Using LAN Communications Pak

Version 3.6

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Chapter 1: Networking Basics

The Microware Local Area Network Communications Pak (LAN Communications Pak) enables your OS-9 system to communicate with other computer systems connected to a TCP/IP network. This enables you to send data, receive data, and log on to other computer systems.

This chapter introduces you to the basics of networking and provides you with a working knowledge of internetworking.

This chapter covers the following topics:

- **Basic Networking Terminology**
- **Available Network Protocols**
- **Network Addressing**

Note

If you are already familiar with networking, you may want to proceed to the next chapters.

Basic Networking Terminology

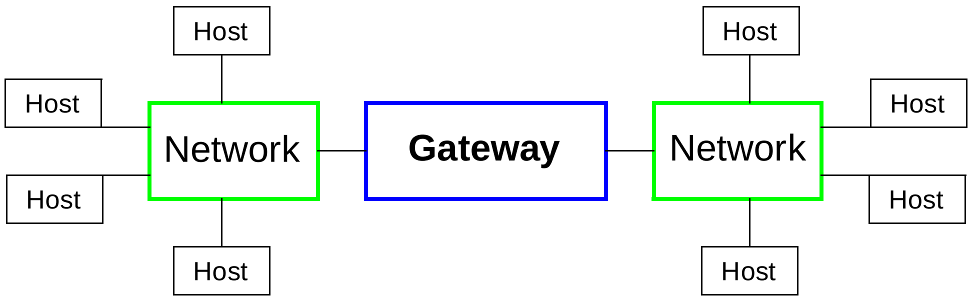
A computer *network* is the hardware and software enabling computers to communicate with each other. Each computer system connected to the network is a *host*. There can be different types of host computers, and they can be (and usually are) located at different sites. For example, you may have your OS-9 system connected to a network consisting of other OS-9 systems, as well as UNIX and DOS systems.

An *internet* is the connection of two or more networks, using the Internet Protocol, enabling computers on one network to communicate with computers on another network. An internet is sometimes referred to as an *internetwork*.

Networks are connected to each other by *gateways*. Gateways are computers dedicated to connecting two or more networks.

Figure 1-1 illustrates two networks connected by a gateway.

Figure 1-1 Gateway Connected Networks



Datagrams

When information (data) is passed from one host to another, either on the same network or across gateways, the data are carried in packets. Packets are the actual physical data transfered across the network layer. A *datagram* is a specific type of packet and is the basic unit of information passed on a network. In internetworking, this unit is called an Internet Protocol or IP datagram.

A datagram is divided into a header area and a data area. The datagram header contains the source and the destination Internet Protocol address and a type field identifying the datagram's content.

Figure 1-2 Basic Datagram

Header Area	Data Area

Fragmentation

The datagram size depends on the network's *Maximum Transfer Unit* (MTU). Because each network may have a different MTU, hosts and routers divide large datagrams into smaller *fragments* when the datagram needs to pass through a network having a smaller MTU. The process of dividing datagrams into fragments is known as *fragmentation*.

Fragmentation usually occurs at a gateway somewhere along the path between the datagram source and its final destination. The gateway receives a datagram from a network with a large MTU and must route it over a network where the MTU is smaller than the datagram size. The size of the fragment must always be a multiple of eight and is chosen so each fragment can be shipped across the underlying network in a single *frame*. A frame is passed across the data link layer and contains an *encapsulated datagram*.

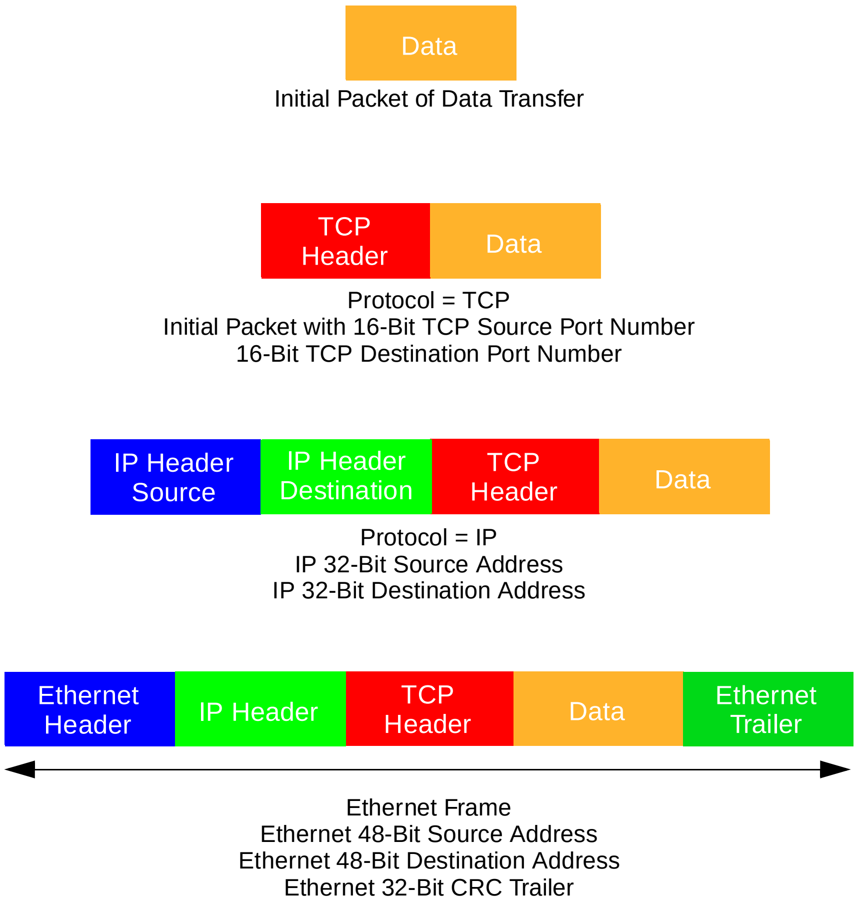
Hosts may also fragment large datagrams into multiple packets according to the size of the local MTU.

Fragments are reassembled at the final destination to produce a complete copy of the original datagram before it can be processed by the upper protocol layers.

Encapsulation

The addition of information to the datagram is called *encapsulation*. Datagrams are encapsulated with information as they pass through layers of the network. **Figure 1-3** illustrates this concept.

Figure 1-3 Encapsulated Datagram Example



Client and Server

The terms *client* and *server* appear frequently in networking documentation. A *server* process provides a specific service accessible over the network. A *client* process is any process requesting to use a service provided by a server.

Available Network Protocols

When client and server processes communicate, both processes must follow a set of rules and conventions. These rules are known as a *protocol*. Without protocols, hosts could not communicate with each other.

The protocols you need to be familiar with when using networks are:

- **Internet Protocol (IP)**
- **Transmission Control Protocol (TCP)**
- **User Datagram Protocol (UDP)**

Internet Protocol (IP)

Internet Protocol (IP) is the datagram delivery protocol. IP is a lower-level protocol located above the network interface drivers and below the higher-level protocols such as the UDP and the TCP. IP provides packet delivery service for higher level protocols such as TCP and UDP.

Due to the IP layer's location, datagrams flow through the IP layer in two directions:

- Network up to user processes
- User processes down to the network

The IP layer supports fragmentation and reassembly. If the datagram is larger than the MTU of the network interface, datagrams are fragmented on output. Fragments of received datagrams are dropped from the reassembly queues if the complete datagram is not reconstructed within a short time period.

The IP layer provides for a checksum of the header portion, but not the data portion of the datagram. IP computes the checksum value and sets it when datagrams are sent. The checksum is checked when datagrams are received. If the computed checksum does not match the checksum in the header, the packet is discarded.

The IP layer also provides an addressing scheme. Every computer on an Internet receives one (or more) 32-bit address. This allows IP datagrams to be carried over any medium.

Note

A checksum is a small, integer value used for detecting errors when data is transmitted from one machine to another.

Transmission Control Protocol (TCP)

The Transmission Control Protocol (TCP) is layered on top of the IP layer. It is a standard transport level protocol allowing a process on one machine to send a stream of data to a process on another machine. TCP provides reliable, flow controlled, orderly, two-way transmission of data between connected processes. You can also shut down one direction of flow across a TCP connection, leaving a one-way (simplex) connection.

Software implementing TCP usually resides in the operating system and uses IP to transmit information across the underlying Internet. TCP assumes the underlying datagram service is unreliable. Therefore, it performs a checksum of all data to help implement reliability. TCP uses IP host level addressing and adds a per-host port address. The endpoints of a TCP connection are identified by the combination of an IP address and a TCP port number.

The TCP packets are encapsulated as shown in **Figure 1-4**.

Figure 1-4 IP Datagrams

User Datagram Protocol (UDP)

The User Datagram Protocol (UDP) is also layered on top of the IP layer. UDP is a simple, unreliable datagram protocol allowing an application on one machine to send a datagram to an application on another machine using IP to deliver the datagrams. The important difference between UDP and IP datagrams is that UDP includes a protocol port number. This enables the sender to distinguish among multiple application programs on the remote machine. Like TCP, UDP uses a port number along with an IP address to identify the endpoint of communication.

UDP datagrams are not reliable. They can be lost or discarded in a variety of ways, including a failure of the underlying communication mechanism. UDP implements a checksum over the data portion of the packet. If the checksum of a received packet is incorrect, the packet is dropped without sending an error message to the application. Each UDP socket is provided with a queue for receiving packets. This queue has a limited capacity. Datagrams that arrive after the capacity of the queue has been reached are silently discarded.

Network Addressing

Regardless of which protocol you use to send messages across a network, each host is assigned one or more unique 32-bit internet addresses, or *IP addresses*.

IP addresses are usually represented visually as four decimal numbers, where each decimal digit encodes one byte of the 32-bit IP address. This is referred to as *dot notation*. IP addresses specified using the dot notation use one of the following forms:

a.b.c.d
a.b.c
a.b
a

Usually, all four parts of an address are specified. In this form, the most significant byte is written first and the least significant byte is written last.

Sometimes a written address may omit one or more of the four bytes. When this happens, the address is expanded to a normal four-part address by replacing the missing bytes with zeros. The following list demonstrates this process.

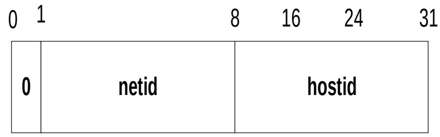
Short Address	Expanded Address
127	0.0.0.127
127.1	127.0.0.1
127.1.2	127.1.0.2

Network Classes

The 32-bit address space is divided into five groups, or network classes. The first three classes consist of the unicast addresses assigned to hosts, the fourth class contains multicast addresses, and the fifth class is reserved for future use. In the first three classes, each 32-bit address is divided into two parts—the network and host portion. These identify the network the host is on and which host it is within that network.

Class A

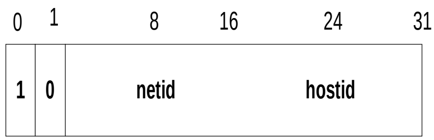
All addresses with a 0 as the first bit in their binary representation are considered Class A addresses.



The first byte represents the `netid` portion of the address, and the remaining 3 bytes represent the `hostid`. Class A addresses range from 0.0.0.0 to 127.255.255.255.

Class B

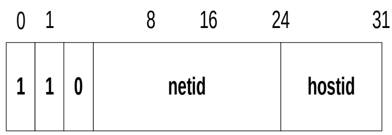
Addresses that start with a binary 10 are in Class B.



These addresses contain 2 bytes for each of the `netid` and `hostid` portions. Class B addresses range from 128.0.0.0 to 191.255.255.255.

Class C

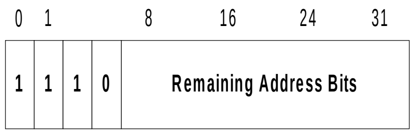
Class C addresses are distinguished by 110 as the first three bits in their binary representation.



The first three bytes of the address form the `netid`, and the remaining byte is used for the `hostid`. Class C addresses range from 192.0.0.0 to 223.255.255.255.

Class D

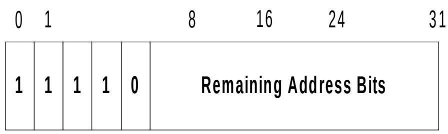
Class D addresses are multicast addresses with the first 4 bits set to 1110.



Class D addresses range from 224.0.0.0 to 239.255.255.255.

Class E

Class E addresses are reserved for future use and have 11110 as the first five bits in their binary representation.



Class E addresses range from 240.0.0.0 to 247.255.255.255

Subnet Masks

The A, B, and C class distinctions are now mostly historical. Instead of using the first few bits of the address to determine the boundary between the `netid` and the `hostid`, a `subnet mask` is used. Wherever the bits in the subnet mask are set to 1, the corresponding bits in the address are part of the `netid`. Wherever the bits are zero, the corresponding address bits are part of the `hostid`. For example:

```
Address: 172.16.193.27
Subnet mask: 255.255.255.0

netid: 172.16.193.0 (or just 172.16.193)
hostid: 0.0.0.27 (or just 27)
```

While it is common to use byte boundaries for subnet masks, it is not required. Another example is:

```
Address: 172.16.193.27
Subnet mask: 255.255.192.0 (18 bits)

netid: 172.16.192.0
hostid: 0.0.1.27
```

Chapter 2: LAN Communications Pak Overview

This chapter is an overview of the Local Area Network (LAN) Communications Pak. It includes:

- A list of example programs and utilities
- A list of software libraries provided
- A list of supported drivers and descriptors
- A diagram of the architecture and organization of the modules

Introduction

The LAN Communications Pak provides a small footprint Internet package that enables small embedded devices to communicate in a network environment. The User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Internet Protocol (IP), as well as a raw socket interface are supported in this package.

Note

For information on Microware Systems communications software packages that carry UDP/TCP/IP protocols over other networks (such as ATM), contact your Microware Systems sales representative.

LAN Communications Pak Requirements

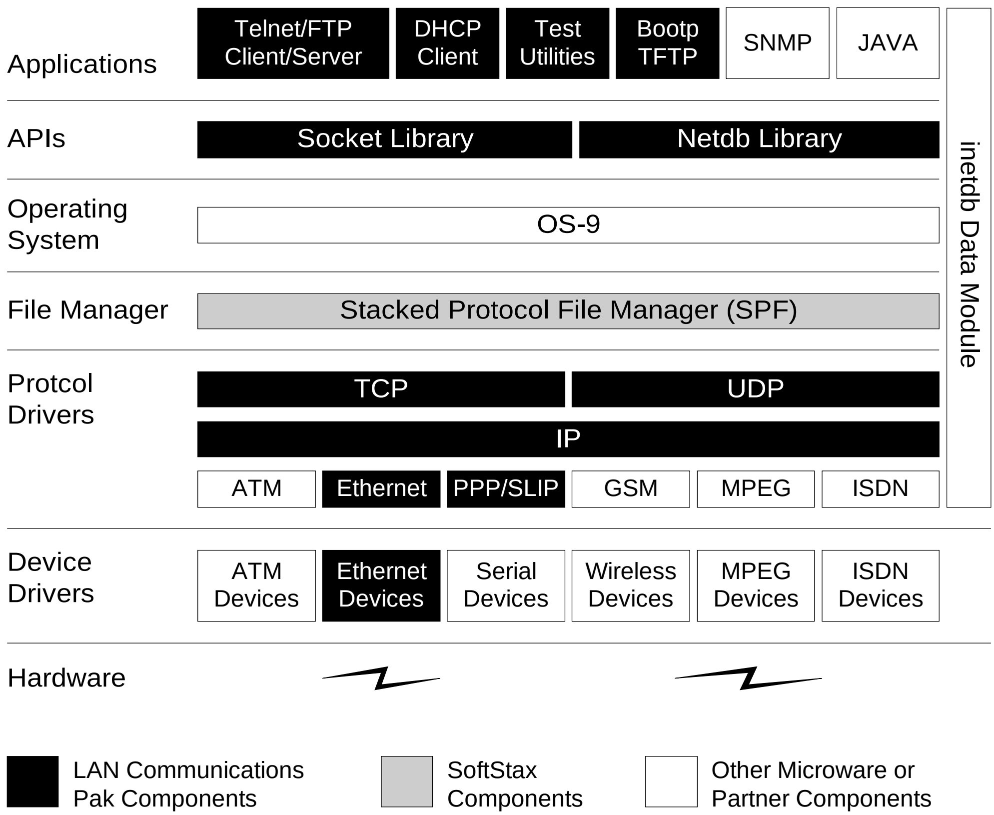
The LAN Communications Pak uses SoftStax, the Stacked Protocol File Manager (SPF), for its I/O system. SoftStax is required and provides a complete SPF environment for creating applications and drivers.

LAN Communications Pak Components

LAN Communications Pak provides local area connectivity support for SoftStax™, the Microware integrated communications and control environment for OS-9. LAN Communications Pak adds device-level ethernet and serial interface capability using PPP and CSLIP.

Figure 2-1 shows the LAN Communications Pak components. Each software subsystem is defined in the following sections.

Figure 2-1 LAN Communications Pak Components



Applications

Telnet

Telnet provides the user interface for communication between systems connected to the Internet and enables log-on to remote systems.

File Transfer Protocol (FTP)

FTP transfers files to and from remote systems.

Dynamic Host Configuration Protocol (DHCP)

DHCP enables a host to retrieve the network configuration from a server.

Application Programming Interfaces (APIs)

LAN Communications Pak supports the standard Berkeley Socket Library (`socket.l`) and network/host library `netdb.l`. Socket applications access the `netdb.l` library or `netdb` trap handler for network/host functions and for local or DNS client resolution. `netdb` locates configuration information in the `inetdb` data module or through a DNS client lookup.

File Manager

LAN Communications Pak plugs into the SoftStax™ environment underneath the Stacked Protocol File Manager (SPF). The tight network/OS integration of SPF enables the speed and efficiency crucial for maximizing throughput while minimizing footprint and CPU use over local and wide area networks.

Protocol Drivers

LAN Communications Pak provides drop-in protocol drivers that can be stacked and unstacked as required by applications to communicate over LANs. These include the following:

- Transmission Control Protocol (TCP)—TCP provides reliable data transfer service over IP.
- User Datagram Protocol (UDP)—UDP provide datagram services over IP.
- Internet Protocol (IP)—IP provides Internet packet forwarding.
- Ethernet Protocol—spenet driver provides Ethernet connectivity, ARP request and reply layer for Ethernet hardware.
- Point-to-Point Protocol (PPP)—PPP supports IP over serial links.
- Serial Line Internet Protocol (SLIP)—SLIP supports IP over serial links.

For IP-based communications over Wide Area Networks (WANs), LAN Communications Pak can be combined with many wide area connectivity communications packages available for SoftStax™.

Device Drivers

LAN Communications Pak supports the following device drivers. This is not an exhaustive list. Not all of these drivers are available on all platforms, and some platforms have additional driver support not listed here. See the processor specific documentation for more information.

- AM7990
- NS83902
- NS83690/NS83790 (SMC Elite/SMC Ultra)
- DEC21040/21140/21143
- QUICC within Communications Processor Module (CPM).
- I82596

- E509 (3COM EtherLink III, PCMCIA EtherLink III, and EtherLink XL)
- SMSC LAN91C94/91C96

Data Module

LAN Communications Pak stores Internet configuration information in resident data modules with a prefix of `inetdb`. `inetdb` is a database containing Internet configurations for the local machine as well as the hosts, networks, protocols, and services that are available.

`inetdb` functions on a standard file system or can be configured to work in small embedded environments that require Internet connectivity. `inetdb` contains information on machine names, IP addresses and interfaces, and network protocol names and their identification values.

For More Information

See **Appendix A: Configuring LAN Communications Pak** for information about the files that compose the `inetdb` data modules.

Software Description

Table 2-1 LAN Communications Pak Examples and Utilities

Examples/Utilities	Purpose
`arp`	Print and update the ARP table.
`beam`, `target`	Example UDP/IP socket program. Source and objects are provided.
`bootpd`	BOOTP server daemon.
`bootpdc`	BOOTP connection handler (`bootpdc` is forked by `bootpd`).
`bootptest`	Test the BOOTP server connection.
`chat`	Modem dialer utility used with PPP.
`dhcp`	Dynamic Host Configuration Protocol (DHCP) client for setting host networking paramater.
`ftp`	File Transfer Protocol (FTP) that handles sending and receiving files.
`ftpd`	FTP server daemon.
`ftpdc`	FTP server connection handler. (`ftpdc` is forked by `ftpd` or `inetd`.)
`hostname`	Prints or sets the string returned by the socket library.

Table 2-1 LAN Communications Pak Examples and Utilities (continued)

Examples/Utilities	Purpose
`idbdump`	Dumps the contents of the `inetdb` data module.
`idbgen`	`inetdb` data module generator for host, networks, protocols, services, DNS resolving `gethostname()` function, interfaces, and routes.
`ifconfig`	Interface configuration utility.
`inetd`	Internet Services Master Daemon; `inetd` can be configured to fork a particular program to handle data for a particular protocol/port number combination. For example, `inetd` can replace the `ftpd` and `telnetd` server daemons.
`ipstart`	Initializes the IP stack.
`ndbmod`	Adds, removes, or modifies information stored in the `inetdb` data module.
`netstat`	Reports network information and statistics.
`ping`	Sends ICMP ECHO_REQUEST packets to host.
`pppauth`	Utility for configuring PPP authentication.
`pppd`	Utility to initiate a PPP connection.
`route`	Add or delete entries from the routing table.
`routed`	Dynamic routing daemon.

Table 2-1 LAN Communications Pak Examples and Utilities (continued)

Examples/Utilities	Purpose
`tcprecv`, `tcpsend`	Example TCP/IP socket program. Source and objects are provided.
`telnet`	Telnet User Interface; `telnet` provides the ability to log on to remote systems.
`telnetd`	Telnet Server Daemon.
`telnetdc`	Telnet Server Connection Handler. (`telnetdc` forked by `telnetd` or `inetd`.)
`tftpd`	TFTP Server Daemon.
`tftpdc`	TFTP Server Connection Handler. (`tftpdc` forked by `tftpd`)

For More Information

Chapter 8: Utilities contains more detailed information about utilities and example applications.

Table 2-2 LAN Communications Pak Libraries

Libraries	Purpose
`socket.l`	Berkeley socket library.
`netdb.l`	Library for local or remote host name resolution and network/host functions. Uses the `netdb` trap handler.
`netdb_dns.l`	DNS client host name resolution and network functions. Does not use the `netdb` trap handler. The code is inlined in the application.
`netdb_local.l`	Local name resolution and network functions. Does not use the `netdb` trap handler. The code is inlined in the application.
`ndblib.l`	Library for `inetdb` data module manipulation.

For More Information

Refer to the ***LAN Communications Pak Programming Reference*** for detailed information concerning libraries.

Table 2-3 LAN Communications Pak Descriptors and Drivers

Drivers & Descriptors	Purpose
`netdb_local`	Local host name resolution module. No Domain Name Service (DNS) support.
`netdb_dns`	Local and remote host name resolution module. Client DNS (Domain Name Service) support.
`spenet`, `enet`	Driver and descriptor for Ethernet layer. Source files are provided for the descriptor.
`spip`, `ip0`	Driver and descriptor for IP protocol. Source files are provided for the descriptor.

`spipcp`, `ipcp0`
`splcp`, `lcp0`
`sphdlc`, `hdlc0`
	Drivers and descriptors for the Point-to-Point Protocol (PPP). Source files are provided for the descriptors.

`spslip`, `spsl0`	Driver and descriptor for the Serial Line Internet Protocol device driver (SLIP). The driver and descriptor provide a point-to-point serial interface between serial connections for transmitting TCP/IP packets. Source files are provided for the descriptor.
`spudp`, `udp0`	Driver and descriptor for the UDP protocol. Source files are provided for the descriptor.
`sptcp`, `tcp0`	Driver and descriptor for the TCP protocol. Source files are provided for the descriptor.

Table 2-3 LAN Communications Pak Descriptors and Drivers (continued)

Drivers & Descriptors	Purpose
`spraw`, `raw0`	Driver and descriptor for raw IP support. Source files provided for the descriptor.
`sproute`, `route0`	Driver and descriptor for IP routing domain support. Source files provided for the descriptor.

Note

The supported Ethernet drivers are listed below. Depending on the package you ordered, you may not receive all of them, or may receive additional drivers not listed here.

`sp162, sp167, sp172, sp177, spie0`	Driver and descriptor for the I82596 ethernet driver. Source and object files are provided for the driver and descriptor for the MVME162/167/177 processors.
`sp403evb, spne0,`	Driver and descriptor for the 403GAEVB—chip NS83902.
`sp360, spqe0`	Driver and descriptor for the QUICC 68360 QUADS board.
`sp147`, `sple0`	Driver and descriptor for the AM7990 LANCE Ethernet driver. Source and object files are provided for the driver and descriptor for the MVME147.

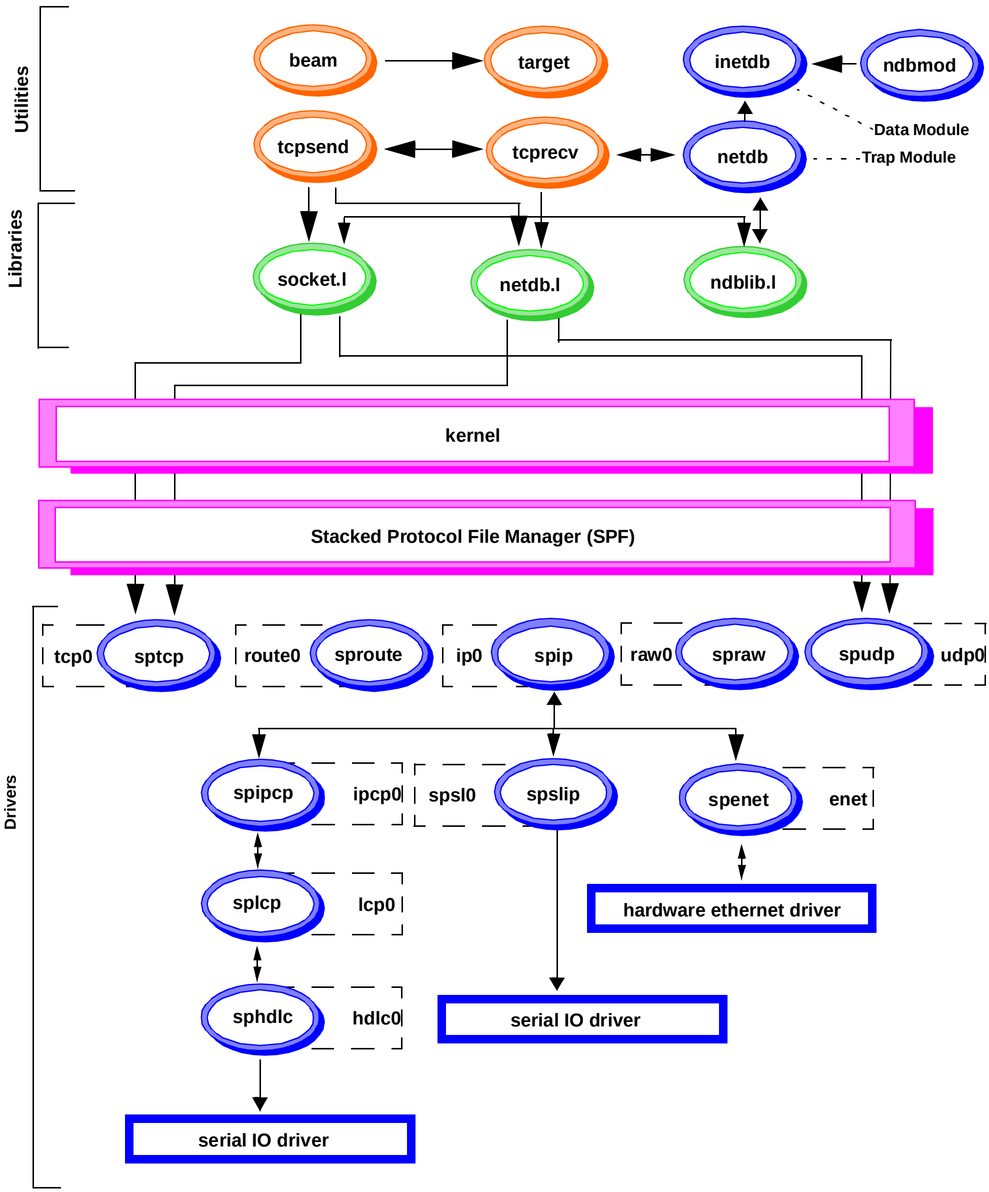
Table 2-3 LAN Communications Pak Descriptors and Drivers (continued)

Drivers & Descriptors	Purpose
`sp1603`, `spde0`	Driver and descriptor for the DEC21040 Ethernet driver. Source and object files are provided for the driver and descriptor for the MVME1603.
`sp821`, `spqe0`	Driver and descriptor for the QUICC Ethernet driver. Source and object files are provided for the 821ADS.
`sp8390, sp83C790, spns0, spwd0`	Driver and descriptor for the SMC Elite and SMC Ultra.
`spe509, spe30, spe31`	Driver and descriptor for the 3Com EtherLink III, PCMCIA EtherLink III, and EtherLink XL (10 Mbs).

LAN Communications Pak Architecture

The following figure shows the architecture and organization of the modules in the LAN Communications Pak. The example applications provided use the socket libraries (`socket.l` and `netdb.l` for network/host functions) to make standard BSD socket calls.

Figure 2-2 LAN Communications Pak Architecture



The `idbgen` or `ndbmod` utilities create the `inetdb` data module containing host/network and other configuration information.

The ndbmod utility allows dynamic inetdb generation for entries in the inetdb data module on the resident system.

For More Information

See **Appendix A: Configuring LAN Communications Pak** for more information about files that compose the inetdb data module.

Chapter 3: Serial Line Internet Protocol (SLIP) Driver

The SPF Serial Line Internet Protocol device driver (`spslip`) provides a point-to-point interface between serial connections for transferring IP packets.

SPSLIP Introduction

`spslip` is based on the RFC 1055 specification for SLIP. In addition, it supports multicasting and the Van Jacobson CSLIP protocol enhancements.

`spslip` is typically used as an Internet interface to SCF devices (generally an RS-232 serial port) to perform telnet and FTP sessions and other communication functions.

The following table lists the driver and descriptor provided for SLIP:

Table 3-1 `spslip` Driver and Descriptor

Driver	Descriptor
`spslip`	`spsl0`

Installation

To install the `spslip` device driver on your system, perform the following steps:

Step 1. Setup the `inetdb and inetdb2` data files.

Note

You may also use the `ifconfig` utility to add the slip interface after starting IP.

For More Information

Refer to **Chapter 8: Utilities** and **Appendix A: Configuring LAN Communications Pak** for more information about setting up the `inetdb` files.

