number for protocol definitions and details. RFCs are published by RFC Editor, a group funded by the Internet Society, which is responsible for the final editorial review of the documents. Their website is at http://www.rfc-editor.org/.

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Installing and Starting TCP/IP 2

The TCP/IP software is installed along with the rest of the iRMX OS under a general installation. Edit text files to configure the system for your network, following the TCP/IP software requirements and configuration instructions in this chapter, and then start the network jobs. This chapter provides additional software requirements and configuration instructions for TCP/IP. This chapter does not describe the hardware installation or setup.

See also: *Installation and Startup* for installation instructions

Before You Begin

During the installation, some new files replace existing files of the same name. The old files are saved in a different directory. If you install over a previous version of TCP/IP software, there may be old versions of configuration files that you want to merge with the new files.

Existing configuration files are preserved during installation, but it is a good precaution to back up your entire hard drive to tape before beginning the installation.

Software Required

Previous versions of iRMX required that iNA 960 software had to be loaded in order to provide Ethernet services to the TCP/IP software. That is no longer a requirement, but it is still possible. The normal arrangement is to use a separate Network Interface Controller (NIC) driver for the TCP/IP software.

Figure 2-1 on page 10 shows the relationship between TCP/IP software and the iNA 960 software. The two separate stacks are the two sets of network protocols that can operate simultaneously when you run iNA 960 software, an iRMX network job, and TCP/IP software. In the center of the figure, note that the EDL NIC driver provides the direct interface between the TCP/IP NIC driver and the iNA 960 software.

See also: *Network User's Guide and Reference* for more information about the layers and multiple subnets in iNA 960 software

See also: Configuring and Administering Network Files, Chapter 6

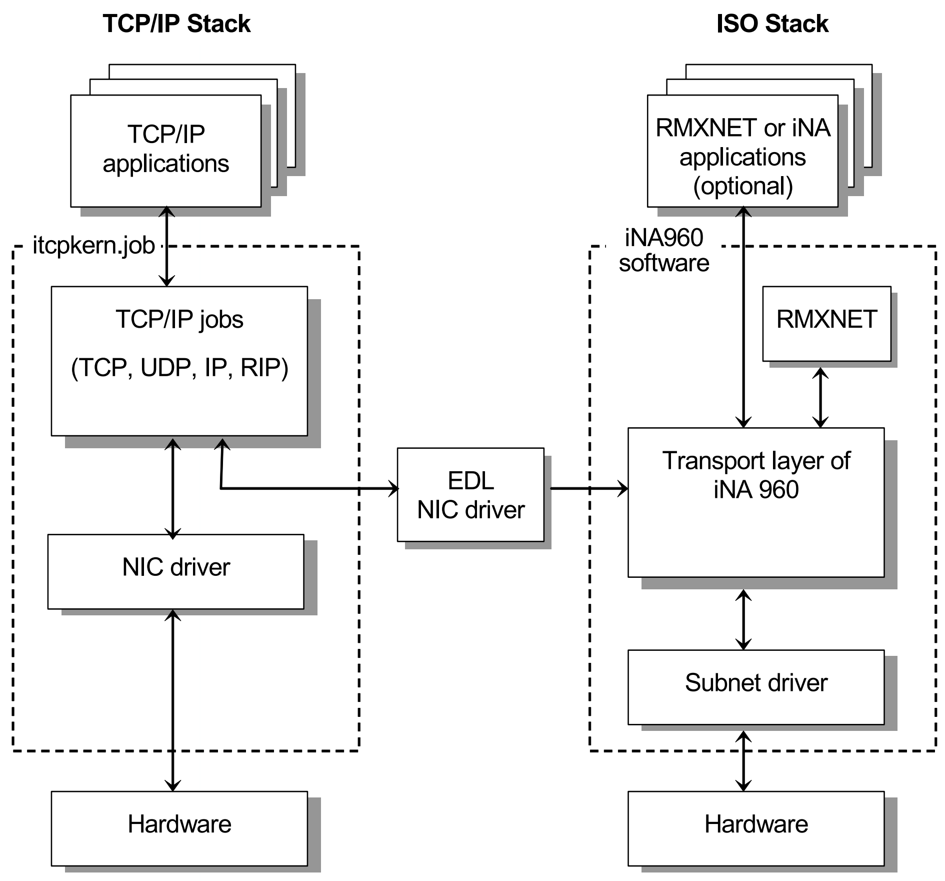

Figure 2-1. How TCP/IP Works with iNA 960 Software

Hardware Required

TCP/IP can run on any system supported by the required iRMX software.

The NIC must be one supported by the NIC driver software. The current software includes drivers for the following devices:

Job	Network Interface Controller
ne.job	NE2000 compatible ISA Ethernet interfaces
eepro100.job	Intel Pro/100 PCI Ethernet interfaces
3c59x.job	3COM PCI Ethernet interfaces
rtl8139,job	Realtek 8139 PCI Ethernet controller
edl.job	iNA Datalink interface driver
slip.job	Serial Line IP driver

See also: Tunable Parameters, Chapter 9;
i.job* and *clib.job*, *System Configuration and Administration*;
Hardware Environments, *Network User's Guide and Reference*

Overview of the Setup

To begin using the TCP/IP software:

1. Install the iRMX OS software.
2. Configure the TCP/IP software by editing the *:CONFIG:tcp.ini* configuration file.
3. Load the TCP/IP jobs with the **sysload** command.
4. For servers, optionally start the daemons required to support TCP/IP commands: **ftpd** and **telnetd**.
5. If users will run **telnet** from a PC console to a UNIX host, set up the remote UNIX host to support the RMXPC terminal type.

TCP/IP Configuration

TCP/IP is configured as a number of jobs loaded with the **sysload** command. Configuring TCP/IP involves editing one or more of these ASCII text files:

- Hosts file

- tcpstart.csd
- tcp.ini

The purpose of each file is explained in more detail later in this manual, but the instructions here will get you started using TCP/IP.

The files are installed in the :CONFIG: directory. Edit the files while logged in as the Super user. On a multiuser machine, access to these files should be restricted to a network administrator.

The network administrator for your organization should assign the name and address values described here.

See also: Understanding Internet Addresses, Chapter 1

Editing the Hosts File

For any TCP/IP communications you can specify an IP address for a remote host or obtain the address from one of two places: the *:CONFIG:hosts* database or the Domain Name Service (DNS).

✏ **Note**
The iRMX TCP/IP software does not include **named**, the DNS server. However, it does include a DNS client. Another system running an OS such as Unix must provide the DNS server.

The client contacts any DNS name server running on the network and uses its name translation services to get the IP address. Regardless of whether you use DNS or not, you must edit the :CONFIG:*hosts* file.

See also: **gethostent**, Chapter 11 for more information on DNS;
:CONFIG:*hosts*, Chapter 9

Using DNS

TCP/IP applications may use a DNS client to get an IP address associated with a name from the DNS server on the network. If you choose to use the DNS server, you need to specify only the local host name in the :*config*:*hosts* file. You also need to edit the DNS section of the tcp.ini file to configure the DNS client.

See also: Tunable Parameters, Chapter 9
gethostent, Chapter 11

Not Using DNS

If you don't use DNS, add one line to *:config:hosts* for each system on your network, including the local host. Each line must have at least these two entries:

```
    IP_address official_name
```

Specify the official name of the host machine, using a fully qualified domain name if you have one. You can add alias names on the same line after the official name.

Configuring TCP/IP as Loadable Jobs

To configure TCP/IP as loadable jobs (loaded by the **sysload** command), you need check the contents of the :*config*:*tcpstart.csd* and *:config:tcp.ici* files.

Editing the tcpstart.csd File

For TCP/IP jobs loaded with the **sysload** command, edit the *:config:tcpstart.csd* file. This file is an esubmit file that sets values and starts jobs needed to run TCP/IP software.

Configuring the Interfaces

To configure the interfaces you use, edit the *:config:tcp.ini* file. You must change the address and mask values to be appropriate for your host and network. The primary interface is normally called **eth0** and the values for this interface are in the [ETH0] section.

See also: Tunable Parameters, Chapter 9

To configure which NIC driver will be loaded, edit the *:config:tcpstart.csd* file and uncomment the appropriate line. Some drivers (such as ne.job) require parameters.

See also: *System Administration and Configuration Guide*

Starting TCP/IP

To load the TCP/IP jobs, you need to submit a file to start the jobs. (This assumes that you have already installed a NIC.) You can submit the file yourself at the iRMX prompt while logged in as **super**. You can also add the submit command to the startup files so that the file is submitted automatically every time you boot the system.

The submit command is:

```
esubmit :config:tcpstart
```

In addition to the entries described in the earlier Configuration section, the *tcpstart.csd* file also starts the TCP/IP kernel as a set of loadable jobs. To automatically submit the file every time the system boots, remove the semicolon character at the start of the line.

✏ **Note**

Do not place commands that prompt for keyboard input in any of the configuration files *:config:loadinfo*, *:config:r?init*, or *:config:r?init2*. Running commands from the *:config:r?init2* file can make booting a little slower.

Testing the TCP/IP Setup

Test the TCP/IP software and its connection to the network by issuing this command:

```
ping loopback 56 3
```

This command sends packets on the network to the local machine. It tests both TCP/IP and the network hardware; TCP/IP must be able to send and receive packets to display a message similar to this:

```
PING loopback: 56 data bytes
64 bytes from IP_address: icmp_seq=0. time=0 100th of sec
64 bytes from IP_address: icmp_seq=1. time=0 100th of sec
64 bytes from IP_address: icmp_seq=2. time=0 100th of sec
----loopback PING Statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip (100th of sec)    min/avg/max = 0/0/0
```

Notice the next-to-last line, indicating that all the packets sent were received.

If this command succeeds, test the connection to other hosts on the network. Repeat the **ping** command, specifying the remote host's name or address instead of `loopback`. To use names, you must configure the name-to-address translation in the *:config:hosts* file or from the DNS server as described earlier.

If you enter the **ping** command without the numeric values, it continues sending packets until you interrupt it with a <Ctrl-C>.

See also: Network Tests, Chapter 9, for other tests you can perform
ping command, *Command Reference*

Troubleshooting

Problems can occur at several different levels. For example, TCP/IP may have failed to install correctly. This in turn causes jobs dependent on TCP/IP to not load correctly. This section provides some general troubleshooting guidelines and explains some specific error conditions.

General TCP/IP Debugging

Follow these ordered steps to try and isolate TCP/IP problems:

1. Try to execute some of these commands:

   ```
   netstat -i
   netstat -a
   ```

   If you get errors then perform steps a through c.

If these commands execute correctly, you can assume that TCP/IP is loaded and running. Steps a through c do not apply.

   a. Check the messages in *:config:r?init2.log*, the log file of the *:config:r?init2* file. Be sure that *r?init2* submitted the file *:config:tcpstart.csd* and that all the commands in the submit file ran properly.

   b. Check the `[ETH0]` settings in *:config:tcp.ini* to be sure they are correct.

   c. Check the *:config:hosts* file to be sure your `hostname` is there with the correct IP address.

2. If you are having trouble with **telnet** try the following:

   a. Check the *pttydrvnn.log*, where *nn* is the slot number of the client board.

   b. Enter **initstatus** and see if any *ttyp_** are available and not locked.

Setting Up a Remote Unix Host for Telnet

Once the **ping** command succeeds, TCP/IP is set up and ready to support file transfer via the File Transfer Protocol (FTP). Before you can begin remote login through the **telnet** command, however, you may need to do additional setup on the remote Unix host.

Creating a Terminal Definition for the PC Console

To run any Unix program that supports cursor movement (any program using the curses library, such as the vi editor) you must set a TERM environment variable that matches your iRMX terminal. If you make a connection through the **telnet** command from any standard terminal, the Unix host should already have a matching terminal type definition. However, to use **telnet** from a PC console (*:d_cons:* or *:con:*) you need to define a new terminal name, RMXPC. This procedure modifies system files on the remote Unix host, which requires root privileges. If necessary, contact your Unix system administrator for assistance.

To set up the RMXPC terminal definition:

1. Edit the *:config:termcap.bsd* file and locate the definition for the RMXPC terminal type. Copy this definition to a file called *termcap.*rmx and copy it to the UNIX host.

2. Log into the Unix host as root.

3. Edit the existing *termcap* file to add the contents of *termcap.rmx*. (If you are sure that users will be running only applications that use *terminfo*, instead of *termcap*, you can skip this step. But if there is any doubt, perform this step.)

4. Run this command:

```
tic terminfo.rmx
```

If your system does not have a **tic** command, skip this step.

Setting Terminal Characteristics for User Sessions

When iRMX users remotely log into a Unix host, the **telnet** command change the Unix terminal type to the name of the iRMX terminal. If the Unix host is set up to support that terminal type, and the Unix account does not reset the terminal type, nothing more is necessary.

However, Unix accounts that are also used for local logins need to set the terminal type during initialization. This overwrites the **telnet** terminal setting. Because the remote iRMX terminals and local Unix terminals are likely to be different, the best way to handle this is to prompt for the terminal type.

Use this procedure to set up Unix user accounts for users who use the **telnet** command. You may need to experiment; the specifics vary for different shells and versions of Unix. If you need help, ask your Unix system administrator.

1. Check that the Unix host is set up to support the required terminal types and that the terminal names are the same on the Unix and iRMX OS. The possible names include:

   - Standard terminals, like `wyse50`
   - RMXPC for the PC console, as discussed earlier

2. Edit the initialization file in each user's home directory. For those who use the Bourne shell, bash, or Korn shell, the file should be *$HOME/.profile*, and for C shell users, *$HOME/.login*.

   - Set up handling of the terminal type. If the account will only be used for logins via **telnet**, comment out any reference to terminal type, such as:

     ```
     setenv TERM
     TERM=wyse50
     export TERM
     ```

     Or, if the account will be used for both remote and local logins, set up a prompt for the terminal type. This simple example for the Bourne shell *.profile* produces a prompt:

     ```
     echo "TERM=\c"
     read TERM
     ```

   - Define the interrupt sequence, erase sequence, and tab settings for the potential terminal types. This Bourne shell example for the RMXPC terminal sets the interrupt to <Ctrl-C> and erase to <Del>, and sets tab expansion.

```
If [ $TERM = "RMXPC" ]
then
   stty intr ^C erase ^? -tabs
fi
```

See also: Documentation for your Unix system

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Using NFS 3

Network File System (NFS) support gives you access to remote files across a network of machines that don't necessarily run the same operating system. NFS is commonly used on Unix systems and is now supported by the iRMX OS. You can access any machine on your network that uses NFS files by using the same commands that access local files. For example, you can use the iRMX **dir** command to examine the contents of a remote machine's directory under NFS.

This chapter presents some basic NFS concepts and tells you how to set up NFS in the iRMX environment. For general information on NFS, consult the recommended reading list in Appendix A.

NFS Concepts

To use NFS, a server system defines parts of its local file system as shared by NFS. A client system then attaches (mounts) whatever parts of the server's file system that it must access. After attaching (mounting) the directories or files, the client can access them as if they were local.

In order for a client to access an NFS file or directory, four requirements must be met:

- TCP/IP must be running as part of the network.
- NFS server and client jobs must be loaded on the respective machines.
- Each server must define any local file systems accessible to remote machines as NFS-shared resources.
- Each client that accesses an NFS-shared file or directory must attach to (mount) the resource.

When these requirements are met, clients can make system calls or issue commands that access the NFS file or directory.

✏ **Note**

Throughout this chapter the terms attach and mount are synonymous. In the iRMX environment, you attach a remote file system. In the Unix environment, you mount a remote file system.

To help you understand the concept of NFS consider the system shown in Figure 3-1. This figure shows four separate machines. The machines have logical names "hosta", "hostb", "hostc", and "hostd". Hosta is a file server that is running a version of Unix. Hostb also runs a version of Unix. Hostc and hostd both run the iRMX OS.

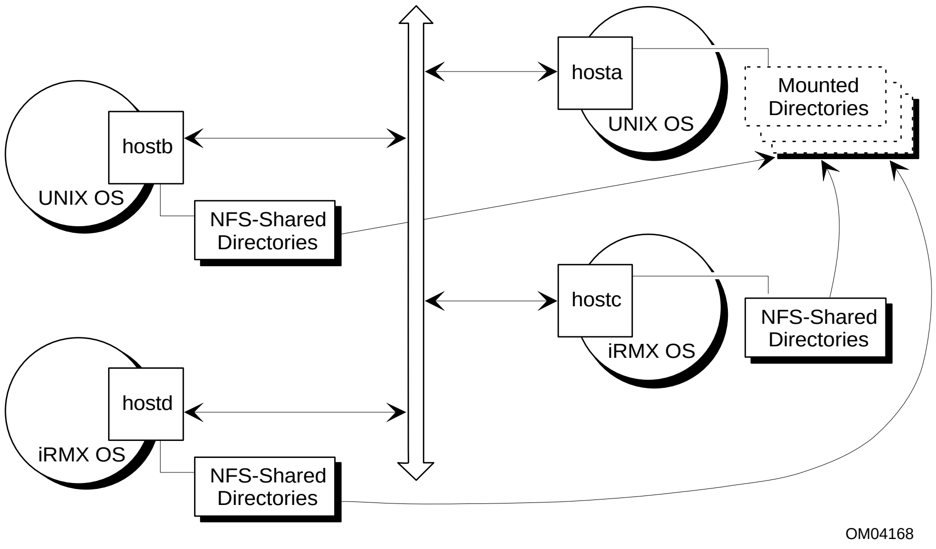


Figure 3-1. Sample NFS Network

Hosta runs an application that must read specific directories on hostb and hostc, calculate some results, and then write the results into a data base on hostd. In this situation, hostb, hostc, and hostd have defined the directories that hosta must access as NFS-shared resources. Hosta has mounted each of the directories. This makes the directories in hostb, hostc, and hostd seem like local directories to hosta. The application running on hosta can use simple file I/O calls to open, read, write, and close the required files on the remote machines.

NFS Jobs

The iRMX implementation of NFS includes four loadable jobs. For a machine to function as an NFS server, it must load *pmapd.job*, *nfsd.job*, and *mountd.job*. For a machine to function as an NFS client, it must load *nfsfd.job*. These four jobs enable you to access NFS files across the network.

See also: NFS in Appendix A for general information on NFS

You can start and stop NFS client and server jobs through the *nfsstart.csd* and *nfsstop.csd* files. Or, you can use the **sysload** command directly to load or unload these jobs.

See also: Starting and Stopping NFS Support, later in this chapter

NFS Commands

These commands allow you to work with NFS:

share	Lets you define a local directory as NFS-shared. NFS-shared directories can be attached and accessed by remote NFS clients.
unshare	Lets you remove shared access from a local file. Local files that do not have shared access (defined as NFS-shared) cannot be attached by remote NFS clients.
attachdevice	Lets you attach a remote NFS-shared file system. Once you have the file attached, you can access the file as if it were local. NFS clients use **attachdevice**.
showmount	Lets you see which local files are defined as NFS-shared and which (if any) remote NFS clients have the file system attached.
rpcinfo	Reports Remote Procedure Call (RPC) information on a given host. This command lets you see what services are available on a host.

See also: **share**, **unshare**, **attachdevice**, **showmount**, and **rpcinfo** commands, *Command Reference*

NFS Files

These user-visible files facilitate set up and use of NFS:

:config:sharetab.cf	Contains entries for each local file system defined as NFS-shared. Each entry contains the local pathname to the file system, a symbolic name, and file access options.
:config:nfsstart.csd	Contains commands that load NFS client and server jobs, define local file systems as NFS-shared, and attach files on remote NFS servers.
:config:nfsstop.csd	Contains commands that unload NFS client and server jobs.

See also: Files, Chapter 11;

Tuning NFS Performance

You can tune NFS parameters to better suit your application or system. Tunable parameters fall into these categories: RPC Client/Server, NFS File Driver, and NFS/Mount Daemon.

See also: NFS Parameters, Chapter 10

NFS Limitations

Finally, you should be aware of some limitations to NFS on an iRMX machine:

- You can only use normal iRMX system calls (such as BIOS, EIOS, UDI, Application Loader) or specific commands to access NFS files. No programmatic access is provided to Remote Procedure Calls (RPC), as exists in some implementations of NFS.
- While hard and soft links are supported in the standard NFS protocol, the iRMX NFS does not support either type of link in its file drivers. The iRMX OS does not support these links.
- iRMX NFS supports only the Unix style authentication of users as defined by RFC 1057 (Request For Comments). Other security, such as DES style authentication (Secure RPC), is not supported.
- There is no support for various iRMX volume management commands such as **format** and **diskverify** on remote volumes shared by NFS.

How NFS Works

The following points describe in general how NFS works within the iRMX operating system:

- Hosts that function as NFS servers must have the NFS server jobs loaded, while hosts that function as NFS clients need the NFS client job loaded.
- An NFS server maintains entries in the *:config:sharetab.cf* file for each local file system able to be attached to by NFS clients. These files are defined as NFS-shared. You can add and remove entries in the *:config:sharetab.cf* file by using the **share** and **unshare** commands, respectively.
- An NFS client gains access to a remote NFS-shared file system by first attaching the file system with **attachdevice** or programatically with appropriate system calls.
- Before attaching an NFS-shared file, users from an NFS client can use **showmount** to see what symbolic name the NFS server uses for a specific file system. With this information, you can attach the device.
- Each time an NFS client attempts to attach a file system, the NFS server checks the *:config:sharetab.cf* file to see if the requested file system has been defined as NFS-shared. If so, the server uses the access options defined for the file system and makes the file system available to the requesting NFS client.
- Once an NFS client has attached an NFS-shared file system, the connection remains until either the NFS job(s) in the client or server stop, or the file system is detached from the client. Modification of the *:config:sharetab.cf* file on the NFS server has no effect on an existing NFS connection.

