

Chapter 1

Configuring SLIP

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This chapter describes the Serial Line Internet Protocol (SLIP) and its implementation on the Cisco Systems terminal servers and the TRouter. This chapter contains information about:

- The Serial Line Internet Protocol
- Cisco's implementation of SLIP
- Configuring a line for SLIP access
- Configuring SLIP access controls

The Serial Line Internet Protocol (SLIP)

As personal computers (PCs) become increasingly powerful, they can be connected to networks as full network nodes and not simply as dumb terminals. As a full network node, a PC can send and receive mail, transfer files using sophisticated file transfer protocols, use network file systems, form virtual terminal connections to other hosts, and so on. Several protocol suites can perform these functions, but the TCP/IP suite is preferred when a variety of computers must communicate.

The Serial Line Internet Protocol, or SLIP, defines a method of sending Internet packets over standard RS-232 asynchronous serial lines. In general, SLIP is used today as a means to allow access to resources on a network by remote PCs.

SLIP is an inexpensive way of connecting PCs to a network. SLIP can be used over asynchronous dial-up modems, allowing computers in people's homes to be connected to a network without the cost of a leased line. Dial-up SLIP links can also be used for remote sites that need only occasional or backup connectivity. Both public-domain and vendor-supported SLIP implementations are available for a variety of personal computers, including the IBM PC, the Apple Macintosh, and the Commodore Amiga.

The Cisco Systems terminal servers combine the ability to run SLIP with hardware and software optimized to handle terminal line traffic. The terminal server concentrates a large number of SLIP PC hosts onto a network interface, allowing the PCs to communicate to any host on the network. The terminal server can support any combination of SLIP lines and lines dedicated to normal asynchronous devices, such as terminals and modems.

The version of SLIP described in this manual was originally implemented by researchers at the University of California at Berkeley in their 4.2 BSD version of the UNIX operating

system. Although variants have been proposed, the Berkeley version has emerged as a de facto standard. SLIP lacks error detection, and can run only the Internet Protocol suite.

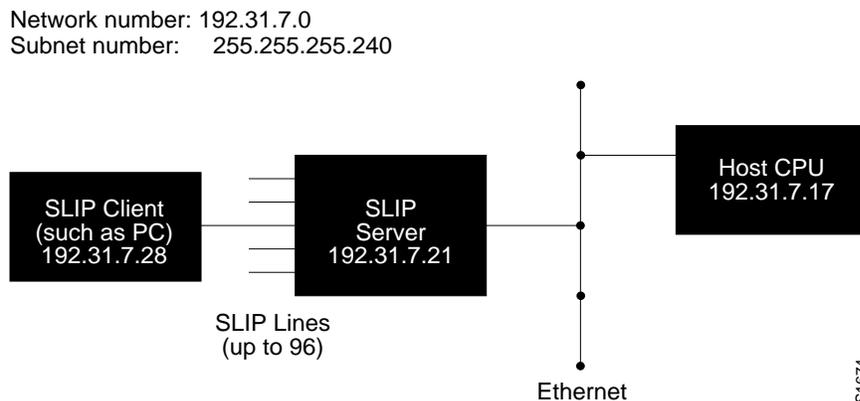
Cisco's Implementation of SLIP

There are two ways of implementing SLIP: the network server model (Cisco TRouter), and the terminal server model. The Cisco Systems terminal servers support the terminal server model. In a network server model, each SLIP line has its own network or subnet number. Another network may exist on the other side of the SLIP client (the PC); Internet routing protocols are used to exchange information about how to reach hosts on that network. The SLIP client can pick its own Internet address by pretending to be a router between the SLIP link and its own network (if the link address is fixed), or by negotiating the address of that interface with the server.

The network server model has the advantage of allowing hosts to have permanent Internet addresses and names. It has the disadvantage of needing a full network or subnet for each SLIP connection, which makes routing more complex. The network server model allows a SLIP link to connect two full networks, as opposed to a single host and a network. In the terminal server model, each SLIP line has a unique Internet address. The terminal server replies to Address Resolution Protocol (ARP) requests for those addresses, acting much like a multiport Ethernet transceiver. Each SLIP client must have an assigned Internet address on the same network or subnet as the terminal server's network interface. Only one Internet address at the other end is possible, namely the one for which the terminal server is configured. Therefore, the SLIP client cannot serve as a router to another network.

The terminal server displays in text form the address it expects the SLIP client to have when the user issues the EXEC command **slip**, which enables SLIP mode. The SLIP client may also determine this address using the Boot Protocol (BootP).

Figure 1-1 Sample SLIP Configuration (Terminal Server Model)



SLIP and Broadcasts

The Cisco Systems terminal servers recognize a variety of Internet broadcast addresses. When a terminal server receives an Internet packet with one of these addresses from a SLIP client, it rebroadcasts the packet onto the network without changing the Internet header. The terminal server does not alter the packet's broadcast address to match the form of broadcast address it prefers.