Step 2. Modify the `spf_desc.h` file to set baud rate, stop bits, and parity. This file is located in the following directory:

```
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/SLIP/DEFS
```

Note

For OS-9 systems with only one serial port, be sure to also set the serial device name to be that of your console. For example:

```
#define I_DEV_NAME     "/term"
#define O_DEV_NAME     "/term"
```

Step 3. Modify the `spf_desc.h` file to set baud rate, stop bits, and parity. This file is located in:

```
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/SLIP/DEFS
```

Step 4. Remake the descriptor `spsl0`.

```
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/SLIP
os9make
```

After running the make, the descriptor binary can be found in the directory:

```
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/CMDS/BOOTOBJS/
SPF
```

The driver `spslip` can be found in the directory:

```
MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF
```

Step 5. On disk-based systems, initialize the protocol stack manually or with the `startspf` script (see `startspf` example). `startspf` is located in `MWOS/SRC/SYS`. Otherwise, enter the following commands:

```
mbinstall
ipstart
```

Note

For OS-9 systems with only one serial port, be sure to run `inetd` (or `ftpd/telnetd`) after initializing the protocol stack if you want to be able to handle incoming service requests (e.g. using telnet to regain access to a shell). For example:

```
mbinstall
ipstart; inetd<>>>/nil&
```

Step 6. On disk-based systems, initialize the protocol stack by hand or with the `startspf` script (see `startspf` example). `startspf` is located in `MWOS/SRC/SYS`. Otherwise, enter the following commands:

- `mbinstall`
- `ipstart`

Step 7. Verify that everything is working correctly by attempting to `ping` to the remote host.

Note

If you have more than one SLIP connection, make sure each connection has a different port address (`PORTADDR` in the driver descriptor configuration section).

Compression is not negotiated and is ON by default.

The default serial device used is `/t1`.

Baud rate is 19200 by default.

Baud rates, parity, compression, and MTU must match on both ends.

spslip Transmission Process

The spslip driver processes the data packets it sends and receives in four ways, including:

- **Initialization**
- **Sending Data**
- **Reading Data**
- **Header Compression**

Initialization

During initialization, the driver acquires the input and output device names to be opened from the device descriptor. After opening the input and output devices, it sets the options for the input and output paths such as baud rate, echo, and X-ON/X-OFF. spslip then creates two processes called spslip. These processes control the data flow from the input and output paths.

To see the two processes, enter a `procs -e` command after starting up the system. If both processes are not running for every SLIP port in the system, the SLIP driver did not initialize successfully.

Sending Data

When data is sent over the serial line, spslip checks to see if the amount of data being sent is less than the protocol's Maximum Transmission Unit (MTU). The default MTU is 1006, as defined in ***RFC 1055***. To change the MTU, update the `spf_desc.h` file and remake `spsl0`.

The sending output process actually performs the SLIP data packaging. Basically, SLIP defines two special characters:

- `END` (octal 300).
- `ESC` (octal 333).

The output process starts sending the data over the serial line. When a data byte is detected to be the END character, the process replaces it with the ESC and octal 334 for transmission. If the data byte is the same as the ESC character, ESC and octal 335 are sent instead. When the last character of the packet has been sent, an END is sent.

Reading Data

When data is received, spslip calls an entry point to push data up to SPF to perform the read. The input process reverses the procedures of the far end SLIP transmitter. When the END character is detected, the input process places the packet in the receive queue.

Header Compression

The macro COMPRESS_FLAG turns header compression on and off.

To turn compression on (the default), in spf_desc.h, use:

```
#define COMPRESS_FLAG(1)
```

To turn compression off, in spf_desc.h, use:

```
#define COMPRESS_FLAG(0).
```

spslip Device Descriptor

The `spsl0` device descriptor is created by updating the `spf_desc.h` file in the directory:

MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/SLIP/DEFS

The following is an example of configurable sections of `spf_desc.h`:

```
**Device Descriptor for SPF Slip driver
/*************************************************************/
/**** Device Descriptor for the SPF slip driver (spslip)  ****/
/****                                                     ****/
/****  This section contains the configurable parameters  ****/
/*************************************************************/
#define MAXSLIPMTU      SLIPMTU
#define PORTADDR        0
/*
** Name of serial device
*/
#define I_DEV_NAME      "/t1"
#define O_DEV_NAME      "/t1"
/*
** serial data format
*/
#define SL_RCV_BUF_SIZ  4096   /* input raw receive buffer */
#define SL_PAR_BITS     0x00   /* parity/stopbits          */
#define SL_BAUD_RATE    0x10   /* baud rate                */
/*
** These values come from the ISP slip driver and are used to
** set the buffer sizes used by spslip
*/
#define OUTBUFSIZE  SLIPMTU * 2 + 36
#define INBUFSIZE   SLIPMTU + 32
/*
** thread priority
*/
#define SL_IN_PRIOR     128
#define SL_OUT_PRIOR    128
/*************************************************************/
```

The previous example makes the `spslip` driver's descriptor `/spsl0` which uses `/t1` as its port.

Table 3-2 Baud Rates

Baud Rate	OS-9 for 68K Value	OS9 Value
9600	0x0e	0x0f
19200 (default)	0x0f	0x10

For More Information

See the ***OS9 for 68K Technical I/O Manual*** for 68K processors or the ***OS9 Device Descriptor and Configuration Module Reference*** for all other processors.

Chapter 4: Point-to-Point Protocol (PPP) for non-68K Processors

This chapter discusses PPP for non-68K processors. It includes the following sections:

For More Information

For information on PPP for 68K processors, see Chapter 5: Point to Point Protocol (PPP) for 68K Processors.

Introduction to Point-to-Point Protocol

The PPP device driver provides a point-to-point serial interface between serial connections for transferring TCP/IP packets (as described in ***Request for Comment (RFC) 1661*** and ***1662***). The PPP device drivers provide PPP functionality in the SoftStax environment.

The following PPP topics are discussed in conjunction with PPP:

- installation
- transmission process
- device descriptors
- utilities

PPP is typically used as an Internet interface to Serial Character File Manager (SCF) devices--generally on an RS-232 serial port--to perform telnet sessions, FTP sessions, and debugging capabilities.

PPP Drivers and Descriptors

The following is a list of drivers and descriptors provided for PPP:

Table 4-1 PPP Drivers and Descriptors

Drivers	Descriptors
`sphdlc`	`hdlc0`
`spipcp`	`ipcp0`
`splcp`	`lcp0`
`sppscf`	`pscf`<n> (corresponds to SCF device /t<n>)

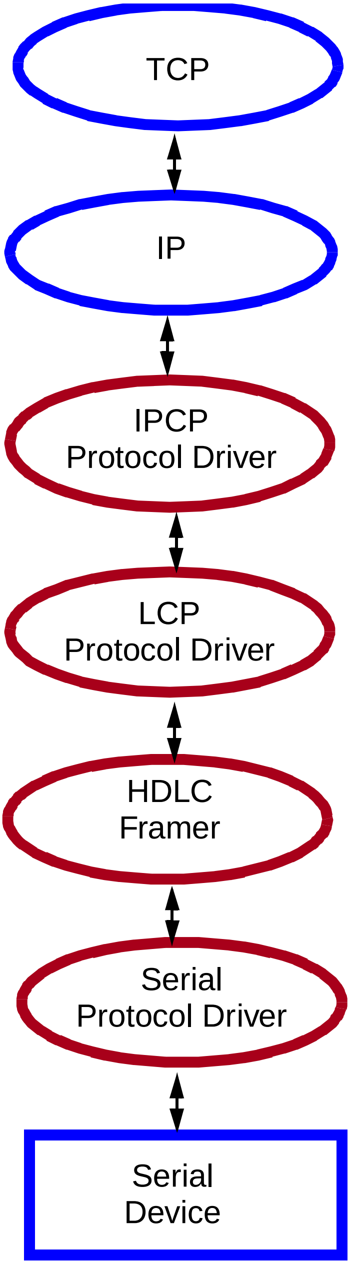
Protocol Drivers

The SPF PPP protocol driver is implemented as a stack of four protocol drivers:

- Internet Protocol Control Protocol (IPCP) driver
- Link Control Protocol (LCP) driver
- link-level High-Level Data Link Control (HDLC) framer
- Softstax serial protocol driver

Figure 4-1 shows how the drivers communicate with each other and the serial device.

Figure 4-1 PPP Data Flow



Utility Programs

Two utility program examples are provided for the PPP driver:

Table 4-2 Utility Programs

Program	Name	Source Code Location
PPP Daemon Utility	`pppd`	`MWOS/SRC/SPF/PPP/UTILS/PPPD`
Authentication setup utility	`pppauth`	`MWOS/SRC/SPF/PPP/UTILS/PPP_AUTH`

Installation

To install PPP on your system, perform the following steps:

Step 1. Set up `inetdb` and `inetdb2`.

Note

You may also use the `ifconfig` utility to add the PPP interface after starting IP.

For More Information

Refer to **Chapter 8: Utilities** and **Appendix A: Configuring LAN Communications Pak** for more information about the `inetdb` and `inetdb2` data modules.

Step 2. If necessary, modify the `spf_desc.h` file for the `sppscf` descriptor. SPF descriptor information, such as baud rate, can be set up in this file.

`spf_desc.h` is located in the following directory:
`MWOS/SRC/DPIO/SPF/DRVR/SPPSCF/DEFS`

Step 3. If necessary, modify the `spf_desc.h` file for the IPCP descriptor.

`spf_desc.h` is located in the following directory:
`MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP/DEFS`

Step 4. If necessary, modify the `spf_desc.h` file for the LCP descriptor.

`spf_desc.h` is located in the following directory:
`MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP/DEFS`

Step 5. Remake the `pscf<n>`, `hdlc0`, `lcp0`, `ipcp0`, and descriptors.

For each descriptor, run `os9make`.

Below are the directories in which the makefiles can be found. (These pathnames correspond with the descriptors listed above.)

```
MWOS/SRC/DPIO/SPF/DRVR/SPPSCF
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP
```

Step 6. Load the system modules `inetdb` and `inetdb2`.

Step 7. Start SPF. (For an example, refer to the `startspf` script.) Load the PPP system modules either manually or with the `loadspf` file. `loadspf` is located in `MWOS/SRC/SYS`.

Step 8. Start the system. If you are using a disk-based system, use `startspf` in `MWOS/SRC/SYS`. Otherwise, enter the following commands:

- `mbinstall`
- `ipstart`
- `pppd pcsf<n>&`

PPP Initialization

During initialization, the following items are set up:

- the `pscf<n>/hdlc0/lcp0/ipcp0` stack
- the `IPCP` and `LCP` state tables

`sppscf` calls the appropriate SCF driver in order to gather information about incoming data and transmit outgoing data to the serial device.

Sending Data

During the sending data process, the following events occur:

1. IP sends data to the IPCP driver, which checks to verify whether or not the packet is IP, and compresses the TCP header, if necessary.
2. The IPCP driver adds a protocol field to the front of the packet and passes it to the LCP driver.
3. The LCP driver passes the unprocessed packet to the HDLC driver.
4. The HDLC driver adds an HDLC frame to the packet and passes it to `sppscf`.
5. The `sppscf` puts it on the transmit queue for the serial device to transmit.

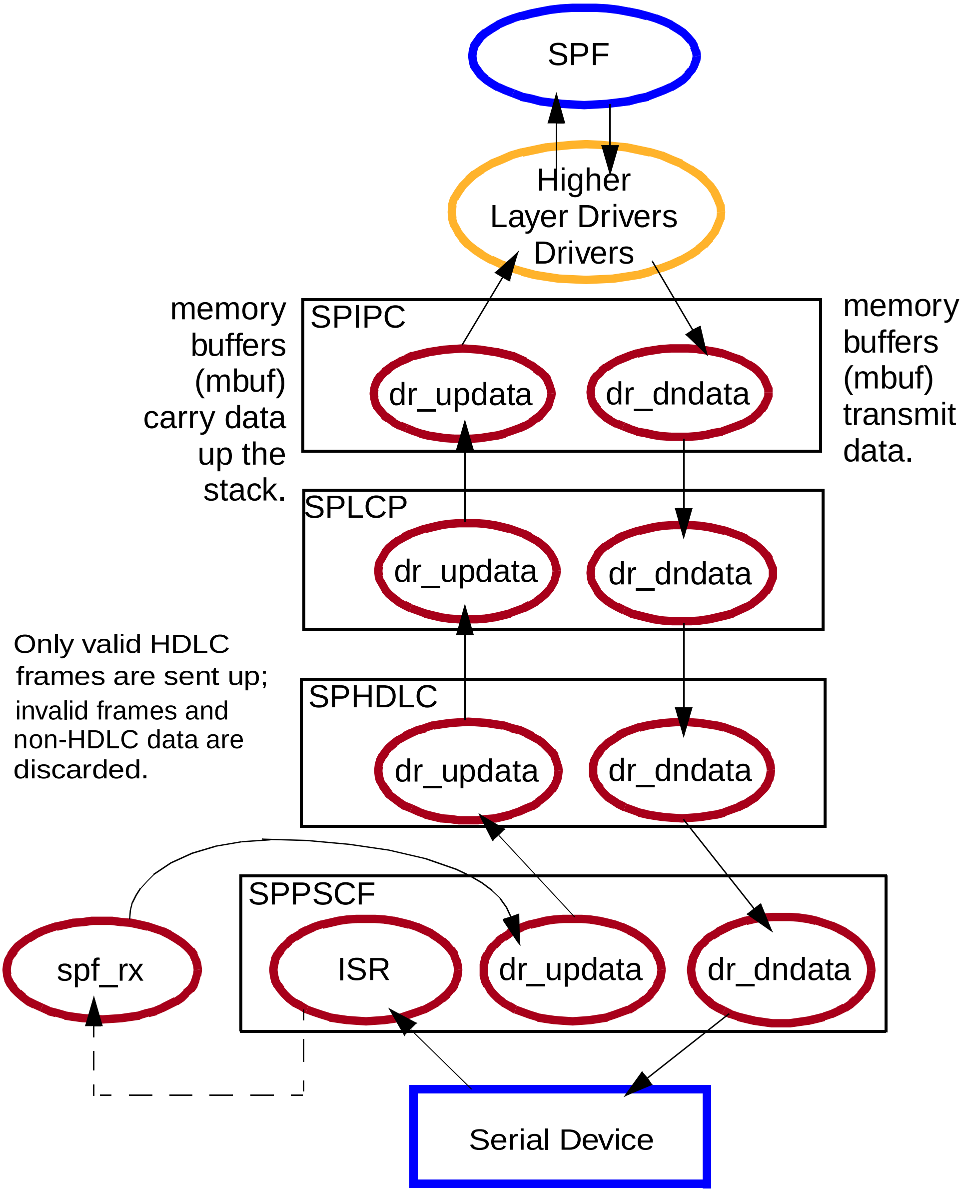
Reading Data

During the reading data process, the following events occur:

1. The sppscf ISR gathers data and wakes the SPF receive thread (spf_rx) in order to take the data up the stack.
2. The HDLC driver processes the data for proper HDLC framing. The valid frames have the HDLC frame removed and the remaining packet is sent up the stack. Invalid frames and non-HDLC data are discarded.
3. The LCP driver examines the packet to check for an LCP message, and handles it accordingly.
4. Other packets are sent to higher level drivers according to the protocol field in the packet. Packets that cannot be delivered for any reason are discarded.

Figure 4-2 details the data flow through the HDLC framer.

Figure 4-2 Data Flow through HDLC Framer



PPP Device Descriptors

The PPP device descriptors are modified by updating the `spf_desc.h` file in the following directories:

```
MWOS/SRC/DPIO/SPF/DRVR/SPPSCF/DEFS
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC/DEFS
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP/DEFS
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP/DEFS
```

The PPP device descriptors `pscf<n>,hdlc0`, `lcp0`, and `ipcp0` contain the device settings for making a PPP connection. Below are the locations in which default settings for each PPP device descriptor can be found. (These pathnames correspond with the descriptors listed above.)

```
MWOS/SRC/DPIO/SPF/DRVR/SPPSCF/defs.h
MWOS/SRC/DPIO/SPF/DRVR/SP_PPP/HDLC/defs.h
MWOS/SRC/DPIO/SPF/DRVR/SP_PPP/LCP/defs.h
MWOS/SRC/DPIO/SPF/DRVR/SP_PPP/IPCP/defs.h
```

Note

The values that may be selected for device descriptor options are defined in the following location:

`MWOS/SRC/DEFS/SPF/ppp.h`

Overriding Default Settings

To override the default settings, add a new option definition to `spf_desc.h` in the following directories: (Do not modify `defs.h` to change settings.)

```
MWOS/SRC/DPIO/SPF/DRVR/SPPSCF/DEFS
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC/DEFS
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP/DEFS
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP/DEFS
```

PPP Descriptor Makefiles

The makefile for each PPP descriptor can be found in the following directories:

```
MWOS/SRC/DPIO/SPF/DRVR/SPPSCF
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP
```

Rebuilding the Descriptor

Run the following command in each `makefile` directory to rebuild the descriptor:

```
os9make
```

The rebuilt descriptor modules (`hdlc0`, `lcp0`, and `ipcp0`) can be found in the following directory:

```
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/CMDS/BOOTOBJS/SPF
```

The serial driver descriptor, `pscf<n>`, can be found in the following directory:

```
MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF
```

Example: Changing the Baud Rate

The following sections give an example of how to change the baud rate for a generic processor.

To change the baud rate for your processor to `38400`, complete the following steps:

Step 1. Because the baud rate is set in the SPPSCF descriptor (see `MWOS/SRC/DPIO/SPF/DRVR/SPPSCF/defs.h`), open `spf_desc.h` from the following directory:

```
MWOS/SRC/DPIO/SPF/DRVR/SPPSCF/DEFS
```

Step 2. Once you have opened the `spf_desc.h` file, scroll to the section that contains the macro definitions for your specific `pscf` descriptor. For example, if you are using the `/t1` interface on your system, find the section containing the macros definitions and code for the `pscf1` descriptor.

Note

If you are using an unlisted device descriptor, you will need to create a section of code with the appropriate information for your descriptor. For example, suppose you are using the unlisted interface, `/t5`. You will need to add the following lines:

```
#ifdef pscf5        /* Macro definitions for the "pscf5" descriptor */
#define SCF_DEVNAME      "/t5"           /* SCF driver path to use */
#define LUN        0x05                /* log.unit num: dd_lu_num */
#endif /* pscf5 ***************************************************/
```

Step 3. Once at the section discussed in step two, locate the line of code that contains the SCF driver path:

```
#define SCF_DEVNAME      "/t<n>"          /* SCF driver path to use */
```

Underneath the code containing the driver path, enter the following command: (This will override the default baud rate set in `defs.h.`)

```
#define BAUD_RATE BAUDRATE_38400
```

This section of code should now look similar to the following example:

```
#ifdef pscf<n>     /* Macro definitions for the "pscf<n>" descriptor */
#define SCF_DEVNAME       "/t<n>"         /* SCF driver path to use */
#define BAUD_RATE BAUDRATE_38400    /* Override default baude rate */
#define LUN        0x0<n>              /* log.unit num: dd_lu_num */
#endif /* pscf<n>*************************************************/
```

Note

The values that may be selected for baud rates are defined in the following location:
`MWOS/SRC/DEFS/SPF/ppp.h`.

Step 4. Save the file.

Step 5. Enter `cd..` to move up one directory.

Step 6. Run `os9make`.

Step 7. The rebuilt `pscf<n>` descriptor resides in the following location:
`/MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF`

Utilities

The following sections detail the `pppd` and `pppauth` utilities provided with PPP.

PPP Daemon Utility

The PPP daemon utility (`pppd`) opens a connection to the PPP stack, then sleeps indefinitely. This `pppd` utility can also change some of the device settings in the driver stack.

The source code for `pppd` is located in the following directory:

`MWOS/SRC/SPF/PPP/UTILS/PPPD`

PPP Daemon Command Line Arguments

```
$ pppd -?
```

The command line for the daemon program is shown below:

```
pppd [<options>] <stack_name> [<parameters>]
```

Function: Set up point-to-point connection.

Options:

`-c=<name>`	Run the chat script located in `<name>`. `<name>` may either be a disk file or data module.
`-d=<dev>`	Use `<dev>` as the chat device. (The default is `/hdlc0`.) This requires the `-c` option.
`-i=<index number>`	Specify the PPP stack index number.
`-k`	Terminate the `pppd` session specified by the `-i` option.

`-p <name>`	Select `<name>` in `ppp_auth` (used for authentication). This is the equivalent to `pppauth -h <name>`.
`-v`	Turn on verbose mode.
`-x`	Terminate all `pppd` sessions.
`-z`	Read commands from `stdin`.
`-z=<name>`	Read commands from file or data module.
`stack_name`	This is the name of stack to open. (If no forward slash (`/`) is specified, then `/hdlc0/lcp0/ipcp0` is automatically appended.)
`parameters`	These are the PPP stack configuration parameters.

pppd Script Commands

The following commands may be used in a pppd script. The commands may be used in any order. Each command must be on a separate line. Comments may be included in the file using a pound (#) sign and can be placed on a separate line or at the end of a command line. The commands are not case-sensitive, but device names are used exactly as entered in the script.

Table 4-3 PPP Script Commands

Command	Description
`set auth_challenge`	Request LCP to challenge the server for authentication. *This feature is not currently supported.*
`set baud[rate] <rate>`	Set baud rate. `<rate>` must be one of the following values: 50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600, 19200, 31250, 38400, MIDI. (*MIDI is not available for OS9 for 68K systems*.)
`set flow <RTS | XON>`	Set hardware (RTS/CTS) or software (X-On/X-Off) type flow control.
`set ipcp accept_local`	During IPCP negotiation, allow the peer to set the local address.
`set ipcp accept_remote`	During IPCP negotiation, allow the peer to set the remote address.
`set ipcp cslot <value>`	Set flag for compressing slot identification in TCP header compression. (0=do not compress; 1=compress.)

Table 4-3 PPP Script Commands (continued)

Command	Description
`set ipcp defaultroute`	Set the system IP default route to the address of the system at the other end of the link.
`set ipcp scv <value>`	Perform the maximum number of attempts allowed to send configuration requests (sent by IPCP layers), without receiving a valid `configure-ack`, `configure-nak`, or `configure-reject` message. The default value is typically `10`.
`set ipcp scn <value>`	Perform the maximum number of attempts allowed to send `configure-nak` messages without sending a `configure-ack`, prior to assuming negotiation is impossible. *This feature is not currently supported.*
`set ipcp stv <value>`	Perform the maximum number of attempts allowed to send `terminate-request` messages without receiving a `terminate-ack` response. The default value is typically 2.
`set ipcp mslot <value>`	Perform maximum slot identification for TCP header compression. The typical values that allow slot identification are between 0 to 15.

Table 4-3 PPP Script Commands (continued)

Command	Description
`set ipcp timeout <value>`	This is the wait time (in milliseconds) for the IPCP retry timer. The default value is typically 3000 ms (three seconds).
`set mode <option,option...>`	Set mode flags. Choose options from the following: `nowait`, `passive`, `updata`, `modem`, `loopback`, `norxcomp`, `notxcomp`, `nopap`, `nochap`, `nopfc`, `noacfc`. Options are described in **Table 4-4**.
`set parity <mode>`	Set parity mode. Choose `<mode>` from the following: `None`, `Odd`, `Even`, `Mark`, `Space`.
`set rx accm <value>`	Set RX->receive Async Control Character Map.
`set rx acfc <value>`	Set RX->receive Address/Control Field Compression flag. Set to `1` if Address/Control Field Compression flag peer is desired. *This feature is currently not implemented.*
`set rx buffer <value>`	Set RX->receive buffer size.
`set rx device <name>`	Set receive port device. The maximum length of the device name is `16`.

Table 4-3 PPP Script Commands (continued)

Command	Description
`set ipcp proto <value>`	Specify the IP compression protocol to be used. This may be zero for no compression, or `COMPRESSED_TCP` for Van Jacobsen compression algorithm.
`set rx mru <value>`	Set RX->Receive Max Receive Unit.
`set rx pfc <value>`	Set RX->Receive Protocol Field compression flag. Set to `1` if Protocol Field compression flag peer is desired. *This feature is currently not supported.*
`set scr <value>`	Set and perform maximum number of attempts to send configuration requests (sent by LCP layers) without receiving a valid `configure-ack`, `configure-nak`, or `configure-reject` message. The default value is typically `10`.
`set stop <bits>`	Set the number of stop bits. Choose <bits> from `1`, `1.5`, or `2`.
`set str <value>`	Set and perform maximum number of attempts to send `terminate-request` messages without receiving a `terminate-ack` response. The default value is typically 2.

Table 4-3 PPP Script Commands (continued)

Command	Description
`set timeout <value>`	Set the number of seconds for time-out value. This is the wait time (in milliseconds) for the LCP retry timer. The default value is typically 3000 ms (seconds).
`set tx accm <value>`	Set TX->Transmit Async Control Character Map.
`set tx acfc <value>`	Set TX->Transmit Address/Control Field Compression flag. *This feature is currently not supported.*
`set tx block[size] <value>`	Set the maximum block size for transmit.
`set tx device <name>`	Set the transmit port device. The maximum length of device name is `16`.
`set tx mru <value>`	Set the TX->Transmit Max Receive Unit.
`set tx pfc <value>`	Set the TX->transmit Protocol Field Compression flag. *This feature is currently not implemented.*
`set word[size] <size>`	Set word size. Select `<size>` from the following options: 5, 6, 7, 8.

Mode Settings

The mode setting controls the behavior of the HDLC, LCP, and IPCP drivers. It is a bitmask and can have multiple values. The different values and their meanings are described in **Table 4-4**. (The symbols in parentheses indicate descriptor settings defined in ppp.h.)

Table 4-4 Mode Settings for HDLC, LCP, and IPCP Drivers

Mode	Description
wait	(WAIT_FOR_MODEM) HDLC will delay coming up until the chat script executes port_ready on and finishes.
passive	(PASSIVE_OPEN) LCP and IPCP will not initiate the connection, but wait for a configuration request from the peer.
nowait	(NO_WAIT_ON_OPEN) LCP and IPCP will not wait for a lower layer to enable the I/O path.
nopap	(NO_PAP) LCP will not use PAP authentication.
nochap	(NO_CHAP) LCP will not use CHAP authentication.
nopfc	(NO_PFC) LCP will not use protocol field compression.
noacfc	(NO_ACFC) LCP will not use address/control field compression.
norxcomp	(NO_RX_COMPRESS) IPCP will reject compression configuration requests from the peer.
notxcomp	(NO_TX_COMPRESS) IPCP will not request compression during link negotiation.

Table 4-4 Mode Settings for HDLC, LCP, and IPCP Drivers (continued)

Mode	Description
`updata`	(`XPARENT_UPDATA_OK`) Allows a driver to be stacked below HDLC and causes it to send data up unaltered.
`loopback`	(`LOOPBACK_MODE`) Notifies HDLC to loopback characters. This is only useful for testing.

Chat Script Commands

A CHAT script is a series of commands that controls the setup of a connection pathway. (It is necessary to set up a connection pathway before PPP can begin negotiating its own parameters.) The CHAT script may control a modem, log a user onto a host computer, and run a PPP-startup shell command on a host computer. However, a CHAT script is not always required, as some links require no pre-PPP setup.

CHAT scripts are very simplistic and are often referred to as "send/expect" exchanges. A CHAT script consists of a series of commands that are executed sequentially (much like a shell script). Commands may exist in any combination of upper/lower case characters; however, some commands require a string parameter. For example, the send command requires a string in order to send out the CHAT path. Strings may or may not be enclosed within quotation marks. In addition, it is possible to embed nonprintable characters within a string. Below is a list of embeddable escape sequences:

`\???`	??? is the octal value of the byte to be inserted in the string.
`\x??`	?? is the hexadecimal value of the byte to be inserted into the string.
`\c`	Do not send carriage return at end of string (for send command, only).
`\n`	Insert a newline (`$0D`) into the string.

An example send command is shown below:

```
send "Hello\nGoodbye"
```

The above is the same as the following command:

```
send Hello\x0dGoodbye
```

In addition, comment lines may be inserted into a script by starting the line with either a pound (#) or asterisk (*) symbol. Empty lines are treated as comment lines. If a CHAT script is contained within a data memory module, the end of the script must be terminated by a NULL ('\0') character to denote “end-of-file”. Below is a list of commands supported by the PPP API's CHAT scripting engine.

abort <string>	Initiate abort sequence if the indicated string is received from the CHAT path.
expect <string>	Wait until the indicated string is received from the CHAT path before proceeding.
flush	Clear all input data from CHAT path.
if_abort <delay>, <string>	Add the indicated string to the list of modem commands to be sent during the abort sequence. if_abort strings are sent in the order by which they were placed in the list. The script engine will wait for delay seconds before sending the assigned if_abort string.
end	Successfully terminates the CHAT script.
quiet <ON | OFF>	Set quiet flag accordingly. When quiet flag is on, characters sent to the log_path are translated as asterisks (*). This is useful when sending a password that is embedded in the chat script. Default for quiet is OFF.
send <string>	Send the indicated string to the CHAT path.

`show_data <ON | OFF>`	Set the state of the show_data flag accordingly. When this flag is on, characters received from the CHAT path are echoed to the log_path. Default for `show_data` is OFF.
`timeout <seconds>`	Set the value of the expect timeout timer. This may be specified as often as needed, resulting in different timeout periods for various sections on the chat script.
`wait <seconds>`	Pause for the specified time interval before proceeding with the chat script.

Example CHAT script to send to the username "foo" and password "bar":

```
* Define some if_abort strings…
if_abort 2, "+++\c"
if_abort 2, "ATH"
* Set up some options…
show_data ON
timeout 10
* Try to log in…
send "\n\c"
expect "user:"
send "foo"
expect "password:"
send "bar"
expect "successful"
end
```

Applications that use a `ppp_conninfo` structure may force the CHAT script to abort at any time by setting the `PPP_CIFLAG_CHATABORT` bit within the flags field of the `ppp_conninfo` structure. This is typically set within an application's signal handler since the `ppp_chat_script()` and `ppp_connect()` calls are synchronous (blocking) calls.

Troubleshooting Modem Settings for PPP

If your board uses a serial device that does not support hardware flow control (RTS/CTS), it may be necessary to turn off hardware flow control on your modem. One symptom that this may be necessary is the occurrence of data not returning to your target board after a modem-to-modem connection is made.

pppauth

Configure PPP Authentication

Syntax

```
pppauth <option>
```

Options

`-a`	Add mode: Add specified entry. `--c` or `-p` *must* be specified, along with `<ISP name>`, `<Auth ID>` and `<Secret>`.
`-c`	CHAP specifier: Operate on CHAP entry(ies).
`-d`	Delete mode: Delete specified entry. `-c` or `-p` *must* be specified, along with `<ISP name>`.
`-f <num entries>`	Free entries so `<num entries>` are available.
`-h <ISP name>`	Set current ISP name.
`-i <Auth ID>`	Used in Modify mode to specify new Auth ID.
`-l`	List mode: List specified entries. `-c` or `-p` may be specified.
`-m`	Modify mode: Modify specified entry. `-c` or `-p` must be specified, along with `<ISP name>` and parameters to change.
`-n`	New mode: Copy existing entry with new type. `-c` or `-p[ap]` must be specified, along with `-t[ype]`.
`-p`	PAP specifier: Operate on PAP entry(ies).
`-s <Secret>`	Used in Modify mode to specify new Secret.
`-t [CHAP | PAP]`	Type specifier: Change type to CHAP or PAP. CHAP or PAP may be abbreviated `C` or `P`.
`-v`	Verbose mode. Show progress information.