Starting and Stopping NFS

You start NFS by submitting the *:config:nfsstart.csd* file. This file loads either the NFS client job, the NFS server jobs, or both. An NFS client must load *:config:nfsfd.job*. An NFS server must load *pmapd.job*, *nfsd.job*, and *mountd.job*.

See also: Specific NFS jobs, *System Configuration and Administration*

Here are the relevant **sysload** commands from *:config:nfsstart.csd*:

```
; ***  Start NFS jobs for client system
;sysload -w /rmx386/jobs/nfsd.job
       .
       .
       .
; *** Start NFS jobs for server system
;sysload -w /rmx386/jobs/pmapd.job
;sysload -w /rmx386/jobs/nfsd.job
;sysload -w /rmx386/jobs/mountd.job
       .
       .
       .
```

Depending on whether you want a host to act as an NFS client, NFS server, or both, you would remove the semicolons for either the client system **sysload** command, the server system **sysload** commands, or both sets.

See also: **sysload** command, *Command Reference*;
Specific NFS jobs, *System Configuration*

✏ **Note**

Before a client can access a remote file system, the server must define the file system as NFS-shared and then the client must attach (or mount) the device.

See also: Sharing File Systems, later in this chapter;
Attaching NFS Devices, later in this chapter

During system initialization, the *:config:r?init2* file is executed. This file submits the *:config:nfsstart.csd* file using the following command:

```
;esubmit :config:nfsstart.csd
```

To submit the *:config:nfsstart.csd* file at the system initialization time, simply remove the leading semicolon character from this command.

To stop NFS, submit the *:config:nfsstop.csd* file. This file unloads NFS jobs in the following order:

```
; ***  Stop NFS jobs for a server system
sysload -u mountd.job
sysload -u nfsd.job
sysload -u pmapd.job

; ***  Stop NFS jobs for a client system
sysload -u nfsfd.job
```

To unload a particular NFS job, you can use the **sysload** command with `-u` option directly from the command line.

It is important that you shut the jobs down in the order shown in *:config:nfsstop.csd* and that no local file systems are attached by remote clients.

✏ **Note**
Because NFS depends on TCP/IP, always unload the NFS jobs before stopping TCP/IP.

See also: **sysload**, **showmount**, and **unshare** commands, *Command Reference*; Displaying Shared and Mounted File Systems, later in this chapter; Removing Shared Access from File Systems, later in this chapter

Sharing File Systems

In order for an NFS client to access a remote file system, the remote NFS server must define the file system as NFS-shared and the client must attach to (or mount) the file system. This section describes how to define a local file system as NFS-shared.

See also: Attaching NFS Devices, later in this chapter

The *:config:sharetab.cf* file contains entries for all NFS-shared file systems. You add entries to *:config:sharetab.cf* by using the **share** command. When you use **share** you must provide the local pathname, can optionally provide a symbolic name by which remote clients can refer to the device, and can optionally provide a set of access privilege options. The local pathname must exist on the host and not be an NFS device logical name. If the path does not exist or it is an NFS device logical name, the **share** command will fail.

Once a file system has an entry in the *:config:sharetab.cf* file, a remote client can attach (mount) the resource. You should not edit *:config:sharetab.cf* directly; always use **share** to add entries to this file.

See also: **share**, *Command Reference*

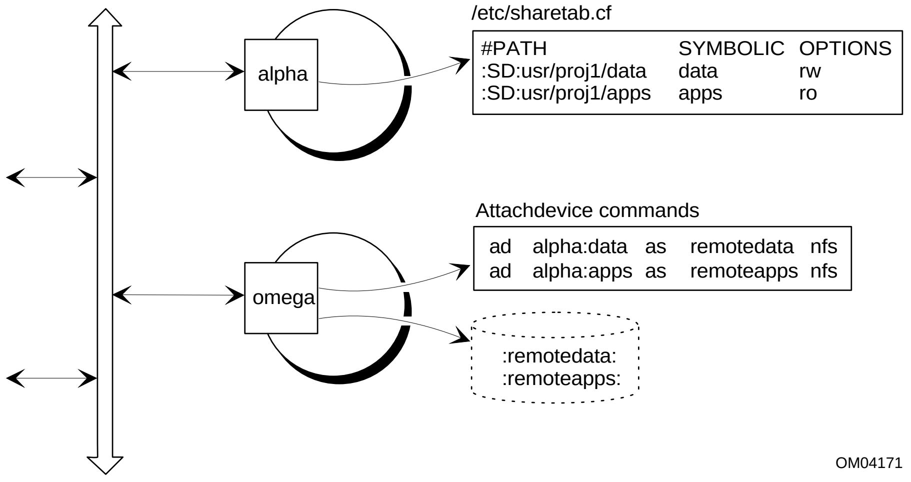
You can use the *:config:nfsstart.csd* file to define local file systems as NFS-shared at system initialization time. In *:config:nfsstart.csd* the **share** commands should appear after starting the NFS server jobs. Here is an example:

```
        .
        .
        .
; *** Define shared resources
;     Add/modify "share" entries according to your
;     system needs.
;unshare -a
;share :sd:
;share -d "Work Directory" -s /work :sd:work
        .
        .
        .
```

You should include the **unshare -a** command just prior to defining file systems with the **share** command. The **unshare -a** command deletes any existing entries from the *:config:sharetab.cf* file. This ensures that no file systems previously defined as NFS-shared are still defined as such when the system comes up.

See also: Removing Shared Access from File Systems, later in this chapter

As an example, consider a situation where two hosts exist on an NFS network: alpha and omega. Alpha acts as a file server and has data that users from omega must access. Consequently, alpha defines some directories to share. Users from omega can attach the directories and access the data as if it were local. Figure 3-2 shows the scenario.



/etc/sharetab.cf
#PATH SYMBOLIC OPTIONS
:SD:usr/proj1/data data rw
:SD:usr/proj1/apps apps ro
alpha
Attachdevice commands
ad alpha:data as remotedata nfs
ad alpha:apps as remoteapps nfs
omega
:remotedata:
:remoteapps:
OM04171

Figure 3-2. Defining NFS-shared File Systems

In this example, the system administrator of alpha could use the following **share** commands in *:config:nfsstart.csd* to make *:SD:/usr/proj1/data* and *:SD:/usr/proj1/apps* available:

```
share -o rw -s data :sd:usr/proj1/data
share -o ro -s apps :sd:usr/proj1/apps
```

When the system initializes, these local directories are defined as NFS-shared. Remote NFS clients can then attach and access the file systems as if they were local.

✏ **Note**

If you do not specify a symbolic name when you issue the **share** command, the system converts the supplied pathname into a root directory path. For example, specifying *:sd:usr* as the pathname on a command line without the -s option results in an entry of */sd/usr* in the *:config:sharetab.cf* file.

Users from omega could attach the shared file systems with the **attachdevice** commands shown in the figure. The **attachdevice** commands in this example use symbolic names *remotedata* and *remoteapps*. These are the names by which the client system omega can recognize the shared file systems. Once the file systems are attached, you could enter `dir :remotedata:` to see what the remote directory *:alpha::SD:/usr/proj1/data* contains.

See also: **share**, **unshare**, and **attachdevice** commands, *Command Reference*; *:config:sharetab.cf*, Chapter 11; Attaching NFS Devices, later in this chapter

Removing Shared Access from File Systems

You can remove shared access from a local file system by using the **unshare** command. This command simply deletes a corresponding entry (or all entries when you use the `-a` option) from the *:config:sharetab.cf* file. Issuing **unshare** prevents remote clients from subsequently attaching to the file system. However, it does not break any existing client/server connections. In other words, if an NFS client has previously attached an NFS-shared directory, using **unshare** from the server does not detach the client. The client can continue to access the remote file system. You can break the connection by stopping the NFS job(s) on the server or the client, or by detaching the file system from the client.

See also: **unshare** and **share** commands, *Command Reference*

When issuing the **unshare** command you can specify either a single local directory or all local directories. You can specify the full pathname of the directory or its symbolic name. Restricting a file system with the **unshare** command makes it impossible for an NFS client to subsequently attach (or mount) it.

Consider a server with many of its local file systems defined as NFS-shared. As a system administrator you decide that it becomes necessary to restrict access to these file systems. Entering the following command from the server prevents remote NFS clients from being able to attach (or mount) any file system local to the server.

```
- unshare -a
```

Attaching NFS Devices

In order for an NFS client to use an NFS-shared file system, the file system must be defined as NFS-shared and the client must attach it. Access of NFS-shared files involves file ownership and access rights mapping. You need to keep these mappings in mind when manipulating NFS files.

See also: Sharing NFS Files, earlier in this chapter;
Accessing NFS Files, *System Concepts*

You can attach an NFS device in these ways:

- With the **attachdevice** command. The volume name for the NFS device is the host name as supplied in the **attachdevice** command.
- With the **rq_a_physical_attach_device** (BIOS) or **rq_logical_attach_device** (EIOS) system calls

See also: **a_physical_attach_device** and **rq_logical_attach_device**, *System Call Reference;*
attachdevice command, *Command Reference*

✏ **Note**

To access an NFS-shared file system from a Unix NFS client, use the **mount** command.

When specifying the file system to attach, you can use the physical or logical name. The form is either:

```
<host:logical_name>
```

or

```
<host:physical_name>
```

The pathname that **showmount** returns is the logical name; use it in the **attachdevice** command or the system calls.

You can use the *:config:nfsstart.csd* file to attach NFS-shared file systems at system initialization time. In *:config:nfsstart.csd* the **attachdevice** commands should appear after the NFS client job is loaded. Here is an example:

```
       .
       .
       .
; *** Start NFS jobs for client system
;sysload -w /rmx386/jobs/nfsfd.job

; *** Attach NFS devices
;     Add/modify "attachdevice" entries according to
;     your system needs.
;attachdevice itcp:/user/guest/data as data nfs
       .
       .
       .
```

See also: **attachdevice** command, *Command Reference*

Displaying Shared and Mounted File Systems

On an iRMX NFS server you can determine which local file systems are currently shared by using the **share** command with no options. The command displays the shared local directories as in the following example:

```
- share
:sd:user/bill    /bill         rw     my_directory
:sd:rmx386       /sd/rmx386    ro     rmx_config
```

See also: **share** command, *Command Reference*

Using **share** with no options shows only the shared resources local to the host.

You can also get information about resources by using the **showmount** command. This command displays a list of the shared file systems and which clients have mounted or attached them.

When you enter the **showmount** command you can specify a remote server for which information is displayed, or you can default to the local server.

For example, consider the system shown in Figure 3-2 on page 27. To see the directories and a list of the clients that have mounted from hosta, enter the following command:

```
- showmount -a hosta
Client/directory mount list for hosta:
jimd:/usr1/proj1/data
sallyz:/usr1/proj1/apps
```

See also: **showmount** command, *Command Reference*

Reporting RPC Information

Sometimes it is necessary to report a host's RPC information. For example, you may need to know which RPC services are registered with the port mapper. You can report this type of information using the **rpcinfo** command.

For example, to see which RPC services are registered with the port mapper running on hostc, use this command. Partial output could be similar to the following:

```
- rpcinfo -p hostc
Get registered programs on hostc ...
      program   vers   proto  port   service
      100000    2      tcp    111    rpcbind
      100000    2      udp    111    rpcbind
      100003    2      udp    2049   nfs
      100005    1      tcp    977    mountd
      100005    1      udp    976    mountd
```

To get the same information about the local host, use the command without specifying a host name:

```
- rpcinfo -p
```

To see if a particular RPC service is registered on a particular host use the **rpcinfo** command and either the transport udp or tcp option. Then supply the host, program name as it appears in *:config:rpc* or number, and optionally a version number. For example, this command reports on the RPC service with program number 100001 and version 2 registered on hostb for the transport udp:

```
- rpcinfo -u hostb 100001 2
```

✏ **Note**

When port mapper information is requested by a remote machine running some Unix operating systems, the request must use the `-p` option. If the `-p` option is not present, the iRMX machine will look for version 3 of the port mapper (not supported by iRMX) and report that the RPC program is not registered. iRMX supports only version 2 of the port mapper.

See also: **rpcinfo** command, *Command Reference*

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Using Telnet 4

With TELNET you can log in to a remote host as if your terminal were directly cabled to it. TELNET provides reliable, virtual terminal communication with any network host that supports the TCP standard, regardless of the host's OS. The remote host must implement a TELNET server.

Before You Begin

Before you begin a TELNET session on a remote host, you must know:

- A user login name and password on the remote host
- One of the valid names for the remote host: its Internet address, its official host name, or its alias

You can get valid host names and addresses from your :config:*hosts* file, or names can be resolved by a DNS server.

The remote host must have a TELNET server process, **telnetd**, and be listening for TELNET requests. If you need additional information or help setting up a remote host login, see your network administrator.

Telnet Modes

TELNET operates in two modes: input mode and command mode. In input mode, you log in and enter OS commands, which are processed by the OS on the remote host. In command mode, you enter TELNET commands, which are processed by the TELNET program on the local host.

You can start the TELNET program in either mode then switch between modes during a TELNET session.

Figure 3-1 shows how commands are processed in input mode and in command mode.

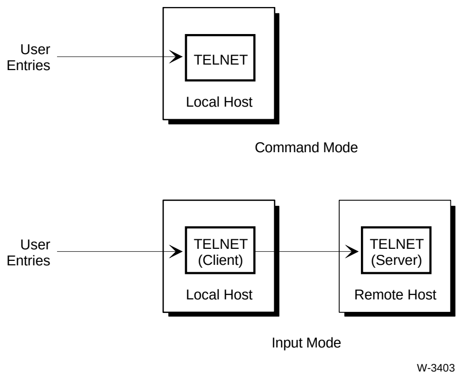

Figure 3-1. TELNET Modes

Starting TELNET

You can use this command to start TELNET and connect to any other remote host:

- **telnet**

Starting in Input Mode

To start TELNET in input mode enter `telnet` *`hostname`* at the iRMX prompt, specifying the name of the remote host to which you want to connect. If TELNET connects to the host, you are prompted to log in. After you log in, any commands you enter are processed by the remote host. The input mode prompt is the remote host's OS prompt. When you exit the remote session, the TELNET program terminates, and you are returned to the OS prompt on the local host.

Starting in Command Mode

To start TELNET in command mode, enter **telnet** at the iRMX prompt. The TELNET program starts and displays the command mode prompt, `telnet>`. It does not attempt to connect you to a remote host; in command mode you enter TELNET commands that are processed by the local host. From the `telnet>` prompt, you can use the **open** command to connect to a remote host in input mode. If you open a remote session in this way, you will be returned to command mode when you close the session.

Switching Telnet Modes

To switch from input mode to command mode, enter the current TELNET escape character, followed by a carriage-return. The default escape character is ^] (control]) . You can change the escape character with the TELNET **escape** command. The `telnet>` prompt confirms that you have entered command mode. You can specify several options on the **telnet** command line.

To switch back from command mode to input mode, enter a <CR> at the command mode prompt. At this point you can resume what you were doing before you entered command mode.

Using TELNET for a Remote Session

When you use TELNET for a remote session, you establish a virtual terminal connection to the remote host. The remote host gives you the same privileges and capabilities as it does for users with terminals directly cabled to it. While you are working on the remote host, your session with the local host is maintained.

The procedure for conducting a remote TELNET session consists of three general steps:

1. Connecting to the remote host
2. Entering commands during the session
3. Closing the remote connection

Connecting to the Remote Host

You can begin a remote session at the iRMX system prompt or at the TELNET command mode prompt. In either case, the TELNET client process in your local host activates a TELNET server process in the remote host to service your session.

You specify a remote host by its Internet address, its official name, or an alias name. To connect to a remote host named *host2* at Internet address 128.215.12.21, you could use either of the command methods shown below to open the connection. You could use either form of the name in either command:

From the iRMX Prompt	**From the TELNET Prompt**
- telnet 128.215.12.21	
- telnet	telnet> open host2

If the attempt succeeds, your screen displays a connection message and the remote host login prompt. The connection message includes information about the TELNET session, including the current escape character. The output from the above commands is similar to this:

```
Trying 128.215.12.21 ...
Connected to 128.215.12.21.
Character mode is enabled.
Escape character is ^].
UNIX System V Release 3.2 (host2.intel.com)

login:
```

If all ptty devices are in use and a TELNET request comes in, **telnetd** will send the following error back to the client:

```
No ptty devices available at this time.
```

Regardless of the reason, if the connection attempt does not succeed, you are returned to the `telnet>` prompt and are requested to log in. This cycle repeats until you successfully log in or until you close the TELNET session with the **^]quit** command, where ^] is the current escape character.

Setting the Terminal Type on a Unix System

When you log in to a Unix host, TELNET changes the Unix terminal type to the name of your iRMX terminal. If the Unix host is set up to support that terminal type, and your Unix account does not reset the terminal type, you do not need to do anything more.

Some Unix accounts, however, reset the terminal type during initialization. This overwrites TELNET's terminal setting. If a terminal prompt appears when you log in, respond with the name of your iRMX terminal. For example, if you are working at a Wyse 50 terminal, specify:

```
TERM=wyse50
```

If you are using the PC console as your iRMX terminal, the terminal type is `RMXPC`. For ICU-configurable iRMX OS with Multibus II and the iSBX 279 Graphics Module, the terminal type is `i279`. If the system does not recognize your terminal type, see your Unix system administrator.

Sometimes the initialization file automatically sets a predetermined terminal type. TELNET will not work properly with this setup, unless the terminal type happens to be the same as your iRMX terminal. If you suspect this has happened, check your current terminal type:

```
echo $TERM
```

If you need to reset the terminal type, it is best to do it in your initialization file. Otherwise, the problem will happen again every time you log in. If you need help, ask your Unix system administrator.

See also: Setting Up a Remote Unix Host for Telnet and Rlogin, Chapter 2, for initialization file setup

Terminal Type Strings

iRMX supports terminal type lengths of six characters or less. When a TELNET session begins, the client passes a string representing the terminal type to the server. If a client with a terminal type of more than six characters tries to connect to a **telnetd**/**rlogind** server running on iRMX, the following warning displays at the client end:

```
Terminal type too long for iRMX, try another
```

Disabling Local Echo on Berkeley Unix Hosts

When you connect to a TELNET server on a Berkeley Unix host, before any other commands, you need to enter the TELNET **localecho** command. This is a toggle that turns local echo off. Use the instructions for entering TELNET commands in this section.

Entering Commands During the Session

During the remote session, you can enter input mode commands at the remote host's OS prompt or command mode commands at the TELNET prompt.

At the remote OS prompt, enter any command that is appropriate for that environment. The local host will pass your commands to the remote host for processing without interpreting them.

To enter TELNET commands, switch to command mode by entering the escape character, followed by a space. The system displays the `telnet>` prompt. At the prompt, type your command, then press <Enter>. You can enter any of the TELNET commands in this manner. TELNET processes your command, then returns to input mode so you can continue your remote session.

This example uses the escape character ^] and the TELNET **status** command during a remote host session. The `$` is the remote OS's prompt. Unlike the way it is shown here, the escape character does not appear on your screen when you enter it.

```
$ ^]

telnet> status

Connected to host2.intel.com.
Character mode is enabled.
Escape character is ^].
$
```

There are several other TELNET commands that let you control options for the TELNET session. Use the TELNET **?** command to list all the commands and their descriptions:

```
telnet> ?

Commands may be abbreviated.  Commands are:

close     close current connection
logout    forcibly logout remote user and close the
          connection
display   display operating parameters
mode      try to enter line or character mode ('mode ?' for
          more)
telnet    connect to a site
open      connect to a site
quit      exit telnet
send      transmit special characters ('send ?' for more)
set       set operating parameters ('set ?' for more)
unset     unset operating parameters ('unset ?' for more)
status    print status information
toggle    toggle operating parameters ('toggle ?' for more)
slc       change state of special charaters ('slc ?' for
          more)
!         invoke a subshellenviron   change environment
variables ('environ ?' for                  more)
?         print help information
```

See also: **telnet** command, *Command Reference*

Closing the Remote Connection

To close a connection to a remote host, you can:

- Enter the TELNET **quit** command
- Use the remote host's logout procedure
- Enter the TELNET **close** command

The **quit** command releases your remote connection, stops the TELNET client and server processes on both hosts, and returns you to the OS prompt on your local host.

The remote host logout procedure and the **close** command have the same effect as the **quit** command if you connected to the remote host from input mode (the iRMX system prompt). If you connected to the remote host from command mode (the `telnet>` prompt), you are returned to the `telnet>` prompt on your local host.

Using Telnet for a Local Session

It is sometimes convenient to use the TELNET program locally without a connection to a remote host. For example, you might want to use TELNET locally to get information about its commands or to set up a new configuration (such as defining a new escape character) before you begin working on a remote host.

Whenever you use TELNET without a connection to a remote host, TELNET is in command mode and the `telnet>` prompt is displayed. You can enter only TELNET commands, not OS commands. To start the TELNET program without a remote host connection, enter the **telnet** command without a *`hostname`* parameter:

```
- telnet
telnet>
```

Entering Commands in a Local Session

During a local session you can enter any of the TELNET commands except **close**. This command is valid only when you are connected to a remote host.

The **status** command prints information about the current TELNET session. In this example, it identifies the host's escape character:

```
telnet> status

No connection.
Character mode is enabled.
Escape character is '^]'.
telnet>
```

Ending the Local Session

To end a local TELNET session, enter the **quit** command at the `telnet>` prompt. The TELNET process ends and you are returned to the iRMX system prompt on your local host.

❑ ❑ ❑

File Transfer Protocol 5

TCP/IP for the iRMX OS includes an implementation of the File Transfer Protocol: FTP. File Transfer Protocol (FTP) is the most powerful file transfer program available among the standard TCP/IP protocols and is therefore preferred by many users.

Before You Begin

Before you begin a file transfer session, you must know:

- A user login name and password on the remote host
- One of the valid names of the remote host: its Internet address, its official name, or its alias

You can get information about valid remote host names from the *:config:hosts* file, which lists the Internet address, official name, and aliases for each host on the network. Alternatively, you can use a DNS server to resolve a name to a network address.

If you need additional information or help setting up a remote host login, see your network administrator.

File Transfer Protocol (FTP)

FTP lets you transfer accessible files between your local host and a remote host that supports TCP/IP. You don't need to know the remote host's OS to transfer files. FTP is implemented entirely as a command line interpreter, where the commands are processed by the FTP client process on the local host.

During an FTP session, you enter commands to the FTP process to control the file transfer and manage the files and directories on the remote host. For example, you can issue FTP commands to open and close a remote host connection, delete remote files, or create new directories on the remote host.

Some FTP commands, such as **bell**, **debug,** and **help**, are processed completely by the FTP client process on the local host. These commands can be executed with or without an established connection to an FTP server process on a remote host. However, most FTP commands require a connection. These commands are translated by the FTP client process into one or more FTP protocol commands, which the client sends to the FTP server process on the remote host for processing. The FTP server, called **ftpd**, is described later in this manual.

As with TELNET, you can start FTP without making a connection to the remote host, using this command at the iRMX prompt:

```
ftp
```

or you can start FTP and open the remote connection with the command

```
ftp hostname
```

In either case the FTP client process starts and displays its prompt, `ftp>`. You can now enter FTP commands as described in these sections.

See also: **ftp** command, *Command Reference*

FTP Help Information

For on-line information about FTP commands, enter **?** to list all the commands and their descriptions. Use **?** *command_name* for a description of a single command.

See also: **ftp**, *Command Reference* for descriptions of all FTP commands

FTP File Transfer Session

An FTP file transfer session consists of three general steps:

1. Connecting to the remote host
2. Using FTP commands
3. Ending the FTP session

Connecting to the Remote Host

In most cases, you begin a file transfer session by entering a command to establish a connection to a particular remote host. Upon receipt of your command, the FTP client process on your local host activates an FTP server process on the remote host to service the session. If you did not invoke FTP with a *`hostname`* parameter, you establish a connection with the **open** command at the `ftp>` prompt.

Specify *`hostname`* as the Internet address, official name, or alias of the remote host. To connect to a remote host named *host2* at Internet address 128.215.12.21, you could use either name in either of the command methods shown below:

From the iRMX Prompt	From the FTP Prompt
- ftp 128.215.12.21	
- ftp	ftp> open host2

FTP attempts to connect you to the specified remote host. If the connection is established, FTP prompts you to log in. The message is similar to this:

```
Connected to host2.intel.com.
220 host2.intel.com FTP server (Version 1.2 May 02 1992)
ready.
Name (host2.intel.com:acct):
```

If the connection cannot be established, you are returned to the `ftp>` prompt.

When a connection is established, FTP prompts you to begin the remote host's login procedure. You must use a valid login name and password to gain access to the remote host. If you need help with logging in, see your system administrator.

When the login is successfully completed, FTP again displays the `ftp>` prompt. You can begin entering file transfer commands.

If the login is not successful, FTP displays a message to that effect and returns you to the `ftp>` prompt. At this point you are still connected to the remote host. To log in, enter:

```
ftp> user name
```

where *name* is your user name on the remote host. You are then prompted for your password.

You can automate the FTP login procedure to make it more convenient with a *netrc* file.

See also: FTP Initialization File, in this chapter

Using FTP Commands

Two commands commonly used for file transfer, the **put** and **get** commands, are described here. Several other FTP commands can be used to manage files and directories on both the local and remote hosts during a session. For example:

- The commands **dir**, **ls,** and **mls** provide you with listings of the files and directories on the remote host.
- The commands **lcd** and **cd** enable you to change directories on the local and remote hosts, respectively.
- The commands **mkdir** and **rmdir** enable you to create or delete directories on the remote host.

See also: **ftp** command, *Command Reference*, for descriptions of these FTP commands

Put Command

To copy a file from your local host to a remote host, enter this at the `ftp>` prompt:

```
put localfile [remotefile]
```

where *localfile* is the name of the local file to transfer and *remotefile* is the name for the remote copy of the file. If you do not enter a remote filename, FTP gives it the same name as the local copy.

You can use the **send** command as an alias for **put**.

The next example shows how FTP prompts for local and remote filenames when you enter **put** with no filename parameters. It also shows the message FTP displays when the transfer is successful.

Note

The **verbose** option must be on, as it is by default, to produce the display shown in this interactive session.

```
ftp> put
(local-file) payroll.1
(remote-file) payroll.2
200 PORT command okay.
150 Opening ASCII mode data connection for payroll.2.
226 Transfer complete.
2103 bytes sent in 0.29 seconds (6.9 Kbytes/s)
ftp>
```

The **put** command transfers one file per transaction. To transfer more than one file in a single transaction, use the **mput** command.

Get Command

To copy a file from the remote host to your local host, enter this at the `ftp>` prompt:

```
get remotefile [localfile]
```

where *`remotefile`* is the name of the remote file to be transferred and *`localfile`* is the name for the local copy of the file. If you do not enter a local filename, FTP gives it the same name as the remote copy.

You can use the **recv** command as an alias for **get**.

The next example shows how FTP prompts for remote and local filenames when you enter **get** with no filename parameters, and the message FTP displays when the transfer is successful.

```
ftp> get
(local-file) personnel.1
(remote-file) personnel.2
200 PORT command okay.
150 Opening ASCII mode data connection for personnel.1 (5909
bytes).
226 Transfer complete.
6123 bytes received in 1 seconds (5.979 Kbytes/s)
ftp>
```

The **get** command transfers one file per transaction. To transfer more than one file in a single transaction, use the **mget** command.

Transferring Files Between Systems With Different File Naming Conventions

When you transfer files between hosts with different operating systems, be sure to specify a name for the new file that conforms to the local file naming conventions. If you do not specify a destination name on the command line, FTP attempts to use the source name. If that name is not valid on the local host, the command fails. For example, you may need to copy a Unix tar file to the DOS file system on iRMX for PCs. Use a command line like one of these:

```
ftp> get bash.tar.Z bash_t.Z
ftp> put bash.tar.Z bash_t.Z
```

The destination file name, *bash_t.Z*, conforms to the DOS 8.3 file name convention, so it can be used with the DOS file drivers.

Transferring Large Files

To transfer large files to a remote Unix host using FTP, you might need to increase the value of the system parameter ulimit on the remote host. Ulimit is a Unix System V security feature that enables the network administrator to limit the size of files that can be created by local users. The default limit on many systems is 2048 512-byte blocks, or 1 MB. File transfer applications such as FTP and TFTP and rcp must obey the file size limitations imposed by the system on which the file is to be created. The default value of ulimit for the remote host governs the maximum size of a file that can be sent.

FTP allows you to change ulimit on a remote Unix host, but you must have root privileges on the Unix host to increase the value. Users without root privileges can only check the value or decrease it. If you do decrease the ulimit in a remote session, you cannot increase it, even to its original value, unless you have root privileges. If you need to increase ulimit on a host on which you do not have root privileges, contact your network administrator for assistance.

First you need to establish an FTP connection with the remote host, logging in as root. Then change the ulimit value for the remote session, using the FTP site command as follows:

```
ftp> site ulimit 16384
200 ULIMIT set to 16384 blocks
ftp> put big1
[File transfer information]
 .
 .
 .
ftp>
```

There are other remote commands you can execute with **site**, depending on the commands made available by the remote FTP server, **ftpd**.

See also: **ftp** and **ftpd** commands, *Command Reference*

Ending the FTP Session

To end a file transfer session, enter one of these commands:

- **bye**, or its alias **quit**
- **close**

The bye and quit commands release your connection, stop the FTP client and server processes in the local and remote hosts, and return you to the iRMX OS prompt on your local host.

The close command releases your connection to the remote host and returns you to the ftp> prompt on your local host.

FTP Initialization File

If you set up an FTP initialization file, the FTP process will log you on to a remote host automatically. Name the file *r?netrc* and put it in your home directory on the local host. If the FTP process finds *:home:r?netrc* at startup, it reads the file to obtain the information it needs to complete remote host login procedures.

Note
For those familiar with FTP in a Unix environment, on iRMX this file is named *netrc* without a beginning . (period or dot) in the filename. To hide the file on an iRMX system, name it *r?netrc*. When any program refers to *netrc*, the iRMX OS automatically maps it to *r?netrc*.

To create *netrc*, build a file that contains this information about each remote host where you want to log in automatically:

- The official host name as set with the **hostname** command; an Internet address or alias is not acceptable
- Your user login name on the remote host
- Optional: the password to your login on the remote host

Each line of the *netrc* file describes a different host. There is no limit to the number of lines the file can contain. The format for each line is:

```
machine host login login-name [password password]
```

The keywords `machine` and `login` must appear in each line, followed by the official host name and your remote user login name, respectively. Each word on the line must be separated from other words by a space or tab.

The keyword `password` and your password are optional. If you do not enter password information for a remote host in the *netrc* file, FTP prompts you for it when you log in to the host. Because the *netrc* file might contain password information, make the file readable only by the owner. FTP for the iRMX OS, unlike other versions, does not enforce owner-only file access. FTP does print a warning if the *netrc* file contains account information or passwords.

Below is an example of a record in a *netrc* file. In this example, `tvi386` is the official name of the remote host and `nancy` is the login name on that host. Because the password is omitted, Nancy will be prompted for it during login.

```
machine  tvi386  login  nancy
```

See also: *netrc* file, Chapter 10

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Network Services and Daemons 6

As network administrator, you determine which services each host on the network will provide. Many network services involve the interaction of a client process on one host and a server process on another. By defining the server processes that run on a particular host, you control the types of access available to remote clients.

An example of this type of network service is FTP, which is implemented by a client process (**ftp**) and a server process (**ftpd**). In general, the client and server share the same root name, and the server name includes the suffix `d`, which designates it as a *daemon*. A daemon operates in the background. A server daemon operates when it receives a client request. Virtually all of the networking commands available to the general user invoke the client process of a client/server pair.

Several additional network services are implemented by network daemons that are not associated with client processes. These daemons exchange messages with their counterparts on remote hosts and update local kernel tables or network databases based upon the information received. By defining the daemon processes that will be running on a particular host, you control the automatic (by daemon) or manual (by administrative command) updating of the related network tables.

These sections describe the network services that you can control for each host. Each section contains a brief description of the service, some guidelines for determining whether or not the service should be enabled, and instructions for configuring, enabling, or disabling the service, where applicable. The servers and daemons are described in alphabetical order.

See also: TCP/IP daemons, Chapter 2;
Stopping and Restarting TCP/IP, Chapter 2

Ftpd Server

Ftpd.job is the server process for the File Transfer Protocol (FTP). The client process is the **ftp** command. Running **ftpd.job** on the local machine allows remote **ftp** users to connect to this host to transfer files.

To enable FTPD on the local host, edit the startup script :config:tcpstart.csd and uncomment the line which sysloads the ftpd.job. If you are starting the TCP/IP stack from the *:config:loadinfo* file, uncomment the line which sysloads the ftpd.job in this file. Because FTP is one of the basic networking services provided by the TCP/IP package, it is very unusual to encounter a network host that is not listening for FTP requests.

If the local host is currently providing FTP access, the display from a **netstat -a** command includes an entry with a local address of **.ftp*.

See also:**ftpd.job**, *System Configuration and Administration*

Telnetd Server

Telnetd.job is the server process for the TELNET protocol, which defines the network virtual terminal access to a remote host. The client process is the **telnet** command.

To enable TELNETD on the local host, edit the startup script :config:tcpstart.csd and uncomment the line which sysloads the telnetd.job. If you are starting the TCP/IP stack from the :config:loadinfo file, uncomment the line which sysloads the telnetd.job in this file. Because TELNET is one of the basic networking services provided by the TCP/IP package, it is very unusual to encounter a network host that is not listening for TELNET requests.

If the local host is currently providing the TELNET service, the display from a **netstat -a** command includes an entry with a local address of **.telnet*.

Configuring Pseudo-terminals for Telnetd

The telnetd server node needs some additional configuration to set up pseudo-terminals for the remote client TELNET sessions to access. Like terminals, pseudo-terminals need to be identified and enabled in the :config:terminals file. Then the number of supported pseudo-terminals needs to be specified as a parameter to telnetd.job as follows:

1. Add an entry to the *:config:terminal(s)* file to initialize each iRMX pseudo-terminal device for users. List these devices as ptty_0, ptty_1, up through ptty_n-1 where n is the number of pseudo terminals supported. N can vary from 1 to 16 inclusively. For example:

   ```
   ptty_0,,,any
   ```

   Also edit the first line of the file, increasing the number by one for each new entry added. If that number is smaller than the number of entries, the extra entries are ignored

   For example, `ptty_2` in the following file cannot be used because the 3 at the beginning means the Human Interface initializes only the first three terminals.

   ```
   3
   d_cons,,,pc
   ptty_0,,,any
   ptty_1,,,any
   ptty_2,,,any
   ```

2. Update the :config:tcpstart.csd and/or the :config:loadinfo files to uncomment the line which sysloads the /rmx386/jobs/telnetd.job service and specify the

number of pseudo-terminals to be supported. The sysload command has the following form:

Sysload /rmx386/jobs/telnet.job num_pttys=n

Where

n is the number of pseudo-terminals to be supported. This number can vary between 1 and 16 inclusively. If num_pttys is not specified, the telnetd service assumes 4 pseudo-terminals.

See also: Configuring terminals, *System Configuration and Administration*;
telnetd.job, *System Configuration and Administration*

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Configuring and Administering Network Files 7

As network administrator, you define the operation of several network daemons and servers by setting up their configuration files. The network configuration files are described in this chapter.

Network Configuration File	**Network Daemon or Job**
:config:tcp.ini	TCP/IP jobs

Restricting and Updating Network Databases and Files

The following list shows files that that maintain information about hosts, networks, protocols, and available network services. Some of these files enable remote user access. As network administrator, you should ensure that these files are updated whenever the topology of the network changes. Only the network administrator should have permission to modify these files.

File	**Purpose**
:config:*hosts*	Lists addresses and names of accessible hosts and interfaces on the net
:config:*services*	Lists names, port numbers, and protocols associated with available services
:home:netrc	User-specific file that provides login information to FTP servers

See also: Chapter 9 for details about the contents of each file

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Commands for the Network Administrator 8

There are several TCP/IP commands that display configuration information and perform network maintenance. The network administrator uses these commands to monitor the overall status of the network, monitor and make available remote resources, test specific interfaces or functions, and configure certain interface characteristics. This chapter describes the purpose for using such commands.

See also: Command syntax and descriptions, *Command Reference*

Administrative Commands

These are the network maintenance commands:

netstat	Displays information from network data structures so you can identify network problems. This chapter describes network tests you can perform with this command.
ping	Tests low-level communications between two hosts to determine if there is a fault between them.

Performing Network Tests

As network administrator, you perform tests to determine whether the network services and daemons are running as expected, whether the interfaces and routes have been correctly configured, and whether each interface is functioning properly.

You should run a comprehensive set of tests after the network is first installed. These tests should include the functional tests of the software loopback interface as well as the basic assessment of the network configuration. At subsequent times when the network is brought up, you should run a subset of the initial tests to determine, at a minimum, that the correct daemons and interfaces are available. You should also thoroughly test each network interface when it is initially configured.

The tests described here are only suggestions. Your own networking environment will determine the tests that you select as most useful.

See also: **netstat** command, *Command Reference*, for more information about test results

Verifying Network Services

When the network is first brought up, you can perform the Network Status Test to verify that the network startup script *tcpstart.csd* has been properly configured.

Network Status Test

For the Network Status Test, perform these steps:

1. Use the **netstat -a** command to display all the active network connections and listening servers.
2. Verify that there is an entry in the **netstat -a** table for every network server daemon you have configured.

   See also: Chapter 5 for definitions of network servers

3. For TCP-based services, verify that the entries in the **netstat -a** table have these attributes:
   - The protocol is tcp.
   - The address part of the local address is wild-carded.
   - The port part of the local address shows the service name as defined in the *:config:services* file.
   - Both the address and port parts of the foreign address are wild-carded.
   - The state is LISTEN.
4. For UDP-based services, verify that entries in the **netstat -a** table have these attributes:
   - The protocol is udp.
   - The address part of the local address is wild-carded.
   - The port part of the local address shows the service name as defined in the *:config:services* file.
   - The address part of the foreign address is a name, address, or wildcard.
   - The port part of the foreign address is wild-carded.
   - The state is empty.

Verifying Network Configuration

You can perform the Interface Status Test, the Interface Configuration Test, and the Route Configuration Test to verify network configuration.

Interface Status Test

For the Interface Status Test, perform these steps:

1. Use the **netstat -i** command to display the configured network interfaces.
2. Compare the **netstat -i** display with the contents of the network configuration file *tcp.ini* to verify that all interfaces have been successfully configured.

3. Ensure these conditions are true for each entry in the **netstat -i** table:

   - The interface name is the same as the one defined in the *tcp.ini* file. This name is unique.
   - The maximum transfer unit (MTU) for each interface is a positive nonzero integer that reflects the type of communications medium used: 4096 for the software loopback interface and 1500 for Ethernet interfaces. If the MTU is zero, the interface did not initialize properly.
   - The network and address fields each contain a name, not an Internet address. The address field contains the host name assigned to the interface in the *tcp.ini* file. The network field contains the network name from the *:config:networks* file that matches the network portion of the address associated with that host name in the *:config:hosts* file. (If the network address is displayed, make sure the *:config:networks* file has an entry for the address also.)
   - The input and output error fields are 0. The input packets field is at least 2. The output packets field is 0 or a positive integer.

Verifying Interface Functionality

The purpose of this type of network testing is to verify that each configured interface is functioning properly and that all three of the Transport Layer protocols (tcp, udp, and raw) are working as expected. Test the software loopback interface first as described below to determine that the basic streams have been properly constructed. Then test each network interface in the same manner.

1. To test the tcp transport layer, perform these steps:

   - Enter:

     ```
     telnet me
     ```

     In response to your command, a DNS database or the *:config:hosts* file is accessed to obtain the Internet address for the host `me`, at which point TELNET displays this message:

     ```
     Trying 127.0.0.1 .....
     ```

     If this message is n t displayed, check the *:config:hosts* file to make sure that the proper name-to-address translation is available.

     As soon as TELNET makes the connection, it displays the connection status and then the login banner received from the remote host (in this case, the local host through the loopback connection).

   - Log in and then log off to terminate the test.

     The three errors most often encountered when running this test are:

- No address translation can be found for the remote host name (unknown host).
- The remote host is not listening for TELNET connections (connection refused).
- The remote host did not respond to the connection request (connection timed out).

The last error can be caused by a hardware problem. It can also occur if the remote host is down, does not have the network running, or is very busy.

2. To test the udp transport layer, use the command:

   ```
   tftp me
   ```

3. To test the raw transport layer, use the command:

   ```
   ping me 1 10
   ```

   This sends ten one-byte ECHO_REQUEST packets to the local host, using the loopback device. The transmission summary should show no packet loss and reasonably consistent round trip times for the individual packets.

You can use the **netstat** command to test the functionality of the udp and tcp transport layers.

See also: **telnet**, **netstat**, and **ping** commands, *Command Reference*

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Tunable Parameters 9

A number of tunable parameters affect the functionality and performance of TCP/IP software. For each TCP/IP job, there are parameters that define how that job operates.

Tuning is a tradeoff between allocating enough resources to facilitate networking operations and keeping the kernel small enough to be manageable. The recommendations made in this chapter are generally on the small end of the scale. You will almost certainly need to revise them to meet the needs of your network's configuration. Start with the values specified and monitor the system closely for a while to determine what your environment really needs.

Determining When to Tune Parameters

The TCP/IP kernel is installed with default parameters that are adequate for a simple host configuration, with one network interface and a moderate amount of network traffic. After you determine your host and network configuration, you should review the TCP/IP parameters listed in this chapter and reset them as needed.

TCP/IP Parameters

Parameters in the*:config:tcp.ini* file affect the TCP/IP jobs' operation, and performance.

✏ **Note**
Values *not* enclosed in single quotes are hexadecimal numbers.