Description

The `pppauth` utility creates a data module used by `splcp` during the link authentication process.

Prior to creating the authentication module, complete the following actions:

- Obtain information about the peer or Internet Service Provider (ISP) on the other end of the link.
- Know the authentication method being used (for example CHAP).
- Know the shared secret (or password).
- Know your authentication ID (user id).

Choose a name for this connection, or use the name provided by the ISP. This name (ISP name) is used with `pppauth` to store the authentication method, authentication ID, and the secret. The `-a` option is used to add a new entry to the data module. It must be accompanied by `-c` or `-p` to indicate CHAP or PAP authentication. You can add multiple ISP entries.

Prior to making a PPP connection, use the `-h` option to select the ISP name to which you want to connect.

Example pppauth Setting

The ISP “`cserve`” uses CHAP authentication, and provides you with the user id "`acct1304`", and a password of "`b5kosh`". The ISP "webnet" uses PAP authentication, and provides you with the userid "webhead", and a password of "doc-oc". Use the following commands to add this information:

```
pppauth -a -c 'cserve' 'acct1304' 'b5kosh'
pppauth -a -p 'webnet' 'webhead' 'doc-oc'
```

Step 1. Prior to connecting to `cserve`, set it as the current ISP by entering the following command:

```
pppauth -h 'cserve'
```

Step 2. Examine the current settings by using the `-l` option:

```
pppauth -l
Current ISP name is 'cserve'.
Type ISP NameAuthentication ID / Secret
CHAP 'cserve''acct1304' 'b5kosh'
PAP 'webnet''webhead' 'doc-oc'
```

Step 3. Once the authentication module (`ppp_auth`) has been created, it can be saved using the `save` command and loaded as part of the network startup procedure.

Setting Up the Client Machine

After the device descriptors are built, load the drivers and descriptors onto the client (target) machine, if it is different from the machine on which the drivers and descriptors were built. Using FTP or another file transfer mechanism, load the following files onto the machine that is to be used for the PPP client:

Step 1. Load `pppd` and `pppauth` from the directory:

```
MWOS/<OS>/<PROCESSOR>/CMDS
```

Step 2. Load `sppscf`, `pscf<n>`, `sphdlc`, `splcp`, and `spipcp` from the `CMDS/BOOTOBJS/SPF` directory:

```
MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF
```

Step 3. Load `hdlc0`, `lcp0`, and `ipcp0` from the directory:

```
MWOS/<OS>/<PROCESSOR>/PORTS/PROTOCOLS/CMDS/BOOTOBJS/SPF
```

Step 4. Set up the `inetdb` and `inetdb2` files, making sure to include a PPP interface.

For More Information

Refer to **Chapter 8: Utilities** for more information about the `inetdb` file.

Step 5. If necessary, add default route using the `route` command if the descriptors have not already been configured to do so.

For More Information

Refer to **Chapter 8: Utilities** for more information about the `route` utility.

Prepare Chat Script

On the client machine, prepare a `CHAT` script based on the **CHAT Scripting** section in chapter three of the ***LAN Communications Pak Programming Reference*** manual included with this CD.

Setup Authentication

If you are using Authentication, create the `ppp_auth` module using the `pppauth` utility, or load the module previously created and saved.

For More Information

Refer to the **`pppauth`** section for more information on `ppp_auth`.

Start PPP Daemon Process

Step 1. On the client machine, run the following command in the background:

```
pppd -v pscf<n> &
```

Step 2. The daemon program prints status information.

For example:

```
Device/stack pscf<n>/hdlc0/lcp0/ipcp0 open, path = n
```

pppd also can read information from a file:

```
pppd -v -z=setup.pppd pscf<n> &
```

Running PPP Over a Modem Link

To dial the modem and connect to the server, run the following command on the client machine:

```
pppd -v -c=<chat file name> -d=<device name> pscf<n> &
```

(If the device name is not specified, the default device name is `/hdlc0`.)

Chapter 5: Point to Point Protocol (PPP) for 68K Processors

Note

For information on PPP for non-68K processors, see Chapter 4: Point-to-Point Protocol (PPP) for non-68K Processors.

The Point-to-Point Protocol (PPP) device driver provides a point-to-point interface between serial connections for transferring TCP/IP packets.

Introduction to Point-to-Point Protocol

The PPP device driver provides a point-to-point serial interface (as described in ***RFC-1661*** and ***RFC-1662***) between serial connections for transferring TCP/IP packets. The PPP device driver provides PPP functionality in the Stacked Protocol File (SPF) manager environment.

The following PPP topics are discussed:

- Installation
- Transmission process
- Device descriptors
- Utilities

PPP is typically used as an Internet interface to SCF devices—generally on an RS-232 serial port to perform `telnet` sessions, `ftp` sessions, and debugging capabilities.

PPP Drivers and Descriptors

The following is a list of drivers and descriptors provided for PPP:

Table 5-1 PPP Drivers and Descriptors

Drivers	Descriptors
`sphdlc`	`hdlc0`
`spipcp`	`ipcp0`
`splcp`	`lcp0`

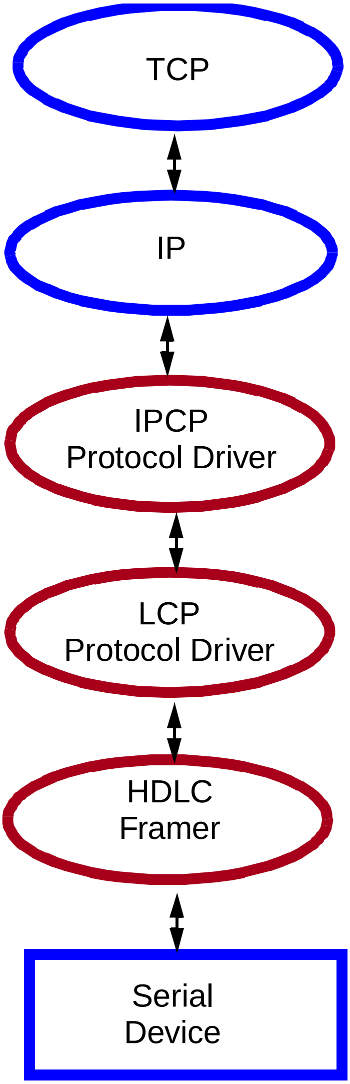
Protocol Drivers

The SPF PPP protocol driver is implemented as a stack of three protocol drivers as follows:

- Internet Protocol Control Protocol (IPCP) driver
- Link Control Protocol (LCP) driver
- Link level High Level Data Link Control (HDLC) framer

Figure 5-1 shows how the drivers communicate with each other and the serial device.

Figure 5-1 PPP Data Flow



Utility Programs

Three utility program examples are provided to use the PPP driver:

Table 5-2 Utility Programs

Program	Name	Source Code Location
PPP Daemon Utility	`pppd`	`MWOS/SRC/SPF/PPP/UTILS/PPPD`
Modem dialer utility	`chat`	`MWOS/SRC/SPF/PPP/UTILS/CHAT`
Authentication setup utility	`pppauth`	`MWOS/SRC/SPF/PPP/UTILS/PPP_AUTH`

Installation

To install PPP on your system, perform the following steps:

Step 1. Set up `inetdb` and `inetdb2`.

Note

You may also use the ifconfig utility to add the PPP interface after starting IP

For More Information

Refer to **Chapter 8: Utilities** and **Appendix A: Configuring LAN Communications Pak** for more information about the `inetdb` and `inetdb2` data modules.

Step 2. Modify the `spf_desc.h` file for the `HDLC` descriptor if necessary.

Descriptor information such as baud rate can be set up in this file.

`spf_desc.h` is located in the following directory:
`MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC/DEFS`

Step 3. Modify the `spf_desc.h` file for the IPCP descriptor if necessary.

`spf_desc.h` is located in the following directory:
`MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP/DEFS`

Step 4. Modify the `spf_desc.h` file for the LCP descriptor if necessary.

`spf_desc.h` is located in the following directory:
`MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP/DEFS`

Step 5. Remake the appropriate descriptors `hdlc0`, `lcp0`, and `ipcp0`.

For each, run `os9make`

The directories in which the makefiles can be found are:
`MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC`
`MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP`
`MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP`

Step 6. Load the system modules, `inetdb` and `inetdb2` and start SPF. (For an example, review the `startspf` script.) Load the PPP system modules either manually or with the `loadspf` file. `loadspf` is located in `MWOS/SRC/SYS`.

Step 7. Start the system. If disk-based, use `startspf` in `MWOS/SRC/SYS`. Otherwise, enter the following commands:

- `mbinstall`
- ipstart

- pppd /hdlc0/lcp0/ipcp0&

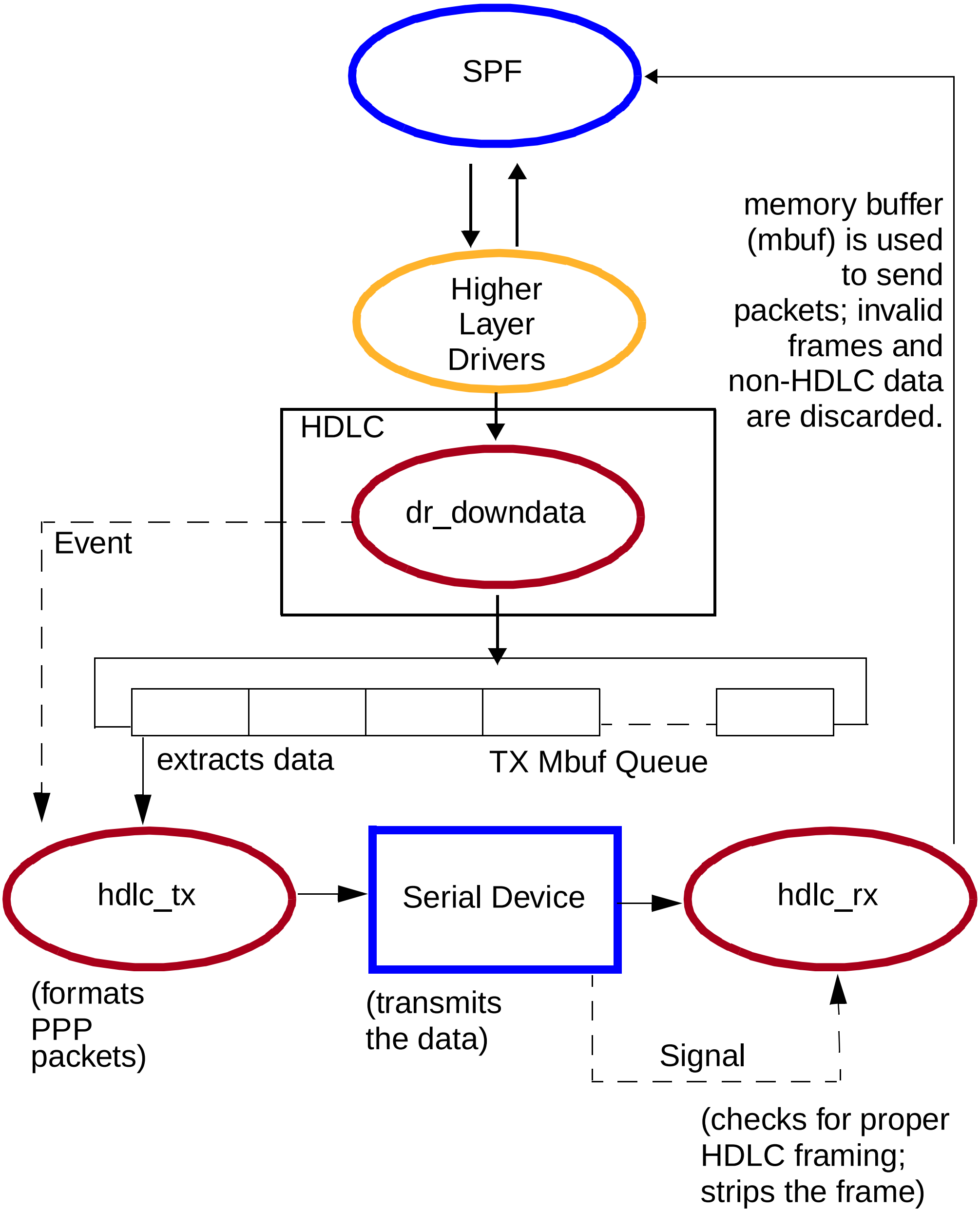
PPP Transmission Process

Initialization

During initialization, the following events occur:

1. The driver acquires the input and output device names to be opened from the device descriptor.
2. After opening the input and output devices, the driver sets the options for the input and output paths such as the baud rate.
3. `sphdlc` creates the processes `hdlc_rx and hdlc_tx,` which control input and output data flow, respectively.
4. To view additional processes, enter a `procs -e` command after initializing the PPP drivers to view additional processes. Refer to Figure 5-2 Data Flow through HDLC Framer.

Figure 5-2 Data Flow through HDLC Framer



Sending Data

During the sending data process, the following events occur:

1. IP sends data to the IPCP driver, which checks to verify if the packet is IP, and compresses the TCP header if necessary.
2. The IPCP driver adds a protocol field to the front of the packet and passes it to the LCP driver.
3. The LCP driver passes the unprocessed packet to the HDLC driver.
4. The HDLC driver adds an HDLC frame to the packet and passes it to the transit queue. It also sends an event to the `hdlc_tx`.
5. The `hdlc_tx` (transmit thread) process extracts data from the circular transmit queue, formats it into PPP packets, and transmits the data through the serial device.

Reading Data

During the reading data process, the following events occur:

1. The `hdlc_tx` (receive thread) process reads data from the serial device and checks for proper HDLC framing.
2. Valid frames have the HDLC frame removed and the remaining packet is sent up to the SPF file manager in the form of an mbuf.

   Invalid frames and non-HDLC data are discarded.
3. The LCP driver examines the packet to check for an LCP message, and handles it accordingly.
4. Other packets are sent to higher level drivers according to the protocol field in the packet.

   Packets that cannot be delivered for any reason are discarded.

PPP Device Descriptors

The PPP device descriptors are modified by updating the spf_desc.h file in the directories:

```
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC/DEFS
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP/DEFS
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP/DEFS
```

The PPP device descriptors hdlc0, lcp0,and ipcp0 contain the device settings for making a PPP connection. Default settings for each PPP device descriptor can be found in:

```
MWOS/SRC/DPIO/SPF/DRVR/SP_PPP/HDLC/defs.h
MWOS/SRC/DPIO/SPF/DRVR/SP_PPP/LCP/defs.h
MWOS/SRC/DPIO/SPF/DRVR/SP_PPP/IPCP/defs.h
```

Note

Selectable values for device descriptor options are defined in MWOS/SRC/DEFS/SPF/ppp.h.

Override Default Settings

Do not modify defs.h to change settings. To override the default settings, add a new option definition to spf_desc.h in the following directories:

```
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC/DEFS
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP/DEFS
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP/DEFS
```

PPP makefile Descriptors

The makefile for each PPP descriptor can be found in the directories:

```
MWOS/<OS9>/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC
```

```
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/LCP
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/IPCP
```

Rebuilding the Descriptor

Run the following command in each `makefile` directory to rebuild the descriptor:

```
os9make
```

The rebuilt descriptor modules can be found in the directory:

```
MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/CMDS/BOOTOBJS/SPF
```

Example: Changing the Baud Rate

To change the baud rate to 19200 for a generic processor, complete the following steps:

Step 1. Baud rate is set in the SPPSCF descriptor (see `MWOS/SRC/DPIO/SPF/DRVR/SP_PPP/HDLC/defs.h`). Therefore, modify `spf_desc.h` in `MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/SPF/PPP/HDLC/DEFS`

Step 2. Add the line `#define BAUD_RATE BAUDRATE_19200` to the user modifiable section. This overrides the default baud rate set in `defs.h`.

Step 3. Save the file.

Step 4. Change directory to

`MWOS/OS9/<PROCESSOR>/PROTOCOLS/CMDS/BOOTOBJS/SPF`.

Step 5. Run `os9make`.

Step 6. The rebuilt `pscf <n>` descriptor resides in

`MWOS/OS9/<PROCESSOR>/PROTOCOLS/CMDS/BOOTOBJS/SPF`.

Utilities

The following sections detail the `pppd`, `chat`, and `pppauth` utilities provided with PPP.

PPP Daemon Utility

The PPP daemon utility (`pppd`) opens a connection to the PPP stack, then goes to sleep indefinitely. This `pppd` utility is capable of changing some of the device settings in the driver stack.

The source code for `pppd` is located in:

```
MWOS/SRC/SPF/PPP/UTILS/PPPD
```

PPP Daemon Command Line Arguments

The command line for the daemon program is shown below:

```
pppd [<options>] <stack_name> [<parameters>]
```

The descriptor stack must be specified, but all other parameters are optional. The options for this program are:

`-?`	Print help text for the program.
`-d`	Read commands from the data module.
`-h`	Show daemon script commands.
`-v`	Show progress information.
`-z`	Read script commands from `stdin`.
`-z=<name>`	Read script commands from file or data module.

Multiple options may be grouped together with a single hyphen. For example, you could use the command:

```
pppd -vz=script.pppd /hdlc0/lcp0/ipcp0&
```

pppd Script Commands

The following commands may be used in a pppd script. The commands may be used in any order. Each command must be on a separate line. Comments may be included in the file using a pound (#) sign and can be placed on a separate line or at the end of a command line. The commands are not case sensitive, but device names are used exactly as entered in the script.

Table 5-3 PPP Script Commands

Command	Description
`set baud[rate] <rate>`	Set baud rate. `<rate>` must be one of the following values: 50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600, 19200, 31250, 38400, MIDI (MIDI not available for OS9 for 68K systems)
`set flow <RTS | XON>`	Set hardware (RTS/CTS) or software (X-On/X-Off) type flow control.
`set ipcp accept_local`	During IPCP negotiation, allow the peer to set the local address.
`set ipcp accept_remote`	During IPCP negotiation, allow the peer to set the remote address.
`set ipcp cslot <value>`	Set flag for compressing slot identification in TCP header compression.
`set ipcp mslot <value>`	Set maximum slot identification for TCP header compression.

Table 5-3 PPP Script Commands (continued)

Command	Description
`set ipcp proto[col] <value>`	Set the IP compensation protocol value = `<proto_num>`.
`set ipcp defaultroute`	Set the system IP default route to the address of the system at the other end of the link.
`set mode <option,option...>`	Set mode flags. Choose options from the following: `nowait`, `passive`, `updata`, `modem`, `loopback`, `norxcomp`, `notxcomp`, `nopap`, `nochap`, `nopfc`, `noacfc`. Options are described in **Table 5-4 Mode Settings for HDLC, LCP, and IPCP Drivers**.
`set parity <mode>`	Set parity mode. Choose `<mode>` from the following: `None`, `Odd`, `Even`, `Mark`, `Space`.
`set rx accm <value>`	Set RX->receive Async Control Character Map.
`set rx acfc <value>`	Set RX->receive Address/Control Field Compression flag.
`set rx buffer <value>`	Set RX->receive buffer size.
`set rx device <name>`	Set receive port device.
`set rx mru <value>`	Set RX->receive Max Receive Unit.
`set rx pfc <value>`	Set RX->receive Protocol Field Compression flag.

Table 5-3 PPP Script Commands (continued)

Command	Description
set scr <value>	Set maximum number of Configure Request messages to be sent.
set stop[bits] <bits>	Set number of stop bits. Choose <bits> from the following: 1, 1.5, 2.
set str <value>	Set maximum number of Terminate Request messages to be sent.
set timeout <value>	Set number of seconds for timeout value.
set tx accm <value>	Set TX->transmit Async Control Character Map.
set tx acfc <value>	Set TX->transmit Address/Control Field Compression flag.
set tx block[size] <value>	Set maximum block size for transmit.
set tx device <name>	Set transmit port device.
set tx mru <value>	Set TX->transmit Max Receive Unit.
set tx pfc <value>	Set TX->transmit Protocol Field Compression flag.
set word[size] <size>	Set word size. Select <size> from the following: 5, 6, 7, 8.

Mode Settings

The mode setting controls the behavior of the HDLC, LCP, and IPCP drivers. It is a bitmask, and can have multiple values. The different values and their meanings are described in **Table 5-4 Mode Settings for HDLC, LCP, and IPCP Drivers** (symbols in parentheses indicate descriptor setting defined in `ppp.h`):

Table 5-4 Mode Settings for HDLC, LCP, and IPCP Drivers

Mode	Description
`wait`	(`WAIT_FOR_MODEM`) HDLC will delay coming up until the chat script executes `port_ready` on and finishes.
`passive`	(`PASSIVE_OPEN`) LCP and IPCP will not initiate the connection, but wait for a configuration request from the peer.
`nowait`	(`NO_WAIT_ON_OPEN`) LCP and IPCP will not wait for a lower layer to enable the I/O path.
`nopap`	(`NO_PAP`) LCP will not use PAP authentication.
`nochap`	(`NO_CHAP`) LCP will not use CHAP authentication.
`nopfc`	(`NO_PFC`) LCP will not use protocol field compression.
`noacfc`	(`NO_ACFC`) LCP will not use address/control field compression.
`norxcomp`	(`NO_RX_COMPRESS`) IPCP will reject compression configuration requests from the peer.
`notxcomp`	(`NO_TX_COMPRESS`) IPCP will not request compression during link negotiation.

Table 5-4 Mode Settings for HDLC, LCP, and IPCP Drivers (continued)

Mode	Description
`updata`	(`XPARENT_UPDATA_OK`) Allows a driver to be stacked below HDLC, and causes it to send data up unaltered.
`loopback`	(`LOOPBACK_MODE`) Notifies HDLC to loopback characters. Only useful for testing.

PPP Modem Dialer Utility (chat)

The PPP modem dialer utility `chat` opens a connection to the PPP stack, places it into a special mode, then performs reads and writes. The data transmitted informs the device to perform the modem commands contained in the `chat` script specified on the command line.

The source code for `chat` is located in:

`MWOS/SRC/SPF/PPP/UTILS/CHAT`

The `chat` utility maintains a linked list of strings which, if encountered in a modem response, cause the program to initiate an abort sequence. By default, this list is empty. You may add strings to the list by placing the appropriate command in the `chat` script.

The `chat` utility also maintains a linked list of modem commands to be sent during the abort sequence described above. By default, this list is empty. You may add commands to the list by placing the appropriate command in the chat script.

PPP Modem Dialer Command Line Arguments

The command line for the modem dialer program is:

```
chat [<options>] <HDLC descriptor name> [<options>]
```

The HDLC descriptor name must be specified, but all other parameters are optional. The HDLC descriptor name must be the same as the one used when starting the daemon `pppd`. The options for this program are:

`-?`	Print help text for the program.
`-c`	Display control characters when displaying data.
`-d`	Read commands from data module.
`-e`	Echo characters received from modem.
`-h`	Show `chat` script commands.
`-l=<name>`	Specify logfile name.
`-v`	Show progress information.
`-z`	Read commands from `stdin`.
`-z=<name>`	Read commands from file or data module.

Multiple options may be grouped together with a single hyphen. For example, you could use the command:

```
chat -cevz=script.chat /hdlc0
```

Chat Script Commands

The following commands can be used in a `chat` script. They can be in any order.

- Each command must be on a separate line.
- Comments can be included in the file using a pound (#) sign.
- Comments can be placed on a separate line or at the end of a command line.

- The commands are not case sensitive, but modem data is used exactly as it appears in the script.
- Strings sent or received should be enclosed in single quotes.

Table 5-5 Chat Script Commands

`abort <string>`	Initiate abort sequence if the indicated string is received from the modem.
`exp_data <hex data>`	Similar to `expect` command, but compares incoming bytes as unsigned with the specified hexadecimal bytes.
`expect <string>`	Wait until the indicated string is received from the modem before proceeding with `chat` script.
`if_abort <string>`	Add the indicated string to the list of modem commands to be sent during the abort sequence. `if_abort` strings are sent out in the order they were placed into the list.
`port_ready <ON | OFF>`	Set the state of the port ready flag accordingly. This flag informs the driver whether or not a successful connection was made.
`retry <count>`	Set number of times to retry when an expect or send command times out. This may be specified as often as needed, resulting in different retry counts for various sections of the chat script.

Table 5-5 Chat Script Commands (continued)

`query <prompt string>`	Prints the prompt on the terminal, then waits for user input. Characters typed are not echoed to the terminal. The string entered is then sent to the modem. This is useful for obtaining a password interactively.
`quiet <ON | OFF>`	Set quiet flag accordingly. When `quiet` flag is on, characters sent to or received from the modem print on the screen as asterisks (*). This is useful when sending a password that is embedded in the `chat` script. Default is "`quiet OFF`".
`send <string>`	Send the indicated string to the modem.
`show_data <ON | OFF>`	Set the state of the show data flag. When this flag is on, characters received from the modem are echoed to the display. Default is "`show_data OFF`".
`timeout <seconds>`	Set the value of the timeout timer. This can be specified as often as needed, resulting in different timeout periods for various sections of the `chat` script.
`wait <seconds>`	Pause for specified interval before proceeding with chat script.

chat script Example

```
# ppp.chat - chat script to log into server "ppp_server"
abort "ogin incorrect" # abort if username/password incorrect
abort "BUSY"           # abort if busy signal from modem
if_abort "+++ATH"      # this will hang up phone if we abort
if_abort "ATZ"         # this will reset modem if we abort
timeout 360            # three minute time limit otherwise we
                       # may hang if no answer from server!
send "ATDT9,555-1212"  # 9 to get outside line, comma for pause,
                       # then telephone number for server.
expect "ogin:"         # wait for login prompt.
send "ppp_client"      # our login name as a ppp client
expect "ssword"        # wait for password prompt
quiet ON               # Don't print our password on the screen
send "ppp_password"    # our password - we could also use the
                      # "query" command here to get it from user
quiet OFF              # OK to print stuff again
expect "ast login:"    # other servers may send something else
port_ready ON          # if we get this far, our connection is
                       # ready!
# end of chat script
```

Troubleshooting Modem Settings for PPP

If your board uses a serial device that does not support hardware flow control (RTS/CTS), it may be necessary to turn off hardware flow control on your modem. One symptom is data not returning to your target board after a modem-to-modem connection is made.

pppauth

Configure PPP Authentication

Syntax

```
pppauth <option>
```

Options

-a	Add mode: Add specified entry. --c or -p MUST be specified, along with <ISP name>, <Auth ID> and <Secret>.
-c	CHAP specifier: Operate on CHAP entry(ies).
-d	Delete mode: Delete specified entry. -c or -p MUST be specified, along with <ISP name>.
-f <num entries>	Free entries so <num entries> are available.
-h <ISP name>	Set current ISP name.
-i <Auth ID>	Used in Modify mode to specify new Auth ID.
-l	List mode: List specified entries. -c or -p may be specified.
-m	Modify mode: Modify specified entry. -c or -p must be specified, along with <ISP name> and parameters to change.
-n	New mode: Copy existing entry with new type. -c or -p[ap] MUST be specified, along with -t[ype].
-p	PAP specifier: Operate on PAP entry(ies).
-s <Secret>	Used in Modify mode to specify new Secret.
-t [CHAP | PAP]	Type specifier: Change type to CHAP or PAP. CHAP or PAP may be abbreviated C or P.
-v	Verbose mode. Show progress info.

Description

The `pppauth` utility creates a data module used by `splcp` during the link authentication process.

Prior to creating the authentication module, you must:

- obtain information about the peer or Internet Service Provider (ISP) on the other end of the link
- know the authentication method being used (for example CHAP)
- know the shared secret (or password)
- know your authentication ID (userid)

Choose a name for this connection, or use the name provided by the ISP. This name (ISP name) is used with `pppauth` to store the authentication method, authentication ID, and the secret. The `-a` option is used to add a new entry to the data module. It must be accompanied by `-c` or `-p` to indicate CHAP or PAP authentication. You can add multiple ISP entries.

Prior to making a PPP connection, use the `-h` option to select the ISP name to which you want to connect.

Example pppauth Setting

The ISP “`cserve`” uses CHAP authentication, and provides you with the userid "`acct1304`", and a password of "`b5kosh`". The ISP "webnet" uses PAP authentication, and provides you with the userid "webhead", and a password of "doc-oc". Use the following commands to add this information:

```
pppauth -a -c 'cserve' 'acct1304' 'b5kosh'
pppauth -a -p 'webnet' 'webhead' 'doc-oc'
```

Step 1. Prior to connecting to cserve, set it as the current ISP with:

```
pppauth -h 'cserve'
```

Step 2. Examine the current settings by using the `-l` option:

```
pppauth -l
```

```
Current ISP name is 'cserve'.
Type ISP NameAuthentication ID / Secret
CHAP 'cserve''acct1304' 'b5kosh'
PAP 'webnet''webhead' 'doc-oc'
```

Step 3. Once the authentication module (`ppp_auth`) has been created, it can be saved using the `save` command and loaded as part of the network startup procedure.

Setting Up the Client Machine

After the device descriptors are built, load the drivers and descriptors onto the client (target) machine, if different from the machine they were built on. Using ftp or some other file transfer mechanism, make sure the following files are loaded onto the machine to be used for the PPP client:

1. Load `pppd`, `pppauth`, and `chat` from the directory:

   ```
   MWOS/OS9/<PROCESSOR>/CMDS
   ```

2. Load `sphdlc`, `splcp`, and `spipcp` from the `CMDS/BOOTOBJS/SPF` directory:

   ```
   MWOS/OS9/<PROCESSOR>/CMDS/BOOTOBJS/SPF
      sphdlc     splcp       spipcp
   ```

3. Load `hdlc0`, `lcp0`, and `ipcp0` from the directory:

   ```
   MWOS/OS9/<PROCESSOR>/PORTS/PROTOCOLS/CMDS/BOOTOBJS
   /SPF
   ```

4. Setup the `inetdb` and `inetdb2` files, making sure to include a PPP interface.

For More Information

Refer to **Chapter 8: Utilities** for more information about the `inetdb` file.

5. If necessary, add default route using the `route` command if the descriptors have not already been configured to do so.

For More Information

Refer to **Chapter 8: Utilities** for more information about the `route` utility.

Prepare Chat Script

On the client (target) machine, prepare a `chat` script.

For More Information

See the **PPP Modem Dialer Utility (chat)** section discussed previously in this chapter.

Setup Authentication

If you are using authentication, create the `ppp_auth` module using the `pppauth` utility, or load the module previously created and saved.

For More Information

See the **pppauth** section above.

Start PPP Daemon Process

Step 1. On the client (target) machine, run the following command in the background:

```
pppd -v /hdlc0/lcp0/ipcp0 &
```

Step 2. The daemon program prints status information.

For example:

```
Device/stack /hdlc0/lcp0/ipcp0 open, path = n
```

pppd also can read information from a file:

```
pppd -v=setup.pppd /hdlc0/lcp0/ipcp0 &
```

Run Chat Script

Step 1. To dial the modem and connect to the server, run the following command on the client (target) machine:

```
chat -evz=ppp.chat /hdlc0
```

Step 2. You should see something similar to the following:

```
(status information)
Reading from file ppp.chat
send( ATDT9,5551212<CR> )
Expect( ogin: )
<NUL>ATDT9,5551212<CR>
<CR><LF>
CONNECT LAPM COMPRESSED<CR><LF>
<CR>
<CR><LF>
login:
Got expected string
send( ppp_login<CR> )
Expect( ssword: )
 ppp_login<CR><LF>
Password:
Got expected string
send( *********** )
Expect( ast login: )
 <CR><LF>
Last login:
Got expected string
Handling if_abort strings
```

```
Clearing abort strings
Port is ready.
(status information)
chat done. Status code = 0
```

At this point, you should have a Point-to-Point connection with the server.

Step 3. If pppd was invoked with the `-v` option, you should see “`pppd(n): I/O on device /ipcp0 is enabled`.” This indicates the PPP link is active.

Chapter 6: Protocol Drivers

This chapter provides information about the IP, RAW, ROUTE, TCP, UDP, and ethernet protocol drivers.

SPF IP (spip) Protocol Driver

The SPF IP (spip) protocol driver is an IP protocol implementation used in embedded systems requiring internet routing, gateway, fragmentation, and reassembly capabilities. The spip driver also contains support for ICMP control messages such as redirects, port and destination unreachable, time exceeded, and source quenches. It also responds to the ICMP_ECHO messages used by ping.

The following table lists the driver and descriptor provided for IP:

Table 6-1 IP Driver and Descriptor

Driver	Descriptor
spip	ip0

Data Reception and Transmission Characteristics

The spip driver receives incoming IP packets from the driver below it, and maps the protocol field in the IP header to the appropriate protocol driver above it. For transmission, spip sends the packet to the appropriate interface below it based on the routing tables it maintains. If non-IP packets, or IP packets without a corresponding protocol driver above spip are received, they are discarded.

The spip driver can send and receive packets from multiple SPF drivers below it. These drivers must support certain IP specific setstats that are described later in this chapter.

Upon reception, the packet is passed to the appropriate driver above spip based on the protocol field in the IP header. Protocol drivers above spip are tightly coupled to the internals of spip. Therefore, generic SPF drivers are not supported directly above spip. Additional protocol support can be done through the raw socket interface provided by spraw. If IP fragments are received they are reassembled back into the original packet before being delivered to higher layer protocols.

For transmission, `spip` passes the packet to the appropriate driver below it based on the destination IP address and the routing tables it maintains. If the packet is too large for the selected interface it is fragmented.

Default Descriptor Values for spip

`ip0` is the only IP descriptor provided with the LAN Communications Pack. There should only be one `ip0` descriptor for the machine. The following discussion explains how to configure this descriptor and change it by editing the `spf_desc.h` file in the `SPIP` directory:

`MWOS/SRC/DPIO/SPF/DRVR/SPIP/DEFS/spf_desc.h`

How to Configure and Change the ip0 Descriptor

Step 1. Edit/update `spf_desc.h` in the `/DEFS` directory.

Step 2. Change to the root `/SPIP` directory and run `os9make`.

This process creates an updated descriptor in the following directory:

`MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF`.

For More Information

Refer to the ***Using SoftStax*** manual for more information about the contents and usage of the `spf_desc.h` file.

Other Default Settings

You can configure the following variables found in the `spip` descriptor. All others should not be changed.

- `GATEWAY`—Defaults to 0, indicating the host should not forward packets. In this mode incoming IP packets with destination addresses that are not broadcasts and do not match any local interface addresses are discarded. If set to 1, `spip` attempts to forward the packet based on the current routing table. If no route to the destination exists, the packet is dropped.
- `DEFTTL`—This value is put into the TTL field of the IP header on all packets sourced from this host. It defaults to 64 and must be between 1 and 255.
- `MAXSOCKBUF`—This variable controls the maximum size of the send and receive buffers for a socket. The default for each protocol is set in the protocol's descriptor. The `SO_SNDBUF` and `SO_RCVBUF` socket options may be used to change the default to any value between 1 and `MAXSOCKBUF`.
- `IPOFFSET`—If interfaces are added dynamically to the system with large hardware header requirements, previously opened paths may not have enough header space allocated. This value indicates how much extra header space `spip` should request to avoid an unnecessary data copy in this case. The default is 16 bytes.

Application Return Codes from API Calls

The return codes for socket API functions are described along with the functions in the ***LAN Programming Reference Manual***.

Considerations for Other Drivers

There are extra operations that `spip` performs at certain times with protocol drivers above and below it.

Drivers above SPIP

Only those protocol drivers (above spip) shipped with the LAN Communications Pak are supported. However, you can implement new protocols using the raw socket interface provided by spraw.

Drivers below SPIP

Drivers below spip are notified of their current IP addresses through the SPF_SS_SETADDR and SPF_SS_DELADDR setstats. spip can associate multiple addresses with the same interface.

When applications join and leave multicast groups, the appropriate interface is notified with an IP_SS_IOCTL setstat. This setstat contains a pointer to an ifreq structure which contains the address of the multicast group being joined or left.

When drivers below spip are opened (during ipstart or a SPF_SS_ATTIF setstat) an SPF_GS_SYMBOLS getstat is sent down the newly opened stack looking for a bsd_if_data symbol. If the driver does not implement this getstat, netstat will not print interface statistics for this interface.

When spip is transmitting data, it passes some additional information within the mbuf. If the packet should be sent as a link layer broadcast, the M_BCAST flag will be set in the mbuf's m_flags field. If the packet is not a broadcast, the IP address of the host to deliver it to is contained in the four bytes immediately preceding the mbuf data. This is a different address than the destination address in the IP header when the next hop is an intermediate gateway.

When spip receives data from drivers below through its dr_updata entry point the data must be 4-byte aligned. This ensures that the source and destination IP addresses may be accessed as 4-byte integers.

If a driver below spip supports multiple interfaces (such as spenet), it must set lu_pathdesc in the logical unit statics to the path descriptor associated with the interface that received the packet before passing it up to spip. Drivers that do not support multiple interfaces do not have to set lu_pathdesc. However, these will suffer a slight performance loss.

Note

For best performance, `mbufs` passed up to `spip` should have at least 12 unused bytes between the `mbuf` header and the start of data.

Getstats and Setstats above SPIP

This section provides details about getstats and setstats sent by applications and protcol drivers above `spip`.

SPF_SS_ATTIF

This setstat is used to dynamically add an interface to `spip`. It causes SPF to open a path to the specified protocol stack but it does not become usable until an address is added via `IP_SS_IOCTL`.

Example usage:

```
#include <netdb.h>
#include <SPF/spf.h>
#include <net/if.h>

int s;
error_code error;
struct n_ifnet ifp;
struct spf_ss_pb pb;

s = socket(AF_INET, SOCK_RAW, 0); /* May also use SOCK_DGRAM or */
                                  /* SOCK_STREAM */
strcpy(ifp.if_name, "enet0");
strcpy(ifp.if_stack_name, "/spde0/enet");
ifp.if_flags = IFF_BROADCAST;   /* Initial interface status flags */
ifp.if_data.ifi_mtu = 0;        /* Use the stacks TXSIZE for an MTU */
ifp.if_data.ifi_metric = 0;     /* Not currently used */
pb.code = SPF_SS_ATTIF;
pb.param = &ifp;
pb.size = sizeof(struct n_ifnet);
pb.updir = SPB_GOINGDWN;
error = _os_setstat(s, SS_SPF, &pb);
```

IP_SS_IOCTL

This setstat implements the UNIX style interface I/O controls such as add and delete addresses, get and set netmasks, broadcast addresses, destination addresses, flags, and retrieve the interface table.

This setstat can be used to add an IP address to an interface. Multiple addresses are supported by calling the `IP_SS_IOCTL` command `SIOCAIFADDR` more than once on the same interface. If the interface does not support more than one address or limits the number of addresses, the driver should return an error on the setstat. Example:

```
#include <SPF/spf.h>
#include <SPF/spinet.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <sys/ioctl.h>
#include <net/if.h>
#include <netinet/in.h>
#include <netinet/in_var.h>

int s;
error_code error;
struct in_aliasreq ifr;
struct bsd_ioctl ioctl_arg;
struct spf_ss_pb pb;

s = socket(AF_INET, SOCK_RAW, 0); /* May also use SOCK_DGRAM or */
                                  /* SOCK_STREAM */
memset(&ifr, 0, sizeof(struct in_aliasreq));
strcpy(ifr.ifra_name, "enet0");
ifr.ifra_addr.sin_len = sizeof(struct sockaddr_in);
ifr.ifra_addr.sin_family = AF_INET;
ifr.ifra_addr.sin_addr.s_addr = htonl(0xac1002e2);
ifr.ifra_broadaddr.sin_len = sizeof(struct sockaddr_in);
ifr.ifra_broadaddr.sin_family = AF_INET;
ifr.ifra_broadaddr.sin_addr.s_addr = htonl(0xac10ffff);
ifr.ifra_mask.sin_len = sizeof(struct sockaddr_in);
ifr.ifra_mask.sin_family = AF_INET;
ifr.ifra_mask.sin_addr.s_addr = htonl(0xffff0000);
ioctl_arg.cmd = SIOCAIFADDR;
ioctl_arg.arg = &ifr;
pb.code = IP_SS_IOCTL;
pb.param = &ioctl_arg;
pb.size = sizeof(struct bsd_ioctl);
pb.updir = SPB_GOINGDWN;
error = _os_setstat(s, SS_SPF, &pb);
```

Other Supported SPF_SS_IOCTL Commands

Most of the other supported `SPF_SS_IOCTL` commands are used similarly although the argument passed is a pointer to an `ifreq` structure rather than an `in_aliasreq` structure.

The following list consists of the commands that take the parameter described in the previous paragraph.

`SIOCGIFCONF`	Get list of all interfaces.
`SIOCGIFADDR`	Get address of interface.
`SIOCGIFNETMASK`	Get netmask of interface.
`SIOCGIFDSTADDR`	Get point-to-point address.
`SIOCGIFBRDADDR`	Get broadcast address of interface.
`SIOCGIFFLAGS`	Get interface flags.
`SIOCSIFADDR`	Set address of interface.
`SIOCSIFNETMASK`	Set netmask of interface.
`SIOCSIFDSTADDR`	Set point-to-pint address.
`SIOCSIFBRDADDR`	Set broadcast address of interface.
`SIOCSIFFLAGS`	Get interface flags.

The following example deletes an IP address from an interface.

Example usage:

```
#include <SPF/spf.h>
#include <SPF/spinet.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <sys/ioctl.h>
#include <net/if.h>
#include <netinet/in.h>

int s;
error_code error;
struct ifreq ifr;
struct bsd_ioctl ioctl_arg;
struct spf_ss_pb pb;
s = socket(AF_INET, SOCK_RAW, 0); /* May also use SOCK_DGRAM or */
                                  /* SOCK_STREAM */
memset(&ifr, 0, sizeof(struct ifreq));
strcpy(ifr.ifr_name, "enet0");
ifr.ifr_addr.sa_len = sizeof(struct sockaddr_in);
ifr.ifr_addr.sa_family = AF_INET;
((struct sockaddr_in *)&ifr.ifr_addr)->sin_addr.s_addr =
                                                htonl(0xac1002e2);
ioctl_arg.cmd = SIOCDIFADDR;
ioctl_arg.arg = &ifr;
pb.code = IP_SS_IOCTL;
pb.param = &ioctl_arg;
pb.size = sizeof(struct bsd_ioctl);
pb.updir = SPB_GOINGDWN;
error = _os_setstat(s, SS_SPF, &pb);
```

The interface table may also be retrieved using the `IP_SS_IOCTL` setstat.

Example usage:

```
#include <SPF/spf.h>
#include <SPF/spinet.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <sys/ioctl.h>
#include <net/if.h>
#include <netinet/in.h>

int s;
error_code error;
struct ifconf ifc;
struct bsd_ioctl ioctl_arg;
struct spf_ss_pb pb;
char buffer[256];
s = socket(AF_INET, SOCK_RAW, 0); /* May also use SOCK_DGRAM or */
                                  /* SOCK_STREAM */
ifc.ifc_len = 256;
ifc.ifc_buf = buffer;
ioctl_arg.cmd = SIOCGIFCONF;
ioctl_arg.arg = &ifc;
pb.code = IP_SS_IOCTL;
pb.param = &ioctl_arg;
pb.size = sizeof(struct bsd_ioctl);
pb.updir = SPB_GOINGDWN;
error = _os_setstat(s, SS_SPF, &pb);
```

Getstats and Setstats below SPIP

This section provides details about the getstats and setstats sent by spip to drivers below it.

SPF_SS_SETADDR

Drivers that need to know their IP address (such as spenet for ARP processing) should implement the SPF_SS_SETADDR setstat. If the number of addresses is limited, an EOS_FULL error should be returned when the limit is reached. A driver that does not need to know the protocol addresses may return EOS_UNKSVC.

Example Usage:

```
case SPF_SS_SETADDR: {
   struct sockaddr_in *sin = (struct sockaddr_in *)pb->param;
   error = add_ip_address(sin->sin_addr);
   return (error);
}
```

SPF_SS_DELADDR

If the SPF_SS_SETADDR setstat is supported to add addresses, the SPF_SS_DELADDR setstat must be supported to remove them. If an attempt is made to remove an unknown address, EADDRNOTAVAIL should be returned.

Example Usage:

```
case SPF_SS_DELADDR: {
   struct sockaddr_in *sin = (struct sockaddr_in *)pb->param;
   error = del_ip_address(sin->sin_addr);
   return (error);
}
```

IP_SS_IOCTL

The IP_SS_IOCTL setstat is used to notify interfaces to join or leave a particular multicast group. If the interface wishes to limit the number of multicast groups joined, a EOS_FULL error should be returned when the threshold has been exeeded.

Example Usage:

```
#include <sys/ioctl>
#include <net/if.h>
case IP_SS_IOCTL: {
    struct bsd_ioctl *arg_ptr;
    struct ifreq *ifr;

    arg_ptr = pb->param;
    ifr = arg_ptr->arg;
    switch(arg_ptr->cmd) {
        case SIOCADDMULTI:
            return (AddMulticast(ifr->ifr_addr));
        case SIOCDELMULTI:
            return (DeleteMulticast(ifr->ifr_addr));
    }
    return(EOPNOTSUPP);
}
```

SPF_GS_SYMBOLS

The SPF_GS_SYMBOLS getstat is used to retrieve the address of one or more symbols (variables) maintained by a driver. After obtaining this information, a program can examine the variable dynamically. This getstat assists porting programs that use the kvm_nlist or nlist functions on other systems, and relieves drivers of copying statistic information from driver space to user space.

When processing the SPF_GS_SYMBOLS getstat, a driver receives a pointer to an array of nlist structures. The nlist structure is defined in MWOS/SRC/DEFS/SPF/BSD/nlist.h as:

```
struct nlist {
    char          *n_name;    /* symbol name */
    unsigned long n_value;    /* address/value of the symbol */
    unsigned char n_type;     /* type defines */
    unsigned char res[3];     /* reserved space */
};
```

You must initialize each n_name member to point to the name of the symbol to be retrieved, and zero the rest of the structure. On a successful return, the n_type member of each element found is non-zero (typically N_ABS). n_value contains the address of the symbol corresponding to the name you specified in n_name. The driver processes every member of the nlist array until it reaches an element where the n_name member is zero. After processing the getstat, the driver passes this getstat to the next driver in the path. This enables one system call to retrieve multiple symbols from multiple drivers.

The following code fragment shows how to use the SPF_GS_SYMBOLS getstat. It retrieves information for the two symbols _ipstat and _rtstat from spip.

```
#include <nlist.h>
#include <spf.h>
struct nlist  nl[5];     /* name list to be passed to IP */
struct nlist *nl_ptr;    /* pointer to walk through list after*/
                         /* getstat */
spf_ss_pb     pb;        /* SPF parameter block */
path_id       path;

memset(nl, sizeof(nl), 0); /* zero list */
nl[0].n_name = "_ipstat";     /* first element to get IP statistics */
nl[1].n_name = "_rtstat";     /* second element to get routing stats */
pb.code = SPF_GS_SYMBOLS;
pb.size = sizeof(nl);         /* or # elements * sizeof(element) */
pb.param = nl;
```

```
pb.updir = SPB_GOINGDWN;
if (_os_open("ip0", FAM_READ, &path) == 0) {
   _os_getstat(path, SS_SPF, &pb);
   _os_close(path);
}
for (nl_ptr = nl; nl_ptr->n_name; nl_ptr++)
   if (nl_ptr->n_type) /* non-zero means symbol was found */
      printf("Address of %s is %X\n", nl_ptr->n_name,
                                    nl_ptr->n_value);
```

Note

To access the memory pointed to by `n_value`, a process must be system state. User state processes must use `_os_permit`.

Possible return codes:

`EOS_BPADDR`	The `nlist` pointed to by `pb.param` failed `_os_chkmem`

SPF RAW (spraw) Protocol Driver

The SPF RAW protocol driver (`spraw`) provides a standard raw socket interface to the IP layer.

The following table lists the driver and descriptor provided for RAW.

Table 6-2 SPRAW Driver and Descriptor

Driver	Descriptor
`spraw`	`raw0`

Data Reception and Transmission Characteristics

The `spraw` driver handles input of all IP datagrams where the protocol field of the IP header is 1 (ICMP), 255 (RAW), or any other value that does not have a corresponding driver above `spip`. On reception of such a datagram, it is delivered to any application that has requested to receive that protocol number. If multiple processes have requested a particular protocol, the incoming mbuf is duplicated and a copy delivered to each path.

On transmission, `spraw` fills in the required IP header fields and passes the datagram to `spip` for delivery to the destination. If the `IP_HDRINCL` option is set for a path, the application has filled in the IP header and the datagram is passed to `spip` for delivery.

Default Descriptor Values for spraw

raw0 is the only spraw descriptor provided with the LAN Communications Pak. There should only be one raw0 descriptor for the machine. The following discussion explains how this descriptor is configured, and how you can change this descriptor by editing the spf_desc.h file in the SPRAW directory:

MWOS/SRC/DPIO/SPF/DRVR/SPRAW/DEFS

How to Configure and Change the raw0 Descriptor

Step 1. Edit/update spf_desc.h in the /DEFS directory.

Step 2. Change to the root /SPRAW directory and run os9make.

This process creates an updated descriptor in the following directory:

MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF.

For More Information

Refer to the ***Using SoftStax*** manual for more information about the contents and usage of the spf_desc.h file.

ITEM Addressing

The spraw driver does not support ITEM addressing.

Other Default Settings

The following variables are configurable in the `raw0` descriptor. All others should not be changed.

- `READSZ`—If more than `READSZ` number of incoming data bytes are queued in the SPF read queue, an `SPF_SS_FLOWON` setstat is sent to `spraw`. This causes incoming data to be buffered in the receive socket buffer. When an application reads data and the queue length falls below `READSZ`, an `SPF_SS_FLOWOFF` setstat is sent, causing all buffered data in the socket buffer to be added to the SPF read queue. As a result, the maximum `mbuf` usage for a single path is 2 * `TCPWINDOW` + `READSZ`. The default value for this variable is 4096 bytes.
- `RECVBUFFER`—The maximum amount of incoming data `spraw` will buffer after receiving an `SPF_SS_FLOWON` setstat before it starts silently dropping packets. The default value is 8K and may be changed on a per path basis using the `SO_RCVBUF` socket option.
- `SENDBUFFER`—Since `spraw` does not queue outgoing data, this variable only limits the maximum size of a single datagram that can be sent. The default value is 8K and may be changed on a per path basis using the `SO_SNDBUF` socket option.

Application Return Codes from API Calls

The return codes for socket API functions are described along with the functions in the ***LAN Communications Pak Programming Reference***.

Consideration for Other Drivers

The `spraw` driver depends on functions located in `spip` and will only work on top of `spip`.

SPF Routing Domain (sproute) Protocol Driver

The `sproute` driver provides a BSD 4.4 style routing domain. This domain allows a process to send and receive routing messages with `spip` using the normal sockets API. A routing domain socket can be created by issuing the socket system call and specifying a family of `AF_ROUTE` and a socket type of `SOCK_RAW`.

The following table lists the driver and descriptor provided for sproute.

Table 6-3 SPROUTE Driver and Descriptor

Driver	Descriptor
`sproute`	`route0`

Data Reception and Transmission Characteristics

The routing domain enables an application to send a datagram containing an `rt_msghdr` structure to add, delete, or change routes within the system routing table.

Note

The size of the routing table supported by `sproute` is limited by the amount of memory available. Each routing table entry is approximately 128 bytes.

An application reading from a routing domain socket receives datagrams containing `rt_msghdr` structures, indicating changes in the system routing table. It receives datagrams containing `if_msghdr` structures when interfaces go up and down, as well as `ifa_msghdr` structures when addresses are added to and deleted from the system.

Routing sockets do not require a `connect` or a `bind`. After creation they may be immediately written to and read from using the normal socket API calls.

Default Descriptor Values for sproute

`route0` is the only routing domain descriptor provided with the LAN Communications Pak. There should only be one `route0` descriptor for the machine. The following discussion explains how this descriptor is configured, and how you can change this descriptor by editing the `spf_desc.h` file in the `SPROUTE` directory:

`MWOS/SRC/DPIO/SPF/DRVR/SPROUTE/DEFS`

How to Configure and Change the route0 Descriptor

Step 1. Edit/update `spf_desc.h` in the `/DEFS` directory.

Step 2. Change to the root `/SPROUTE` directory and run `os9make`.

This process creates an updated descriptor in the following directory:

`MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF`.

For More Information

Refer to the ***Using SoftStax*** manual for more information about the contents and usage of the `spf_desc.h` file.

ITEM Addressing

The `sproute` driver does not support ITEM addressing.

Other Default Settings

- `READSZ`—The threshold of queued data that triggers SPF to initiate flow control. The default value is 4096 bytes. This limit is normally not reached since `sproute` is used for message passing and not bulk data transfer.

Application Return Codes from API Calls

The return codes for socket API functions are described along with the functions in the ***LAN Communications Pak Programming Reference***.

Consideration for Other Drivers

The `sproute` driver depends on functions located in `spip` and thus only works on top of `spip`.

SPF TCP (sptcp) Protocol Driver

The SPF TCP (`sptcp`) protocol driver provides reliable data transfer service over IP.

The following table lists the driver and descriptor provided for TCP:

Table 6-4 TCP Driver and Descriptor

Driver	Descriptor
`sptcp`	`tcp0`

Data Reception and Transmission Characteristics

The `sptcp` driver receives incoming TCP packets from the `spip` driver and maps the TCP port and IP destination address to a particular path with matching socket address. If no matching path is found, a TCP reset is returned to the sender.

Upon transmission, `sptcp` repackages the data to the correct size for the transmitting interface, fills in the necessary header information, and passes the packet to `spip` for delivery to the destination.

Default Descriptor Values for sptcp

`tcp0` is the TCP descriptor provided with the LAN Communications Pak. There should only be one descriptor for the machine. The following discussion explains how this descriptor is configured and how you can change the descriptor by editing the `spf_desc.h` file located in:

`MWOS/SRC/DPIO/SPF/DRVR/SPTCP/DEFS`

How to Configure and Change the tcp0 Descriptor

Step 1. Edit/update `spf_desc.h` in the `/DEFS` directory.

Step 2. Change to the root `/SPTCP` directory and run `os9make`.

This process creates an updated descriptor in the following directory:

`MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF`.

For More Information

Refer to the ***Using SoftStax*** manual for more information about the contents and usage of the `spf_desc.h` file.

ITEM Addressing

The `sptcp` driver does not support ITEM addressing.

Other Default Settings

The following variables are configurable in the `tcp0` descriptor. All others should not be changed.

- `READSZ`—If more than `READSZ` number of incoming data bytes are queued in the SPF read queue, an `SPF_SS_FLOWON` setstat is sent to `sptcp`. This causes incoming data to be buffered in the receive socket buffer. When an application reads data and the queue length falls below `READSZ`, an `SPF_SS_FLOWOFF` setstat is sent, causing all buffered data in the socket buffer to be added to the SPF read queue. As a result the maximum `mbuf` usage for a single path is `2 * TCPWINDOW + READSZ`. The default value for this variable is 4096 bytes.

- TCPWINDOW—The maximum amount of incoming data sptcp will store in the socket receive buffer after receiving an SPF_SS_FLOWON setstat. The TCP window size advertised in ACK's to the other end of the connection is equal to the space available in the receive buffer. The default value is 16K and can be changed on a per path basis using the SO_RCVBUF socket option.
- SENDBUFFER—The maximum transmit data sptcp buffers before blocking the writing process, or in the case of non-blocking I/O return an EWOULDBLOCK error. The default value is 20K and may be changed on a per path basis using the SO_SNDBUF socket option. The maximum amount of mbuf usage is SENDBUFFER + size of application write or 3 times the size of application write, whichever is larger. For example, if an application is passing 32K bytes of data to the write(), _os_write(), or send() system calls, it is possible to use 96K bytes of mbuf space.
- TXSIZE—This variable controls the maximum size of an mbuf SPF will request when packaging user data for transmission. The default value is 4380 bytes.
- DFLT_MSS—The maximum segment size for a connection. This is set to the MTU of the interface selected for transmission based on the routing table at the time the connection is established. DFLT_MSS is no longer used in the calculation, so changing it has no effect.

Application Return Codes from API Calls

The return codes for socket API functions are described, along with the functions in the ***LAN Communications Pak Programming Reference.***

Considerations for Other Drivers

The sptcp driver depends on functions located in spip and only works on top of spip.

SPF UDP (spudp) Protocol Driver

The SPF UDP protocol driver (spudp) provides datagram service over IP.

The following table lists the driver and descriptor provided for UDP:

Table 6-5 UDP Driver and Descriptor

Driver	Descriptor
spudp	udp0

Data Reception And Transmission Characteristics

The spudp driver receives incoming UDP packets from the spip driver below and maps the UDP port and IP address to a particular path with matching socket address. The spudp driver creates an address mbuf with each incoming packet and chains the data to it using the m_pnext field of the mbuf header. If multiple paths match, as can happen with wildcard addresses or multicasts, the incoming mbuf is duplicated and a copy sent to each path. If no match is found, an ICMP port unreachable error is returned.

On transmission, spudp fills in the necessary header information and passes the datagram to spip for delivery to the destination.

The amount of memory used by a single UDP connection is limited to avoid using all the available mbuf pool. When an application's read queue grows beyond the READSZ specified in the udp0 descriptor, an SPF_SS_FLOWON setstat is generated. When spudp receives this, it buffers up to the number of bytes specified in the RECVBUFFER descriptor variable. If more data is received, the packets are silently dropped. On transmit, spudp does not buffer the data and the mbuf pool may be exhausted if the bottom layer hardware drivers queue an unlimited number of packets.

Default Descriptor Values for spudp

udp0 is the only UDP descriptor provided with the LAN Communications Pak. There should only be one udp0 descriptor for the machine. The following discussion explains how this descriptor is configured, and how you can change this descriptor by editing the spf_desc.h file in the SPUDP directory:

MWOS/SRC/DPIO/SPF/DRVR/SPUDP/DEFS

How to Configure and Change the udp0 Descriptor

Step 1. Edit/update spf_desc.h in the /DEFS directory.

Step 2. Change to the root /SPUDP directory and run os9make.

This process creates an updated descriptor in the following directory:

MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF.

For More Information

Refer to the ***Using SoftStaxUsing SoftStax*** manual for more information about the contents and usage of the spf_desc.h file.

ITEM Addressing

The spudp driver does not support ITEM addressing.

Other Default Settings

The following variables can be configured in the `udp0` descriptor. All others should not be changed.

- `CHECKSUM`—By default this is set to 1, causing a UDP checksum to be calculated for all transmitted datagrams. A value of `0` will disable checksums. This has no effect on received mbufs because their checksum, if present, is always checked.
- `READSZ`—If more than `READSZ` number of incoming data bytes are queued in the SPF read queue, an `SPF_SS_FLOWON` setstat is sent to `spudp`. This causes incoming data to be buffered in the receive socket buffer. When an application reads data and the queue length falls below `READSZ`, an `SPF_SS_FLOWOFF` setstat is sent, causing all buffered data in the socket buffer to be added to the SPF read queue. As a result, the maximum mbuf usage for a single path is `2 * RECVBUFFER + READSZ`. The default value for this variable is 4096 bytes.
- `RECVBUFFER`—The maximum amount of incoming data `spudp` buffers after receiving an `SPF_SS_FLOWON` setstat before it starts silently dropping packets.The default value is 32K and may be changed on a per path basis using the `SO_RCVBUF` socket option.
- `SENDBUFFER`—Since `spudp` does not queue outgoing data, this variable only limits the size of the largest UDP datagram that can be sent and defaults to 9216 bytes. This value can be changed on a per path basis using the `SO_SNDBUF` socket option.

Application Return Codes from API Calls

The return codes for socket API functions are described, along with the functions in the ***LAN Communications Pak Programming Reference***.

Considerations for Other Drivers

The `spudp` driver depends on functions located in `spip` and, therefore, only works on top of `spip`.

SPF Ethernet (spenet) Protocol Driver

The `spenet` protocol driver sits between the hardware Ethernet drivers and `spip`. Its main function is to map between Ethernet addresses and IP addresses using the Address Resolution Protocol (ARP). See RFC-826 for additional details. The `spenet` driver also adds and removes Ethernet headers for outgoing and incoming packets.

`Spenet` maintains an ARP table for mapping between Ethernet and IP addresses. When `spenet` receives a unicast packet from `spip`, and the destination address has no entry in the ARP table, `spenet` broadcasts an ARP request to discover the Ethernet address. The results are then added to the ARP table, and are removed after 20 minutes. The `arp` utility can be used to view or modify the ARP table.

Table 6-6 SPF Ethernet Driver and Descriptor

Driver	Descriptor
`spenet`	`enet`

Data Reception and Transmission Characteristics

The `spenet` driver receives incoming Ethernet packets from one or more drivers below it and maps the destination Ethernet address to the destination IP address. Before passing the packet to `spip`, the `lu_pathdesc` component of the logical unit statics is set to point to the appropriate path descriptor to enable `spip` to determine which interface received the packet.

For transmission, `spenet` adds the appropriate Ethernet hardware destination and source addresses to the packet. If the `M_BCAST` flag is set in the `mbuf` header, the packet is assumed to be a broadcast and the all 1's hardware broadcast address is used. If the `M_MCAST` flag is set the destination address in the IP header is converted to the appropriate link layer multicast address. In all other cases the ARP cache is searched using the IP address of the next hop destination. If no ARP entry exists, the ARP protocol is initiated. When the Ethernet header has been completed, the packet is sent to an interface driver below.

Default Descriptor Values for `spenet`

`enet` is the only descriptor for `spenet` provided with the LAN Communications Pak. This descriptor is generic for all Ethernet drivers and should not need to be updated.