[TCP]

Key	Default Value	Description
DEFMSS	200	Default maximum segment size
RCVSPACE	4000	Maximum receive space per socket
SNDSPACE	4000	Max send space per socket
CTLBUFS	40	Maximum total control buffers
TRANSBUFS	40	Maximum total transaction buffers
MAXTRANS	10	Maximum simultaneous IP transactions
MAXPORTS	1388	Maximum port ids

LOWFIXPID	1	Well-known port id range
HIFIXPID	3FF	
LOWAUTOPID	400	Ephemeral port id range
HIAUTOPID	1387	

[UDP]

Key	Default Value	Description
CHECKSUM	1	Enable checksum
RCVSPACE	0A000	Maximum receive space per socket
CTLBUFS	40	Maximum total control buffers
TRANSBUFS	40	Maximum total transaction buffers
MAXTRANS	10	Maximum simultaneous IP transactions
MAXPORTS	1388	Maximum port ids
LOWFIXPID	1	Well-known port id range
HIFIXPID	3FF	
LOWAUTOPID	400	Ephemeral port id range
HIAUTOPID	1387	

[RIP]

Key	Default Value	Description
CTLBUFS	20	Maximum total control buffers
TRANSBUFS	20	Maximum total transaction buffers
MAXTRANS	8	Maximum simultaneous IP transactions
MAXPORTS	80	Maximum port ids

[IP]

Key	Default Value	Description
IFNAMES	’ETH0, LO0'	Interface names
BUFHEAPSIZE	200	Tot al receive buffer size in Kbytes
FORWARDING	0	Enable IP forwarding
LOCALSUBNETS	1	Enable local subnets
TTL	8	Default segment time to live
TOS	0	Default type of service
ARPTIMEOUT	20	ARP cache flush timeout in minutes
CTLBUFS	80	Maximum total control buffers
TRANSBUFS	80	Maximum total transaction buffers

[ETH0]

Key	Default Value	Description
HOST	'206.103.53.115'	Interface IP address
NETMASK	'255.255.255.0'	Net mask
DEFROUTE	'206.103.53.250'	Default route
RCVBUFS	3F	Maximum receive buffers

MAXTRANS	6F	Maximum simultaneous transactions

[LO0]

Key	Default Value	Description
HOST	'127.0.0.1'	Interface IP address
NETMASK	'255.255.0.0'	Net mask
RCVBUFS	3F	Maximum receive buffers
MAXTRANS	6F	Maximum simultaneous transactions

[ROUTE0]

Key	Default Value	Description
DEST	'206.163.82.4'	Destination IP address
MASK	'255.255.255.0'	Net/subnet mask
GATEWAY	‘172.16.1.250’	Gateway IP address
FLAGS	‘GH’	Gateway/Host Flags

TCP Job Parameters

DEFMSS

Default maximum size of segments sent by the TCP job. To avoid fragmentation at the IP level, set this parameter to the smallest maximum packet size that a sent packet is likely to encounter in its route to the destination. Once a connection is established, the source and destination TCPs negotiate an optimum maximum packet size.

RCVSPACE

Size, in bytes, of the receive buffer area per TCP socket. The receive buffer holds incoming data until it is received at the socket by the application.

SNDSPACE

Size, in bytes, of the send buffer area per TCP socket. The send buffer holds outgoing data until it is successfully sent to the destination.

CTLBUFS

Maximum number of control buffers allocated for the TCP job. Control buffers are used by the TCP job whenever data is sent or received through a TCP socket.

If insufficient control buffers are available, an ENOBUFS error is returned to the application. This indicates that the number of configured control buffers for the TCP job should be increased. The default value should be used for most applications.

TRANSBUFS

Maximum number of transaction buffers allocated for the TCP job. Transaction buffers are used by the TCP job whenever data is sent or received through a TCP socket.

If insufficient transaction buffers are available, an ENOBUFS error is returned to the application. This indicates that the number of transaction buffers for the TCP job should be increased. The default value should be used for most applications.

MAXTRANS
: Maximum number of simultaneous transactions allowed between the TCP job and the IP job. Transactions are used by the TCP job whenever data is sent or received through a TCP socket.

  If insufficient transactions are available, an ENOBUFS error is returned to the application. This indicates that the number of transactions for communication between the TCP job and the IP job should be increased. The default value should be used for most applications.

MAXPORTS
: Maximum number of port ids available to the TCP job. Whenever a TCP socket is bound (see the bind() system call), a local port id is assigned to the socket. This parameter specifies the maximum number of unique port ids available.

LOWFIXPID, HIFIXPID
: When a TCP socket is bound (see the **bind()** system call), the user may specify the local port id that is to be associated with the socket. LOWFIXPID and HIFIXPID:

- Define the range of port id values that may be specified.
- Must be within the range of 0 to MAXPORTS, exclusive, and must not overlap the port id range defined by LOWAUTOPID and HIAUTOPID.

LOWAUTOPID, HIAUTOPID
: When a TCP socket is bound (see the **bind()** system call), the user may request that the TCP job select the local port id that is to be associated with the socket (known as an *ephemeral* port id). LOWAUTOPID and HIAUTOPID:

- Define the range of port id values that the TCP job may choose from.
- Must be within the range of 0 to MAXPORTS, exclusive, and must not overlap the port id range defined by LOWFIXPID and HIFIXPID.

UDP Job Parameters

CHECKSUM
: A value of 0 disables checksum calculation on all segments sent or received by the UDP job. A value of 1 enables checksum calculation. This parameter should normally be set to 1.

RCVSPACE
: Size of the receive buffer area per UDP socket, in bytes. The receive buffer holds incoming data until it is received at the socket by the application.

CTLBUFS

Maximum number of control buffers allocated for the UDP job. Control buffers are used by the UDP job whenever data is sent or received through a UDP socket.

If insufficient control buffers are available, an ENOBUFS error is returned to the application. This indicates that the number of configured control buffers for the UDP job should be increased. The default value should be used for most applications.

TRANSBUFS

Maximum number of transaction buffers allocated for the UDP job. Transaction buffers are used by the UDP job whenever data is sent or received through a UDP socket.

If insufficient transaction buffers are available, an EBOBUFS error is returned to the application. This indicates that the number of transaction buffers for the UDP job should be increased. The default value should be used for most applications.

MAXTRANS

Maximum number of simultaneous transactions allowed between the UDP job and the IP job. Transactions are used by the UDP job whenever data is sent or received through a UDP socket.

If insufficient transactions are available, an ENOBUFS error is returned to the application. This indicates that the number of transactions for communication between the UDP job and the IP job should be increased. The default value should be used for most applications.

MAXPORTS

Maximum number of port ids available to the UDP job. Whenever a UDP socket is bound (see the **bind()** system call), a local port id is assigned to the socket. This parameter specifies the maximum number of unique port ids available.

LOWFIXPID, HIFIXPID

When a UDP socket is bound (see the **bind()** system call), the user may specify the local port id that is to be associated with the socket. LOWFIXPID and HIFIXPID:

- Define the range of port id values that may be specified
- Must be within the range of 0 to MAXPORTS, exclusive, and must not overlap the port id range defined by LOWAUTOPID and HIAUTOPID.

LOWAUTOPID, HIAUTOPID

When a UDP socket is bound (see the **bind()** system call), the user may request that the UDP job select the local port id that is to be associated with the socket (known as an *ephemeral* port id). LOWAUTOPID and HIAUTOPID:

- Define the range of port id values that the UDP job may choose from.

- Must be within the range of 0 to MAXPORTS, exclusive, and must not overlap the port id range defined by LOWFIXPID and HIFIXPID.

Raw IP Job Parameters

CTLBUFS

Maximum number of control buffers allocated for the Raw IP job. Control buffers are used by the Raw IP job whenever data is sent or received through a Raw IP socket.

If insufficient control buffers are available, an ENOBUFS error is returned to the application. This indicates that the number of configured control buffers for the Raw IP job should be increased. The default value should be used for most applications.

TRANSBUFS

Maximum number of transaction buffers allocated for the Raw IP job. Transaction buffers are used by the Raw IP job whenever data is sent or received through a RAW IP socket.

If insufficient transaction buffers are available, an ENOBUFS error is returned to the application. This indicates that the number of transaction buffers for the Raw IP job should be increased. The default value should be used for most applications.

MAXTRANS

Maximum number of simultaneous transactions allowed between the Raw IP job and the IP job. Transactions are used by the Raw IP job whenever data is sent or received through a Raw IP socket.

If insufficient transactions are available, an ENOBUFS error is returned to the application. This indicates that the number of transactions for communication between the Raw IP job and the IP job should be increased. The default value should be used for most applications.

MAXPORTS

Maximum total number of Raw IP sockets that may be created.

IP Job Parameters

IFNAMES

A list of interfaces that the IP job may communicate with to send and receive datagrams. Each interface name in the list must match an interface description included in the *:config:tcp.ini* file (e.g., [ETH0]), and also must match the name associated with a NIC driver loaded in the *:config:tcpstart* submit file.

BUFHEAPSIZE
: Total buffer space, in Kbytes, available to the IP job for sending and receiving datagrams. The buffers specified in the interface descriptions (e.g., the RCVBUFS parameter of the [ETH0] interface description) are allocated from the buffer space defined here.

FORWARDING
: If this host is to forward packets from one network segment to another, set this parameter to 1. If not, set it to 0.

LOCALSUBNETS
: If this host is directly connected to a network that is divided into subnets, set this parameter to 1. If not, set it to 0.

TTL
: Default time to live for outgoing datagrams. The TTL is used to limit the life of TCP segments and prevent packets from endlessly circling the Internet on the way to some unreachable destination.

TOS
: Default type of service for outgoing datagrams. This parameter encodes both precedence and the type of service as defined by the MIL-STD 1777. The upper three bits of the byte encode the precedence; the lower five bits encode the type of service.

ARPTIMEOUT
: The number of minutes after which a complete ARP table entry will be deleted from the ARP cache if no ARP packets from the associated host are observed on the network.

CTLBUFS
: Maximum number of control buffers allocated for the IP job. Control buffers are used by the IP job whenever data is sent or received.

  If insufficient control buffers are available, an ENOBUFS error is returned to the application. This indicates that the number of configured control buffers for the IP job should be increased. The default value should be used for most applications.

TRANSBUFS
: Maximum number of transaction buffers allocated for the IP job. Transaction buffers are used by the IP job whenever data is sent or received.

  If insufficient transaction buffers are available, an ENOBUFS error is returned to the application. This indicates that the number of transaction buffers for the IP job should be increased. The default value should be used for most applications.

DNS Configuration Parameters

DOMAIN
: A string containing the name of the local domain.

SERVER1
    A string that contains the IP address of the primary DNS server used by the client

SERVER2
SERVER3
    Each of these parameters takes a string containing the IP addresses of secondary DNS servers. A total of three servers may be configured. If this section is not defined, or no servers are defined, then DNS name resolution does not occur.

Network Interface Parameters

HOST The IP address associated with this interface.

NETMASK
    The net mask for the IP address associated with this interface.

DEFROUTE
    The default route. If the destination of a datagram is not on the network attached to this interface, the default route is used as a destination. The host at the default route address will then forward the datagram to the desired destination. Only one interface should configure a default route.

RCVBUFS
    The number of buffers allocated to receive datagrams from this interface. These buffers are allocated from the memory pool defined by the IP job's BUFHEAPSIZE configuration parameter.

    Set this parameter to the maximum number of datagrams expected to be received at one time on this interface.

MAXTRANS
    The maximum number of simultaneous transactions between the IP job and this interface. Each datagram sent or received consumes one transaction. The transaction is recycled when the send or receive is processed.

    Set this parameter to the sum of the maximum number of incoming datagrams expected at one time (i.e., the value of the RCVBUFS parameter, above) plus the maximum expected number of simultaneous sends to this interface.

Loopback Pseudo-driver Interface Parameters

HOST The IP address associated with the loopback interface.

NETMASK
    The net mask for the IP address associated with the loopback interface.

RCVBUFS

The number of buffers allocated to receive datagrams from this interface. These buffers are allocated from the memory pool defined by the IP job's BUFHEAPSIZE configuration parameter.

Set this parameter to the maximum number of datagrams expected to be received at one time on this interface.

MAXTRANS

The maximum number of simultaneous transactions between the IP job and this interface. Each datagram sent or received consumes one transaction. The transaction is recycled when the send or receive is processed.

Set tthis parameter to the sum of the maximum number of incoming datagrams expected at one time (i.e., the value of the RCVBUFS parameter, above) plus the maximum expected number of simultaneous sends to this interface.

Route Parameters

DEST The IP address of the route destination. This may be a host address or a network address.

MASK

The net mask for the IP address associated with the destination.

GATEWAY

If the route is through a gateway, this parameter specifies the IP address of the gateway host. This parameter is not needed for routes to destinations that are directly connected to the sending host.

FLAGS

The 'H' flag indicates that the route is to a host. The absence of the 'H' flag indicates that the route is to a network.

The 'G' flag indicates that the route is through a host, whose IP address is specified by the GATEWAY parameter, that acts as a gateway to the destination. The absence of the 'G' flag indicates that the route is direct to the destination. A GATEWAY parameter is not needed for a direct route.

NFS Server and Mount Daemon (nfsd) Parameters

Parameters in the [nfsd] section of *stune.ini* affect the NFS server and mount daemon uid/gid mapping, stateless operation, and performance.

Parameter	Default	Description
DELETE_CONN_TIMEOUT_MIN	5	Delete connection timeout
DELETE_FH_TIMEOUT_HR	24	Delete file handle timeout
MAX_CONN	100	Max iRMX connections
MAX_FH	2000	Max NFS file handles
SAVE_FH_INTERVAL_SEC	30	Save file handle to disk interval
WORLD_NFS_GID	1	NFS group ID for World from clients
WORLD_NFS_UID	60000	NFS user ID for World from clients

DELETE_CONN_TIMEOUT_MIN
The time in minutes that the server allows iRMX connections to remain attached or open. If this timeout occurs for a given NFS file handle, the server closes and deletes the connection (the NFS file handle remains active though). If a client subsequently re-accesses the file handle, the server re-attaches or opens the connection.

DELETE_FH_TIMEOUT_HR
The time in hours that the server maintains an NFS file handle. In NFS, there is no concept of “closing” a file handle. The client simply stops using the file handle. If this timeout occurs for a given NFS file handle, the server removes the file handle from internal tables. If a client subsequently re-accesses the file handle, the server returns an error (the Unix message “stale handle”).

This timeout does not apply to mount handles. Handles returned on a mount request are always retained.

MAX_CONN
The maximum number of iRMX connections that the server uses. This affects BIOS resources and performance.

MAX_FH The maximum number of concurrent NFS file handles the server allows clients to use. This affects memory usage and performance.

SAVE_FH_INTERVAL_SEC
The interval in seconds that the server waits before saving to disk the active NFS file handles in use by remote systems. Saving the file handles allows the NFS server to recover after an inadvertent reset or power-down. Decreasing this parameter provides better crash recovery (smaller window). Increasing this parameter provides faster overall system performance (fewer disk writes). Set this parameter to -1 to inhibit saving to disk.

WORLD_NFS_GID

The group ID mapped by the NFS server for remote clients with the iRMX World user ID. Although this may be different than the group ID for the NFS file driver (in the [nfsfd] section of *stune.ini*), it is recommended that they match.

WORLD_NFS_UID

The user ID mapped by the NFS server for remote clients with the iRMX World user ID. Although this may be different than the user ID for the NFS file driver (in the [nfsfd] section of *stune.ini*), it is recommended that they match.

NFS File Driver (nfsfd) Parameters

Parameters in the [nfsfd] section of *stune.ini* affect the NFS file driver uid/gid mapping and performance.

Parameter	**Default**	**Description**
WORLD_NFS_GID	1	NFS group ID for World from servers
WORLD_NFS_UID	60000	NFS user ID for World from servers

WORLD_NFS_UID

The remote NFS user ID equivalent to the local iRMX World user ID. It is recommended that you set up a user on the remote system with this user ID with the name “world”. This will allow files on the remote system to be listed with the native operating system correctly. Although setting this parameter to 65535 may appear to be logical, this can have side-effects on remote hosts. Several Unix systems do not allow user IDs to be created greater than 60002.

WORLD_NFS_GID

The remote NFS group ID equivalent to the local iRMX World user ID. The default setting of 1 is typically the “other” group on Unix systems.

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Files 10

This chapter describes the format and contents of network files for TCP/IP. All the files below are installed in the *:config*: directory except *netrc*, which must be in each user's home directory.

File	**Description**
hosts	host name database
protocols	protocol name database
services	network services database
sharetab.cf	list of local resources mountable by remote systems
netrc	ftp autologin information

hosts

The *:config:hosts* file contains information regarding the known hosts on the Internet. If the Domain Name Service is being used by the local host, this file will usually contain entries for the local network interfaces. The file should contain an entry for each host and each interface accessible through the network. The primary purpose of the file is to provide the Internet address associated with a symbolic host name. This allows users to specify a name instead of an address.

For each host there should be a single line in the file with this information:

```
Internet_address  official_host_name  alias ...
```

Each entry begins in column one of the line. Fields are separated by any number of blanks and/or tab characters. A pound sign (#) indicates the beginning of a comment extending to the end of the line.

Specify Internet addresses in the conventional dot notation. The official host name should be the fully-qualified domain name as stored with a **hostname** command or **sethostname( )** function. Alias names are optional; there may be more than one, but they must all be on the same line. Host names may contain any character or digit other than space, tab, newline, and pound sign.

See also: Internet addresses, Chapter 1

The extent to which this file is used depends somewhat on the host's configuration. At a minimum, the *:config:hosts* file must contain an entry for every interface used in the network configuration file *:config*:*tcp.ini*. For example, if the local host is configured with the software loopback interface (*lo0*), the *hosts* file must contain an entry defining the Internet address (127.0.0.1), the official name (*loopback*) and the aliases (*me* and *localhost*) of that interface. The *hosts* file is the sole source for the name-to-address translations required to initialize the interface correctly.

After the network is running, the use of the hosts file is dependent upon whether or not the local host has been configured to use the Domain Name System (DNS). If DNS has been configured for use by the local host, the networking library functions gethostbyname and gethostbyaddr will use DNS to obtain the requested information. If the DNS cannot be accessed, because either the network interface or the name server is down, both library functions will eventually consult the hosts file to resolve requests.

If the DNS is not configured for use by the local host, the *hosts* file must contain the names and addresses of all local interfaces and remote hosts that will be accessed by name.

No specific order is required for either the entries in the file or the list of aliases in a specific entry. Because both the file and the alias list are searched sequentially for a given name, it may be useful to list the most often used names first in order to speed the process, although the file is rarely long enough to make a noticeable difference.

Below is a typical *hosts* file.

```
# :config:hosts
#
# FORMAT:
#   address official_name alias(es)
#

# software loopback interface
127.0.0.1 loopback me localhost

# add local network interface definitions here

# add remote definitions here (if desired/needed)
```

As network administrator, you should be the owner of this file. Modify it and update it as necessary.

protocols

The *:config:protocols* file contains the official name, protocol number, and aliases of the protocols with which the ip module directly communicates. The protocols are standardized throughout the Internet community and are defined in RFC 1060, Assigned Numbers (Reynolds & Postel).

While the actual protocol numbers are used by the TCP/IP kernel modules, the number-to-name translation information is used primarily by the **netstat** command to display the symbolic name of the protocol instead of its number. There are no required entries in the *protocols* file; the information is used to make displays more readable and meaningful.

For each protocol there should be a single line in the file with this information:

```
official_protocol_name  protocol_number  aliases
```

The first field on each line should begin in column one. Fields are separated by any number of blanks and/or tab characters. A comment begins with a pound sign (#) and continues to the end of the line. A comment can appear on a separate line or at the end of a line listing network name and address information.

Protocol names can contain any printable character other than a space, tab, newline, or comment character. The official name and number of the protocol should be as defined by the RFC 1060. A list of one or more aliases is optional.

Although no specific order is required for entries in the file, entries are generally maintained in numerical order by protocol number. Below is an example of a *protocols* file.

```
# :config:protocols
#
# FORMAT:
#   official_name protocol_number alias(es)
#
# Internet protocols

ip      0   IP    # reserved for ip (pseudo-protocol number)
icmp    1   ICMP  # internet control message protocol
tcp     6   TCP   # transmission control protocol
egp     8   EGP   # exterior gateway protocol
igp     9   IGP   # any private interior gateway protocol
pup    12   PUP   # PARC universal packet protocol
udp    17   UDP   # user datagram protocol
```

As network administrator, you should be the owner of this file. Update it, if necessary, so that its contents always reflect the protocols operating on the local host. You can add entries if protocols interfacing with ip are added to the local host. The information for this file should be obtained from the most current relevant RFC.

See also: **getprotoent** function, Chapter 11

netrc

The *:home:netrc* file contains information used to automatically validate FTP connections to one or more remote hosts.

✏ **Note**

Unlike the Unix environment, the iRMX version of this file is named *netrc* without a beginning . (period or dot) in the filename. To hide the file, name it *r?netrc*. When any program refers to *netrc*, the iRMX OS automatically maps it to *r?netrc*.

When **ftp** opens a connection to a remote machine, it checks the user's home directory (*:home:*) for this file. If the file exists, **ftp** checks for an entry for the specified host machine. If such an entry is found, the login name (and optional password) in that entry is supplied to the FTP server without the user being prompted. If the normal validation process used by the FTP server succeeds, the FTP connection is completed without any interactive input by the user. If the file does not contain password information, the user is not prompted for a login name but is prompted for a password.