This descriptor is configured to change fields by editing the `spf_desc.h` file in the `SPENET` directory:

`MWOS/SRC/DPIO/SPF/DRVR/SPENET/DEFS`

How to Configure and Change the `enet` Descriptor

Step 1. Edit/update `spf_desc.h` in the `/DEFS` directory.

Step 2. Change to the root `/SPENET` directory and run `os9make`.

This process creates an updated descriptor in the following directory:

`MWOS/<OS>/<PROCESSOR>/CMDS/BOOTOBJS/SPF`.

For More Information

Refer to the ***Using SoftStax*** manual for more information about the contents and usage of the `spf_desc.h` file.

ITEM Addressing

The `spenet` driver does not support ITEM addressing.

Other Default Settings

The following variables can be configured in the `enet` descriptor. All others should not be changed.

`MAXADDR_PER_IFACE`—indicates the maximum number of protocol addresses that can be associated per hardware interface. The LAN Communications Pak supports more than one protocol address (IP) per hardware interface. The default value is 4.

`TIMER_INT`—`spenet` runs a cyclic timer that is used to remove old `arp` entries. This value defines the timer interval in seconds. The default value is 60.

`KILL_C`—If a completed (received `arp` reply) entry is not used in this many timer intervals it is deleted. The default value is 20.

`KILL_I`—If an entry remains incomplete (no `arp` reply received) for this many timer intervals it is deleted. The default value is 3.

Considerations for Other Drivers

Drivers Below spenet

When `spip` receives data from drivers below through its `dr_updata` entry point the data must be 4-byte aligned. This requirement ensures that the source and destination IP addresses may be accessed as 4-byte integers. When receiving data, the four bytes immediately preceding the mbuf data must contain a pointer to the device entry of the driver sending data up the stack.

Getstats for SPENET

The structures used for getstats and setstats for `spenet` are found in `MWOS/SRC/DEFS/SPF/BSD/net/if_arp.h` and `MWOS/SRC/DEFS/SPF/BSD/netinet/if_ether.h`. The `spenet` driver provides the following getstats to programmers.

For More Information

See the ***SoftStax Programming Reference Manual*** for additional details on `_os_getstat` and the `spf_ss_pb` structure.

SPF_GS_ARPENT

This setstat retrieves a particular entry from the ARP table. The `param` member of the `spf_ss_pb` structure must point to a user allocated `arptab` structure. The `at_iaddr` member of the `arptab` structure must be set to the IP address (in network order) of the entry to retrieve. On success, `0` is returned. `EOS_PNNF` is returned if the entry cannot be found.

SPF_GS_ARPTBL

This setstat retrieves the entire ARP table. The `param` member of the `spf_ss_pb` structure points to a user allocated array of `arptab` structures. The size member must be set to the size of this array in bytes. On success, `0` is returned, indicating `spenet` copied as much of the table as possible to the users array, and set the size member of the `spf_ss_pb` to the actual size of the ARP table (in bytes).

It is recommended that you retrieve the ARP table using two getstats. The first getstat sets the size to zero. On return, size will indicate the size of the current ARP table. Dynamically allocate this much space (plus some additional space in case the table grows), and issue another getstat.

ENET_GS_STATS

This setstat retrieves the statistics maintained by `spenet`. The `param` member of the `spf_ss_pb` structure points to a user allocated `enet_stat_pb` structure. On success, `0` is returned.

Setstats for SPENET

The `spenet` driver provides the following setstats to programmers.

For More Information

See the ***SoftStax Programming Reference*** for additional details on `_os_setstat` and the `spf_ss_pb` structure.

To alter the ARP table, a process must have super user access.

SPF_SS_ADDARP

This setstat adds an entry to the ARP table. The `param` member of the `spf_ss_pb` structure points to a user allocated `arpreq` structure. You must initialize the `arp_pa` (in network order), `arp_ha`, and `arp_flags` members of this structure. See the file `if_arp.h` for settings of `arp_flags`. The `arp_pa` member should be treated as a `sockaddr_in` stucture, setting the `sin_family` to `AF_INET`. On success, `0` is returned.

SPF_SS_DELARP

This setstat removes an entry from the ARP table. The `param` member of the `spf_ss_pb` structure points to a user allocated `arpreq` structure. You must set the `arp_pa` member to the IP address (in network order) of the entry to be deleted. This member should also be treated as a `sockaddr_in` stucture, setting the `sin_family` to `AF_INET`. On success, 0 is returned. `EOS_PNNF` indicates the address was not found in the ARP table.

For More Information

See the `arp` command in **Chapter 8: Utilities** for additional details.

Chapter 7: BOOTP Server

The Bootstrap Protocol (BOOTP) enables booting from the network. BOOTP clients require a BOOTP server on the connected network to support the BOOTP protocol as specified in RFC 951 (Croft/Gilmore) and Trivial File Transfer Protocol (TFTP) as specified in RFC 906 (Finlayson). It also requires the server to support the BOOTP Vendor Information Extensions described in RFC 1048 and RFC 1084 (Reynolds).

This chapter covers the following topics:

- Overview of the BOOTP server
- BOOTP server utilities
- Setting up the `bootptab` configuration file

Note

The BOOTP server is based on the Carnegie Mellon University implementation. Microware does not provide or support the BOOTP server for UNIX or other operating systems. Contact the University Computer Center at Carnegie Mellon for the availability of the BOOTP server on other operating systems.

Bootstrap Protocol

Bootstrap Protocol (BOOTP) is a client-server protocol. The system being booted is the client. The process includes the following steps.

1. The client system makes requests to a server system on the network or the same VME chassis over the backplane. The server or the client may or may not be an OS-9 system. OS-9 clients request the server to identify the following:
   - Client IP address
   - Server IP address
   - Path to the bootfile
   - Size of the bootfile

Note

You can adjust the number of contact attempts the client makes to a server by editing the `config.des` file in the following directory:
`mwos\OS9000\<PROCESSOR>\PORTS\<TARGET>\ROM\CNFGDATA`
You must add the line `maxbootptry=<number>` to the "eb" section of the file. `<number>` can be from 1 to infinity. The default is 8.

2. The server subsequently transfers the bootfile across the network back to the client using the TFTP protocol.
3. The ROM boot code starts the network boot option (BOOTP) either through the menu selection or automatically without operator intervention. The client broadcasts the BOOTP request containing the client's hardware address (for example, Ethernet address) retrieved from SRAM. A server responds with the information listed above.

4. The client then sends a TFTP request for its bootfile to the server. The responding server calls the TFTP service to transfer the bootfile to the client. The client reads the bootfile as it is transferred across the network and copies it into local RAM in the same manner as other boot device drivers.
5. After the file is successfully read in by the client, control returns to the booting subsystem to complete the bootstrap and pass control to the OS-9 kernel.

Server Utilities

A BOOTP server includes the `bootptab` configuration file and the utility programs identified in **Table 7-1 BOOTP Server Utilities**.

Table 7-1 BOOTP Server Utilities

Name	Description
`bootpd`	Responds to BOOTP client requests with BOOTP server responses.
`bootptest`	A simple utility to test `bootpd` server response.
`tftpd`	Responds to `tftp` read requests and forks `tftpdc` to handle the transfer.
`tftpdc`	Reads a bootfile for a client using the TFTP protocol.

For More Information

Refer to **Chapter 8** for more information about these utilities.

Utility programs are located in the `/MWOS/CMDS` directory. The `bootptab` configuration file is usually located in the `TFTPBOOT` directory copied from `MWOS/SRC/TFTBOOT`.

The procedure for starting a BOOTP server and the associated utilities:

```
tftpd <>>>/nil &
bootpd /h0/TFTPBOOT/bootptab<>>>/nil &
```

The boot file name is dependent on the client BOOTP system. On OS-9, the boot file is called `OS9boot.<hostname>`. The `OS9boot.<hostname>` file should have public read permissions set to allow `tftpd` to access it. While in the `/h0/TFTPBOOT` directory, use the following command to turn on the public read permissions for all `OS9boot` files:

```
$ attr -pr os9boot.*
```

The `bootpd` server is derived from the Version 2.1 `bootpd` source code. This source code contains the following notice:

```
/*
 * Copyright (c) 1988 by Carnegie Mellon.
 *
 * Permission to use, copy, modify, and distribute this
 * program for any purpose and without fee is hereby
 * granted, provided that this copyright and permission
 * notice appear on all copies and supporting
 * documentation, the name of Carnegie Mellon not be used
 * in advertising or publicity pertaining to distribution
 * of the program without specific prior permission, and
 * notice be given in supporting documentation that
 * copying and distribution is by permission of Carnegie
 * Mellon and Stanford University. Carnegie Mellon makes
 * no representations about the suitability of this
 * software for any purpose. It is provided "as is"without
 * express or implied warranty.

 * Copyright (c) 1986, 1987 Regents of the University of
 * California.
 * All rights reserved.
 *
 * Redistribution and use in source and binary forms are
 * permitted provided that this notice is preserved and
 * that due credit is given to the University of California
 * at Berkeley. The name of the University may not be used
 * to endorse or promote products derived from this software
 * without specific prior written permission.
 * This software is provided as is'' without express or
 * implied warranty.
 */
```

bootptab Configuration File Setup

When bootpd is first started, it performs the following functions:

1. Reads a configuration file to build an internal database of clients and desired boot responses for each.
2. Listens for BOOTP boot requests on UDP socket port 67 (bootps).
3. Checks the file time stamp on the configuration file before processing a boot request. If the file time stamp changed since the last check, the client database is rebuilt.

The configuration file has a format similar to termcap in which two-character, case-sensitive tag symbols represent host parameters. These parameter declarations are separated by colons (:). The general format for the bootptab file is as follows:

```
hostname:tg=value...:tg=value...:tg=value:
```

hostname is the actual name of a BOOTP client and tg is a two-character tag symbol. Most tags must be followed by an equal sign and a value. Some tags may also appear in Boolean form with no value (:tg:).

bootpd recognizes the following tags.

Table 7-2 Bootp Tags

Tag	Description
bf	Bootfile
bs	Bootfile size in 512-octet (byte) blocks
ha	Host hardware address
hd	Bootfile home directory
hn	Send hostname

Table 7-2 Bootp Tags (continued)

Tag	Description
`ht`	Host hardware type
`ip`	Host IP address
`sm`	Host subnet mask
`tc`	Table continuation (points to similar “template” entry)
`vm`	Vendor magic cookie selector

There is also a generic tag, `Tn`, where `n` is an RFC-1048 vendor field tag number. This enables immediate use of future extensions to RFC-1048 without first modifying `bootpd`. Generic data may be represented as either a stream of hexadecimal numbers or as a quoted string of ASCII characters. The length of the generic data is automatically determined and inserted into the proper field(s) of the RFC-1048-style BOOTP reply.

The `ip` and `sm` tags each expect a single IP address. All IP addresses are specified in standard Internet dot notation and may use decimal, octal, or hexadecimal numbers (octal numbers begin with 0, hexadecimal numbers begin with 0x or 0X).

Hardware Type

The `ht` tag specifies the hardware type code as:

- Unsigned decimal, octal, or hexadecimal integer
- `ethernet` or `ether` for 10Mb Ethernet

Address

The ha tag takes a hardware address. The hardware address must be specified in hexadecimal. You can include optional periods and/or a leading `0x` for readability. The ha tag must be preceded by the `ht` tag (either explicitly or implicitly; see `tc`).

Host Name, Home Directory, and Bootfile

The host name, home directory, and bootfile are ASCII strings which can optionally be surrounded by double quotes (“ ”). The client’s request and the values of the hd and `bf` symbols determine how the server fills in the bootfile field of the BOOTP reply packet.

- If the client specifies an absolute path name and that file exists on the server machine, that path name is returned in the reply packet.
- If the file cannot be found, the request is discarded and a reply is not sent.
- If the client specifies a relative path name, a full path name is formed by appending the value of the hd tag and testing for the file’s existence.
- If the hd tag is not supplied in the configuration file or if the resulting bootfile cannot be found, the request is discarded. Because BOOTP clients normally supply `os9boot` as the bootfile name, the relative path name case is used. OS-9 BOOTP clients normally supply `sysboot` as the bootfile name.

Clients specifying null boot files elicit a reply from the server. The exact reply depends on the hd and `bf` tags.

- If the `bf` tag specifies an absolute path name and the file exists, that path name is returned in the reply packet.
- If the hd and `bf` tags together specify an accessible file, that file name is returned in the reply.
- If a complete file name cannot be determined or the file does not exist, the reply contains a zeroed-out bootfile field.

In each case, existence of the file means, in addition to actually being present, the public read access bit of the file must be set. `tftpd` requires this to permit the file transfer. Set the hd tag to `/h0/TFTPBOOT` or to the same directory as given on the `tftpd` command line.

All file names are first tried as `filename.hostname` and then as `filename`. This provides for individual per-host bootfiles.

The following table further illustrates the interaction between `hd`, `bf`, and the bootfile name received in the BOOTP request.

Table 7-3 BOOTP Request Matrix

Homedir Specified?	Bootfile Specified?	Client's file Specification	Action
No	No	Null	Send null file name
No	No	Relative	Discard request
No	Yes	Null	Send if absolute else discard request
No	Yes	Relative	Discard request
Yes	No	Null	Send null file name
Yes	No	Relative	Lookup with `.host`
Yes	Yes	Null	Send home/boot or bootfile
Yes	Yes	Relative	Lookup with `.host`

Bootfile Size

The bootfile size, `bs`, may be a decimal, octal, or hexadecimal integer specifying the size of the bootfile in 512-octet blocks, or the keyword `auto`. Specifying `auto` causes the server to automatically set the bootfile size to the actual size of the named bootfile at each request. Specifying the `bs` symbol as Boolean has the same effect as specifying `auto` as its value. OS-9 BOOTP clients require `bs` or `bs=auto`.

Sending a Host Name

The `hn` tag is strictly a Boolean tag. It does not take the usual equal sign and value. Its presence indicates the host name should be sent to RFC-1048 clients. `bootpd` attempts to send the entire host name as it is specified in the configuration file. If this does not fit into the reply packet, the name is truncated to just the host field (up to the first period, if present) and then tried. In no case is an arbitrarily truncated host name sent. If nothing reasonable fits, nothing is sent.

Sharing Common Values Between Tags

Often, many host entries share common values for certain tags (such as name servers). Rather than repeatedly specifying these tags, you can list a full specification for one host entry and shared by others using the `tc` (table continuation) tag. The template entry is often a dummy host which does not actually exist and never sends BOOTP requests. This feature is similar to the `tc` feature of `termcap` for similar terminals.

Note

`bootpd` allows the `tc` tag symbol to appear anywhere in the host entry, unlike `termcap` which requires it to be the last tag.

Information explicitly specified for a host always overrides information implied by a `tc` tag symbol, regardless of its location within the entry. The `tc` tag may be the host name or IP address of any host entry previously listed in the configuration file.

Sometimes you need to delete a specific tag after it has been inferred with `tc`. To delete the tag, use the construction `tag@`. This removes the effect of the tag.

For example, to completely undo the host directory specification, use `:hd@:` at an appropriate place in the configuration entry. After removal with `@`, you can reset a tag using `tc`.

Blank lines and lines beginning with a pound sign (#) are ignored in the configuration file. Host entries are separated from one another by new lines. You can extend a single host entry over multiple lines if the lines end with a backslash (\). You can also have lines longer than 80 characters.

Tags may appear in any order, with the following exceptions:

- The host name must be the very first field in an entry.
- The hardware type must precede the hardware address.
- Individual host entries must not exceed 1024 characters.

bootptab File Example

An example `/h0/TFTPBOOT/bootptab` file follows:

```
# First, we define a global entry which specifies the stuff every host uses.
#
# the bs tag is required for OS-9 BOOTP clients
# bf is set (to anything) to cause the bootfile.hostname lookup action
#
global.dummy:sm=255.255.255.0:hd=/h0/tftpboot:bs:
#
# individual hosts
#
boop:tc=global.dummy:ht=ethernet:ha=08003E205284:ip=192.52.109.96:
#
vite:tc=global.dummy:ht=ethernet:ha=08003e20c300:ip=192.52.109.57:
#
boesky:tc=global.dummy:ht=ethernet:ha=08003E202eae:ip=192.52.109.61:
```

Chapter 8: Utilities

This chapter examines the LAN Communications Pak utilities provided with this package.

Overview

The following utilities are provided with the LAN Communications Pak.

Table 8-1 LAN Communications Pak Utilities

Utility	Description
`arp`	Print and update the ARP table.
`bootptest`	Test the `bootpd` and `tftpd` daemons.
`dhcp`	DHCP client negotiation utility.
`ftp`	File Transfer Protocol. `ftp` transfers files to and from remote systems. There are many `ftp` commands for file manipulation between systems.
`hostname`	Prints or sets the string returned by the socket library `gethostname()` function.
`idbgen`	Internet Database Generation. `idbgen` builds the internet data module from the data files: `host.conf`, `hosts`, `hosts.equiv`, `inetd.conf`, `networks`, `protocols`, `resolv.conf`, `interfaces.conf`, `routes.conf` `services`, `drpw`, `idbgen` must be run each time any of these files are updated.
`idbdump`	Internet Database Display. `idbdump` dumps the current entries in the internet data module (`inetdb`).
`ifconfig`	Displays and modifies the interface table. `ifconfig` allows the addition of new interfaces, modification of IP addresses and broadcast addresses, and deletion of IP addresses.

Table 8-1 LAN Communications Pak Utilities (continued)

Utility	Description
`ipstart`	Initializes IP stack.
`ndbmod`	Allows you to add, remove, or modify information stored in the `inetdb` and `inetdb2` data modules.
`netstat`	Report network information and statistics.
`ping`	send `ICMP ECHO_REQUEST` packets to host.
`route`	Add or delete routes.
`telnet`	Telnet user interface; `telnet` provides the ability to log on to remote systems.

Note

All LAN Communications Pak utilities and servers use the `netdb` shared module and the `inetdb` and `inetdb2` data modules for name resolution.

Note

Windows 95/NT verisions of the `idbgen`, `idbdump`, `rpcdbgen`, and `rpcdump` utilities are provided in addition to the OS-9 versions.

Daemon server programs and connection handlers are identified in the following table.

Table 8-2 Daemon Server Programs and Connection Handlers

Daemon	Description
`bootpd`	Bootp Server Daemon.
`ftpd`	FTP Server Daemon.
`ftpdc`	FTP Server Connection Handler (forked by `ftpd` or `inetd`).
`inetd`	Internet Services Master Daemon. `inetd` can be configured to fork a particular program to handle data on a particular protocol/port number combination. `inetd` can replace the `ftpd` and `telnetd` server daemons. `telnetdc` and `ftpdc` must still be available.
`routed`	Dynamic Routing Daemon.
`telnetd`	Telnet Server Daemon.
`telnetdc`	Telnet Server Connection Handler (forked by `telnetd` or `inetd`).
`tftpd`	TFTP Server Daemon.
`tftpdc`	TFTP Server Connection Handler (forked by `tftpd`).

Utilities

This section includes utility definitions in alphabetical order according to the following alpha sort rules.

1. Special characters (not letters, numbers, or underscores) are listed first.
2. Utilities are listed in alphabetic order next without regard for numbers and underscores.
3. If two utility names are identical using these rules, then they are alphabetized according to the following order:

   1.Symbols

   2.Underscores

   3.Alphabetic characters

   4.Numbers

Sections

Each utility defined includes a minimum of the following sections:

- Syntax
- Options
- Description

In addition, definitions may contain sections for the following:

- Commands
- Examples
- See Also

Syntax

Each utility description includes a syntactical description of the command line. These symbolic descriptions use the following notations:

`[ ]`= Enclosed items are optional

`{ }`= Enclosed items may be used 0, 1, or multiple times

`< >`= Enclosed item is a description of the parameter to use. For example:

`<path>`	=	A legal pathlist
`<devname>`	=	A legal device name
`<modname>`	=	A legal memory module name
`<procID>`	=	A process number
`<opts>`	=	One or more options specified in the command description
`<arglist>`	=	A list of parameters
`<text>`	=	A character string ended by end-of-line
`<num>`	=	A decimal number, unless otherwise specified
`<file>`	=	An existing file
`<string>`	=	An alphanumeric string of ASCII characters

An example of a syntax line follows.

Syntax

```
bootpd [<opts>] {<configfile>}
```

Options

The options section lists and defines command line options for the utility.

Description

The description section defines the processing of the utility.

Commands

Where applicable, commands for each utility are listed and defined.

Examples

The examples section provides sample uses for the utility.

See Also

This section lists utilities that are related to the current one. You may want to refer to these utilities for additional information.

arp

Ethernet/IP Address Resolution Display and Control

Syntax

```
arp [<opts>]
```

Options

`<hostname>`	Display ARP entry for `<hostname>`.
`-a`	Display all of the ARP table entries.
`-d <hostname>`	Delete an entry for the host called `hostname`. This option can only be used by the super-user.
`-n`	This option can be used when specifying a single hostname, or with the `-a` option. It indicates that IP addresses should not be resolved to hostnames. A "?" will be printed instead of the hostname.
`-s  <hostname> <eth_addr> [temp][pub]`	Create an ARP entry for the host called `<hostname>` with the Ethernet address `<ether_addr>`. The Ethernet address is given as six hex bytes separated by colons. The entry is permanent unless the word `temp` is given in the command. If the word `pub` is given, the entry will be published. For instance, this system responds to ARP requests for `hostname` even though the hostname is not its own. This option can only be used by the super-user.

Description

The `arp` program displays and modifies the Internet-to-Ethernet address translation tables used by the address resolution protocol (ARP). This table is maintained by the `spenet` driver. The age field indicates the number of minutes the entry has been in the table. Non-permanent entries are removed after 20 minutes.

With no flags, the program displays the current ARP entry for `<hostname>`. The host may be specified by name or by number, using Internet dot notation.

Note

To use `arp` you must have at least edition 38 of the `spenet` driver. To check the `spenet` edition on your system, type `ident -m spenet` in your OS-9 command line.

Examples

Publish a temporary arp entry for a machine called odin.

```
arp -s odin 04:00:00:12:34:56 pub temp
```

This entry will expire after 20 minutes. To make it permanent, leave the `temp` qualifier off.

See Also

`ifconfig`
`netstat`

bootpd

BOOTP Request Server Daemon

Syntax

```
bootpd [<opts>] {<configfile>}
```

Options

`-?`	Displays the syntax, options, and command description of `bootpd`.
`-d`	Log debug information to `<stderr>`.
`-t <num>`	Exit after `<num>` minutes of no activity.

Description

`bootpd` is the server daemon handling client BOOTP requests. `bootpd` must be run as super user.

The `-d` option causes `bootpd` to display request activity which is useful to diagnose BOOTP client request problems. Each additional `-d` (up to three) appearing on the command line gives more debugging messages.

Each time a client request is received, `bootpd` checks to see if the `<configfile>` has been updated since the last request. This enables changes to `<configfile>` without restarting `bootpd`. By default, configfile is `/h0/TFTPBOOT/bootptab`.

`bootpd` is normally run in a LAN Communications Pak startup file as follows:

```
bootpd /h0/TFTPBOOT/bootptab <>>>/nil&
```

`bootpd` looks in `inetdb` (using `getservbyname()`) to find the port numbers it should use. Two entries are extracted:

`bootps`	The bootp server listening port.
`bootpc`	The destination port used to reply to clients.

If the port numbers cannot be determined this way, the port numbers are assumed to be 67 for the server and 68 for the client.

Note

- Super user account is required to run `bootpd`.
- End the command line with an ampersand (&) to place `bootpd` in the background (example, `bootpd<>>>/nil&`).
- `bootpd` is used in conjunction with `tftpd`.

For More Information

Refer to **Chapter 7: BOOTP Server** for how to set up the BOOTP Server.

bootptest

Test Utility for BOOTP Server Response

Syntax

```
bootptest -h=<hostname> -e=<etheraddr>
-n=<filename> [<opts>]
```

Options

`-h=<hostname>`	Target server IP address (name or dotted decimal).
`-e=<etheradr>`	Ethernet address in colon notation.
`-n=<filename>`	Bootfile name for `bootp` server.
`-f=<filename>`	Copy bootfile into `<filename>`.

Description

`bootptest` sends a BOOTP request to the network and waits for a response from a BOOTP server. If a response is received, `bootptest` attempts to read the bootfile from the server. `bootptest` provides a way to test a BOOTP server setup without using an actual diskless client.

The `-h`, `-e`, and `-n` options are required and must appear on the command line. `-h` accepts a name which is converted to an IP address using `gethostbyname()`.

If a host name is unavailable, the IP address can be given in dotted decimal notation.

To broadcast, specify 0 or 255 as the host portion of the IP network address. This solicits a response from any BOOTP server on the named network.

The BOOTP client test utility may use all ones (255.255.255.255) for the server IP address when it boots if it does not yet know its IP address. An IP address of all ones is received as a broadcast by any IP host with a socket bound to the `bootps` port (UDP 67). `bootpd` uses the contents of the BOOTP message to indicate where the broadcast came. Otherwise, `bootptest` can use the IP address of the system.

The `bootptab` configuration file on the `bootpd` server must specify an entry for the system on which `bootptest` is running. `bootptest` cannot perform a proxy test for another host because the `bootpd` server directs the BOOTP response to the intended client's IP address, not the IP address from which `bootptest` is running.

The most useful test is a simple assurance test that `bootpd` is properly running on the server system. Run `bootptest` naming `loopback` or the host's own hostname and see if a response is received from `bootpd`. Use the `-d` option in `bootpd` to display log messages.

Example: The following is an example of `bootptest`:

```
bootptest -h=192.52.109.255 -e=8:0:3E:20:52:84
-n=os9boot
```

dhcp

DHCP Client Negotiation Utility

Syntax

```
dhcp [<eth_dev>] [<opts>]
```

Options

`-v`	Verbose mode. Prints additional information about what the program is doing.
`eth_dev`	Is the name of Ethernet device in `inetdb` module.
`-broadcast <address>`	Sets the expected DHCP broadcast address.
`-nofork`	Does not fork child DHCP process.
`-timeout <seconds>`	Number of seconds to wait for DHCP reply.
`-port <port>`	UDP port of DHCP server.

Description

`dhcp` is the DHCP client negotiation utility.

The `eth_dev` parameter is the name of the Ethernet interface used with `ndbmod` or `idbgen`. This name should not be confused with the ethernet device descriptor or driver. If no device is specified on the command line, and only one interface was added with `ndbmod` or `idbgen`, `dhcp` uses it.

The `broadcast` flag specifies that the DHCP server does not correctly broadcast IP packets to the address 255.255.255.255, but to some other broadcast address (usually `<network>.255`).

The `timeout` flag enables the user to specify how long `dhcp` waits before retrying a failed request. The default is 10 seconds.

The `-nofork` flag stops the `dhcp` client creating a child process and exiting. This is not normally used.

If the lease time on the IP address supplied by the DHCP server expires, DHCP removes the address, and reverts back to requesting an IP address.

If the DHCP Server supplies DNS information, `dhcp` attempts to add it to an `inetdb` module. Space for this is provided by creating a new `inetdb3` with the `ndbmod` command.

Examples

Sample output from `dhcp` using the verbose mode.

```
# dhcp -v
DHCP: Ethernet device name 'enet0'
DHCP: Ethernet SPF descriptor name '/spe30'
DHCP: Eth Address is 00:60:97:8C:28:7B
DHCP: Adding IP address: 0.0.0.0
DHCP: Adding broadcast address: 255.255.255.255
DHCP: Adding subnet mask: 0.0.0.0
Sending DHCPDISCOVER to 255.255.255.255
Sending DHCPREQUEST to 255.255.255.255
DHCP: Adding IP address: 192.168.3.200
DHCP: Adding broadcast address: 192.168.3.255
DHCP: Adding subnet mask: 255.255.255.0
DHCP: Received a lease for 3600 seconds
DHCP: adding default route to 192.168.3.225
DHCP: Offered domain name: microware.com
DHCP: Offered DNS Server 172.16.1.32
DHCP: Adding DNS Server 172.16.1.32
```

See Also

`ifconfig`

`ndbmod`

ftp

File Transfer Manipulation/Remote Internet Site Communication

Syntax

```
ftp [<opts>] [<host>][<opts>]
```

Options

Options may be specified at the command line or to the command interpreter.

`-?`	Displays the description, options, and command syntax for `ftp`.
`-d`	Turns on debugging mode.
`-g`	Does not expand wildcard file name expansion (globbing).
`-n`	Does not attempt auto-login upon initial connection. If auto-login is enabled, `ftp` uses the login name on the local machine as the user identity on the remote machine. It then prompts for a password, and optionally, an account with which to login.
`-r`	Turn on overwrite mode to allow copying over existing same-name files with files received when performing `get` operations.
`-s`	Does not set the file size on received data. By default, `ftp` attempts to pre-extend the file when retrieving a file. Often, a remote server includes the file size in the response string when it opens a data connection. `ftp` recognizes a byte specification with the form (`xxxx` bytes), if the response code is 150 or 125. If the file size is not included or a different response code is used, `ftp` does not attempt to pre-extend the file.
`-v`	Verify verbose mode is enabled.

Description

ftp is the user interface to the ARPANET standard file transfer protocol. ftp transfers files to and from a remote network site.

If <host> is specified on the command line, ftp immediately attempts to establish a connection to an FTP server on that host.

If <host> is not specified, ftp enters its command interpreter. Then, a current status report of the ftp modes displays and ftp waits for instructions. When waiting for commands, ftp displays the prompt ftp. For example:

```
ftp
Not connected.
Mode: stream   Type: asciiForm: non-printStructure: file
Verbose: on    Bell: offPrompting: onGlobbing: on
Hash mark printing: off Use of PORT commands: off
Overwrite: off Directory Recursion: off
ftp>
```

File Naming Conventions

Local files specified as parameters to ftp commands are processed according to the following rules:

- If the first character of the file name is an exclamation point (!), the remainder of the parameter is interpreted as a shell command. ftp then forks a shell with the supplied parameter and reads (writes) from the standard output (standard input) of that shell. If the shell command includes spaces, the parameter must be quoted (for example "! ls -lt"). A useful example of this mechanism is "dir !more".
- Failing these checks, if globbing (wildcard expansion) is enabled, local file names are expanded.

Note

ftp does not process remote file names. They are passed just as they are typed, except for the mdelete, mdir, mget, mput, and mls commands. The file names passed to these commands are expanded according to the rules of the remote host's server. Expansion is accomplished by sending ls or dir to the server.

File Transfer Protocols

The FTP specifies many parameters which may affect a file transfer. LAN Communications Pak currently supports the following type, mode, and structure parameters.

type — Can be:

- ascii specifies network ASCII (used where end of line conversion is required)
- image or binary specify image

mode — Must be stream.

structure — Must be file.

Commands

Once in the command interpreter, the following ftp commands are available:

$ [<command>] — Runs as a shell command on the local machine. If <command> is unspecified, it starts an interactive shell.

append [<local> [<remote>]]
Appends <local> to a file on the remote machine. If <remote> is unspecified, the <local> name is used in naming the remote file. If neither <local> or <remote> is

	specified, `ftp` prompts for the appropriate information. File transfer uses the current settings for transfer `type`, `structure`, and `mode`.
`ascii`	Sets the file transfer type to network ASCII. This is the default.
`bell`	Announces the completion of file transfers with a bell.
`binary`	Sets the file transfer type to support binary image transfer.
`bye`	Terminates the FTP session and exits (same as `quit`).
`cd[<directory>]`	Changes the current directory on the remote system (same as `chd`). If `<directory>` is not specified, `cd` prompts for one.
`cdup`	Changes remote working directory to parent directory.
`chd[<directory>]`	Changes the current directory on the remote system (same as `cd`). If `<directory>` is not specified, `chd` prompts for one.
`close`	Terminates the remote session and returns to the FTP command interpreter.
`connect[<host>[<port>]]`	Connects to remote FTP. Same as open.
`debug [<value>]`	Toggles socket level debugging mode. When debugging is on, `ftp` prints each command sent to the remote machine, preceded by the string `-->`.

Note

`<value>` is accepted as a parameter, but is not supported.

`delete [<remote>]`	Deletes a file on the remote machine. If `<remote>` is not specified, `ftp` prompts for the file name.
`dir [<remote> [<local>]]`	Displays a remote directory listing. If `<remote>` is not specified, `dir` displays the current remote directory. If `<local>` is specified, `dir` redirects the directory listing to the specified file instead of to standard output.
`form`	Sets the file transfer form. `non-print` is the only form supported.
`get [<remote> [<local>]]`	Copies the file `<remote>` to the local system. If `<local>` is unspecified, `get` copies `<remote>` to a file with the same name. `get` uses the current settings for transfer `type`, `structure`, and `mode` while transferring the file. This command is the same as `recv`. If `<remote>` is not specified, `get` prompts for it and `<local>`.
`glob`	Toggles globbing (wildcard expansion) of remote file names for `mdelete`, `mget`, and `mput`. If globbing is turned off, file names are taken literally. Globbing is on by default.
`hash`	Toggles printing # (hash marks) for each buffer transferred. Hash is off by default.
`help [<command>]`	Prints a help message about a command if specified (same as ?). If `<command>` is unspecified, `help` displays a list of available commands.
`lcd [<directory>]`	Changes the current local directory (same as `lchd`). If directory is unspecified, `ftp` changes to local home directory.
`lchd [<directory>]`	Changes the current local directory (same as `lcd`). If directory is unspecified, `ftp` changes to local home directory.

ls [<remote> [<local>]]
: Displays an abbreviated directory from the remote system. If <remote> is unspecified, ls displays the current remote directory. If <local> is specified, ls redirects the directory listing to the specified file instead of to standard output.

mdelete [<remote>]
: Deletes multiple files on the remote system. Specify <remote> using file name wildcards (example, ch*.doc).

mdir [<remote> <local>]
: Redirects the display of the contents of remote directories to a local file. Specify <remote> using file name wildcards (example, chap*.doc). If <local> and <remote> are unspecified, ftp prompts for the appropriate information.

mget [<remote>]
: Copies the remote files to the current local directory. <remote> may be specified using file name wildcards (example, chap*.doc).

makdir [<remote>]
: Makes a directory on the remote system (same as mkdir). If <remote> is unspecified, ftp prompts for the directory name.

mkdir [<remote>]
: Makes a directory on the remote system (same as makdir). If <remote> is unspecified, ftp prompts for the directory name.

mls [<remote> [<local>]]
: Redirects the display of remote file/directory listings to the file <local>. <remote> may be specified using file name wildcards (example, chap*.doc). If <remote> and <local> are unspecified, ftp prompts for the appropriate information.

mode [<mode>]
: Sets the transfer mode to <mode>. stream is the only accepted <mode>.

`mput [<local>]` — Expands wildcards in the list of `<local>` and copies each file in the resulting list to the current remote directory. If `<local>` is not specified, `mput` prompts for files.

`open [<host> [<port>]]` — Establishes a connection to the specified host FTP server. An optional port number may be supplied, in which case `ftp` attempts to contact an FTP server at that port. If the auto-login option is ON (default), `ftp` also attempts to automatically log the user in to the FTP server. If `<host>` is unspecified, `ftp` prompts for the host name.

`overwrite` — Toggles whether local files are overwritten (if the user has write permissions) on subsequent `get/mget` commands. Overwrite is off by default.

`pd` — Prints the name of the current remote directory pathlist (same as pwd).

`prompt` — Toggles interactive prompting for commands involving multiple file transfers. Interactive prompting occurs during multiple file transfers to enable selective retrieval or storage of files. By default, prompting is turned ON. If prompting is turned off, `mget` or `mput` transfers all files, and `mdelete` deletes all files.

`put [<local> [<remote>]]` — Copies a local file to the remote machine. If `<local>` is unspecified on the command line, `ftp` prompts for both the local and remote file names. If `<local>` is specified on the command line and `<remote>` is unspecified, `ftp` uses the local file name in naming the remote file. File transfer uses the current settings for transfer `type`, `structure`, and `mode`. This command is the same as `send`.

pwd	Prints the name of the current remote directory pathlist (same as pd).
quit	Terminates the ftp session and exits (same as bye).
quote [<params>]	Sends the specified parameters, verbatim, to the remote FTP server. A single FTP reply code is expected in return. If parameters are unspecified on the command line, ftp prompts for them.
recurse	Toggles whether directory recursion takes place during any subsequent mget/mput commands, (example, transfer all files in subdirectories, making any needed directories along the way). Recurse is off by default.
recv [<remote> [<local>]]	Copies a remote file to the local system. If <local> is unspecified, recv copies <remote> to a file with the same name. recv uses the current settings for transfer type, structure, and mode while transferring the file. This command is the same as get. If <remote> is unspecified, recv prompts for both <remote> and <local>.
remotehelp [<command>]	Requests help from the remote FTP server (same as rhelp). If specified, <command> is supplied to the server as well.
rename [<old> [<new>]]	Renames the remote file <old> to have the name <new>. If <old> or <new> are unspecified on the command line, ftp prompts for the appropriate information.
rhelp [<command>]	Requests help from the remote FTP server (same as remotehelp). If specified, <command> is supplied to the server as well.

`rmdir [<remote>]`	Deletes a directory on the remote machine. If `<remote>` is unspecified on the command line, `ftp` prompts for the directory name.
`send [<local> [<remote>]]`	Copies `<local>` to the remote machine. If `<local>` is unspecified, `ftp` prompts for both the local and remote file names. If `<local>` is specified and `<remote>` is not, `send` uses the local file name in naming the remote file. File transfer uses the current settings for transfer `type`, `structure`, and `mode`. This command is the same as `put`.
`sendport`	Toggles the use of PORT commands. By default, `ftp` attempts to use a PORT command when establishing a connection for each data transfer. If the PORT command fails, `ftp` uses the default data port. When PORT commands are disabled, no attempt is made to use PORT commands for each data transfer. This is useful for certain FTP implementations that ignore PORT commands, but incorrectly indicate they were accepted.

Note

This command does not have any effect. It is accepted as a legal command, but not implemented. `Sendport` commands are *always* used in the current implementation of `ftp`.

`status`	Shows the current status of `ftp`.
`struct [<struct>]`	Sets the file structure to `<struct>`. The only valid `<struct>` is `file`.
`type [<type>]`	Sets the representation type to `<type>`. The valid values for `<type>` are: 1. `ascii` for network ASCII

	2. `binary` or `image` for image If `<type>` not specified, `type` displays the current setting.
`user [<user> [<password>] [<account>]]`	Identifies you to the remote FTP server. If `<user>` is unspecified, `ftp` prompts for it. If the `password` and/or the `account` field is unspecified and the server requires it, `ftp` prompts for it after disabling local echo. Unless `ftp` is called with auto-login disabled, this process is performed automatically on initial connection to the FTP server.
`verbose`	Toggles `verbose` mode. In `verbose` mode, all responses from the FTP server are displayed. In addition, if verbose mode is on, when a file transfer completes, it reports statistics regarding the efficiency of the transfer. By default, if commands are coming from a terminal, `verbose` mode is ON; otherwise, `verbose` mode is OFF.
?	Displays a list of commands available. Reference the `help` command for more information.

ftpd

Incoming FTP Server Daemon

Syntax

```
ftpd [<opts>]
```

Options

`-?`	Displays the description, options, and command syntax for `ftpd`.
`-d`	Prints debugging information to standard error.
`-l`	Prints user login information to standard error.
`-u`	Allow unauthenticated access.
`-f "<cmd> <opts>"`	File listing command (default: dir -ua)
`-e "<cmd> <opts>"`	Extended file listing (default: dir -ea)

Description

`ftpd` is the incoming `ftp` daemon process. It must be running to handle incoming `ftp` connection requests. `ftpd` forks the `ftpdc` communications handler each time a connection to the `ftp` service is made.

To save logging output for later use, redirect the standard error path and standard output path to an appropriate file on the command line:

```
ftpd -d </nil >>>-/h0/SYS/ftpd.debug&
```

or

```
ftpd -l </nil >>>-/h0/SYS/ftpd.login&
```

If neither option is used, redirect the standard error path to the null driver along with the standard input/output paths:

```
ftpd <>>>/nil&
```

Anonymous FTP access is allowed if the password file contains an entry for username `ftp` with a password of `anonymous`. An incoming user can specify either ftp or anonymous as a user name along with any password to successfully login. Anonymous ftp users can access all files on the system using the group/user ID specified for the ftp user in the password file.

If the -u option is specified, no authentication is performed and any username and password combination is accepted. This option is useful to download modules to an embedded target because it does not require either the login utility or a password file.

The -e and -f options can be used to override the default commands ftpd runs when responding to directory listing requests. This can be useful for clients that are unable to parse OS-9's dir command output. For example, a port of the Unix ls command can be run instead of dir to allow web browsers to display directory listings.

```
ftpd -e “ls -l” <>>>/nil&
```

The FTPDIRCMD and FTPEDIRCMD environment variables may also be used. The previous ftpd command line is equivalent to the following.

```
setenv FTPEDIRCMD “ls -l”
ftpd <>>>/nil&
```

Note

- Super user account is required to run ftpd.
- End the command line with an ampersand (&) to place ftpd in the background (example, ftpd<>>>/nil&).
- inetd can be used in place of ftpd.

ftpdc

FTP Server Connection Handler

Syntax

`ftpdc [<opts>]`

Options

`-?`	Displays the description, options, and command syntax for `ftpdc`.
`-d`	Prints debugging information to standard error.
`-l`	Prints user login information to standard error.
`-u`	Allow unauthenticated access.
`-f “<cmd> <opts>”`	File listing command (default: dir -ua)
`-e “<cmd> <opts>”`	Extended file listing (default: dir -ea)

Description

`ftpdc` is the incoming communications handler for `ftp`. `ftpd` and `inetd` can fork `ftpdc`.

Note

Do not run this from the command line. Only `ftpd` and `inetd` can invoke this utility.

hostname

Display or Set Internet Name of Host

Syntax

```
hostname [<name>]
```

Options

`-?`	Displays the description, options, and command syntax for `hostname`.

Description

`hostname` prints or sets the string returned by the socket library `gethostname()` function. By default, `gethostname()` returns the `net_name` string appearing in the `inetdb` data module. Use `hostname` to override the default. The length of the string is limited to the length of the current string in the `inetdb` data module.

idbdump

Display Internet Database Entries

Syntax

`idbdump [<opts>] [<inetdb_file>] [<opts>]`

Options

`-?`	Displays the description, options, and command syntax for `idbdump`.
`-d[=]<file>`	Only display `<file>` entries. Allowable files are `host.conf`, `hosts`, `hosts.equiv`, `inetd.conf`, `networks`, `protocols`, `resolv.conf`, `services, interfaces.conf, hostname`, `routes.conf`, or `rpc`.
`-m`	Use the `inetdb` data module in memory (OS-9 resident systems only).

Description

`idbdump` displays a formatted listing of the entries in the internet database. If options are not specified, `idbdump` displays all entries in the database. Specific options display the appropriate type of database entries.

By default, `idbdump` looks for the internet database as the file `inetdb` in the current data directory. This default can be overridden by a command line path list to the file, or by the `-m` option.

This command is also available under the Windows 95/NT operating systems.

See Also

`idbgen`

idbgen

Generate Network Database Module(s)

Syntax

```
idbgen [<opts>] [<filename>] [<opts>]
```

Options

`-?`	Displays the description, options, and command syntax for `idbgen`.
`-c`	Produces an `inetdb` compatible with ISP.
`-d=<path>`	Specifies the directory to find the network database files (default is current directory). This option can be repeated to search multiple directories.
`-r=<num>`	Sets the module revision to `<num>`.
`-to[=]<target>`	Specifies the target operating system. (The default is `OS9000`)

Table 8-3 Target Operating System <target>

<target>	Operating System
OSK	OS-9 for Motorola 68000 family processors
OS9000 or OS9K (default)	OS-9

`-tp=<target>`	Specifies the target processor and options. (default is PPC on cross-hosted machines.)

WARNING

When using `-to=<target>` or `-tp=<target>`, `idbgen` does not recognize the target options in lowercase. For example, `osk`, is not recognized; `OSK` is.

Table 8-4 Target Processor and Options

<target>	Processor
`68k or 68000`	Motorola 68000/68010/68070
`CPU32`	Motorola 68300 family
`020 or 68020`	Motorola 68020/68030/68040
`040 or 68040`	Motorola 68040
`386 or 80386`	Intel 80386/80486/Pentium
`PPC` (default)	Generic PowerPC
`403`	PPC 403
`601`	MPC 601
`603`	MPC 603
`ARM`	Generic ARM processor
`ARMV3`	ARM V3 processor
`ARMV4`	ARM V4 processor

`-x`	Places the modules in the execution directory (only for OS-9 for 68K/OS-9 resident systems).
`-z[=]<file>`	Read additional command line arguments from `<file>`. (The default is standard input.)

Description

`idbgen` generates the OS-9 data modules `inetdb` and `inetdb2` from the network database files: `host.conf`, `hosts`, `hosts.equiv`, `inetd.conf`, `networks`, `protocols`, `resolv.conf`, `interfaces.conf`, `routes.conf`, `services` and `rpc`. Any time a change is made to any of these files, `idbgen` must be used to generate new data modules.

By default, the output internet database modules are named `inetdb` and `inetdb2` and are placed in the current directory. An optional command line file name can override this default by specifying the pathlist to the output files.

By default, `idbgen` looks for the network database files in the current directory. However, the `-d` option can be used to specify the directories containing the files.

For More Information

Refer to **Appendix A: Configuring LAN Communications Pak** for definitions and descriptions of the configuration files.

This command is also available under the Windows 95/NT operating systems.

See Also

`idbdump`

ifconfig

Configure Network Interface

Syntax

```
ifconfig [<interface> [<address> [<dest_address]]
[options]]
```

Options

`<IP Address> <dest_addr|broadcast> [alias]`	Change IP address and broadcast address [add an alias].
`netmask <subnet mask>`	Change subnet mask.
`broadcast <addr>`	Change broadcast address.
`up`	Mark interface as up.
`down`	Mark interface as down.
`delete`	Delete IP address or alias.
`binding <device>`	Bind device to interface name.
`iff_nopointopoint`	Override driver `iff_pointopoint` flag.
`iff_pointopoint`	Indicate the interface being added is a point-to-point link. (deprecated)
`iff_nobroadcast`	Override driver `iff_broadcast` flag.
`iff_broadcast`	Indicate the interface being added is capable of sending broadcasts. (deprecated)
`iff_nomulticast`	Override driver `iff_multicast` flag.

Description

`ifconfig` assigns an address to a network interface and/or configures network interface settings. It can also dynamically add an interface to the system.

`address`	The address is either a host name present in the host name data base, or an Internet address expressed in the standard Internet dot notation.
`alias`	Establish an additional network address for this interface. Useful when changing network numbers and accepting packets addressed to the old interface.
`binding <device>`	Dynamically add a new interface to the system. The device parameter specifies the device/protocol descriptors(s) which will be opened and associated with the specified interface name (for example, `/spe30/enet`).
`broadcast <addr>`	Specify the address to use to represent broadcasts to the network. The default broadcast address has a host part of all 1s.
`delete`	Remove the network address specified. Used when an alias is incorrectly specified, or no longer needed.
`dest_address`	Specify the address of the peer on the other end of a point-to-point link.
`down`	Mark an interface down. When an interface is marked down, the system does not attempt to transmit messages through that interface. Incoming packets on the interface are discarded. This action does not automatically disable routes using the interface.
`iff_nobroadcast`	Drivers that are capable of sending broadcasts will automatically set the `iff_broadcast` flag. If you do not want to send broadcasts from a particular

	ethernet card this option could be used to prevent the flag from being set. This option requires the `binding` option.
`iff_broadcast`	Indicates the interface can send broadcasts. Used in conjunction with the `binding` option when creating a new interface. The broadcast option automatically implies this setting. This option is provided for compatibility, the preferred method is for the driver to set this flag.
`iff_nopointopoint`	Overrides the `iff_pointopoint` flag that is set automatically by the slip and ppp drivers. This option requires the `binding` option.
`iff_pointopoint`	Indicates that the interface is a point-to-point link. Used in conjunction with the `binding` option when creating a new interface. This option is provided for compatibility, the preferred method is for the driver to set this flag.
`iff_nomulticast`	Overrides the `iff_multicast` flag set by multicast capable interfaces. This option is useful if you do not wish to send or receive any multicast packets and are on a network with a high volume of multicast traffic.
`interface`	The interface parameter is a string of the form `nameX` where X is the integer unit number (for example, `enet0`). The name is used internally by IP and is not the name of a file or module.
`netmask <mask>`	Specify how much of the address to reserve for subdividing networks into sub-networks. The mask includes the network part of the local address and the subnet part, which is taken from the host

	field of the address. The mask can be specified as a single hexadecimal number with a leading `0x`, with a dot-notation Internet address, or with a pseudo-network name listed in the `inetdb` network table "networks". The mask contains 1s for the bit positions in the 32-bit address which are to be used for the network and subnet parts, and 0s for the host part. The mask contains at least the standard network portion, and the subnet field is contiguous with the network portion.
`up`	Mark an interface up. Used to enable an interface after an ifconfig down. It happens automatically when setting the first address on an interface.

`ifconfig` displays the current configuration for a network interface when no options are supplied. Only the super-user can modify the configuration of a network interface.

Examples

Create a new interface `enet0`:

```
ifconfig enet0 172.16.1.1 binding /spe30/enet
```

Since no netmask or broadcast address was specified, the appropriate class A, B, or C addresses will be used. In this case, the netmask `255.255.0.0` and a broadcast address of `172.16.255.255` will be used. To override the default netmask:

```
ifconfig enet0 172.16.1.1 netmask 255.255.255.0 binding /spe30/enet
```

This will also change the broadcast address to `172.16.1.255`.

Create a new interface, but disable its multicast capability.

```
ifconfig enet0 odin iff_nomulticast binding /spe30/enet
```

This example also uses a machine name instead of an IP address. For this to work, the name must either be resolvable in your local `inetdb` or by a DNS name server reachable by an interface other than the one being added.

Change the address of an existing interface:

```
ifconfig enet0 loki
```

If the hardware driver supports it, you can add an alias to an already existing interface:

```
ifconfig enet0 thor alias
```

Remove the alias:

```
ifconfig enet0 thor delete
```

Create the point-to-point interface `ppp0` without any address information:

```
ifconfig ppp0 binding /ipcp0
```

Set the local and destination address of a point-to-point link:

```
ifconfig slip0 192.168.8.175 192.168.8.174
```

Show the address information for interface `enet0`:

```
ifconfig enet0
```

The output is similar to the following:

```
enet0: flags=8003<UP,BROADCAST,MULTICAST> mtu 1500
inet 172.16.1.1 netmask 0xffff0000 broadcast 172.16.255.255
```

or for a point-to-point interface:

```
ppp0: flags=8011<UP,POINTOPOINT,MULTICAST> mtu 1500
inet 192.168.8.175 --> 192.168.8.174 netmask 0xffffff00
```

See also

`netstat`

inetd

Internet Master Daemon

Syntax

`inetd [<opts>]`

Options

`-?`	Displays the description, options, and command syntax for `inetd`.
`-i[...]`	Internal `inetd` options.

Description

`inetd` is a master internet daemon process, that can be configured to listen for incoming TCP or UDP connections on up to 25 separate ports. When `inetd` detects an incoming connection, it forks a child process (for example `telnetdc` or `ftpdc`) to handle the connection.

The `inetd.conf` file specifies the configuration for the `inetd` process. Each non-comment or non-white space line in this file specifies a service which `inetd` provides. Each line has the following syntax:

```
<ServiceName> <SocketType> <Protocol> <Flags> <User>
<ServerPathname> [<Args>]
```

`ServiceName`	Specifies the internet service to be provided. This service name must also be specified in the `<services>` section of the `inetdb` data module. The port number for the specified service is referenced through the `<services>` section of `inetdb`.
`SocketType`	Specifies whether the socket type is a `stream` (for TCP services) or `dgram` (for UDP services).
`Protocol`	Specifies the protocol type to use for this service. This protocol name must also be specified in the `<protocols>` section of the `inetdb` data module.

`Flags`	Specifies special actions `inetd` should take when processing incoming connections for this service. `Wait` is the only valid `Flags` action.
`User`	Specifies the group/user under which the forked child process should run—either in the format `<group>.<user>` (such as “12.136”), the keyword `root` (resolving to user “0.0”), or the keyword `nobody` (resolving to user “1.0”).
`ServerPathname`	Specifies the child process to fork when an incoming connection for the specified service is detected. This may be just the program name if it is in memory or in the current path, or it may be a full path name to the program file. Eight special services, `echo` (`dgram` & `stream`), `discard` (`dgram` & `stream`), `daytime` (`dgram` & `stream`), and `chargen` (`dgram` & `stream`) are handled internally by `inetd` by specifying the server path name “`internal`”.
`Args`	Specifies additional arguments to use when forking the child process.

When `inetd` forks a child process to handle an incoming service request, the child is forked with three paths: `stdin` and `stdout` are the connected socket paths and `stderr` is the `stderr` path with which `inetd` was forked. If the service was on a `udp/dgram` socket, a `connect()` is performed before forking the child. If the service was on a `tcp/stream` socket, an `accept()` is performed before forking the child.

Note

Super user account is required to run `inetd`.

ipstart

Initialize IP Stack

Syntax

```
ipstart
```

Options

None.

Description

`ipstart` initializes the IP stack at startup. Run this utility in the foreground.

ndbmod

Dynamically Update the Internet Data Module

Syntax

```
ndbmod <[opts]>
```

Options

-?	Displays the description, options, and command syntax for ndbmod.
hostname <hostname>	Set hostname of the system.
interface <options>	Add or delete an interface.

Options are defined as follows:

```
add <intname> [address <addr> [netmask <addr>] \
[broadcast|destaddr <addr>]] binding <device> [mtu <mtu>] \
[metric <metric>] [up|down] [iff_broadcast][iff_pointopoint]
[iff_nomulticast] [iff_nobroadcast] [iff_nopointopoint]

del <intname>
```

The [iff_broadcast]and [iff_broadcast] flags are for compatibility with older version of the LAN Communications Pak. The preferred method is to let the driver set these flags and to use the [iff_noXXX] flags to override the driver defaults.

resolve <arglist>	Add DNS search and resolver information.

Options are defined as follows:

```
<domainname [server <addr>]* [search <srch-1> <srch-2> ...]
```

`host <options>`	Add or delete a host entry.

Options are defined as follows:

```
add <addr> <name> [<alias-1> <alias-2> ...]

del <name|alias>
```

`route <options>`	Add static route.

Options are defined as follows:

```
add [host|net] <dst-route> <gateway> [<netmask>]

add [default]<gateway>[<netmask>]
```

`create <modname> <num-files> <size-1> <size-2>... <size-n>`

Create a dynamic Internet data module having <num-files> files.

`<size-1>`	indicates bytes to reserve for file 1
`<size-2>`	indicates bytes to reserve for file 2 All file sizes must be specified, with 0 indicating no space is reserved for that file.
`<modname>`	is one of '`inetdb2`', '`inetdb3`', or '`inetdb4`'

File Numbers

1	`/etc/hosts` (aprox. 25 bytes per host)
2	`/etc/hosts.equiv` (not used)
3	`/etc/networks` (aprox. 40 bytes per network)
4	`/etc/protocols` (aprox. 25 bytes per protocol)
5	`/etc/services` (aprox. 25 bytes per service)

6	`/etc/inetd.conf` (aprox. 50 bytes per entry)
7	`/etc/resolv.conf` (aprox. 100 bytes)
8	host config (not used)
9	host interfaces (aprox 200 bytes per interface)
10	hostname (>= length of hostname + 1, recommended 65)
11	static routes (aprox. 64 bytes per entry)
12-32	reserved

Description

The `ndbmod` utility allows the user to add, remove, or modify information stored in the `inetdb` data module such as host names, IP addresses, and DNS Server fields dynamically. It also enables the creation of expansion `inetdb` modules in the event that the `inetdb` data module is full or in ROM.

These expansion modules can also hold additional host specific information such as the machines `hostname`, and interface settings such as IP address and network masks.

Note

`ndbmod` must be run before the IP stack is initialized.

Examples

Example 1:

To create an alternate `inetdb` module called `inetdb2` with 100 bytes for new host information, 0 for `hosts.equiv`, 30 for new network entries:

```
ndbmod create inetdb2 12 100 0 30 30 0 50 200 100 0 150 64
```

Example 2:

To set the hostname for a system name alpha:

```
ndbmod hostname alpha
```

Example 3:

To add a host entry for system beta with alias of beta1 and beta2:

```
ndbmod host add 192.1.1.3 beta beta1 beta2
```

Example 4:

To remove the host entry for beta:

```
ndbmod host del beta
```

Example 5:

To add a SLIP interface to an `inetdb2` data module:

```
ndbmod interface add  slip0 address 192.1.1.1 \
destaddr 192.1.1.2 binding /spsl0
```

Example 6:

To delete a SLIP interface from the `inetdb2` data module:

```
ndbmod interface del slip0
```

Example 8:

To add an ethernet interface and disable the multicast capabilities:

```
ndbmod interface add enet0 address 172.16.1.1 \
iff_nomulticast binding /spe30/enet
```

Example 7:

To add a new DNS resolve entry to the `inetdb2` data module:

```
ndbmod resolve testdns.com server 192.1.1.3 search
   testdns.com misc.org
```

Example 8:

To add a static network route to the `inetdb2` data module:

```
ndbmod route add network 192.2.2.0 192.1.1.2
```

See Also

`idbgen`

netstat

Report Network Information

Syntax

```
netstat [<opts>]
```

Options

`-A`	With the default display, show the address of any protocol control blocks associated with sockets; used for debugging.
`-a`	With the default display, show the state of all sockets; normally sockets used by server processes are not shown. With the interface display show all multicast groups each interface has joined.
`-d`	With either interface display (option `-i` or an interval), show the number of dropped packets.
`-f address_family`	Limit statistics or address control block reports to those of the specified address family. Only `inet` (for `AF_INET`) is currently supported.
`-I interface`	Show information about the specified interface; used with a wait interval.
`-i`	Show information for all interfaces.
`-n`	Show network addresses as numbers (normally `netstat` interprets addresses and attempts to display them symbolically). This option `may` be used with any of the display formats.
`-p protocol`	Show statistics about protocol, which is either a well-known name for a protocol or an alias for it. A null response

	typically means that there are no interesting numbers to report. The program complains if the protocol is unknown or if there is no statistics routine for it.
`-s`	Show per-protocol statistics. If this option is repeated, counters with a value of zero are suppressed.
`-r`	Show the routing tables. When `-s` is also present, show routing statistics instead.
`-w wait`	Show network interface statistics at intervals of wait seconds.

Description

The `netstat` command symbolically displays the contents of various network-related data structures.

The default display, for active sockets, shows the local and remote addresses, send and receive queue sizes (in bytes), protocol, and the internal state of the protocol. Address formats are of the form “`host.port`” or “`network.port`” if a socket's address specifies a network but no specific host address. When known, the host and network addresses are displayed symbolically according to the data module `inetdb` `hosts` and `networks` sections. If a symbolic name for an address is unknown, or if the `-n` option is specified, the address is printed numerically. Unspecified, or “wildcard”, addresses and ports appear as “`*`”.

The interface display provides a table of cumulative statistics regarding packets transferred, errors, and collisions. The network addresses of the interface and the maximum transmission unit (“`mtu`”) are also displayed.

The routing table display indicates the available routes and their status. Each route consists of a destination host or network and a gateway to use in forwarding packets. The flags field shows a collection of information about the route stored as binary choices.

The mapping between letters and flags is shown in **Table 8-5 Mapping Between Letters and Flags** .

Table 8-5 Mapping Between Letters and Flags

1	`RTF_PROTO2`	Protocol specific routing flag #1
2	`RTF_PROTO1`	Protocol specific routing flag #2
B	`RTF_BLACKHOLE`	Just discard pkts (during updates)
C	`RTF_CLONING`	Generate new routes on use
D	`RTF_DYNAMIC`	Created dynamically (by redirect)
G	`RTF_GATEWAY`	Destination requires forwarding by intermediary
H	`RTF_HOST`	Host entry (net otherwise)
L	`RTF_LLINFO`	Valid protocol to link address translation.
M	`RTF_MODIFIED`	Modified dynamically (by redirect)
R	`RTF_REJECT`	Host or net unreachable
S	`RTF_STATIC`	Manually added
U	`RTF_UP`	Route usable
X	`RTF_XRESOLVE`	External daemon translates proto-to-link address

Routes are automatically created for each directly connected subnet. The gateway field for such entries shows the address of the outgoing interface. In addition a route to the loopback address (127.0.0.1) is also added for each interface. The `Refs` field gives the current number of active uses of the route. Connection oriented protocols normally hold on to a single route for the duration of a connection while connectionless protocols obtain a route while sending to the same destination. The `use` field provides a count of the number of packets sent using that route. The interface entry indicates the network interface used for the route.

When `netstat` is invoked with the `-w` option and a wait interval argument, it displays a running count of statistics related to network interfaces. This display consists of a column for the loopback interface and a column summarizing information for all interfaces. The loopback interface may be replaced with another interface using the `-I` option. The first line of each screen of information contains a summary since the system was last rebooted. Subsequent lines of output show values accumulated over the preceding interval.

Examples

Each of the examples consists of the `netstat` command line followed by sample results.