If *netrc* does not exist for that user, or it exists but contains no entry for the remote host, the user is prompted for a login name and password.

The *netrc* file may contain multiple entries, each specifying login information to a different host name. An entry begins with the keyword `machine` (or the special keyword `default`, described below) and ends with the next occurrence of the word `machine` or with the end of the file. Thus a single entry may be on one line or span multiple lines.

```
<machine name | default> login name [password string]
[account string] <[macdef name
string
]> ...
```

Each entry contains several keyword-value pairs in the format shown above. The first field on each line should begin in column one. Subsequent fields should be separated by spaces or tab characters. Comments begin with a pound sign (#) and can appear on a separate line or at the end of a line listing host and login information. The angle brackets shown above are not part of the syntax; they surround multiple items in the same field.

The `machine` keyword identifies the name of a remote host to which autologin is supported. The *`name`* can be either the official host name or an alias. FTP uses the first entry it finds in *netrc* that matches the name of the remote host specified on the **ftp** command line. The keyword `default` is a special instance of `machine` which matches any host name. Since `default` matches every host name, any entries appearing after it in the file are ignored.

The `login` keyword identifies a login name to be used on the remote machine.

The `password` keyword, where present, specifies the password to the given login. The `account` keyword, where present, specifies a resource access password to be used when required by the remote host. The `account` keyword does not apply to a Unix or iRMX OS and should not be used for such remote systems. Specifying a password or account is optional. If you include this information, also set the file permissions so only the owner can read it. FTP for the iRMX OS, unlike other versions, does not enforce the restriction of access permissions to the owner. FTP does print a warning if the *netrc* file contains account information or passwords.

The `macdef` keyword identifies an FTP macro definition to be used during a connection to the specified host. The macro name should follow the keyword; the macro definition should begin on the next line of the file and continue until a blank line or the end of the file is encountered. Multiple macros can be defined in this manner, since the next entry does not start until the `machine` or `default` keyword is encountered. The special macro name `init` causes the associated macro to be invoked as the last step in the autologin process.

See also: **ftp** command *Command Reference*;
FTP Initialization File, Chapter 5

The following example is an empty *netrc* file. To prevent creation of an unauthorized *netrc* file, such as in the Super user's home directory, install an empty file that only Super can access.

```
# netrc
#
# FORMAT:
#     machine hostname     login name
#     machine hostname     login name     password passwd
#
```

The default permissions of the *netrc* file are to be readable and writable by the owner. All owners of a *netrc* file should modify this file and update it as necessary.

services

The *:config:services* file contains information about the services available through the transport layer protocols. The services are defined in RFC 1060, Assigned Numbers (Reynolds & Postel), and are standardized throughout the Internet community. The service information is used by applications and TCP/IP kernel modules to identify and validate logical connections. The **netstat** command uses the *services* file to display the symbolic name of the service instead of its number.

The transport layer protocols use ports to identify the endpoints of a logical connection. Specific application services are associated with certain ports, often called *well-known ports*. The server process for the application listens at the assigned port for incoming connections. The Internet community, through RFC 1060, coordinates and standardizes the ports assigned to specific services. Wherever possible, the TCP, UDP, and ISO-TP4 service assignments are coordinated.

For each service there should be a single line in the *services* file with this information:

```
official_service_name  port_number/protocol_name  aliases
```

The first field on each line should begin in column one. Fields are separated by any number of blanks and/or tab characters. A comment begins with a pound sign (`#`) and continues to the end of the line. A comment can appear on a separate line or at the end of a line listing service information.

Service names may contain any printable character other than a space, tab, newline, or comment character. The port number and protocol name are considered a single field; a slash separates the port and protocol (for example, `512/tcp`). A list of one or more aliases is optional.

Although there is no specific order required for the entries in this file, entries are generally maintained in numerical order by port number.

As network administrator, you should be the owner of this file. Update it, if necessary, so that its contents always reflect the services available on the local host. Port numbers 0 through 1023 are reserved for privileged processes, and should be used only for the service identified by the Assigned Numbers through RFC. Assign port numbers 1024 and above to custom applications and services unique to the local networking environment.

See also: **getservent** function, Chapter 13

This is a typical *services* file:

```
# :config:services
# FORMAT:
# service port/protocol alias(es)
# ports 0 - 512 are privileged ports
#
netstat         15/tcp
netstat         15/udp
ftp-data        20/tcp
ftp             21/tcp
telnet          23/tcp
smtp            25/tcp         mail
nameserver      53/tcp         domain named
nameserver      53/udp         domain named
tftp            69/udp
rpcbind        111/udp
rpcbind        111/udp
nfsd          2049/udp
finger          79/tcp
hostnames       101/tcp        hostname
netbios-ns      137/tcp        nb-ns
netbios-dgm     138/udp        nb-dgm
netbios-ssn     139/tcp        nb-ssn
snmp            161/udp        snmp
snmp-trap       162/udp        snmptrap
exec            512/tcp        rexec
login           513/tcp        rlogin
who             513/udp        rwho whod
cmd             514/tcp        shell rsh rsh
printer         515/tcp        spooler
talk            517/udp
ntalk           518/udp
router          520/udp        route routed#
# ports > 1024 host-specific functions
#
```

sharetab.cf

The *sharetab.cf* file is the NFS configuration file that defines local file systems as NFS-shared. Resources listed in this table are made available for attaching (or mounting) by clients in an NFS network. If a resource does not appear in this table and you want to allow remote NFS clients access to the resource, then you must specifically make it available for attaching (or mounting) by issuing the **share** command.

The *sharetab.cf* file is referenced during these occasions:

- When you enter the **share** command. Entering **share** causes an entry to be added to the *sharetab.cf* file.
- When you enter the **unshare** command. Entering **unshare** causes an entry (or all entries) to be removed from the *sharetab.cf* file.
- When a remote NFS client attaches (or mounts) a file directory on an NFS server. The server jobs reference *sharetab.cf* file to ensure that the requested file system has an entry (is defined as NFS-shared).

✏ **Note**
You should never edit the *sharetab.cf* file directly. Use the **share** and **unshare** commands to add and remove entries.

Each entry in the *sharetab.cf* file contains lines with the following fields:

```
pathname   symbolic_name   options
```

The `pathname` field is the local pathname to the shared resource including a drive device name like *:sd:*.

The `symbolic_name` field is a symbolic name of the local resource that will be shared. You can specify this symbolic name by using the `-s` option with the **share** command. If you do not specify a symbolic name, **share** creates one. You should be aware of file naming conventions that can affect how this symbolic name is interpreted.

See also: **share** command, *Command Reference*

The `options` field is a comma-separated list of keywords and attributes for the shared resource. If you do not specify options, **share** enters `rw` as the default.

Options include:

`rw`	All clients can read and write the shared device
`rw=`*`client`*`[:`*`client`*`]...`	Substitute host names of clients that will have read and write access to the shared device. This option overrides the `ro` option when combinations of options result in the same client having both `ro` and `rw` options.
`ro`	All clients can only read the shared device.
`ro=`*`client`*`[:`*`client`*`] ...`	Substitute host names of clients that will have read-only access to the shared device. This option overrides the `rw` option when combinations of options result in the same client having both `ro` and `rw` options.
`anon=`*`uid`*	Specifies the user identification for unknown (anonymous) users. By default, unknown users are given the user identification World. If uid is set to -1, access to unknown users is denied.
`root=`*`host`*`[:`*`host`*`] ...`	Restricts Super user access to the list of hosts. By default, no host has Super user access.

The following are example entries in a *sharetab.cf* file:

```
#path           symbolic  options
#
:sd:user/jeff1  jeff      rw,ro=hosta,anon=36,root=hosta
:sd:user/jimd   jim       ro,rw=hosta,anon=-1
```

In the previous example, the first entry specifies that the directory *:sd:user/jeff1* will be shared. After attaching the file system, clients will be able to access the directory by specifying its logical name as specified with the **attachdevice** command. The options indicate that all clients will have read/write access. However, users from hosta are restricted to read-only access. The user identification assigned to unknown users will be 36. Super user access is allowed only from hosta.

The second entry options declare that all clients will have read-only access. This access is overruled for hosta, which has read/write privileges. For this second entry no anonymous users are allowed to access *:sd:user/jimd* and there is no Super user access from clients.

See also: Sharing File Systems, Chapter 3
share command, *Command Reference*

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TCP/IP Components 11

This chapter describes the purpose of special files related to the network interface devices, protocols, and protocol families. These files are installed in the */rmx386/jobs* directory:

File	See	Description
ip.job		IP layer
rip.job		Raw IP layer
tcp.job		TCP layer
udp.job		UDP layer
eepro100.job		NIC driver.
edl.job		NIC-sytle interface to iNA jobs
loopback.job		Loopback pseudo-driver
ne.job		NIC driver.
tulip.job		NIC driver.

Protocol Jobs

All network protocols are associated with a specific *protocol family*, such as the Internet family *inet*. Associated with each protocol family is an address format, such as the Internet format AF_INET. A protocol family provides basic services to the protocol implementation to allow it to function within a specific network environment. These services may include packet fragmentation and reassembly, routing, addressing, and basic transport.

A protocol family normally comprises a number of *protocols*, such as the Internet protocols tcp and ip. A protocol normally accepts only one type of address format, as determined by the addressing structure inherent in the design of the protocol family and network architecture.

A *network interface* corresponds to a path through which messages can be sent and received. It can be a hardware device, such as an Ethernet driver, or a pseudo-device, such as the loopback driver. Network interfaces comprise the lowest layer of the networking subsystem, interacting with the actual transport hardware. A network interface may support more than one protocol family and/or address format. Interface structures and attribute flags are defined in the include file <*net/if.h*>.

The interface address structure contains information about an address associated with a particular interface, maintained by an address family. These structures are linked together so that all addresses for an interface can be located.

ip.job

The ip.job implements both the Address Resolution Protocol (ARP) and the Internet Protocol (IP).

ARP is used to dynamically map between Internet software addresses and Ethernet hardware addresses.

ARP caches Internet-to-Ethernet address mappings. When the interface requests a mapping for an address not in the cache, ARP queues the message that requires the mapping and broadcasts a message on the associated network, requesting the address mapping. If ARP receives a response, it caches the new mapping and transmits any pending messages to that host. While waiting for a response, ARP will queue only one packet; it keeps only the most recently transmitted packet.

ARP watches passively for hosts impersonating the local host (that is, a host that responds to an ARP mapping request for the local host's address).

IP is the network layer protocol used by the Internet protocol family. It can be accessed through the higher-level Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) as well as directly through the Raw IP interface.

rip.job

Syntax

```
#include <netinet/in.h>
#include <netinet/raw.h>
```

The raw ip service provides a direct interface to lower-level IP. It can be used to implement a new protocol above IP. The **ping** command uses the raw interface. Rip.job only receives packets for the protocol specified. Getprotobyname can be used to determine a particular protocol number.

The IP header and any IP options are left intact by raw on receipt of datagrams.

tcp.job

Syntax

```
#include <sys/types.h>
#include <netinet/in.h>
#include <netinet/tcp.h>
```

The Transmission Control Protocol (TCP) provides reliable, flow-controlled, two-way transmission of data. It is a byte-stream protocol used to support the SOCK_STREAM abstraction. TCP uses the standard Internet address format augmented by a host-specific collection of port addresses. Thus, each TCP address is composed of an Internet address specifying the host and network, with a specific TCP port on the host identifying the peer entity.

udp.job

Syntax

```
#include <sys/types.h>
#include <netinet/in.h>
#include <netinet/udp.h>
```

The User Datagram Protocol (UDP) is a simple, unreliable datagram protocol. UDP streams are connectionless.

UDP address formats are identical to those used by TCP; UDP provides a port identifier in addition to the normal Internet address format. Note that the UDP port space is separate from the TCP port space (that is, a UDP port may not be connected to a TCP port). If the underlying network interface supports broadcast, UDP can send broadcast packets by using a reserved broadcast address. The broadcast address is dependent on the network interface.

Network Interface Controller (NIC) Jobs

These driver jobs provide an interface between the TCP/IP protocol stack and the network adapters themselves. At least one of the following NIC jobs must be loaded in addition to the loopback.job to allow the TCP/IP protocol stack to communicate with other peers on the network.

loopback.job

The loopback job provides a NIC-style interface to a software loopback mechanism that can be used for performance analysis, software testing, or local communication. The loopback interface is accessible at Internet address 127.0.0.1. By convention, the interface name is *me*, *loopback*, or *localhost*.

The loopback interface should be the last interface configured, as protocols use the order of configuration as an indication of priority. The loopback interface should never be configured first unless no hardware interfaces exist.

edl.job

The file edl.job provides a NIC-style interface to an iNA960 network interface job. Using this interface allows iRMX-NET and the new TCP/IP protocol stack to use the same hardware to gain access to the network.

Parameters

`ifport=<subsystem id>`

This required parameter specifies the subsystem ID of the iNA job. This can be determined after the iNA job has been loaded by use of the `enetinfo` command. Specify the subsystem ID parameter as two hex digits.

`ntrans=<transaction pool size>`

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

`ncbs=<control buffer pool size>`

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

eepro100.job

The file eepro100.job provides an interface to the Intel EtherExpressPro 100 PCI network adapter card. This NIC is capable of 10 or 100 Mbit operation.

Parameters

```
ntrans=<transaction pool size>
```

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

```
ncbs=<control buffer pool size>
```

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

ne.job

The file ne.job provides an interface to NE2000 compatible ISA network adapter cards.

Parameters

`irq=<IRQ number>`

This required parameter specifies the IRQ number to be used by the card.

`base=<base IO address>`

This parameter specifies the base address in I/O space used to access the card's register set. If the card's address is in the range 0x280 to 0x360 then the software is capable of determining the base address automatically.

`ntrans=<transaction pool size>`

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

`ncbs=<control buffer pool size>`

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

tulip.job

The file tulip.job provides an interface to a DEC 21143 based PCI network adapter card. Many of these cards are capable of supporting 10 or 100 Mbit interfaces.

Parameters

```
ntrans=<transaction pool size>
```

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

```
ncbs=<control buffer pool size>
```

This parameter specifies the maximum number of transactions available to the EDL service. The default value is 256.

❑ ❑ ❑

Library Functions 12

This chapter describes functions for the network socket libraries listed below.

C Library	Network Library	Compiler	Model
ciff3m.lib	netiff3m.lib	Microsoft	Flat
cifc32.lib	netifc32.lib	Intel iC386	Compact

See also: Using Non-Intel Tools to Develop iRMX Application in *Programming Techniques* for non-Intel compiler version numbers.

The libraries are installed in the */intel/lib* directory and facilitate the programmatic interface to TCP/IP. In the final bind of your application, add one or both libraries to the list of libraries to be linked to your program.

✏ **Note**

The socket primitives are embedded in the C library.

Table 11-1 lists functions from the socket library.

Table 11-1. Functions in the Socket Library

Name	See	Description
accept	**accept**	accept a connection on a socket
bind	**bind**	bind a name to a socket
connect	**connect**	initiate a connection on a socket
getpeername	**getpeername**	get name of connected peer
getsockname	**getsockname**	get socket name
getsockopt	**getsockopt**	get options on sockets
listen	**listen**	listen for connections on a socket
recv	**recv**	receive a message from a socket
recvfrom	**recv**	receive a message from a socket
recvmsg	**recv**	receive a message from a socket
select	**select**	check status of a set of sockets
send	**send**	send a message from a socket
sendto	**send**	send a message from a socket
sendmsg	**send**	send a message from a socket
setsockopt	**getsockopt**	set options on sockets
shutdown	**shutdown**	shut down part of a connection
socket	**socket**	create an endpoint for communication
socktout	**socktout**	define a timeout for a socket

Table 11-2 lists functions from the network library.

Table 11-2. Functions in the Network Library (continued)

Name	See	Description
bcmp	**bstring**	compare binary strings
bcopy	**bstring**	copy binary string
bzero	**bstring**	put zeros in binary string
endhostent	**gethostent**	close resolver connection
endnetent	**getnetent**	close networks database
endprotoent	**getprotoent**	close the protocols database
endservent	**getservent**	close service database
ffs	**ffs**	identify set bits
gethostbyaddr	**gethostent**	get host entry by address
gethostbyname	**gethostent**	get host entry by name
gethostid	**gethostid**	get unique id of current host
gethostname	**gethostname**	get host name
getnetbyaddr	**getnetent**	get network entry by address
getnetbyname	**getnetent**	get network entry by name
getnetent	**getnetent**	get next network entry
getprotobyname	**getprotoent**	get protocol entry by name
getprotobynumber	**getprotoent**	get protocol entry
getprotoent	**getprotoent**	get next protocol entry
getservbyname	**getservent**	get service entry by name
getservbyport	**getservent**	get service entry by port
getservent	**getservent**	get next service entry
htonl	**byteorder**	host to net order (long)
htons	**byteorder**	host to net order (short)
inet_addr	**inet**	string to Internet address
inet_lnaof	**inet**	get locnet part of address
inet_makeaddr	**inet**	construct Internet address
inet_netof	**inet**	get net part of address
inet_network	**inet**	string to network address
inet_ntoa	**inet**	Internet address to string
ntohl	**byteorder**	net to host order (long)
ntohs	**byteorder**	net to host order (short)
sethostent	**gethostent**	open resolver connection
sethostid	**gethostid**	set unique id of current host
sethostname	**gethostname**	set host name
setnetent	**getnetent**	open/rewind networks database
setprotoent	**getprotoent**	open/rewind protocols database
setservent	**getservent**	open/rewind services database

Using Sockets

The socket compatibility library constitutes a self-contained interface to the transport level protocols.

A *socket* is an endpoint for communication between processes. Each socket has queues for sending and receiving data.

Sockets are typed according to their communications properties, including such things as whether messages sent and received at a socket require the name of the partner, whether communication is reliable, and what format is used in naming message recipients.

See also: **socket** in this chapter for more information about the types available and their properties

Each set of communications protocols supports addresses of a certain format. An address family is the set of addresses for a specific group of protocols. Each socket has an address chosen from the address family in which the socket was created.

Certain semantics of the basic socket abstractions are protocol-specific. All protocols are expected to support the basic model for their particular socket type, but may, in addition, provide nonstandard facilities or extensions to a mechanism. For example, a protocol supporting the SOCK_STREAM type may allow more than one byte of out-of-band data to be transmitted per out-of-band (urgent) message.

Use the TCP protocol to support connection-oriented sockets of type SOCK_STREAM. Use UDP to support connectionless, or datagram, sockets of type SOCK_DGRAM.

Calling Sequence for Connection-oriented Applications

Applications that communicate using connections are typically divided in two parts, designated as client and server. The server uses a *passive open*; it opens a socket, then listens for requests for service. The client uses an *active open*; it opens a socket and requests a connection to a specific server. Once the connection is established, the client and server send and receive data as necessary. Typically the client closes the connection, while the server continues to listen for further connection requests.

This is the sequence of calls used by the client:

Client Call	**Description**
socket( )	Create a SOCK_STREAM socket for connections
bind( )	Bind the socket to a local address (port A)
connect( )	Request a connection to a remote socket, specifying a remote IP address and well-known port B
send( ), recv( )	Send and receive data as determined by the application
shutdown( )	Close the connection

This is the sequence of calls used by the server:

Server Call	Description
socket( )	Create a SOCK_STREAM socket (S_1) for connections
bind( )	Bind the socket to well-known port B
listen( )	Listen for connection requests at port B
accept( )	Accept the connection on a new socket S_2
create_task	Create a child task to perform the service
socket( )	Child task opens SOCK_INHERIT socket so it can receive socket S_2
shutdown( )	Parent closes S_2, specifying the job ID of child task, then continues to listen at port B (socket S_1)
send( ), recv( )	Child sends and receives data with client (port C to port A)
shutdown( )	Child closes S_2 and exits when client breaks connection

Active sockets initiate connections to passive sockets. By default, TCP sockets are created active; to create a passive socket you must use the **listen( )** function after binding the socket with the **bind( )** function. Only passive sockets may use the **accept( )** call to accept incoming connections. Only active sockets may use the **connect( )** call to initiate connections.

Passive sockets may underspecify their location to match incoming connection requests from multiple hosts. This technique, termed wildcard addressing, allows a single server to provide service to clients on multiple hosts. To establish a socket that listens for all network addresses, bind the Internet address INADDR_ANY. You may specify the TCP port in this **bind( )** call; if the port is not specified the system will assign one.

Once a connection has been established, the socket's address is fixed by the peer entity's location. The address assigned to the socket is the address associated with the network interface through which packets are being transmitted and received. Normally, this address corresponds to the peer entity's network.

Calling Sequence for Connectionless Applications

A connectionless application may also be established as a client and server. However, there is no calling sequence that establishes this division of duties. This is the typical sequence of calls for both parties:

Call	Description
socket( )	Create a SOCK_DGRAM socket for UDP
bind( )	Bind the socket to a local address
sendto( ), recvfrom( )	Send and receive data as determined by the application
shutdown( )	Close the connection

However, you can use the **connect( )** call to fix the destination for future packets, in which case you can use **recv( )** and **send( )** calls with the SOCK_DGRAM socket.