Display all open sockets

```
netstat -a
Active Internet connections (including servers)
Proto Recv-Q Send-Q  Local Address          Foreign Address        (state)
tcp        0      0  heimdall.1024          thor.ftp               ESTABLISHED
tcp        0      2  heimdall.telnet        odin.1032              ESTABLISHED
tcp        0      0  *.sunrpc               *.*                    LISTEN
tcp        0      0  *.chargen              *.*                    LISTEN
tcp        0      0  *.daytime              *.*                    LISTEN
tcp        0      0  *.discard              *.*                    LISTEN
tcp        0      0  *.echo                 *.*                    LISTEN
tcp        0      0  *.telnet               *.*                    LISTEN
tcp        0      0  *.ftp                  *.*                    LISTEN
udp        0      0  *.route                *.*
udp        0      0  *.chargen              *.*
udp        0      0  *.daytime              *.*
udp        0      0  *.discard              *.*
udp        0      0  *.echo                 *.*
```

Display the interface information for `enet0`:

```
netstat -I enet0
Name  Mtu   Network       Address             Ipkts Ierrs    Opkts Oerrs   Coll
enet0 1500  <Link>      08.00.3E.30.12.5B  8506469     0   833830     8      0
enet0 1500  corp-net    heimdall           8506469     0   833830     8      0
```

Show the interface information for all interfaces, including multicast groups. Display as numbers rather than names.

```
netstat -ian
Name  Mtu   Network       Address             Ipkts Ierrs    Opkts Oerrs   Coll
lo0   1536  <Link>                              120     0      120     0      0
lo0   1536  127         127.0.0.1               120     0      120     0      0
enet0 1500  <Link>      08.00.3E.30.12.5B  8506188     0   833825     8      0
enet0 1500  172.16      172.16.2.56        8506188     0   833825     8      0
enet1 1500  <Link>      00.60.97.60.FE.07   767197     0   847350     2     53
enet1 1500  192.168.3   192.168.3.225       767197     0   847350     2     53
                        224.0.0.9
                        224.0.0.1
ppp0* 65535 <Link>                                0     0        0     0      0
```

Display UDP protocol statistics:

```
netstat -p udp
udp:
    1675124 datagrams received
    0 with incomplete header
    0 with bad data length field
    0 with bad checksum
    20 dropped due to no socket
    1397615 broadcast/multicast datagrams dropped due to no socket
    0 dropped due to full socket buffers
    277489 delivered
    198780 datagrams output
```

Display the TCP protocol statistics, supressing all zero values:

```
netstat -p tcp -ss
tcp:
    722 packets sent
        702 data packets (41861 bytes)
        16 ack-only packets (9 delayed)
        4 control packets
    1092 packets received
        697 acks (for 41865 bytes)
        4 duplicate acks
        621 packets (822 bytes) received in-sequence
        1 completely duplicate packet (0 bytes)
        3 out-of-order packets (0 bytes)
    1 connection request
    3 connection accepts
```

```
    4 connections established (including accepts)
    4 connections closed (including 0 drops)
    698 segments updated rtt (of 699 attempts)
    415 correct ACK header predictions
    384 correct data packet header predictions
    14 PCB cache misses
```

Display the current routing table:

```
netstat -r
Routing tables

Internet:
Destination       Gateway            Flags      Refs      Use  Interface
default           inet-router        UG            1       46  enet0
localhost         localhost          UH            0        0  lo0
corp-net          heimdall           U             9   831463  enet0
heimdall          localhost          UHS           3      120  lo0
test-net          heimdall2          U             2   846425  enet1
heimdall2         localhost          UHS           0        0  lo0
odin              thor               UGH           0        0  enet0
```

ping

Send ICMP ECHO_REQUEST Packets to Host

Syntax

```
ping [<opts>] host
```

Options

`-s <packetsize>`	Number of data bytes to send.
`-?`	Print help.

Description

`ping` sends an ICMP echo request to a specified host and waits for a reply. With the `-s` option, you can specify the size of data to send to the host. Upon success, `ping` displays the number of bytes received from the host and transmission time.

Note

You can ping broadcast and multicast addresses; however, only the first machine to respond will be printed.

route

Add/Delete Routes

Syntax

```
route <opts>
```

Options

`-n`	Show addresses as numbers rather than names.
`add [-net|-host] <dest> <gateway> [<netmask>][-hopcount <num>]`	
	Add a network or host route to `<dest>` going through `<gateway>` to the routing table.
`delete [-net|-host] <dest> [<gateway>]`	
	Delete the route to `<dest>` from the routing table.
`print`	Print routing table.

Description

`route` updates and prints the current routing table once the IP stack has been initialized.

If the optional `<netmask>` is supplied when adding a route, `-net` is automatically assumed. If no `<netmask>` is supplied and the route is a network route, the standard class A, B, or C netmask for `<dest>` is used.

If `routed` is running, the `-hopcount` parameter causes the new route to be included in RIP responses with a metric of <num>.

Examples

Add a route to the `172.16.64.0` network using `heimdall2` as a gateway. The optional `<netmask>` must be used to override the default class B subnet mask.

```
route add -net 172.16.64.0 heimdall2 255.255.255.0
```

To delete the route use either:

```
route delete -net 172.16.64.0 heimdall2 255.255.255.0
```

or, if the network address unambiguously identifies the route, you can use the shorter:

```
route delete 172.16.64.0
```

Add a network route that will be included in routing updates with a metric of 3:

```
route add -net 172.16.0.0 heimdall2 -hopcount 3
```

See Also

`netstat`

`routed`

routed

Dynamic Routing Daemon

Syntax

`routed [<opts>]`

Options

`-?`	Print help.
`-s`	Force `routed` to send routing updates. This is the default if more than one network interface is configured and IP forwarding has been enabled in `spip`.
`-q`	Do not send any routing updates.
`-h`	Do not advertise host routes if a network route to the host also exists.
`-m`	Advertise a host route for the machine’s primary address. The primary address is found by resolving the machine name returned by `gethostname()`.
`-t`	Increase the debugging level causing more trace information to be written to `stdout`. This option can be specified up to four times to select the highest debug level. The debug level can also be increased or decreased by sending a `SIGUSR1` or `SIGUSR2` signal to the `routed` process.
`-A`	Ignore authenticated RIPv2 packets if authentication is disabled. This option is required for RFC 1723 conformance although it can cause valid routes to be ignored.
`-T <file>`	Output trace information to `<file>` instead of `stderr`.

`-P <parm>{[,<parm>]}`	Equivalent to adding `<parm>{[,<parm>]}` to a single line in the `/h0/SYS/gateways` file.
`-F net[/mask][,metric]`	Only send a "fake" default route to this network. This option is used to minimize RIP traffic but can cause routing loops if the route is propagated.

Description

Note

`routed` requires that routing domain support (`sproute` and `route0`) be loaded in the system.

`Routed` is a network routing daemon used to maintain routing tables. It supports the Routing Information Protocol (RIP) versions 1 and 2, and the Internet Router Discovery Protocol as defined in RFC's 1058, 1723, and 1256.

The daemon opens a UDP socket and listens for any routing packets sent to the route port (normally 520) and updates the routing table maintained by `spip`. If the system is configured as a router, copies of the routing table are periodically sent to all directly connected hosts and networks.

When `routed` is started, all non-static routes are removed from the routing table. Any static routes present (such as those added by the `route` utility) are preserved and included in RIP responses if they have a valid RIP metric. Also, if the file `/h0/SYS/gateways` exists, it is read for additional configuration options.

The following options are supported with the `-P` command line option or from `/h0/SYS/gateways`.

`if=<ifname>`	All other options on this line apply to the interface `<ifname>`.

`passive`	Do not advertise this interface, and do not use this interface for RIP and router discovery.
`no_rip`	Disable RIP processing on the specified interface. If Router Discovery Advertisements are not enabled with the `-s` option, `routed` acts as a client router discovery daemon.
`no_ripv1_in`	Ignore all RIP version 1 responses.
`no_ripv2_in`	Ignore all RIP version 2 responses.
`no_rdisc`	Disables the Internet Router Discovery Protocol
`no_solicit`	Disable the transmission of router discovery solicitations.
`no_rdisc_adv`	Disable transmission of router discovery advertisements.
`rdisc_pref=<num>`	Set the preference in router discovery advertisements to `<num>`.
`rdisc_interval=<num>`	Set the interval that router discovery advertisements are sent to `<num>` seconds and their lifetime to 3`* <num>`.

See Also

`route`

telnet

Provide Internet Communication Interface

Syntax

```
telnet [<opts>]
[<hostname> [<portnum>|<servicename>]][<opts>]
```

Options

`-?` Displays the description, option, and command syntax for `telnet`.

`-d` Turns on socket level debugging.

`-e=<ctrl-character> or "-e=^<character>"`
Set escape to user defined character.

`-n` No escape available.

`-o` Shows options processing.

Description

`telnet` communicates with another host using the TELNET protocol. Executing `telnet` without parameters defaults to command mode. This is indicated by the prompt `telnet`. In this mode, `telnet` accepts and executes the commands listed below. If executed with parameters, `telnet` performs an `open` command with those parameters.

Once a connection is opened, `telnet` enters input mode. In this mode, typed text is sent to the remote host. To issue `telnet` commands from input mode, precede them with the `telnet` escape character. The escape character is initially set to control-right-bracket (`^]`) but can be redefined either from the environmental variable `TELNETESCC` or the command line option `-e`. In command mode, normal terminal editing conventions are available.

Commands

The following commands are available. Type enough of each command to uniquely identify it.

`capture [<param>]`	Captures I/O of a `telnet` session to a specified file. `capture` supports four parameters as identified in the following table.

Table 8-6 Capture Parameters

Parameter	Description
`<file>`	Specifies a new file in which to write the I/O of a `telnet` session. If `<file>` already exists, `capture` returns an error. When `<file>` is specified, `capture` creates and opens the file and turns on capture mode.
`on`	Turns on capture mode; begins to write I/O to the current specified capture file.
`off`	Turns off capture mode; stops writing I/O to the specified capture file. **NOTE:** This does not close the file.
`close`	Closes the capture file.

`close`	Closes the current connection and returns to telnet command mode.
`display`	Displays the current `telnet` operating parameters. Refer to `toggle`.
`help [<command>]`	Prints help information for specified `?[<command>]` command. If no command is specified, `help` lists them all.

`mode <param>` Tries to enter line-by-line or character-at-a-time mode.

Table 8-7 Mode Parameters

Parameter	Description
`character`	character at a time.
`line`	line-by-line.

`open [<host>][<port>]`
Opens a connection to the specified `<host>`. If `<host>` is not specified, `telnet` prompts for the host name. `<host>` may be a host name or an internet address specified in dot notation. If the port number is unspecified, telnet attempts to contact a TELNET server at the default port.

`quit` Closes any open telnet connection and exits telnet.

`send [<chars>]` Transmits special characters to telnet as identified in the following table.

Table 8-8 Send Parameters

Parameter	Description
`ao`	Abort Output
`ayt`	‘Are You There’
`brk`	Break
`ec`	Erase Character
`el`	Erase Line

Table 8-8 Send Parameters (continued)

Parameter	Description
`escape`	Current Escape Character
`ga`	‘Go Ahead’ Sequence
`ip`	Interrupt Process
`nop`	‘No Operation’
`synch`	‘Synch Operation’ Command
?	Display send parameters.

`set <param><value>`

Sets `<telnet>` operating parameters by setting local characters to specific telnet character functions. Once set, the local character sends the respective character function to the telnet utility. Specify control characters as a caret (^) followed by a single letter. For example, `control-X` is ^X. `set` supports the parameters identified in the following table:

Table 8-9 Set Parameters

Parameter	Description
`echo <local char>`	Sets character to toggle local echoing on and off.
`erase <local char>`	Sets the `telnet` erase character.
`flushoutput <local char>`	Abort output.

Table 8-9 Set Parameters (continued)

Parameter	Description
`interrupt <local char>`	Sets the `telnet` interrupt character. This character sends an Interrupt Process.
`kill <local char>`	Sets the `telnet` kill character. This character sends an Erase Line.
`quit <local char>`	Sets the `telnet` quit character. This character sends a Break.
?	Display help information.

`status`	Shows the current telnet status. This includes the connected peer and the state of debugging.
`toggle <param>`	Toggles telnet operating parameters, listed in the following table.

Table 8-10 Toggle Parameters

Parameter	Description
`crmod`	Toggles the mapping of received carriage returns. When `crmod` is enabled, any carriage return characters received from the remote host are mapped into a carriage return and a line feed. This mode does not affect characters typed, only those received. This mode is sometimes required for some hosts asking the user to perform local echoing.
`localchars`	Toggles the effects of the set using the `set` command.
`debug`	Toggles debugging mode. When `debug` is on, it opens connections with socket level debugging on. Turning `debug` on does not affect existing connections.
`netdata`	Toggles the printing of hexadecimal network data in debugging mode.
`options`	Toggles the viewing of options processing in debugging mode. Displays options sent by `telnet` as SENT; displays options received from the `telnet` server as RCVD.
?	Display help information.

`z`	Suspends the current `telnet` session and forks a shell.
$	Suspends the current `telnet` session and forks a shell.

telnetd

Incoming Telnet Server Daemon

Syntax

```
telnetd [<opts>]
```

Options

`-?`	Displays the description, options, and command syntax for `telnetd`.
`-d`	Prints the debug information to standard error.
`-f=<program>`	Program to fork (default = “login”).
`-l`	Prints login information to standard error.
`-t`	Idle connection timeout value (in minutes). Default = 0 (no connection timeout).

Description

`telnetd` is the incoming `telnet` daemon process. It must be running to handle incoming `telnet` connection requests. `telnetd` forks the `telnetdc` communications handler each time a connection to the `telnet` service is made.

To save this information for later use, redirect the standard error path and standard output path to an appropriate file on the command line:

```
telnetd -d </nil >>>-/h0/SYS/telnetd.debug&
```

or

```
telnetd -l </nil >>>-/h0/SYS/telnetd.log&
```

If neither option is used, redirect the standard error path to the null driver (along with the standard in/out paths):

```
telnetd <>>>/nil&
```

Note

- Super user account is required to run `telnetd`.

- End the command line with an ampersand (&) to place telnetd in the background (example, `telnetd<>>>/nil&`).

Note

The `-f` option is useful for remote access to a diskless embedded system. The need for a RAM disk with a password file is eliminated with the following command line:

```
telnetd -f=shell <>>>/nil/b
```

(`mshell` can be used in place of `shell`)

A telnet to this machine goes straight to a shell prompt WITHOUT a login prompt.

telnetdc

Telnet Server Connection Handler

Syntax

```
telnetdc [<opts>]
```

Options

-?	Displays the description, options, and command syntax for telnetdc.
-d	Prints the debug information to standard error.
-l	Prints the login information to standard error.
-t	Idle connection timeout value (in minutes). Default = 0 (no connection timeout).
-f = <program>	Program to fork (default = ‘login’)

Description

telnetdc is the incoming connection handler for telnet. telnetdc can only be forked from telnetd or inetd.

Note

Do not run this from the command line. Only telnetd and inetd can fork this utility.

The psuedo keyboard modules pkman, pkdrv, and pk are required. OS-9 for 68K also requires pks.

tftpd

Respond to tftpd Boot Requests

Syntax

`tftpd [<opts>] [<dirname>] [<opts>]`

Options

`-?`	Displays the syntax, options, and command description of `tftpd`.
`-d`	Log debug information to `<stderr>`.

Description

`tftpd` is the server daemon handling the client Trivial File Transfer Protocol (TFTP) requests. Once a BOOTP client has received the BOOTP response, it knows the name of its bootfile. The client then issues a TFTP “read file request” back to the same server machine from which it received the BOOTP response. `tftpd` forks `tftpdc` to perform the actual file transfer.

`tftpd` in any system is a security problem because the TFTP protocol does not provide a way to validate or restrict a transfer request since login procedures do not exist. To provide some level of security, `tftpd` only transfers files from a single directory. You can specify this directory on the `tftpd` command line. The default is `/h0/TFTPBOOT`.

For More Information

Refer to **Chapter 7: BOOTP Server** for more information about the BOOTP Server.

tftpdc

TFTP Server Connection Handler

Syntax

```
tftpdc [<opts>]
```

Options

`-?`	Display usage.

Description

`tftpdc` is the incoming communications handler for TFTP. Each time a TFTP service connection is made, `tftpd` forks this process.

`tftpdc` is intended to be run only by `tftpd` and, therefore, has no command line options.

Chapter 9: Programming

This chapter covers the following topics:

- Establishing a socket
- Reading/writing data using sockets
- Setting up non-blocking sockets
- Broadcasting
- Multicasting
- Controlling socket operation

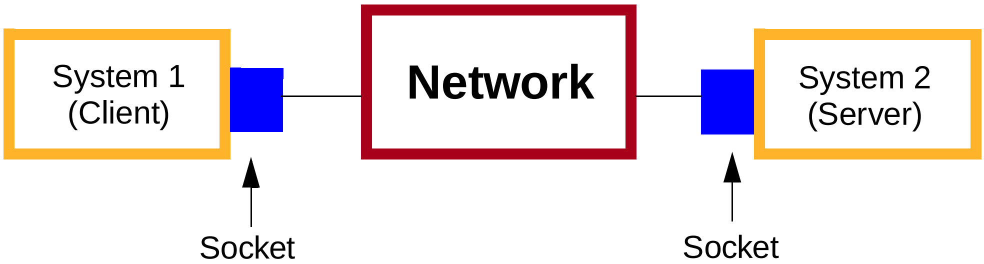
Programming Overview

LAN Communications Pak is based on sockets. Sockets have the following characteristics:

- Sockets are abstractions providing application programs with access to the communication protocols.
- Sockets serve as endpoints of a communication path between processes running on the same or different hosts.
- Sockets enable one system to send and receive information from other systems on the network.
- Sockets also enable programmers to use complicated protocols, such as TCP/IP, with little effort.

The following illustrates how a socket might look in a network:

Figure 9-1 Network



For More Information

See Appendix A: Example Programs and Test Utilities of the ***LAN Communications Pak Programming Reference***. It contains example programs for various types of sockets. You can use these programs as templates for writing your own programs.

Socket Types

Each socket has a specific address family, a specific protocol, and an associated type. Before establishing a socket, familiarize yourself with the types of sockets available and decide which is best for your needs.

The following address families are supported:

Table 9-1 Address Families

Address Family	Description
AF_INET	ARPA internet address family.
AF_ROUTE	BSD 4.4 style routing domain.

Two high-level protocols, the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP), are supported.

For More Information

These protocols are discussed in .

The following types of sockets are supported. Both SOCK_STREAM and SOCK_DGRAM imply a specific protocol to use. When using raw sockets the protocol is indicated when opening the socket.

Table 9-2 Socket Type/Protocol

Socket Type	Description	Implied Protocol
SOCK_STREAM	Stream sockets	TCP
SOCK_DGRAM	Datagram sockets	UDP
SOCK_RAW	RAW Sockets	none

Stream Sockets

Stream sockets are full-duplex byte streams, similar to pipes. Stream sockets must be in a connected state, and only two sockets can be connected at a time. A socket in the connected state has been bound to a permanent destination. Each socket in the connected pair is a *peer* of the other.

Stream sockets use the TCP protocol. TCP ensures data is not lost or duplicated. If data for which the peer protocol has buffer space cannot be successfully transmitted within a reasonable length of time, the connection is considered broken.

Datagram Sockets

Datagram sockets provide bi-directional flow of data packets called *messages*. A datagram socket state can be either connected or unconnected.

Datagram sockets use the UDP protocol. UDP does not guarantee sequenced, reliable, or unduplicated message delivery. However, UDP has a reduced protocol overhead and is adequate in many cases.

Raw Sockets

Raw sockets provide an unreliable datagram service. They enable an application to create its own protocol headers and are used to send and receive ICMP messages as well as implementing protocol types not supported directly by IP. The use of raw sockets is restricted to super user processes.

Establishing a Socket

You can establish sockets in several ways. The sequence required to establish connected sockets and unconnected sockets is different. Further, connected sockets are established differently on the client and server sides.

The following describes how to establish sockets and the necessary LAN Communications Pak system calls.

Stream Sockets

Stream sockets use TCP for a transport protocol and must be connected before sending or receiving data. The sequence for connecting a socket is slightly different between the server and client sides.

Server Steps

Follow this sequence on the server side:

Step 1. Create the Socket

Sockets are created with the `socket()` function. `socket()` requires three parameters:

- Address format (`AF_INET`)
- Type (`SOCK_STREAM`)
- Protocol (0)

`socket()` returns a path number to the created socket. This path number is a handle to the socket, similar to what the `open()` or `create()` functions return.

The following syntax is used to create a stream socket:

```
int s;
s=socket(AF_INET,SOCK_STREAM,0);
```

s is the returned path number of the socket.

Step 2. Bind to the Socket

When a socket is created with `socket()`, it has no association to local or destination addresses. This means a local port number is not assigned to the socket. Server processes operating on a well-known port must specify this port to the system by using the `bind()` LAN Communications Pak function. The `bind()` call binds the port to the address.

The structure used for the address is `sockaddr_in` which is defined in the `in.h` header file.

Normally a server process accepts connections that arrive on any of the machine's interfaces. In this case the IP address passed to `bind()` in the `sockaddr_in` structure is the wildcard address 0.0.0.0, which is represented by `INADDR_ANY`. If the server process wishes to restrict incoming connections to a single interface, the IP address associated with that interface may be used in place of `INADDR_ANY`.

The following syntax is valid for `bind()`:

```
#define PORT 27000 /* port number to bind socket*/
struct sockaddr_in name; /* to define variable ‘name‘ */
                 /* as a sockaddr_in */
                 /* structure */
memset(&name,0,size of(name)); /*initialize structure to
                                 zero*/
name.sin_family = AF_INET;
                 /* address family is AF_INET */
name.sin_port = htons(PORT);/* assign our port number
                     in network byte order */
name.sin_addr.s_addr = INADDR_ANY;
                 /* allow any client to access
                this socket */
bind(s, (struct sockaddr*) &name, sizeof(name));
                 /* bind the port to the socket.
                    The ‘s‘ parameter is the path
                    number for the socket and
                    was returned by socket() */
```

Step 3. Listen for a Connecting Socket

If you have a stream socket (type `SOCK_STREAM`), the `listen()` function sets the socket in a passive state and allows servers to prepare a socket for incoming connections. It also informs the system to queue multiple client requests which arrive at a socket very close in time. This queue length must be specified in the `listen()` call. After client requests fill this queue, any further requests are rejected, and the client socket is notified with an `ECONNREFUSED` error.

`listen()` requires two parameters:

- The socket's path number
- The client's requested queue size

For example, the following syntax is valid for `listen()`:

```
listen(s,4);
```

In this example, four client requests are allowed to queue. When the queue is full, additional requests are refused.

Step 4. Accept a Connecting Socket

Once `listen()` sets up a passive socket, the `accept()` function is used to accept connections from clients. `accept()` blocks the process if pending connections are not presently queued.

If the socket is set up as non-blocking and an `accept()` call is made with no pending connections, `accept()` returns with an `EWOULDBLOCK` error.

`accept()` requires three parameters:

- The socket's path number
- A pointer to a variable with type `sockaddr_in`
- The size of the `sockaddr_in` structure

The following syntax is valid for `accept()`:

```
struct sockaddr_in from;
int ns, size;

size=sizeof(struct sockaddr_in);
ns=accept(s, (struct sockaddr*) &from, &size);
```

Once `accept()` returns without error, a connection has been made to a client process and the following events occur:

1. The client request is removed from the `listen` queue.
2. The client foreign address was put into the `from` variable. This allows the server to see who connected to it.
3. `accept()` returns a new socket path number (ns).

This new socket transfers data to and from the client process. It represents a connected path to the client process. The original socket path number returned by `socket()` can then be used to accept further connections or it can be closed, determined by the application.

At this point in the server process, the socket has been established and communication between the two processes can begin.

Client Steps

Follow these steps on the client side:

Step 1. Create the Socket

Sockets are created with the `socket()` function. `socket()` requires three parameters:

- An address format (`AF_INET`)
- A type (`SOCK_STREAM` or `SOCK_DGRAM`)
- A protocol (usually `0`)

`socket()` returns a path number to the created socket. This path number is a handle to the socket, similar to what the `open()` or `create()` functions return.

The following syntax is used to create a stream socket:

```
int s;
s=socket(AF_INET,SOCK_STREAM,0);
```

s is the returned path number to the socket.

Step 2. Connect to a Listening Socket

To connect to a listening socket, use the `connect()` function call.

`connect()` requires three parameters:

- The path descriptor returned by `socket()`
- A pointer to a structure containing the name
- The length of the name

Using Connect

The following example demonstrates the use of `connect()`.

```
#define PORT 27000
                   /* Port number of server process */
struct sockaddr_in ls_addr;
memset(&ls_addr, 0, sizeof(ls_addr));
                   /* Initialize structure to zero */
ls_addr.sin_family = AF_INET;
ls_addr.sin_port = htons(PORT);
                   /* Assign port in network byte order */
ls_addr.sin_addr.s_addr = inet_addr("thor");
                   /* IP address we wish to connect to */
connect (s, (struct sockaddr *)&ls_addr, sizeof(ls_addr));
```

Note

The `connect()` call automatically binds the socket to a local port number if `bind()` was not explicitly called. `bind()` is not usually called by clients unless the server restricts the ports from which it will accept connections.

Datagram Sockets

Datagram sockets use UDP as a transport protocol and can be connected or connectionless.

The steps for creating connected and connectionless sockets are the same for both the server and client sides:

1. Create the socket

   The following syntax is used to create a datagram socket:

   ```
   int s;
   s=socket(AF_INET,SOCK_DGRAM,0);
   ```

2. Bind a port and/or address to the socket

Note

As with TCP, the client does not need to bind a socket.

The following syntax is valid for bind():

```
struct sockaddr_in ls_addr;
bind(s,(struct sockaddr*) &ls_addr, sizeof (ls_addr);
```

Connect a Socket

Either the client or server can optionally call `connect()` on a UDP socket. Unlike TCP sockets, calling `connect()` on a UDP socket does not cause any information to be sent to the peer. It simply stores the peer address in the local socket and allows the application to use `send()` and `recv()` instead of `sendto()` and `recvfrom()`.

A process may "disconnect" a UDP socket by calling `connect()` with `INADDR_ANY` as the IP address. The application can then no longer use `send()` and `receive()`, but can still use `sendto()` and `recvfrom()`.

The `connect()` function call requires three parameters:

- The path descriptor returned by `socket()`.
- A pointer to a `sockaddr_in` structure containing the peer port and IP address.
- The size of the `sockaddr_in` structure.

The following syntax is used to connect a datagram socket:

```
struct sockaddr_in ls_addr;
connect(s, (struct sockaddr *)&ls_addr, sizeof(ls_addr));
```

Header Files

Table 9-3 Header Files Associated with Berkeley Sockets

Header File	Description
`netinet/in.h`	Provides structures and functions for the socket family `AF_INET`.
`netdb.h`	Provides structures for hosts, networks, services, protocols, and functions calling socket address structures and socket family `AF_INET` structures.
`sys/socket.h`	Provides a definition to the socket address structure.

Note

Header files are found in `MWOS/SRC/DEFS/SPF/BSD`.

The main internet application structure is `sockaddr_in`, defined in the `in.h` header file. The structure is defined as follows:

```
struct sockaddr_in {
    u_char         sin_len;
    u_char         sin_family;
    u_short        sin_port;
    struct in_addr sin_addr;
    char           sin_zero[8];
};
struct in_addr  {
    u_long s_addr;
};
```

The `hostent` structure is in the `netdb.h` header file. It is used to get address information about any host in the `inetdb` database:

```
struct hostent  {
    char *h_name;       /* pointer to host name */
    char **h_aliases;   /* pointer to the pointer */
                        /* to the alias for the host */
    int  h_addrtype;    /* host address type */
    int  h_length;      /* length of host */
    char **h_addr_list; /* list of addresses from */
                        /* name server */
    #define h_addr   h_addr_list[0]
                        /* backwards compatibility:
                         pointer to the address of
                         the host */
}
```

Reading Data Using Sockets

Four functions are available for reading data:

Table 9-4 Reading Functions

Function	Description

`_os_read()`
`read()`
`recv()`
	Returns the data available on the specified socket path, up to the amount requested. For packet oriented protocols, such as UDP, only a single datagram is returned, even if more are available. These calls are only valid on connected sockets.

`recvfrom()`	Functions similar to `recv()` except that it also returns a `sockaddr_in` structure containing the address information of the sender. `recvfrom()` works with unconnected sockets.

For More Information

For more specific information on `recv()` and `recvfrom()`, refer to the ***LAN Communications Pak Programming Reference***. For more specific information on `_os_read()` and `read()`, refer to the ***Ultra C Library Reference.***

Writing Data Using Sockets

Four similar functions are available for writing data.

Table 9-5 Writing Functions

Function	Description

`_os_write()`
`write()`
`send()`
	Writes data from a buffer to the socket path. These functions are only valid with connected sockets.

`sendto()`	Functions the same as `send()` except it also takes a `sockaddr_in` parameter specifying where the data is to be sent. `sendto()` works with unconnected sockets.

Note

If a socket path has been set to nonblocking and there is not enough buffer space available, the call can succeed, but only part of the data may be sent. Check the return value to see how many bytes were sent.

For More Information

For more specific information on `send()` and `sendto()`, refer to the ***LAN Communications Pak Programming Reference***. For more specific information on `_os_write()` and `write()`, refer to the Hawk On-line Help System from the Hawk interface.

Setting up Non-Blocking Sockets

When a program tries to perform some socket functions, the program can block. The following are situations in which this would happen:

- Read from a socket that has no data (`read/recv/recvfrom`).
- Write to a socket that does not have enough space to satisfy size of write (`write/send/sendto`).
- Accept a connection with no waiting connection available (`listen/accept`).
- Calling connect on a TCP socket.

LAN Communications Pak enables you to create a non-blocking socket to prevent the above problems. When your program tries to access a non-blocking socket in one of the above listed blocking conditions, the socket returns the error `EWOULDBLOCK`. The connect call is the exception and returns `EINPROGRESS`.

The following function can be used to set a socket to non-blocking or blocking:

`spath` is the socket path

`blockflag` is either set to `IO_SYNC` for blocking, or `IO_ASYNC` for nonblocking.

```
#include <SPF/spf.h>

error_code setblock(path_id spath, u_int8 blockflag)
{
   struct spf_popts sopts;
   u_int32 soptsz=sizeof(sopts)

   if ((errno=_os_gs_popt(spath,&soptsz,&sopts)) !=SUCCESS) {
      return(errno);
   }
   sopts.pd_ioasync=blockflag;
   return (_os_ss_popt(spath,soptsz,&sopts));
} /*end of setblock*/
```

The common UNIX function `ioctl()` can also be used.

```
#include <UNIX/ioctl.h>
error_code setblock(path_id spath, u_int8 blockflag){
   if (ioctl(spath, FIONBIO, dblockflag)<SUCCESS) {
   return (errno);
   }
   return(SUCCESS);
}
```

Broadcasting

Broadcasting support allows the network to deliver one copy of a packet to **all** attached hosts. Due to the extra overhead involved, multicasting is much preferred over broadcasting as a way to deliver data to multiple recipients. Also, broadcast packets are only sent to the local network and can not be forwarded by routers.

Note

Stream sockets cannot be used for broadcasting messages. The `SO_BROADCAST` option must be enabled before broadcasting on a datagram socket.

Broadcasting Process

The broadcasting process sends its message to the pre-selected port number.