Internet Socket Addresses

An Internet address is defined as a discriminated union:

```
struct in_addr      {
       union  {
              struct { uchar s_b1, s_b2, s_b3, s_b4; } S_un_b;
              struct { unsigned short s_w1, s_w2; } S_un_w;
              unsigned long S_addr;
       } S_un;
#define       s_addr S_un.S_addr
#define       s_imp  S_un.S_un_w.s_w2
#define       s_net  S_un.S_un_b.s_b1
#define       s_host S_un.S_un_b.s_b2
#define       s_lh   S_un.S_un_b.s_b3
#define       s_impno  S_un.S_un_b.s_b4
};
```

In the Internet address family, sockets use this address structure:

```
struct        sockaddr_in  {
   uchar                   sin_len;
   uchar                   sin_family;
   unsigned short          sin_port;
   struct in_addr          sin_addr;
   char                    sin_zero[8];
   };
```

✏ **Note**

The structure above is more correctly called a name than an address. For example, this is the name that you bind the socket to in a **bind( )** call, and the name returned by **getsockname( )** and **getpeername( )**, where the peer uses the Internet address family. The structure is more than just the address; it contains the address family and port number along with the Internet address. However, much of the literature refers to this structure (and the more general `struct sockaddr`) as an address.

See also: *<netinet/in.h>*

Network and Host Byte Order

Two methods used to store data on different computers are little-endian (the least significant byte of multibyte data is stored in the lowest memory) and big-endian (the most significant byte is stored in the lowest memory).

Within these categories there may also be variation. For example, a certain machine may store words in one order, but swap bytes within the words. Whatever method is used is called *host byte order*; it is specific to the local host.

The Internet standard for binary data to be sent across the network is big-endian. The most significant byte of an integer is sent first. This is *network standard byte order*. It may or may not be the same as the byte order used on the local machine.

To write portable code, translate any binary data from host to network order before sending it. Translate from network to host order after receiving the data. This does not apply to data messages you send between applications; the applications themselves should use data in the same format. It does apply to items that will be used by the protocols on the remote machine.

For example, in the **bind( )** and **connect( )** calls you specify a port value as part of the local or remote socket address (`sin_port` in the `sockaddr_in` structure). Convert this unsigned short value from host to network order with **htons( )**, before placing it in the structure. If your application uses such data (for example, doing a **printf** of a port value obtained from an address), convert from network to host order.

See also: **byteorder( )** function, in this chapter

This code fragment shows how to convert the port value properly:

```
#include <netinet/in.h>
int s;
struct sockaddr_in sin;

sin.sin_len = sizeof sin
sin.sin_family = AF_INET;
sin.sin_port = htons (1200);
sin.sin_addr.s_addr = inet_addr ("128.215.18.2");

bind (s, &sin, sizeof sin)
```

This stores the local address in a structure whose elements appear in memory in this order:

Value	**Description**
0x10	Length of sock_addre_in structure
AF_INET	Address family
0xb004	port 1200 = 0x4b0, swapped to network byte order
0x80d71202	Internet address 128.215.18.2

Changes From the Standard Socket Interface

This implementation of the socket library has these differences from the standard socket interface:

- In the standard socket interface, you can only specify whether socket calls are blocking or non-blocking. This library provides the **socktout( )** call that allows you to define the maximum time to wait for completion of a socket call. The timeout resolution is **10 ms**.
- The address family AF_UNIX is not supported.
- The **socketpair( )** call is not implemented.
- The SIGPIPE and SIGPOLL signals are not supported.

⚠ **CAUTION**

The socket descriptors are not equivalent to the file descriptors used in the C *stdio* interface. Never use the **close( )** function on a socket descriptor. You also cannot use such routines as **read( )**, **fread( )**, **write( )**, and **fwrite( )**, among others, to read and write data to socket connections.

Task Priority

User applications that bind to *net3c.lib* should run at a priority between 131 and 254. If you use **rq_create_task**, be sure to create the new task with a priority in this range. When applications launch from the CLI, there should not be a problem, because the typical user priority falls in this range: 141 for Super user and 142 for other users.

Multitasking Considerations

You must ensure that only one iRMX job accesses a connection. Connections may be shared between individual tasks within a single job.

Connections may be inherited by other child jobs if you specify this in the **shutdown( )** and **socket( )** calls. Since socket descriptors are not file descriptors, and under iRMX are not automatically inherited by child jobs as in Unix, these routines provide a means to imitate this functionality under iRMX.

⚠ **CAUTION**

Never delete a task while it is executing a socket call. This will cause a general-protection trap in the TCP/IP job, with unpredictable results. Killing the job, on the other hand, is all right. If a task is hung in a read call, and you want to kill it, first close the connection and wait until the task returns.

Only one task should operate on a socket until a connection is established. After the connection has been established, any number of tasks may use the socket simultaneously. A **shutdown( )** may be performed at any time. All tasks executing a call on the socket at that time will return immediately with **errno** set to EBADF.

Include Files

The descriptions of library functions show which files must be included for each function. The include directory is */intel/include*.

To use socket functions, these include files are generally needed:

```
<sys/types.h>
<sys/errno.h>
<sys/socket.h>
```

Functions that use an argument of type `struct sockaddr` and use a socket in the DARPA Internet domain (AF_INET) may use the Internet view of the `sockaddr` structure, defined in <*netinet/in.h*> as `sockaddr_in`.

Example Programs

Example programs are installed under the */rmx386/demo/c/tcpip* directory, including:

tcpclient.c	creating a TCP socket as a client
tcpserver.c	creating a TCP socket as a server

Compiling and Linking

Libraries are provided for the Intel 386 compact model compilers, and for the 32-bit flat model code produced by the Microsoft C/C++ compiler. Use the standard settings for compiling an iRMX application.

The following libraries are linked with your application to provide the sockets calls:

`netifc32.lib`	(Intel 386 compilers)
`netiff3m.lib`	(Microsoft C/C++ compiler)

Link the library ahead of the C library.

Handling Errors

Most socket calls have one or more error returns. Error conditions are indicated by impossible return values (usually -1); individual descriptions specify details.

Unless otherwise noted, function return codes and values are of type integer. An error number is also made available in the external variable **errno**, which is not cleared on successful calls. Thus, you should test **errno** only after an error occurs.

Link to *cstart.obj* and *cifc32.lib* (or the third party compiler equivalent) if your application makes calls to the socket library and you use Intel 32-bit development tools. You must use in-line exception handling or socket calls will fail, often with the `command aborted by EH` error. To prevent this, add this code to the beginning of `main( )` in your program:

```
EXCEPTIONSTRUCT info;
unsigned short rq_status:
info.exceptionmode = 0:
rqsetexceptionhandler ((EXCEPTIONSTRUCT far *) &info.
&rq_status);
```

Always test the return status of iRMX system calls, and take action if there is an error.

See also: Using Interface Libraries in *Programming Techniques* and *System Call Reference* for shared C libraries to link to when not using Intel 32-bit application development tools.

Errno Values for Network Functions

This list describes errors specific to networking as given in <*sys/errno.h*>.

`EADDRINUSE Address already in use`
Only one usage of each address is normally permitted.

`EADDRNOTAVAIL Can't assign requested address`
Normally results from an attempt to create a socket with an address not on this machine.

`EAFNOSUPPORT Address family not supported by protocol family`
An address incompatible with the requested protocol was used. For example, you shouldn't necessarily expect to be able to use PUP (PARC Universal Packet) Internet addresses with ARPA Internet protocols.

`EALREADY Operation already in progress`
An operation was attempted on a non-blocking object that already had an operation in progress.

`EBADF Bad file`
The socket descriptor is invalid.

`ECONNABORTED Software caused connection abort`

A connection abort was caused internal to your host machine.

`ECONNREFUSED Connection refused`

No connection could be made; the target machine actively refused it. This usually results from trying to connect to a service that is inactive on the foreign host.

`ECONNRESET Connection reset by peer`

A connection was forcibly closed by a peer. This normally results from the peer executing a **shutdown** call.

`EDESTADDRREQ Destination address required`

A required address was omitted from an operation on a socket.

`EHOSTDOWN Host down`

The specified host is not running.

`EHOSTUNREACH Host unreachable`

There is no route to the host.

`EINPROGRESS Operation now in progress`

An operation that takes a long time to complete (such as a **connect**) was attempted on a non-blocking object.

`EISCONN Socket is already connected`

A **connect** request was made on an already connected socket, or a **sendto** or **sendmsg** request on a connected socket specified a destination other than the connected party.

`EMSGSIZE Message too long`

A message sent on a socket was larger than the internal message buffer.

`ENETDOWN Network is down`

A socket operation encountered a dead network.

`ENETRESET Network dropped connection on reset`

The host you were connected to crashed and rebooted.

`ENETUNREACH Network is unreachable`

A socket operation was attempted to an unreachable network.

`ENOBUFS No buffer space available`

An operation on a socket or pipe was not performed because the system lacked sufficient buffer space.

`ENOPROTOOPT Bad protocol option`

A bad option was specified in a **getsockopt** or **setsockopt** call.

`ENOTCONN Socket is not connected`

A request to send or receive data was disallowed because the socket is not connected.

`EOPNOTSUPP Operation not supported on socket`

For example, trying to accept a connection on a datagram socket.

`EPFNOSUPPORT Protocol family not supported`
: The protocol family has not been configured into the system or no implementation for it exists.

`EPOWERFAIL Power failure`
: The connection was lost due to a power-fail/recovery cycle.

`EPROTONOSUPPORT Protocol not supported`
: The protocol has not been configured into the system or no implementation for it exists.

`EPROTOTYPE Protocol wrong type for socket`
: A protocol was specified that does not support the semantics of the socket type requested. For example, you cannot use the ARPA Internet UDP protocol with type SOCK_STREAM.

`ESHUTDOWN Can't send after socket shutdown`
: A request to send data was disallowed because the socket had already been shut down with a previous **shutdown** call.

`ESOCKTNOSUPPORT Socket type not supported`
: The support for the socket type has not been configured into the system or no implementation for it exists.

`ETIMEDOUT Connection timed out`
: A **connect** request failed because the connected party did not properly respond after a period of time. The timeout period is dependent on the communication protocol.

`EUNATCH Protocol driver not attached`
: The TCP/IP kernel has not been loaded.

`EWOULDBLOCK Operation would block`
: An operation that would cause a process to block was attempted on an object in non-blocking mode.

Function Reference

This section provides a reference to the functions from the network and socket libraries. Each function reference page provides a brief description of the function, its syntax, any additional information, and related error messages. Functions are ordered alphabetically for quick reference.

accept

Accepts a connection on a socket.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int accept(s, addr, addrlen)
int s;
struct sockaddr *addr;
int *addrlen;
```

Parameters

`s`	A socket of type SOCK_STREAM, created with the **socket( )** call, bound to an address with **bind( )**, and currently listening for connections with **listen( )**.
`addr`	Points to a structure that **accept( )** fills in with the address of the connected peer. The format of the returned address is determined by the domain in which the communication occurs.
`addrlen`	Initialize to the number of bytes in the buffer referenced by `addr`. On return, `addrlen` will contain the actual length in bytes of the returned address.

Return Value

If the call succeeds, it returns a non-negative integer that is a descriptor for the accepted socket, created by this call. The call returns -1 on an error.

Additional Information

Accept( ) gets the first connection request from the queue of pending connections and creates a new socket with the same properties as `s`. The call accepts the connection on the new socket and returns a file descriptor for that socket. You cannot accept more connections on the new socket; the original socket `s` remains open.

If no pending connections are present on the queue **accept( )** blocks the caller until a connection request arrives.

See also: **bind( )**, **connect( )**, **listen( )**, and **socket( )** functions, in this chapter

Errors

`[EBADF]`
The descriptor is invalid.

`[EFAULT]`
The `addr` parameter is not in a writable part of the user address space.

`[EINVAL]`
One of these has occurred:

- The number of bytes allocated for an incoming argument is not sufficient to store the value of that argument.
- The function was issued in the wrong sequence on the transport endpoint referenced by `s`.
- The transport endpoint referred to by `s` is not in the idle state.
- The specified options were in an incorrect format or contained illegal information.
- The amount of user data specified was not within the bounds allowed by the transport provider.

`[EIO]` One of these has occurred:

- An asynchronous event has occurred on this transport endpoint and requires immediate attention.
- A system error has occurred during execution of this function.
- An unspecified I/O error has occurred.

`[ENOTSOCK]`
The descriptor references a file, not a socket.

`[EOPNOTSUPP]`
The referenced socket is not of type SOCK_STREAM.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

`[EWOULDBLOCK]`
The socket is marked non-blocking and no connections are present to be accepted.

bind

Assigns a name to an unnamed socket. When a socket is created with **socket**( ) it exists in a name space (address family) but has no name assigned. A name must be bound to the socket before the socket can be used.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int bind(s, name, namelen)
int s, namelen;
struct sockaddr *name;
```

Parameters

`s`	The socket to be bound.
`name`	Points to the structure containing the name. The rules used in name binding vary between communication domains. In the AF_INET domain, a name consists of the address family (AF_INET), a port ID, and an IP address. See also: Internet Socket Addresses, in this chapter
`namelen`	The length of the name.

Return Value

Zero if the call is successful or -1 if an error occurs.

Errors

`[EADDRINUSE]`
The specified address is already in use.

`[EADDRNOTAVAIL]`
The specified address is not available from the local machine.

`[EBADF]`
`s` is not a valid descriptor.

`[EFAULT]`
The `name` parameter is not in a valid part of the user address space.

`[EINVAL]`
The socket is already bound to an address.

`[EIO]` An unspecified I/O error has occurred.

`[ENOTSOCK]`
`s` is not a socket.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

bstring

The **bcmp( )**, **bcopy( )**, and **bzero( )** functions execute binary string operations. They operate on variable length strings of bytes but do not check for null bytes as the routines in **string** do.

Syntax

```
#include <sys/types.h>
#include <strings.h>

int bcmp(b1, b2, length)
char *b1, *b2;
int length;

int bcopy(b1, b2, length)
char *b1, *b2;
unsigned int length;

void bzero(b, length)
char *b;
int length;
```

Additional Information

Bcmp( ) compares the first `length` bytes of strings `b1` and `b2`, returning 0 if they are identical, non-zero otherwise. Both strings are assumed to be at least `length` bytes long.

Bcopy( ) copies the first `length` bytes from string `b1` to string `b2`. **Bcopy( )** always returns 0.

Bzero( ) places 0s in the first `length` bytes of string `b`.

✎ **Note**
The **bcopy( )** function takes its two `char *` parameters in the reverse order from **strcpy( )** and **memcpy( ).**

byteorder

The **htonl( )**, **htons( )**, **ntohl( )**, and **ntohs( )** functions convert short (16-bit) and long (32-bit) quantities between network byte order and host byte order.

Syntax

```
#include <sys/types.h>
#include <sys/endian.h>

unsigned long htonl(hostlong)
unsigned long hostlong;

unsigned short htons(hostshort)
unsigned short hostshort;

unsigned long ntohl(netlong)
unsigned long netlong;

unsigned short ntohs(netshort)
unsigned short netshort;
```

Additional Information

These routines are most often used in conjunction with Internet addresses and ports as returned by **gethostent( )** and **getservent( )**. The conversion involves reversing the order of the bytes in the short or long value.

See also: **gethostent( )** and **getservent( )** functions, in this chapter

connect

Initiates a connection on a socket. If the socket type is SOCK_DGRAM, this call permanently specifies the peer to which datagrams are to be sent. If the type is SOCK_STREAM, this call attempts to make a connection to another socket.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int connect(s, name, namelen)
int s, namelen;
struct sockaddr *name;
```

Parameters

`s`	The local socket
`name`	The remote socket, specified as an address in the communications space of the socket. Each communications space interprets the `name` parameter in its own way.
`namelen`	The length of the `name` parameter, in bytes.

Return Value

Zero if the call is successful or -1 if an error occurs.

Errors

`[EADDRINUSE]`
Unused.

`[EADDRNOTAVAIL]`
The specified address is not available on this machine.

`[EAFNOSUPPORT]`
Unused.

`[EBADF]`
`s` is not a valid descriptor.

`[ECONNREFUSED]`
The attempt to connect was forcefully rejected.

`[EFAULT]`
The `name` parameter specifies an area outside the process address space.

`[EINVAL]`
: One of these has occurred:
- The function was issued in the wrong sequence.
- The specified protocol options were in an incorrect format or contained illegal information.
- The amount of user data specified was not within the bounds allowed by the transport provider.
- The number of bytes allocated for an incoming argument is not sufficient to store the value of that argument.
- A previous call to connect() with this socket as a parameter resulted in an error. You must delete this socket and create a new socket for each call to connect().

`[EIO]` An unspecified I/O error has occurred.

`[EISCONN]`
The socket is already connected.

`[ENETUNREACH]`
The network isn't reachable from this host.

`[ENOTSOCK]`
`s` is a descriptor for a file, not a socket.

`[EOPNOTSUPP]`
This function is not supported by the underlying transport provider.

`[ETIMEDOUT]`
Connection establishment timed out without establishing a connection.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

`[EWOULDBLOCK]`
The socket is non-blocking and the connection cannot be completed immediately.

ffs

Identifies the first set bit in a value.

Syntax

```
#include <strings.h>

int ffs(mask)
long mask;
```

Additional Information

This function returns the index of the first (low order) set bit in the argument. Bits are numbered starting at one. If no bits were set (`mask` was 0) a 0 will be returned.

gethostent

The **gethostbyaddr( )**, **gethostbyname( )**, **sethostent( )**, **endhostent( )**, **_gethtbyaddr( )**, **_gethtbyname( ), _sethtent( )**, **_gethtent( )**, and **_endhtent( )** functions set and return entries that identify the network host.

Syntax

```
#include <netdb.h>

struct hostent *gethostbyaddr(addr, len, type)
char *addr;
int len, type;

struct hostent *gethostbyname(name)
char *name;

void sethostent(stayopen)
int stayopen;

void endhostent( )

struct hostent *_gethtbyaddr(addr, len, type)
char *addr;
int len, type;

struct hostent *_gethtbyname(name)
char *name;

void _sethtent(stayopen)
int stayopen;

struct hostent * _gethtent( )

void _endhtent( )
```

Additional Information

Network host information can be obtained from either of two places, the *hosts* database or the Domain Name Service (DNS). The iRMX TCP/IP software does not include **named**, the DNS name server. However, it does include a DNS client. The client contacts any DNS name servers running on other hosts on the network and uses their name translation services.

The DNS tunable parameters determine how the two sources are accessed for requested information. If no DNS configuration is set, host information is retrieved from the host's database *hosts*. If the DNS configuration is set, the host database is searched first; if the search does not succeed, an attempt is made to retrieve the information from a DNS name server on the network.

A set of functions is also provided to explicitly retrieve information from the *hosts* database. All information obtained from the *hosts* database is contained in a static area, so it must be copied if it is to be saved. Only Internet addresses are understood.

The **gethostbyname( )** and **_gethtbyname( )** functions retrieve a specific entry by host name. **Gethostbyname( )** uses the NONAMESERVER environment variable to determine the source; **_gethtbyname( )** always searches from the *hosts* database.

The **gethostbyaddr( )** and **_gethtbyaddr( )** functions retrieve a specific entry by Internet address. **Gethostbyaddr( )** uses the NONAMESERVER environment variable to determine the source; **_gethtbyaddr( )** always searches from the *hosts* database. The Internet address used in both calls should be in host order. The network type should be AF_INET, as defined in the system include file *sys/socket.h*. The `len` argument is the length, in bytes, of the address.

To retrieve a sequential series of host entries from the *hosts* database, it is more efficient to use the **_sethtent( )**, **_gethtent( )**, and **_endhtent( )** functions. However, the **sethostent( )**, **gethostent( )**, and **endhostent( )** functions have the same basic behavior described below.

You must pair the calls to **_sethtent( )** and **_endhtent( )**.

The **_sethtent( )** function opens or rewinds (sets the file pointer to 0) the *hosts* database. If passed a 0 value for the argument `stayopen`, **_sethtent( )** opens the *:config:hosts* file. Subsequent calls to the **_gethtent( )** function return the next entry in the *hosts* database until end of file, opening it if necessary. The **_endhtent( )** function closes the database.

If passed a non-zero value for the argument `stayopen`, **_sethtent( )** rewinds the *:config:hosts* file or opens it, if it is not already open. Subsequent calls to the **_gethtent( )** function return the next entry in the *hosts* database until end of file, opening it if necessary. The *hosts* database remains open until the application executes **exit( )**. Calling **_endhtent( )** does not close the database.

The host entry has this structure:

```
struct hostent {
   char                * h_name;
   char               ** h_aliases;
   int                   h_addrtype;
   int                   h_length;
   char               ** h_addr_list;
#define h_addr           h_addr_list[0]
};
```

Where:

`h_name`	The official name of the host.
`h_aliases`	A list of alternate names for the host. The list is terminated by a null string.
`h_addrtype`	The type of host address; AF_INET is the only type supported.
`h_length`	The length, in bytes, of the host address.
`h_addr_list`	A list of addresses for the host. The first entry in the list can be retrieved by the defined name *h_addr* as well as by its position in the list. The list is terminated by a 0 address. All host addresses are returned in network byte order.

See also: *hosts* file, Chapter 11, and the system include file <*sys/socket.h*>

Errors

A null pointer is returned by **gethostbyaddr( )**, **gethostbyname( )**, **_gethtbyaddr( )**, **_gethtbyname( )**, and **_gethtent( )** on an EOF or on an error.

gethostid

The **gethostid( )** and **sethostid( )** functions get or set the unique 32-bit identifier of the local host.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>

unsigned long gethostid( )

int sethostid(hostid)
unsigned long hostid;
```

Return Value

For a successful call, **gethostid( )** returns the host ID and **sethostid( )** returns 0. If an error occurs, both calls return -1.