The broadcasting process uses the internet address for the address of the network. Usually this address is the same as the sender's broadcast address. For example, on a class C network, a system with address `192.7.44.105` has a broadcast address of `192.7.44.255`.

The broadcasting process must open the socket as a datagram socket.

A `bind()` call is required before broadcasting.

The broadcasting process must use the `sendto()` function.

WARNING

Do **not** use `send()` or `_os_write()`.

Receiving Process

The receiving processes must receive from the pre-selected port number the broadcaster is using.

The receiving socket must be opened as a datagram socket.

A `bind()` call is required before attempting to receive.

The receiving processes use the `recvfrom()` function.

Multicasting

Multicasting support allows the delivery of a single packet to multiple hosts. The main difference between multicasting and broadcasting is that with multicasts, only the machines interested in receiving the packets see them. Also, multicast packets can be routed across networks, while broadcasts are only seen on the local network.

Note

Currently, the LAN Communications Pak does not support routing multicast packets. It can only be used as an end node to send or receive them. Also, only datagram sockets can be used for multicasting.

Sending Multicasts

The same mechanism used to send unicast datagrams can be use to send multicasts by simply using a multicast destination IP address. However, to provide more control, 3 additional socket options may be used.

- `IP_MULTICAST_TTL`—This option limits the number of routers a multicast packet can pass through before being dropped. The default value is 1, which means multicasts will not travel beyond the locally attached network. Link local multicasts (addresses 224.0.0.0 - 224.0.0.255) are never routed, regardless of the TTL value.
- `IP_MULTICAST_LOOP`—The default is for multicasts not to be sent to the loopback interface. If you want to see the multicast packets you send, or another application on your hosts needs to see them, this option needs to be enabled.

- IP_MULTICAST_IF—When sending multicast packets, the output interface is selected via the normal routing procedure. This option allows an application to override this selection and pick the appropriate interface.

Note

The normal routing lookup is performed first and fails, the IP_MULTICAST_IF option is not checked. This means a route to the selected multicast address must exist in the routing table. Normally this consists of either a network route such as 224.0.0.0 or, more commonly, the presence of a default route.

Receiving Multicasts

In order for an application to receive multicast packets, it must join the appropriate multicast group. After the group has been joined, receiving multicast packets is no different than normal unicast packets. Two socket options are provided for joining and leaving multicast groups.

- IP_ADD_MEMBERSHIP—This option informs IP that an application wants to receive packets for the given multicast group. If this is the first application on the host to join the group on the requested interface, IP will notify the interface to begin receiving multicast packets for group. Additionally, any multicast routers present on the subnet will be notified that a host has joined the group.
- IP_DROP_MEMBERSHIP—This option informs IP that packets for the indicated group should no longer be sent to the application. If this is the last application receiving this group on the indicated interface, IP will notify the interface to no longer receive the group.

For More Information

See the ***LAN Communications Pak Programming Reference*** for more information on using `setsockopt`.

Controlling Socket Operations

Socket level options control the socket's operation. These options are defined in the `socket.h` header file. `setsockopt()` and `getsockopt()` are used to set and get options.

Table 9-6 Socket Level Options

Option	Description
SO_DEBUG *	Turns on recording of debugging information. This allows debugging in the underlying protocol modules.
SO_REUSEADDR	Indicates the rules used in validating addresses supplied in a `bind()` call should allow reuse of local addresses.
SO_KEEPALIVE	Allows the periodic transmission of messages on a connected socket. If a connected party fails to respond to these messages, the connection is considered broken and the socket is closed.
SO_DONTROUTE	Indicates outgoing messages should bypass the standard routing facilities. Instead, messages are directed to the appropriate network interface according to the network portion of the destination address.

Table 9-6 Socket Level Options (continued)

Option	Description
SO_LINGER	Controls the actions taken when unsent messages are queued on a socket and a `close()` is performed. If the socket promises reliable delivery of data and `SO_LINGER` is set, the system blocks the process on the close attempt until it is able to transmit the data or until it decides it is unable to deliver the information. A time out period, referred to as the *linger interval,* is specified by `setsockopt()` when `SO_LINGER` is requested.
SO_BROADCAST	Enable an application to send broadcast messages. Valid for datagram sockets only.
SO_OOBINLINE	Place any incoming out-of-band data in the normal input queue.
SO_SNDBUF	Set or retrieve the size of the socket send buffer.
SO_RCVBUF	Set or retrieve the size of the socket receive buffer.
SO_SNDLOWAT	Indicates the minimum amount of space that must be available in the send buffer before data is accepted for sending. If this much space is not available the process blocks, or if the socket is non-blocking an `EWOULDBLOCK` error is returned.
SO_RCVLOWAT*	Indicates the minimum amount of data that must be available to be read before `select` considers a path "readable".

Table 9-6 Socket Level Options (continued)

Option	Description
SO_SNDTIMEO*	Control the maximum amount of time a process will block waiting for buffer space when sending data.
SO_RCVTIMEO*	Control the maximum amount of time a process will block waiting for incoming data.
SO_TYPE	Return the type of a socket such as SOCK_STREAM or SOCK_DGRAM. This option is only valid for getsockopt().
SO_ERROR	Retrieves the current socket error if one exists. This option is only valid for getsockopt().
SO_USELOOPBACK	This option is only valid for sockets in the routing domain (AF_ROUTE). It controls whether a process receives a copy of everything it sends.

* Unsupported option

Appendix A: Configuring LAN Communications Pak

This appendix explains how to configure and start the LAN Communications Pak for Internet access. It includes the following sections:

Configuring Network Modules

You can configure the host, network, DNS client, routing, and interface information by updating text files found in `MWOS/SRC/ETC`.

Step 1: Updating Files

You may need to update the following files for your system.

- `hosts`
- `networks`
- `resolv.conf` (if using DNS Client)
- `routes.conf` (if using static routing)
- `interfaces.conf` (located in `MWOS/<OS>/<CPU>/PORTS/<BOARD>/SPF/ETC` or `MWOS/SRC/ETC`)

Note

These files are described in later in this appendix.

Step 2: Creating Modules

Create the `inetdb`/`inetdb2`/`rpcdb` modules by running `os9make` on cross-development systems. This executes the `idbgen` and `rpcdbgen` utilities.

The makefile is found in `MWOS/SRC/ETC`. If you are working from a ports directory, the makefile is found in the `MWOS/<OS>/<CPU>/PORTS/<TARGET>/SPF/ETC` directory in the port.

The `inetdb/inetdb2/rpcdb` data modules will be placed in `MWOS/<OS>/<CPU>/CMDS/BOOTOBJS/SPF`, or the local ports `CMDS/BOOTOBJS/SPF`.

The `idbgen` utility is called, which reads files in the local `SPF/ETC` directory and/or files in `MWOS/SRC/ETC`. The `rpcdbgen` utility reads files from `MWOS/SRC/ETC`.

The `idbdump` utility can be used to print out the contents of the `inetdb/inetdb2` data modules. The `rpcdump` utility can be used to print out the contents of the `rpcdb` data module.

For More Information

The `rpcdbgen` utility and `rpcdb` data module are described in the **Using Network File System/Remote Procedure Call** manual.

Contents of inetdb

Below is an example of the contents of an `inetdb` data module.

```
> idbdump inetdb
Dump of OS-9000/PowerPC INETDB network database module [inetdb]
  Compatability :  1
  Version Number:  9

Host Entries:
     Host Name            Host Address     Host Aliases
--------------------   ---------------   -----------------------------
localhost              127.0.0.1         me

Hosts Equivalent Entries:

Network Entries:
    Network Name        Network Address   Network Aliases
--------------------   ---------------   -----------------------------
loopback               127
private-A              10
private-B              172.1
private-C              192.1.2
localnet               10.0.0
```

```
Protocol Entries:
 Protocol     Number   Protocol Aliases
----------    ------   ------------------------------------------------
ip                 0   IP
icmp               1   ICMP
igmp               2   IGMP
tcp                6   TCP
udp               17   UDP

Service Entries:
 Service Name       Port/Protocol     Service Aliases
---------------   -----------------   --------------------------------
ndp                  13312/tcp        ndpd
npp                  13568/tcp        nppd
echo                     7/tcp
echo                     7/udp
discard                  9/tcp
discard                  9/udp
daytime                 13/tcp
daytime                 13/udp
chargen                 19/tcp
chargen                 19/udp
ftp-data                20/tcp
ftp-data                20/udp
ftp                     21/tcp
ftp                     21/udp
telnet                  23/tcp
telnet                  23/udp
nameserver              42/tcp
nameserver              42/udp
bootps                  67/tcp
bootps                  67/udp
bootpc                  68/tcp
bootpc                  68/udp
tftp                    69/tcp
tftp                    69/udp
touyr                  520/udp

InetD Configuration Entries:
 Service Name  Socket Type  Protocol  Flags   Owner  Server Arguments
-------------  -----------  --------  ------  -----  ----------------
ftp            SOCK_STREAM  tcp        WAIT     0.0   ftpdc
telnet         SOCK_STREAM  tcp        WAIT     0.0   telnetdc
echo           SOCK_STREAM  tcp        WAIT     0.0   internal
echo           SOCK_DGRAM   udp        WAIT     0.0   internal
```

```
Resolve Configuration Entries:
   Domain Name:  alpha.com
   Nameserver List:
      1:  10.0.0.1
      2:  10.0.0.2
      3:  10.0.0.3
   Search List:
      1:  alpha.com

Host Configuration Entries:

Interface Configuration Entries:

Hostname Configuration Entries:

Route Configuration Entries:
Destination     Gateway         Netmask         Type
--------------- --------------- --------------- ----

RPC Entries:
 Program            Number    Aliases
---------------   ---------   ----------------------------------------
portmapper           100000   rpcinfo
rstatd               100001   rup
rusersd              100002   rusers
nfs                  100003   nfsrbf
ypserv               100004   yp
mountd               100005   mount  showmount
ypbind               100007
walld                100008   rwall  shutdown
yppasswdd            100009   yppasswd
etherstatd           100010   etherstat
rquotad              100011   rquotaprog  quota  rquota
sprayd               100012   spray
rje_mapper           100014
selection_svc        100015   selnsvc
database_svc         100016
rexd                 100017   on
llockmgr             100020
nlockmgr             100021
statmon              100023
status               100024
bootparam            100026
ypupdated            100028   ypupdate
keyserv              100029   keyserver
dird                     76   rdir
msgd                     99   msg
sortd                 22855   rsort
```

Contents of inetdb2

Below is an example of the `inetdb2` data module.

```
>idbdump inetdb2
Dump of OS-9000/PowerPC INETDB network database module [inetdb2]
  Compatability :  1
  Version Number:  9
Host Entries:
     Host Name          Host Address     Host Aliases
--------------------   ---------------   -----------------------------
Hosts Equivalent Entries:
Network Entries:
    Network Name       Network Address   Network Aliases
--------------------   ---------------   -----------------------------
Protocol Entries:
 Protocol    Number   Protocol Aliases
----------   ------   ------------------------------------------------
Service Entries:
 Service Name       Port/Protocol     Service Aliases
---------------   -----------------   --------------------------------
InetD Configuration Entries:
 Service Name Socket Type  Protocol   Flags   Owner  Server Arguments
------------- ------------ ---------  ------  ------ ----------------
Resolve Configuration Entries:
Host Configuration Entries:
Interface Configuration Entries:
Interface:  enet0
  Binding:  /spe30/enet
    Flags:  0x1 <UP>
 MW_Flags:  0x8000 <NO_MULTICAST>
      MTU:  0
   Metric:  0
   Address          Netmask          Broadcast
   172.16.4.32      0.0.0.0          0.0.0.0
Interface:  ppp0
  Binding:  /ipcp0
    Flags:  0x1 <UP>
      MTU:  0
   Metric:  0
   Address          Netmask          Broadcast
   None
Hostname Configuration Entries:
Hostname: Beta
Route Configuration Entries:
Destination     Gateway          Netmask          Type
--------------- --------------- --------------- ----
RPC Entries:
 Program            Number    Aliases
```

Step 3: Configure the Interface Descriptor

To set port-specific parameters such as baud rate or interrupt number, you must configure the interface descriptor for PPP, SLIP, or Ethernet. To do this, perform the following steps:

Step 1. Update the `spf_desc.h` descriptor file in the local ports directory. For Ethernet, this file is found in the port directory for your target under `MWOS/<OS>/<CPU>/PORTS/<TARGET>/SPF/<driver>/DEFS`.

Step 2. To make, run `os9make` in the `SPF/<driver>` directory.

The following list provides the supported Ethernet devices for LAN Communications Pak.

Supported Ethernet Devices for 68000

- MVME147. Support for the AM7990 chip is available. The `sp147` driver and `sple0` descriptor can be found in:

  `MWOS/OS9/68020/PORTS/MVME147/CMDS/BOOTOBJS/SPF`

  The driver and descriptor can be compiled in:

  `MWOS/OS9/68020/PORTS/MVME147/SPF/SPLANCE`

- MVME162/167/172/177. Support for the I82596 chip is available. The `sp162/sp167/sp172/sp177` driver and `spie0` descriptor can be found in:

  ```
  MWOS/OS9/68020/PORTS/MVME162/CMDS/BOOTOBJS/SPF
  MWOS/OS9/68020/PORTS/MVME167/CMDS/BOOTOBJS/SPF
  MWOS/OS9/68060/PORTS/MVME172/CMDS/BOOTOBJS/SPF
  MWOS/OS9/68060/PORTS/MVME177/CMDS/BOOTOBJS/SPF
  ```

  The driver and descriptor can be compiled in:

  `MWOS/OS9/<PROCESSOR>/PORTS/<TARGET>/SPF/SP82596`

- QUADS. Support for the QUICC chip is available. The `sp360` driver and `spqe0` descriptor can be found in:

MWOS/OS9/CPU32/PORTS/QUADS/CMDS/BOOTOBJS/SPF

The driver and descriptor can be compiled in:

MWOS/OS9/CPU32/PORTS/QUADS/SPF/SPQUICC

Supported Ethernet Devices for PPC

- 821ADS. Support for the QUICC chip is available. The `sp821` driver and `spqe0` descriptor can be found in:

  MWOS/OS9000/821/PORTS/821ADS/CMDS/BOOTOBJS/SPF

  The driver and descriptor can be recompiled in:

  MWOS/OS9000/821/PORTS/821ADS/SPF/SPQUICC

Supported Ethernet Devices for 80X86

- PCAT. Support for the 3COM Etherlink III, SMC Ultra, and SMC Elite is available. The drivers include `spe509` (3Com), `sp8390` (elite), `sp83c790` (ultra). The descriptors include `spe30` (3Com), `spwd0` (elite), `ns0` (ultra).

  The drivers and descriptors can be found in:

  MWOS/OS9000/80386/PORTS/PCAT/CMDS/BOOTOBJS/SPF

  The driver and descriptor can be recompiled in:

  MWOS/OS9000/80386/PORTS/PCAT/SPF/SPE509
  MWOS/OS9000/80386/PORTS/PCAT/SPF/SP8390
  MWOS/OS9000/80386/PORTS/PCAT/SPF/SP83C790

Step 4: Load LAN Communications Pak modules

The minimum modules required to test connectivity with `ping` are included in the following list. Uncomment or add these files to your bootlist.

inetdb	inetdb2
SysMbuf	mbinstall
pkman	pks (OS-9 68K only)
pkdvr	ip0
spip	tcp0
spudp	sptcp
udp0	spf
netdb_local or netdb_dns	ipstart
spraw	raw0
ping	

- For SLIP, PPP, or Ethernet support, uncomment the appropriate driver(s) and descriptor(s).
- To include other utilities in your boot, such as telnet, uncomment the appropriate entry.

An example bootlist follows. Depending on the OS software version you are using, you may need a relative path of:

../../../../../../<CPU> or ../../../<CPU>.

```
*
* SysMbuf P2 Module:
*
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/SysMbuf
*
* SysMbuf utilities:
*
*../../../../../../<CPU>/CMDS/mbinstall
../../../../../../<CPU>/CMDS/mbinstall_csl
*../../../../../../<CPU>/CMDS/mbdump
*
* SPF file manager:
*
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/spf
*
* LAN protocol drivers and descriptors:
*
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/sptcp
```

```
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/tcp0
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/spudp
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/udp0
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/spip
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/ip0
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/spraw
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/raw0
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/sproute
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/route0
*
* Pseudo Key Board File Manager and Driver required for telnetdc)
*
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/pkman
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/pkdvr
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/pk
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/pks <OS-9 only>
*
* LAN trap handler and configuration data module:
*
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/netdb_local
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/netdb_dns
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/inetdb
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/inetdb2
*
* LAN SLIP drivers and descriptors:
*
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/spslip
*../../../CMDS/BOOTOBJS/SPF/spsl0
*
* LAN PPP client drivers and descriptors:
*
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/spipcp
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/splcp
*../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/sphdlc
*../../../CMDS/BOOTOBJS/SPF/spipcp0
*../../../CMDS/BOOTOBJS/SPF/splcp0
*../../../CMDS/BOOTOBJS/SPF/sphdlc0
*
* LAN PPP client utilities:
*
*../../../../../../<CPU>/CMDS/chat
*../../../../../../<CPU>/CMDS/pppd
*../../../../../../<CPU>/CMDS/pppauth
*../../../../../../<CPU>/CMDS/ppplog
*
* Ethernet Protocol Driver (required for hardware ethernet drivers)
*
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/spenet
../../../../../../<CPU>/CMDS/BOOTOBJS/SPF/enet
```

```
*
* LAN ethernet driver and descriptor:
*
../../../CMDS/BOOTOBJS/SPF/<ethernet driver>
../../../CMDS/BOOTOBJS/SPF/<ethernet descriptor>
*
* LAN utilities:
*
*../../../../../../<CPU>/CMDS/arp
*../../../../../../<CPU>/CMDS/bootpd
*../../../../../../<CPU>/CMDS/bootptest
*../../../../../../<CPU>/CMDS/dhcp
*../../../../../../<CPU>/CMDS/ftp
*../../../../../../<CPU>/CMDS/ftpd
*../../../../../../<CPU>/CMDS/ftpdc
*../../../../../../<CPU>/CMDS/hostname
*../../../../../../<CPU>/CMDS/idbdump
*../../../../../../<CPU>/CMDS/idbgen
*../../../../../../<CPU>/CMDS/ifconfig
*../../../../../../<CPU>/CMDS/inetd
../../../../../../<CPU>/CMDS/ipstart
*../../../../../../<CPU>/CMDS/ndbmod
*../../../../../../<CPU>/CMDS/netstat
../../../../../../<CPU>/CMDS/ping
*../../../../../../<CPU>/CMDS/route
*../../../../../../<CPU>/CMDS/routed
*../../../../../../<CPU>/CMDS/telnet
*../../../../../../<CPU>/CMDS/telnetd
*../../../../../../<CPU>/CMDS/telnetdc
*../../../../../../<CPU>/CMDS/tftpd
*../../../../../../<CPU>/CMDS/tftpdc
*
```

Also available is the example `loadspf` script in `MWOS/SRC/SYS`. This file provides an example of the modules to load in order to start the protocol stack.

If you are using a disk-based system, the following file can be used as an example or modified to match your system. This file can be copied from `MWOS/SRC/SYS`.

```
*
* loadspf for SPF LAN Communication Package Release
*
*
* Load SPF System Modules
*
chd CMDS/BOOTOBJS/SPF
*
```

```
load -d inetdb  inetdb2    ;* Load system specific inetdb
                              modules
load -d SysMbuf            ;* System Mbuf module
                           ;*(sets size of mbuf pool on
                              OS-9)
load -d pkman pkdvr pk     ;* Pseudo keyboard modules
                   (required for telnetdc)
*load -d pks;              ;* Pseudo keyboard addtional
                              for 68K
*
*
load -d spf                ;* SPF file manager
load -d spip ip0           ;* IP driver and descriptor
load -d sptcp tcp0         ;* TCP driver and descriptor
load -d spudp udp0         ;* UDP driver and descriptor
load -d spraw raw0         ;* RAW IP driver and descriptor
*load -d sproute route0    ;* Dynamic Routing driver and
                              descriptor
*
* Load SPF Trap library and Commands
* Load one of the following Netdb name resolution trap
* handlers
*
load -d netdb_local        ;* Load trap handler for local
                            * name resolution
*load -d netdb_dns         ;* Load trap handler for  DNS
                            * name resolution
*
* Load SPF Ethernet Drivers and Descriptors
*
*load -d spenet enet       ;* Ethernet Protocol driver and
                         * descriptor (required by
                         * hardware Ethernet drivers)
*
* Load SPF Drivers and Descriptors ... Uncomment those
* needed
*
* <Ethernet drivers and descriptors>
*
* Serial Drivers and Descriptors
*
*load -d spslip   spsl0    ;* Slip /t1
*load -d spipcp   ipcp0    ;* PPP IPCP
*load -d splcp    lcp0     ;* PPP LCP
*load -d sphdlc   hdlc0    ;* PPP HDLC
*(chd ../..; load -d chat pppd ppplog pppauth; chd BOOTOBJS/SPF)   ;
*PPP Utilities
*
*
```

```
* Chd up to CMDS directory
*
chd ../..
load -d mbinstall                ;* Load mbinstall memory
                                  * handler (or can be done
                                  * within init
load -d ipstart                  ;* Load ipstart stack
                                  * initializer
*
*
*load -d routed                  ;* Dynamic routing daemon
*load -d telnet telnetd telnetdc ;* Telnet support
                                  * modules
*load -d ftp ftpd ftpdc          ;* FTP support modules
*load -d tftpd tftpdc bootpd     ;* Bootp/TFTP support
                                  * modules
*load -d inetd                   ;* Super-Server Daemon
*load -d idbgen idbdump ndbmod   ;* Development tools
*load -d route hostname ifconfig arp  ;* Runtime tools
load -d netstat ping                  ;* Statistics/
                                       * verification tools
```

Starting the Protocol Stack

Step 1. Install the network or SPF memory handler.

After loading the modules, the first step is to install the network or SPF memory buffer handler (`SysMbuf`). This can be done with the `mbinstall` utility.

```
shell> mbinstall
```

Step 2. Start the TCP/IP protocol stack by executing the `ipstart` utility.

```
shell> ipstart
```

If you did not define your interfaces in `inetdb2`, you can add them now using `ifconfig`.

Running `devs` and `procs` shows the protocol drivers initialized and SPF receive thread process in the process table.

Step 3. Use the `ping` utility to verify that the network components are working correctly.

```
shell> ping localhost
```

The following appears on your screen:

```
PING localhost (127.0.0.1): 56 data bytes
64 bytes from 127.0.0.1: ttl=255 time=0 ms
```

Next test to another system.

```
shell> ping <hostname>
```

Where `<hostname>` is the name of a computer in the `inetdb` module (hosts section), or a name that can be resolved by the DNS server specified in the `resolve.conf` section of `inetdb`. `<hostname>` can also be an IP address.

Something similar to the following appears on your screen:

```
PING delta.microware.com (172.16.1.40): 56 data bytes
64 bytes from 172.16.1.40: ttl=255 time=10 ms
```

Example Configuration

If you are using a disk-based system, the following `startspf` file can be used as an example or modified to match your system. This file can be copied from `MWOS/SRC/SYS`.

```
*
* startspf
* Shell Script to Start SPF System
*
* Set default directories before starting daemon programs
*
chd /h0
chx /h0/cmds
*
* Load SPF modules
*
SYS/loadspf
*
* Load and start mbuf handler  (May be done via p2 list in init module)
*   Allow for error returned in case sysmbuf is already initialized.
*
-nx
mbinstall
-x
*
* Start SPF system using ipstart
*
ipstart
*
* Add interfaces not specified in inetdb2
*
*ifconfig enet0 <my_address> binding /<dev>/enet
*ifconfig ppp0 binding /ipcp0
*
* Add any static routes. Even if running routed it may be useful
*   to add multicast routes.
*
*route add -net 224.0.0.0 <my_address>
*
* Start service daemons
*   routed: Dynamic routing server
*   inetd: FTP/Telnet and other protocols server
*   telnetd: Remote terminal server
*   ftpd: Remote file-transfer server (FTP)
*   bootpd: Network boot protocol server
*   tftpd: Trivial file transfer protocol server
*
routed <>>>/nil&
inetd <>>>/nil&
*telnetd <>>>/nil &
*ftpd <>>>/nil &
*bootpd /h0/TFTPBOOT/bootptab <>>>/nil&
*tftpd /h0/TFTPBOOT <>>>/nil &
*
*   spfndpd: Hawk User state debugging daemon
*   spfnppd: Hawk Profiling daemon
*
spfndpd <>>>/nil &
*spfnppd <>>>/nil &
```

Configuration Files

Files identified in **Table A-1** on page 268 reside in `MWOS/SRC/ETC` and provide the protocol stack with pertinent information. Utilities available to create, modify, or dump the `inetdb` modules are: `idbgen`, `ndbmod`, and `idbdump`, respectively.

Table A-1 Networking Files

File	Description
`hosts`	A list of hosts known to your system. If using DNS, this file may not need to be updated. Otherwise, add an entry for each of your hosts (including the host you are using) to the file.
`networks`	A list of networks analogous to hosts.
`protocols`	A list of protocols available.
`services`	A list of services available.
`inetd.conf`	A list of server daemon routines `inetd` supports (for example, telnet and FTP).
`resolv.conf`	Configuration information for a Domain Name System (DNS).
`interfaces.conf`	Configuration information for hostname and network interfaces to initialize when the stack is brought up.
`routes.conf`	List of static routes to add when the stack is brought up.
`rpc`	List of RPC support services, program number, and the client program.

Each file contains single-line entries consisting of one or more fields and (optionally) comments. Fields are separated by any number of spaces and/or tab characters. A pound sign (#) indicates the beginning of a comment. The comment includes all characters up to the end of the line. All files are described in the following sections.

Hosts

The `hosts` file contains information regarding the known hosts on the internet. For each host, a single-line entry must be present. Each entry contains the following:

- Internet address
- Official host name
- Aliases (optional)

Internet addresses are specified in the conventional dot notation. Host names can contain any printable character other than a field delimiter, new line, or comment character.

The following example `hosts` entry consists of an address, name, and comment:

```
192.1.1.1 balin #documentation
```

Networks

The `networks` file contains information regarding the known networks composing the internet. A single line entry must be present for each network. Each entry consists of the following information:

- Official network name
- Network number
- Aliases (optional)

Network numbers are specified in the conventional dot notation. Network names can contain any printable character other than a field delimiter, new line, or comment character.

The following example `networks` entry consists of a name, number, alias, and comment:

```
arpanet 10 arpa #just a comment
```

Note

Consult your local network administrator for conventions to determine the proper host and network information.

Protocols

The `protocols` file contains information regarding the known protocols used in the internet. A single-line entry must be present for each protocol. Each entry contains the following information:

- Official protocol name
- Protocol number
- Aliases (optional)

Protocol names can contain any printable character other than a field delimiter, new line, or comment character.

The following example `protocols` entry consists of a name, number, alias, and comment:

```
udp 17 UDP # user datagram protocol
```

Services

The `services` file contains information regarding known services available to your system. A service is a reserved port number for a specific application. For example, FTP is a service reserved at port 21. Each service also specifies the protocol it uses. Because each network can have a unique `services` file, networks can offer different services.

A single-line entry must be present in the `services` file for each service. Each entry contains the following information:

- Official service name
- Port number at which the service resides
- Official protocol name
- Aliases (optional)

Service names can contain any printable character other than a field delimiter, new line, or comment character.

The port number and protocol name are considered a single item; a slash character (`/`) separates them.

The following example services entry consists of a service name, port number, protocol name, alias, and comment:

```
shell 515/tcp cmd #no passwords used
```

To create a service, select a port number greater than 1024 (port numbers less than 1024 are reserved), a protocol, and a name; then add this information to the `services` file.

inetd.conf Configuration File

The `inetd.conf` file contains information regarding program services the `inetd` service daemon handles. `inetd` can currently take the place of `ftpd` and `telnetd`.

A single-line entry must be present in the `inetd.conf` file for each service available. Entries contains the following information:

- service name (program)
- socket type
- protocol
- flags

- user
- server path name (child process to fork)
- [additional arguments]

The following example `inetd.conf` entry consists of a service name, socket type, protocol, flags, user, and server path name.

```
ftp    stream  tcp    wait    root    ftpdc
```

resolv.conf Configuration File

A resolver finds the IP address of a host—given the host name—by using the Domain Name System (DNS). The `resolv.conf` file contains the necessary information to use DNS. Consult your local network administrator for local conventions.

The `resolv.conf` file contains three main sections:

- local domain name
- name server list
- optional domain search list

The following example `resolv.conf` listing contains these three sections.

```
#
# NAME RESOLUTION CONFIGURATION
#
# format: <keyword> <value>
#  see keywork explanations for specific formatting
#  requirements
#
#
# local domain name (1): domain <DomainName>
#
domain test.com
#
# ordered local nameserver list (1-3): nameserver
#  <IPAddress>
#
nameserver 192.1.1.1
nameserver 192.1.1.2
nameserver 192.1.1.3
```

```
#
#optional domain search list
#   <Domain1> [<Domain2> ...]
#
search test.com
```

interfaces.conf Configuration File

The `interfaces.conf` file contains the hostname and interfaces to initialize when `ipstart` is run. The entry for the host name is a string and may be up to 64 characters long.

The entry for the interface list may contain the following information:

- interface name
- `address` keyword and IP address of interface
- `broadcast` or `destaddr` keyword and broadcast or destination IP address
- `binding` keyword and device list
- optional values
  `[mtu <mtu>] [metric <metric>] [up|down]`
  `[netmask<mask>] [iff_broadcast] [iff_pointopoint]`
  `[iff_nomulticast] [iff_nobroadcast]`
  `[iff_nopointopoint]`

The following `interfaces.conf` entry contains the initialization information for a SLIP device:

```
slip0 address 10.0.0.1 destaddr 10.0.0.2 binding /spsl0
```

routes.conf Configuration File

The `routes.conf` file contains a static list of default, host, and network routes to be initialized when the stack is started. The entry for the route list contains a keyword and appropriate addresses as follows:

- default keyword and IP address of gateway network IP
- host keyword, host IP address, and gateway IP address
- network keyword, network IP address, gateway IP address, and optional network mask

There may be multiple host and network routes, but only one default route.

The following `routes.conf` entry contains the static host route entry to get to IP address 192.2.2.1 by going through router 192.1.1.2:

```
host 192.2.2.1 192.1.1.2
network 10.0.0.0 192.2.3.3
network 172.16.40.0 192.2.3.3 255.255.255.0
```

rpc Configuration File

The `rpc` file contains a list of supported RPC services, associated program numbers, and the client program. Update this table to register services and program numbers with `portmap`.

The following rpc entry contains the service mapping for `rstatd`:

```
rstatd    100001    rup
```

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Product Discrepancy Report

To: Microware Customer Support

FAX: 515-224-1352

From:____

Company:______________________________________

Phone:____

Fax:______________________Email:___________________

Product Name: LAN Communications Pak

Description of Problem:

Host Platform_____________________________________

Target Platform____________________________________