Additional Information

Sethostid( ) establishes a 32-bit identifier for the current processor which is intended to be unique among all Internet systems in existence. This is normally an Internet address for the local machine's primary network interface. This call is normally performed at boot time. Only the Super user can set host identifier.

Gethostid( ) returns the 32-bit identifier for the current processor.

See also: **hostid** command, *Command Reference*;
gethostname( ) function, in this chapter

Errors

[EADDRNOTAVAIL]	The specified host ID is invalid.
[EPERM]	Only the Super user is allowed to set the host identifier.
[EUNATCH]	The TCP/IP kernel has not been loaded.

gethostname

The **gethostname( )** and **sethostname( )** functions get and set the local host name.

Syntax

```
#include <arpa/inet.h>

int gethostname(name, len)
char *name;
int len;

int sethostname(name, len)
char *name;
int len;
```

Additional Information

Gethostname( ) retrieves the host name and places it in the character string pointed to by the argument `name`. The `len` is the maximum number of characters of the name that can be returned; it should be set to the size of `name`. If the host name is longer than `len`, it will be truncated; it will be null terminated only if the name is shorter than `len`.

Sethostname( ) sets the host name to the argument `name`. Only the Super user can set the host name.

Errors

Both functions return 0 on success and -1 on failure; **errno** may be one of these:

`[EFAULT]`
The `name` was a null pointer.

`[EINVAL]`
The `len` was less than one.

`[EPERM]`
Only the Super user can set the host name.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

See also: **uname** and **hostname** commands, *Command Reference*

getnetent

The **getnetbyaddr( )**, **getnetbyname( )**, **setnetent( )**, **getnetent( )**, and **endnetent( )** functions return information about a network entry from the *:config:networks* database.

Syntax

```
#include <netdb.h>

struct netent *getnetbyname(name)
char *name;

struct netent *getnetbyaddr(net, type)
int net, type;

void setnetent(stayopen)
int stayopen;

struct netent *getnetent( )

void endnetent( )
```

Additional Information

A specific entry can be retrieved by the network name with **getnetbyname( )**, or by its Internet address with **getnetbyaddr( )**. Both functions sequentially search the database for the specified entry. The network address used in the **getnetbyaddr( )** call should be in host order; the network type should be AF_INET, as defined in the system include file <*sys/socket.h*>.

All returned information is contained in a static area, so it must be copied if it is to be saved. Only Internet network numbers are understood.

To retrieve a sequential series of network entries, it is more efficient to use the **setnetent( )**, **getnetent( )**, and **endnetent( )** functions. You must pair the calls to **setnetent( )** and **endnetent( )**.

The **setnetent( )** function opens or rewinds (sets the file pointer to 0) the *networks* database. If passed a 0 value for the argument `stayopen`, **setnetent( )** opens the *:config:networks* file. Subsequent calls to the **getnetent( )** function return the next entry in the *networks* database until end of file, opening it if necessary. The **endnetent( )** function closes the database.

If passed a non-zero value for the argument `stayopen`, **setnetent( )** rewinds the *:config:networks* file or opens it, if it is not already open. Subsequent calls to the **getnetent( )** function return the next entry in the *networks* database until end of file, opening it if necessary. The *networks* database remains open until the application executes **exit( )**. Calling **endnetent( )** does not close the database.

The network entry has this structure:

```
struct netent {
   char                 * n_name;
   char                ** n_aliases;
   int                     n_addrtype;
   unsigned long           n_net;
};
```

Where:

`n_name`	The official name of the network.
`n_aliases`	A list of alternate names for the network. The list is terminated by a null string.
`n_addrtype`	The type of network address; AF_INET is the only type supported.
`n_net`	The network number in host order.
See also:	*networks* file, Chapter 9, and the system include file <*sys/socket.h*>

Errors

A null pointer is returned by **getnetbyaddr( )**, **getnetbyname( )**, and **getnetent( )** on an EOF or on an error.

getpeername

Returns the socket name of the connected remote socket.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int getpeername(s, name, namelen)
int s;
struct sockaddr *name;
int *namelen;
```

Parameters

`s`	The local socket.
`name`	A pointer to the space where the call returns a name.
`namelen`	Initialize this to indicate the amount of space pointed to by `name`. On return it contains the actual size of the name returned, in bytes.

Return Value

Zero if the call is successful or -1 if an error occurs.

Additional Information

A socket name in the AF_INET family contains the length, address family, a port number, and the IP address.

See also: **bind( )** and **getsockname( )** functions, in this chapter

Errors

`[EBADF]`
The argument `s` is not a valid descriptor.

`[EFAULT]`
The `name` parameter points to memory not in a valid part of the process address space.

`[EINVAL]`
The `namelen` parameter is too small.

`[ENOBUFS]`
Insufficient resources were available in the system to perform the operation.

`[ENOTCONN]`
The socket is not connected.

`[ENOTSOCK]`
The argument `s` is a file, not a socket.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

getprotoent

The **getprotobyname( )**, **getprotobynumber( )**, **setprotoent( )**, **getprotoent( )**, and **endprotoent( )** functions return an entry from the *:config:protocols* database file.

Syntax

```
#include <netdb.h>

struct protoent *getprotobyname(name)
char *name;

struct protoent *getprotobynumber(proto)
int proto;

void setprotoent(stayopen)
int stayopen;

struct protoent *getprotoent( )

void endprotoent( )
```

Additional Information

All returned information is contained in a static area, so it must be copied if it is to be saved. Only Internet protocols are understood.

A specific entry can be retrieved by the protocol name with **getprotobyname( )**, or by its number with **getprotobynumber( )**. Both functions sequentially search the database for the specified entry. The protocol number used in the **getprotobynumber( )** call should be in host order.

To retrieve a sequential series of protocol entries, it is more efficient to use the **setprotoent( )**, **getprotoent( )**, and **endprotoent( )** functions. You must pair the calls to **setprotoent( )** and **endprotoent( )**.

The **setprotoent( )** function opens or rewinds (sets the file pointer to 0) the *protocols* database. If passed a 0 value for the argument `stayopen`, **setprotoent( )** opens the *:config:protocols* file. Subsequent calls to the **getprotoent( )** function return the next entry in the *protocols* database until end of file, opening it if necessary. The **endprotoent( )** function closes the database.

If passed a non-zero value for the argument `stayopen`, **setprotoent( )** rewinds the *:config:protocols* file or opens it, if it is not already open. Subsequent calls to the **getprotoent( )** function return the next entry in the *protocols* database until end of file, opening it if necessary. The *protocols* database remains open until the application executes **exit( )**. Calling **endprotoent( )** does not close the database.

The returned protocol entry has this structure:

```
struct protoent {
   char                * p_name;
   char               ** p_aliases;
   unsigned long         p_proto
};
```

Where:

`p_name`	The official name of the protocol.
`p_aliases`	A list of alternate names for the protocol. The list is terminated by a null string.
`p_proto`	The protocol number in host byte order.
so:	*protocols* file, Chapter 9

Errors

A null pointer is returned by **getprotobynumber( )**, **getprotobyname( ),** and **getprotoent( )** on an EOF or on an error.

getservent

The **getservbyport( )**, **getservbyname( )**, **setservent( )**, **getservent( )**, and **endservent( )** functions set or return an entry from the *:config:services* database file.

Syntax

```
#include <netdb.h>

struct servent *getservbyname(name, proto)
char *name, *proto;

struct servent *getservbyport(port, proto)
int   port;
char *proto;

void setservent(stayopen)
int stayopen;

struct servent *getservent( )

void endservent( )
```

Additional Information

All returned information is contained in a static area, so it must be copied if it is to be saved. Only Internet services are understood.

A specific entry can be retrieved by the service name with **getservbyname( )**, or by its port with **getservbyport( )**. Both functions sequentially search the database for the specified entry. The port number used in the **getservbyport( )** call must be in network order. Use the **htons( )** function to convert the port number from host byte order to network byte order.

See also: **htons( )** function, in this chapter

To retrieve a sequential series of service entries, it is more efficient to use the **setservent( )**, **getservent( )**, and **endservent( )** functions. You must pair the calls to **setservent( )** and **endservent( )**.

Setservent( ) opens or rewinds the *services* database. If passed a non-zero value for the argument `stayopen`, **setservent( )** will set a flag to prevent the database from being closed until **endservent( )** is called.

Endservent( ) closes the *services* database.

Getservent( ) returns the next entry in the *services* database, opening it if necessary. If preceded by a call to **setservent( )** with the `stayopen` flag set, it can be called successively to retrieve, in order, all of the database entries. When **getservent( )** is called without a previous call to **setservent( )**, it opens the database, retrieves the first entry, and closes the database.

The returned service entry has this structure:

```
struct          servent {
   char               * s_name;
   char              ** s_aliases;
   int                  s_port;
   char               * s_proto;
};
```

Where:

`s_name`	The official name of the service.
`s_aliases`	A list of alternate names for the service. The list is terminated by a null string.
`s_port`	The port number at which the service can be reached, in network byte order.
`s_proto`	The name of the protocol to be used when contacting the service.
See also:	*protocols* and *services* files, Chapter 9

Errors

A null pointer is returned by **getservbyaddr( )**, **getservbyname( )** and **getservent( )** on an EOF or on an error.

getsockname

Returns the current name for the specified socket.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int getsockname(s, name, namelen)
int s;
struct sockaddr *name;
int *namelen;
```

Parameters

`s`	A local socket.
`name`	A pointer to the space where the call returns a name.
`namelen`	Initialize this to indicate the amount of space pointed to by `name`. On return it contains the actual size of the name returned, in bytes.

Return Value

Zero if the call is successful or -1 if an error occurs.

Additional Information

A socket name in the AF_INET family contains the length, address family, a port number, and the IP address.

See also: **bind( )** and **getpeername( )** functions, in this chapter

Errors

`[EBADF]`
The argument `s` is not a valid descriptor.

`[ENOTSOCK]`
The argument `s` is a file, not a socket.

`[ENOBUFS]`
Insufficient resources were available in the system to perform the operation.

`[EFAULT]`
The `name` parameter points to memory not in a valid part of the process address space.

`[EADDRNOTAVAIL]`
Socket not bound.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

See also: **bind( )** function, in this chapter

getsockopt

The **getsockopt( )** and **setsockopt( )** functions return or set options associated with a socket.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int getsockopt(s, level, optname, optval, optlen)
int s, level, optname;
char *optval;
int *optlen;

int setsockopt(s, level, optname, optval, optlen)
int s, level, optname, optlen;
char *optval;
```

Parameters

`s`	The socket whose options will be set or returned.
`level`	The level at which the option is maintained. At the socket level, specify SOL_SOCKET. To manipulate options at any other level, specify the protocol number of the appropriate protocol controlling the option. For example, if the option is to be interpreted by the TCP protocol, set `level` to the protocol number of TCP (IPPROTO_TCP). See also: **getprotoent( )** function, in this chapter
`optname`	Specify the name of the option to set or return.
`optval`	For **setsockopt( )**, specify the value of the option. For **getsockopt( )**, the value is returned in this buffer.
`optlen`	Specify the length of the `optval` buffer, in bytes. For **getsockopt( )**, `optlen` is a pointer; the value it points to is modified on return to indicate the actual size of the `optval` parameter.

Return Value

Getsockopt( ) returns 0 if the call succeeds and the specified option is set; otherwise, the return is -1. **Setsockopt( )** returns 0 if the call succeeds or -1 if it fails.

Additional Information

Options may exist at multiple protocol levels; they are always present at the uppermost, or socket, level. To manipulate socket options, you must specify the level at which the option resides and the name of the option. If no option value is to be supplied or returned, `optval` may be set to 0.

The following options are supported:

level	***optname***	**Description**
SOL_SOCKET	SO_ATMARK	Report if at OOB mark
	SO_BROADCAST	Permit sending of broadcast msgs
	SO_DONTROUTE	Just use interface addresses
	SO_KEEPALIVE	Keep connections alive
	SO_LINGER	Linger on close if data present
	SO_OOBINLINE	Leave received OOB data in-line
	SO_RCVLOWAT	Receive low-water mark
	SO_SNDLOWAT	Send low-water mark
	SO_REUSEADDR	Allow local address reuse
	SO_RCVBUF	Size of socket receive buffer
	SO_SNDBUF	Size of socket send buffer
	SO_REUSEPORT	Allow local port reuse
IPPROTO_TCP	TCP_MAXSEG	Get TCP maximum segment size
	TCP_NODELAY	Don't delay send to coalesce packets
	TCP_NOOPT	Don't use TCP options
	TCP_NOPUSH	Don't push last block of write
IPPROTO_IP	IP_TOS	Type of service
	IP_TTL	Segment time to live
	IP_HDRINCL	Application (RAW IP) supplies IP header

`Optname` and any specified options are passed without interpretation to the appropriate protocol module for interpretation. Options at other protocol levels vary in format and name.

See also: **socket( )** and **getprotoent( )** function, in this chapter;
protocols, Chapter 9

Errors

`[EBADF]`
: The argument `s` is not a valid descriptor.

`[ENOTSOCK]`
: The argument `s` is a file, not a socket.

`[ENOPROTOOPT]`
: The option is unknown at the level specified.

`[EFAULT]`
: The options are not in a valid part of the process address space.

`[ENOBUFS]`
: No buffer space is available.

`[EINVAL]`
: Invalid option specified.

`[EPROTO]`
: Invalid level specified.

`[EUNATCH]`
: The TCP/IP kernel has not been loaded.

inet

The **inet_addr( )**, **inet_lnaof( )**, **inet_makeaddr( )**, **inet_netof( )**, **inet_network( )**, and **inet_ntoa( )** functions manipulate Internet addresses.

Syntax

```
#include <sys/types.h>
#include <netinet/in.h>

unsigned long inet_addr(cp)
char *cp;

int inet_lnaof(in)
struct in_addr in;

struct in_addr inet_makeaddr(net, host)
int net, host;

int inet_netof(in)
struct in_addr in;

unsigned long inet_network(cp)
char *cp;

char *inet_ntoa(in)
struct in_addr in;
```

Additional Information

The functions **inet_addr( )** and **inet_network( )** convert dot notation character strings to the equivalent Internet address and network number, respectively. The function **inet_ntoa( )** performs the reverse operation, converting an Internet address to the equivalent dot notation character string.

The function **inet_makeaddr( )** constructs an Internet address from a network number and host address. The functions **inet_netof( )** and **inet_lnaof( )** return the network and local network portions, respectively, of the Internet number passed as an argument.

All functions correctly handle Class A, B, and C Internet addresses; Internet addresses are returned in network byte order.

The dot notation form of an Internet address consists of one to four numbers separated by dots (periods). Each number can be expressed in decimal, octal (leading 0), or hexadecimal (leading 0x).

A four-part address (a.b.c.d) consists of four 8-bit numbers, each in the range 0- 255. The four parts are assigned, in order, to the four bytes in the long Internet address. This is the most commonly used format.

A three-part address (a.b.c) consists of two 8-bit numbers followed by a 16-bit number. The first two parts are assigned in order to the leftmost two bytes of the long Internet address; the third part is placed in the rightmost two bytes. This format is often used for specifying Class B network addresses as *128.net.host*.

A two-part address (a.b) consists of a single 8-bit number followed a 24-bit number. The first part is assigned to the leftmost byte of the long Internet address; the second part is placed in the rightmost three bytes. This format is often used for specifying Class A addresses as *net.host*.

A one-part address is converted to a 32-bit quantity and stored directly in the long Internet address without any byte rearrangement.

See also: **gethostent( )** and **getnetent( )** functions, in this chapter;
hosts and *networks*, Chapter 9

Errors

The value -1 is returned by **inet_addr( )** and **inet_network( )** for malformed requests.

listen

Listens for connection requests on a socket.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int listen(s, backlog)
int s, backlog;
```

Parameters

`s`	An unconnected socket of type SOCK_STREAM, which has been bound to a name with **bind( )**.
`backlog`	The maximum number of incoming connection requests that can be queued. If a connection request arrives with the queue full, the client will receive an error with an indication of ECONNREFUSED.

Note
This parameter is ignored.

Return Value

Zero if the call is successful or -1 if an error occurs.

Additional Information

For a server application to accept connections, it must first create a socket with **socket( )**, then specify a backlog for incoming connection requests with **listen( )**. To complete a connection, accept connection requests with **accept( )**.

A **listen(*s*,0)** call succeeds and sets a connection queue length of 0. This causes all **connect( )** attempts to the listening port to fail, with the error ECONNREFUSED. A **listen(*s*,1)** call accepts only a single connection with no pending requests allowed.

See also: **accept( )**, **connect( )**, and **socket( )** functions, in this chapter

Errors

`[EBADF]`
The argument `s` is not a valid descriptor.

`[ENOTSOCK]`
The argument *`s`* is not a socket.

`[EOPNOTSUPP]`
The socket is not of a type that supports the operation **listen( )**.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

recv

The **recv( )**, **recvfrom( )**, and **recvmsg( )** functions receive a message from a socket. You can use the **recv( )** call only on a connected socket, while **recvfrom( )** and **recvmsg( )** can receive data on a socket whether it is in a connected state or not.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int recv(s, buf, len, flags)
int s, len, flags;
char *buf;

int recvfrom(s, buf, len, flags, from, fromlen)
int s, len, flags;
char *buf;
struct sockaddr *from;
int *fromlen;

int recvmsg(s, msg, flags)
int s, flags;
struct msghdr msg[];
```

Parameters

`s`	The socket to receive the message from.	
`buf`	A pointer to a buffer where the received message will be placed.	
`len`	The length in bytes of the buffer indicated by `buf`.	
`flags`	You may set `flags` to one of the following:	
	0	No special handling.
	MSG_PEEK	Peek at the incoming data present on the socket; the data is returned but not consumed, so that subsequent receive operation will see the same data.

✏ **Note**
This parameter is not currently supported.

	MSG_WAITALL Wait for all data requested.
`from`	If `from` is non-zero, the source address of the message is filled in.
`fromlen`	Initialize to the size of the buffer associated with `from`. `Fromlen` is modified on return to indicate the actual size of the address stored there.
`msg`	The **recvmsg( )** call uses a `msghdr` structure to minimize the number of directly supplied parameters. This structure has this form, as defined in <*sys/socket.h*>:

```
struct msghdr {
   caddr_t   msg_name;        /* optional address */
   int       msg_namelen;     /* size of address */
   struct    iovec *msg_iov;  /* scatter/gather array */
   int       msg_iovlen;      /* # elements in msg_iov */
   caddr_t   msg_accrights;   /* access rights sent/received */
   int       msg_accrightslen;
};
```

Here `msg_name` and `msg_namelen` specify the destination address if the socket is unconnected; `msg_name` may be given as a null pointer if no names are desired or required.

Return Value

The number of bytes received in the message, or -1 if an error occurs.

If a message is too long to fit in the supplied buffer, excess bytes may be discarded depending on the type of socket the message is received from. If no messages are available at the socket, the receive call waits for a message to arrive, unless the socket is non-blocking. In this case a value of -1 is returned with **errno** set to EWOULDBLOCK.

See also: **send( )** and **socktout( )** functions, in this chapter

Errors

`[EBADF]`
The argument `s` is an invalid descriptor.

`[EFAULT]`
The data was specified to be received into a non-existent or protected part of the process address space.

`[EINTR]`
The receive was interrupted by delivery of a signal before any data was available for the receive.

`[EINVAL]`
: Invalid `flags`, `len` or `fromlen` parameters specified; the number of bytes allocated for the incoming protocol address or options is not sufficient to store the information.

`[ENOTSOCK]`
: The argument `s` is not a socket.

`[EOPNOTSUPP]`
This function is not supported by the underlying transport provider.

`[EPIPE]`
: A broken connection exists or a peer has closed the connection.

`[EUNATCH]`
: The TCP/IP kernel has not been loaded.

`[EWOULDBLOCK]`
: The socket is marked non-blocking and the receive operation would block.

select

The **select( )** function checks the sockets specified in the sets of descriptors supplied as parameters to see if any of the sockets are ready for receiving or sending, or have out of band data pending. On return, the descriptor sets are replaced with subsets consisting of those sockets of each set that are ready for the associated operation. Only one thread may select on a particular aspect of a socket at a time. For example, one thread may select on only receiving and another thread may simultaneously select on only sending on the same socket, but both threads may not select on receiving on the same socket at the same time. If this is attempted, only one thread will succeed and an `EALREADY` error will be returned to any other threads.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int select(nfds, recvfds, sendfds, oobfds, timeout)
int nfds;
fd_set *readfds, *writefds, *oobfds;
unsigned short timeout;
```

Parameters

`nfds`	The number of socket descriptors represented by each of the supplied descriptor sets. The first `nfds` descriptors of each set (i.e., sockets 0 through `nfds` -1) are checked.
`recvfds`	A pointer to a set of socket descriptors to be checked to see if any of them are ready for receiving. On return, it contains a set of ready socket descriptors. A null value causes **select( )** to skip the descriptor set.
`sendfds`	A pointer to a set of socket descriptors to be checked to see if any of them are ready for sending. On return, it contains a set of ready socket descriptors. A null value causes **select( )** to skip the descriptor set.
`oobfds`	A pointer to a set of socket descriptors to be checked to see if any of them have out of band data pending. On return, it contains a set of ready socket descriptors. A null value causes **select( )** to skip the descriptor set.
timeout	The timeout period in **10-ms** units. Setting `timeout` to `0xffff` causes **select( )** to wait until one or more of the sockets specified by the descriptor sets are ready. Setting `timeout` to 0 causes **select( )** to

return immediately with the current status of the sockets specified by the descriptor sets. Setting `timeout` to any value in between specifies the maximum amount of time to wait for any socket specified by the descriptor sets to become ready.

Return Value

The total number of ready sockets contained in the descriptor sets, or -1 if an error occurs. If the timeout expires before any sockets become ready, 0 is returned. If **select( )** returns an error, the socket descriptor sets are unmodified.

See also: **recv( ), send( )** and **socktout( )** functions, in this chapter

Additional Information

A set of macros is supplied to ease manipulation of sets of socket descriptors.

`FD_SET(s, &fds)`	Adds socket `s` to descriptor set `fds`
`FD_CLR(s, &fds)`	Removes socket `s` from descriptor set `fds`
`FD_ISSET(s, &fds)`	Returns nonzero if socket `s` is in set `fds`; zero if not
`FD_ZERO(&fds)`	Clears descriptor set `fds`

An additional macro is supplied for compatibility with other implementations to convert a timeout specified as a number of seconds and microseconds in a timeval structure to the equivalent number of 10 ms ticks required by the **select( )** function. A null pointer translates to a timeout value that causes **select( )** to wait indefinitely. A timeval structure that specifies a timeout of more than 655.35 seconds produces an undefined result.

`TV_TICKS(&tv)`	Converts timeout in timeval structure `tv` to 10 ms ticks

Errors

`[EALREADY]`

Another thread is currently performing a **select( )** on at least one of the sockets referenced by `recvfds, sendfds` or `oobfds`.

`[EBADF]`

At least one of the sockets referenced by `recvfds, sendfds` or oob`fds` is an invalid descriptor.

[EINVAL]
: Invalid `nfds` parameter specified; the `recvfds, sendfds` and oob`fds` pointer parameters are all null.

[ENOTSOCK]
: At least one of the descriptors referenced by `recvfds, sendfds` or `oobfds` is not a socket.

[EUNATCH]
: The TCP/IP kernel has not been loaded.

send

The **send( )**, **sendto( )**, and **sendmsg( )** functions send a message from one socket to another. **Send( )** may be used only when the socket is in a connected state, while **sendto( )** and **sendmsg( )** may be used at any time.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int send(s, buf, len, flags)
int s, len, flags;
char *buf;

int sendto(s, buf, len, flags, to, tolen)
int s, len, flags, tolen;
char *buf;
struct sockaddr *to;

int sendmsg(s, msg, flags)
int s, flags;
struct msghdr msg[];
```

Parameters

`s`	The local socket.
`buf`	Points to the buffer holding the message to be sent.
`len`	The length of the message in bytes, for **send( )** and **sendto( )**.
`flags`	May be set to MSG_OOB, to send out-of-band data on sockets that support this notion (for example, SOCK_STREAM). The underlying protocol must also support out-of-band data. The BSD MSG_DONTROUTE flag is not supported. You may set the flag to one of the following:

0	No special handling.
MSG_OOB	Process out of band data

`to`	The address of the target socket.
`tolen`	The length in bytes of the `to` argument.
`msg`	Points to a structure holding the message and information about it.

The `msghdr` structure is as follows:

```
struct msghdr {
   caddr_t   msg_name;        /* optional address */
   int       msg_namelen;     /* size of address */
   struct    iovec *msg_iov;  /* scatter/gather array */
   int       msg_iovlen;      /* # elements in msg_iov */
   caddr_t   msg_accrights;   /* access rights sent/received */
   int       msg_accrightslen;
};
```

Here `msg_name` and `msg_namelen` specify the destination address if the socket is unconnected; `msg_name` may be given as a null pointer if no names are desired or required.

Return Value

The number of characters sent, or -1 if an error occurs.

Additional Information

No indication of failure to deliver is implicit in a **send( )**. Return values of -1 indicate some locally detected errors.

If no message space is available at the socket to hold the message to be transmitted, **send( )** normally blocks, unless the socket has been placed in non-blocking I/O mode.

Errors

`[EBADF]`
`s` is a invalid descriptor.

`[EFAULT]`
An invalid user space address was specified for a parameter.

`[ENOTSOCK]`
The argument `s` is not a socket.

`[EOPNOTSUPP]`
This function is not supported by the underlying transport provider.

`[EUNATCH]`
The TCP/IP kernel has not been loaded.

`[EPIPE]`
A broken connection exists or a peer has closed the connection.

shutdown

Shuts down all or part of a full-duplex connection.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int shutdown(s, how)
int s, how;
```

Parameters

`s`	A connected socket.
`how`	Specifies what part(s) of the connection to shut down:

Value	**Description**
0	Disallow further receives (not currently implemented)
1	Disallow further sends (not currently implemented)
2	Disallow further receives and sends
job-ID	Transfer the socket to the specified iRMX job.

Additional Information

This call closes the socket when you disallow both receive and send functions. This can occur with a `how` of 2, or with subsequent calls specifying a `how` of 1 and a `how` of 0.

There is an extension to this call which allows the transfer of a socket to another iRMX job. If the `how` parameter is the job ID of a valid iRMX job, the connection remains and is transferred along with the socket to the specified job. To inherit the socket, the other job must specify SOCK_INHERIT as the `type` parameter in a **socket( )** call.

The task that bequeaths a socket (using the inherit-style shutdown) will block in the **shutdown( )** call until the task in `job-ID` inherits it (calls **socket( )** with SOCK_INHERIT). If the bequeathing task creates the inheriting task, it must do so prior to calling **shutdown( )**.

See also: **connect( )** and **socket( )** functions, in this chapter

Return Value

Zero if the call is successful or -1 if an error occurs.

Errors

`[EBADF]`
: `s` is not a valid descriptor.

`[EINVAL]`
: Invalid value specified for `how`.

`[ENOTSOCK]`
: `s` is not a socket.

`[EUNATCH]`
: The TCP/IP kernel has not been loaded.

socket

Creates an endpoint for communication.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int socket(af, type, protocol)
int af, type, protocol;
```

Parameters

`af` An address format for interpreting addresses specified in later operations:

Value	Format
AF_INET	Internet addresses

`type` Specifies the semantics of communication; one of these:

Value	Meaning
SOCK_STREAM	The socket will be used for connections.
SOCK_DGRAM	The socket will be used for datagrams.
SOCK_RAW	The socket gives direct access to the IP layer.
SOCK_INHERIT	This iRMX job blocks, waiting to inherit another job's open socket

`protocol` The protocol to be used with the socket. For a socket of type SOCK_STREAM or SOCK_DGRAM, specify 0 to get the default protocol, IPPROTO_TCP and IPPROTO_UDP, respectively. A SOCK_RAW socket can use IPPROTO_ICMP or IPPROTO_RAW. Specify 0 for a SOCK_INHERIT socket. If you include <*netinet/in.h*>, these values are defined:

Literal	Value	Meaning
IPPROTO_IP	0	dummy for IP
IPPROTO_ICMP	1	Internet control message protocol
IPPROTO_GGP	3	gateway-gateway protocol
IPPROTO_TCP	6	transmission control protocol
IPPROTO_EGP	8	exterior gateway protocol
IPPROTO_PUP	12	PARC universal packet protocol
IPPROTO_UDP	17	user datagram protocol
IPPROTO_IDP	22	Xerox XNS IDP
IPPROTO_RAW	255	raw IP packet

See also: *services* and *protocols* files, Chapter 9

Return Value

A descriptor referencing the socket, or -1 if an error occurs.

Additional Information

Sockets of type SOCK_STREAM are sequenced, reliable, two-way connection-based byte streams with an out-of-band data transmission mechanism. They are similar to Unix pipes. A stream socket must be in a *connected* state before any data may be sent or received on it. A connection to another socket is created with a **connect( )** call. Once connected, data may be transferred using some variant of the **send( )** and **recv( )** calls. When a session has been completed a **shutdown( )** must be performed. Out-of-band data may also be transmitted and received.

The communications protocols used to implement a SOCK_STREAM ensure that data is not lost or duplicated. If a piece of data for which the peer protocol has buffer space cannot be successfully transmitted within a reasonable length of time, the connection is considered broken. Such calls indicate an error with -1 returns and with ETIMEDOUT as the specific code in the global variable **errno**. The protocols optionally keep sockets viable by forcing transmissions approximately every minute, in the absence of other activity. An error is then indicated if no response can be elicited on an otherwise idle connection for an extended period (e.g., five minutes).

SOCK_DGRAM sockets allow you to send and receive datagrams. A datagram is a connectionless, unreliable message with a fixed maximum length, typically small.

See also: **send( )** and **recv( )** functions, in this chapter

A SOCK_RAW socket gives direct access to the IP layer.

If SOCK_INHERIT is specified as the `type` parameter, the current job will block in the **socket( )** call until another job closes a socket using the current job's ID number as the `how` parameter to the **shutdown( )** call. The result is that the job which specifies SOCK_INHERIT in its **socket( )** call actually inherits an open socket from another iRMX job. This is a non-standard extension to the iRMX implementation of TCP/IP.

See also: **shutdown( )** function, in this chapter

All sockets are, by default, SO_LINGER. If the socket promises reliable delivery of data, the system will block the process on a shutdown attempt until it is able to transmit the data or until it decides it is unable to deliver the information.

Errors

`[EAFNOSUPPORT]`
: The specified address family is not supported in this version of the system.

`[EINVAL]`
: An unknown error occurred.

`[EIO]` TCP/IP is not configured into the iRMX system.

`[ENOBUFS]`
: Unused.

`[EPROTONOSUPPORT]`
: Unused.

`[ESOCKTNOSUPPORT]`
: The specified socket type is not supported in this address family.

`[EUNATCH]`
: The TCP/IP kernel has not been loaded.

socktout

Defines a maximum time to wait for completion of any subsequent calls on the socket.

Syntax

```
#include <sys/types.h>
#include <sys/socket.h>

int socktout(s, val)
int s;
unsigned int val;
```

Parameters

`s`	The socket.
`val`	The timeout period in **10-ms** units. Setting `val` to `0xffff` disables the timeouts.

Return Value

Zero if the call is successful or -1 if an error occurs.

Additional Information

After reaching the timeout limit, the timed-out socket call returns with the return value -1, and **errno** is set to EWOULDBLOCK. The **socktout( )** call is a nonstandard extension to the iRMX implementation of TCP/IP. Since the iRMX environment does not have the alarm function built into Unix, this call serves as a substitute measure.

An example of using this function is when you want to receive a datagram. Since UDP is unreliable service, the datagram might be sent but never received. If this occurred, your **recvfrom( )** call would block forever unless you had first issued a **socktout( )** call.

See also: **accept( )**, **connect( )**, **recv( )**, and **send( )** functions, in this chapter

Errors

`[E2BIG]`
: `val` is too big.

`[EBADF]`
: `s` is not a valid descriptor.

`[EUNATCH]`
: The TCP/IP kernel has not been loaded.

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Glossary

alias	A symbolic name for a domain, host, or user.
ARP	Address Resolution Protocol. An Internet protocol which runs on Ethernets and Token Rings which maps Internet addresses to MAC addresses.
ARPA	Advanced Research Projects Agency. The former name of what is now called DARPA.
ARPANET	A wide area network developed in the 1960s by the Advanced Research Projects Agency. The ARPANET links government, commercial, and academic installations around the world.
BIOS	The Basic I/O System layer of the iRMX OS. This is different from the ROM BIOS stored in ROM on a DOS system.
bps	Bits per second. A measure of data transmission speed.
broadcast	A technique by which a single system on a network can send information to all other systems on the network using a single operation.
BSD	Berkeley Software Distribution. An enhanced Unix operating system that was designed at the University of California at Berkeley. Local network support is one of the enhancements provided by BSD-based systems.
canonical	The standard or regular name or expression, not the alias.
client process	A process activated by a user when issuing a networking command. The client process sends a request for service to a process on the remote host. If the request is honored, a connection is established between the local client and the remote server process.
connection	The path between two protocol modules that provides reliable stream delivery service. In TCP/IP Internet, a connection extends from a TCP module on one machine to a TCP module on the other.

connectionless service	Characteristic of the packet delivery service offered by most hardware and Internet Protocol (IP). The connectionless service treats each packet or datagram as a separate entity that contains source and destination addresses. Usually, connectionless service can drop packets or deliver them out of sequence.
DARPA	Department of Defense Advanced Research Projects Agency. The government agency that funded the ARPANET and later started the Internet.
datagram	The unit transmitted between a pair of internet modules. The Internet Protocol provides for transmitting blocks of data, called datagrams, from sources to destinations. The Internet Protocol does not provide a reliable communication facility. There are no acknowledgments either end-to-end or hop-by-hop. There is no error control for data, only a header checksum. There are no retransmissions. There is no flow control. See IP.
DDN	Defense Data Network. Comprises the MILNET and several other networks.
decimal address	*See* dotted decimal
default route	A routing table entry which is used to direct any data addressed to any network numbers not explicitly listed in the routing table.
domain	A grouping of hosts according to affiliation. For example, most universities belong to the EDU domain of educational institutions.
DNS	The Domain Name System is a mechanism used in the Internet for translating names of host computers into addresses. The DNS also allows host computers not directly on the Internet to have registered names in the same style.
dotted decimal	An Internet address that uses the base-10 number system, with the parts of the address separated by periods (dots).
EGP	External Gateway Protocol. A protocol which distributes routing information to the routers and gateways which interconnect networks.
EIOS	The Extended I/O System.

Ethernet	A network standard for the hardware and Data Link levels. There are two types of Ethernet: Digital/Intel/Xerox (DIX) and IEEE 802.3.
frame	A self-contained package of data at the link layer.
FTP	File Transfer Protocol. A TCP/IP protocol used for transferring files between hosts on the network.
gateway	A special-purpose dedicated computer that attaches to two or more networks and routes packets from one network to the other. In particular, an Internet gateway routes IP datagrams among the networks it connects. Gateways route packets to other gateways until they can be delivered to the final destination directly across one physical network. This definition is more commonly used in TCP/IP literature for a gateway. However, a more strict definition is that a gateway not only routes between networks but can translate between network protocols as it routes.
globbing	Determines how local filenames are processed by the shell in FTP. With globbing disabled, names specified on the command line are treated literally. With globbing enabled, each local file or pathname is processed for the shell metacharacters *** ? [ ] ~ { }**. Globbing is always enabled for references to remote files.
header	The portion of a packet, preceding the actual data, containing source and destination addresses and error-checking fields.
host	An individual computer on a network.
host name	A text name that can be used to identify a network host.
host number	The part of an internet address that designates which node on the (sub)network is being addressed.
ICMP	Internet Control Message Protocol. A protocol used by the Internet Protocol to report errors, give limited routing advice, and provide simple low-level services.
ICU	Interactive Configuration Utility. A screen-oriented utility provided by the iRMX III OS to help build the OS desired.
IEEE	Institute of Electrical and Electronics Engineers.

IGP	Interior Gateway Protocol. The generic term applied□ to any protocol used to propagate how reachable a network is and the routing information within an autonomous□ system. Although there is no Internet standard IGP,□ RIP is among the most popular.
internet	Short for internetwork, meaning any connection of two or more local or wide-area networks.
Internet	The global collection of interconnected regional and wide-area networks that use IP as the network layer protocol.
Internet address	A unique address that identifies a host on a TCP/IP network. The Internet address or IP address, consists of four decimal numbers separated by periods (129.84.3.71, for example). Each number has a value between 0 and 255 and represents eight bits of the complete 32-bit address. The Internet address is independent of the hardware to which it is assigned.
Internet Protocol (IP)	The network layer protocol for the Internet. It is the datagram protocol defined by RFC 791.
InterNIC	An organization that provides network users with information about services provided by the network. It is the primary repository for RFCs and Internet drafts.
IP	*See* Internet Protocol.
IP address	The 32-bit address assigned to hosts that want to participate in the Internet using TCP/IP.
IP datagram	The basic unit of information passed across the Internet. An IP datagram is to the Internet as a hardware packet is to a physical network. It contains a source and destination address along with data.
ISO	International Standards Organization. It developed the OSI (Open Systems Interconnection) reference model for networking.
LAN	Local Area Network. A collection of computers, typically connected by a single transmission cable, joined together for the purpose of sharing resources and facilitating communication. A LAN is limited to a small area such as a single building or a set of closely grouped buildings.

local host	The computer from which the user originates a networking command.
MAC	Medium (or Media) Access Control. For broadcast networks, it is the method which devices use to determine which device has access to the line at any given time.
MAC address	The hardware-level address, such as an Ethernet address.
MTU	The maximum transfer unit for a given interface. This is the largest number of bytes of data that can be transferred in a single packet. For example, the maximum frame size for Ethernet is 1526 bytes, including header information. The MTU is 1500.
network number	The part of an internet address that designates the network to which the addressed node belongs.
NFS	Network File Support. NFS enables hosts to share their local resources with remote hosts (clients) in a manner that hides the heterogeneous nature of a network. For example, a server running the iRMX OS may share a specific directory with a client machine running the Unix OS. The client can access the directory using commands and calls that appear to be directed at local resources.
nslookup	A tool that queries a name server for information about hosts on the network.
octet	Eight bits. Since data is sent across the network as individual bits, the logical 8-bit groups are sometimes called octets instead of bytes.
octal address	An Internet address that uses the base-8 number system.
out-of-band	An urgent data message. TCP attempts to expedite out-of-band data by notifying the application of its urgency. Normal (in-band) data is received after any out-of-band data.
packet	A single unit of data and control information that is transmitted over the network. The length of a packet varies. A single message may be transmitted in one packet or a series of packets.
point-to-point network	A network configuration that consists of two computers connected by a single communications line.

port	A number associated with a particular service. The port number is part of the address bound to a socket. As the Internet address defines a particular host, the port (combined with the protocol) defines the destination on that host. Certain well-known ports are reserved for certain services; for example, 21 for FTP and 23 for TELNET. In general, port numbers greater than 1024 are available for definition by a local application. However, some port numbers in this range have become standardized for certain services through common usage.
POSIX	Portable Operating System Interface. An operating system procedure call interface, based on Unix.
protocol	A formal description of message formats and the rules two computers must follow to exchange those messages. Protocols can describe low-level details of machine-to-machine interfaces (e.g., the order in which bits and bytes are sent across a wire) or high-level exchanges between allocation programs (e.g., the way in which two programs transfer a file across the Internet).
RawEDL	The raw External Data Link layer of iNA software. This interface allows non-OSI protocols such as TCP/IP to use iNA.
RFC	The Internet's Request for Comments documents series. The RFCs are working notes of the Internet research and development community. A document in this series may be on any topic related to computer communication, and may be anything from a meeting report to the specification of a standard.
router	A computer that attaches to two or more networks and routes packets from one network to the other. A router may understand more than one address protocol but does not translate from one protocol to another.
RPC	Remote Procedure Call. A procedure-oriented interface to remote services used to implement the client-server model of distributed computing.
server	A computer that shares its resources, such as printers and files, with other computers on the network.

server process	The remote host process that services the request made by the client process. The server is started up at network boot time as a background process that listens for incoming service requests. When it receives a request, it establishes a connection with the requesting client, spawns a child process, and goes back to listening for more incoming requests.
socket	A communication endpoint. A socket is identified by an address derived from a host's Internet address concatenated with a TCP port number.
Streams	This emulates the STREAMS mechanism on Unix systems. It constructs a series of protocol drivers and code modules to sequentially act on data passing through them. The series of drivers is called a stream, and can act on data flowing in either direction. Upstream is the stream head, put in place below a user process. Downstream is the stream end, a device driver (interface to a hardware device) or pseudo-device driver (interface to other software rather than directly to hardware). With the stream in place, a user process such as FTP makes use of the network hardware without needing to be aware of the protocols managing the data in between.
subnet	A portion of a network, which may be a physically independent network. A subnet shares a network address with other portions of the network and is distinguished by a subnet number. A subnet is to a network what a network is to an internet.
subnet number	A part of the internet address which designates a subnet. It is ignored for the purposes of internet routing, but is used for intranet routing.
TCP	Transmission Control Protocol. A transport layer protocol for the Internet. It is a connection-oriented, stream protocol defined by RFC 793.
TCP/IP	Transmission Control Protocol/Internet Protocol. A set of computer networking protocols and applications that enables two or more hosts to communicate. TCP/IP includes a suite of protocols besides TCP and IP; it has been widely adopted as a networking standard.
TELNET	A TCP/IP protocol used for remote login between hosts.

TFTP	Trivial File Transfer Protocol. A Department of Defense standard for transferring files between hosts. TFTP lacks the error-checking and user-authentication facilities offered by FTP.
UDP	User Datagram Protocol. A transport layer protocol for the Internet, defined by RFC 768. It is a datagram protocol that adds a level of reliability to IP datagrams.

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