The terminal server receives a copy of SLIP client broadcasts, and responds to BootP requests with the Internet address of the line that received them. This facility allows the SLIP client software to automatically determine its own Internet address.

Making a SLIP Connection

The EXEC command **slip** typically begins a SLIP connection. Enter this command at the EXEC prompt:

```
slip
```

The terminal server displays in text form the address it expects the SLIP client to have, which enables SLIP mode. The SLIP client may also determine this address using the Boot Protocol (BootP).

Note: SLIP can also be initiated using the **slip dedicated** line configuration subcommand. When **slip dedicated** is included in a configuration, the user will not get a prompt. A line is reinstated into a connection-oriented mode by including the line configuration subcommand **slip interactive** in the terminal server's configuration. This is the equivalent of a **no slip dedicated** command (although this form of the **slip dedicated** command does not exist).

Example:

In this session, the user enters the slip EXEC command to make connection, and then the IP address to use is displayed:

```
TS>slip  
Ip address: 192.31.7.28
```

Once the IP address and any login requirements from the host system (login name, password, and so on) are entered, SLIP confirms that SLIP mode has been successfully entered:

```
Entering SLIP mode...
```

The following sections describe how to configure a line for SLIP mode, and how to maintain the SLIP line.

Configuring SLIP

Following are the basic steps for configuring SLIP on the Cisco terminal server.

- Step 1:** Enable SLIP on a terminal server line using the **slip** line subcommand.
- Step 2:** Set the appropriate settings for the line. Line settings include baud rate, flow control, stop bits, addressing and packet size limits, and modem control.
- Step 3:** Specify access lists for control of traffic to or from a SLIP-enabled line.

Additionally, SLIP supports simultaneous routing of packets to networks connected via SLIP lines on the Cisco TRouter, the combination terminal server/router product.

The commands to define the configuration are done in configuration mode, which is privileged. To enter configuration mode, type the **configure** command at the EXEC prompt. You can then enter the commands described in this sections. For more information about the configuration mode, see the chapter “Configuring the System.”

The following sections describe these tasks. The EXEC commands used to monitor and maintain a SLIP link are described at the end of this chapter, along with alphabetic summaries of the configuration commands described in this chapter.

Configuring a SLIP Line

This section describes the line subcommands for configuring SLIP support.

For information about the **configure** command and the **line** configuration command, see the chapter “Configuring the System.”

Disabling SLIP Mode on the Line

SLIP mode is enabled by default. The **no slip** line subcommand disables SLIP mode. It has this syntax:

no slip

The **no slip** subcommand cancels SLIP support on the line.

When a line is configured for SLIP, the EXEC responds to the **slip** EXEC command by turning on SLIP on the line, displaying the Internet address to use and the size of the largest Internet packet the SLIP support can handle. The line exits SLIP mode when the modem is hung up or a **clear line** command is issued.

Example:

This example disables SLIP mode on line 3.

```
line 3
no slip
```

Setting the Baud Rate

The **speed** line subcommand sets the transmit and receive speeds for the line.

speed *baud*

The argument *baud* can be 100, 1200, 2400, 4800, 9600, 19200, or 38400. Whether or not a higher baud rate improves performance depends on the SLIP client's ability to handle the interrupt load.

Example:

This example sets the baud rate to 9600:

```
line 3
slip
speed 9600
```

Configuring Dynamic Address Assignment

The IP address associated with a SLIP line can be assigned when a user issues the **slip EXEC** command, rather than when the terminal server is configured. Use this line subcommand to do so:

slip address dynamic

This subcommand allows flexibility when the lines are in a rotary configuration, when you cannot predict which line a user will connect to. This feature is supported when a TACACS server is used.

Note: The hostname sent in a TACACS request will be in all uppercase letters.

Once you have configured the line with the **slip address dynamic** command, users can set the IP address using the EXEC **slip** command.

Example:

In the following example, line 3 is configured for dynamic address assignment:

```
line 3
slip address dynamic
```

Note: The subcommand **slip address dynamic** also supports ranges of lines.

Now, when users enter the EXEC **slip** command, they are prompted for an IP address. The IP address can be either a hostname, such as *Eng2*, or an IP address in dotted decimal format. When users enter a valid hostname or IP address, they are prompted for a password. If they enter a valid password, they then enter SLIP mode, as seen in the following sample session:

Sample Session:

```
TS>slip
Ip address: Eng2
Password:
Entering SLIP mode...
```

The terminal server uses the TACACS protocol to authenticate the IP-address/password pair. It also checks other aspects of validity, such as whether the IP address is currently in use, and whether the correct network has been selected. The terminal server sends the TACACS query using the host name (or IP address) as typed by the user as the host name.

Configuring Flow Control

The **flowcontrol hardware** line subcommand for SLIP sets hardware flow control on the line, which improves line performance if the SLIP client also supports hardware flow control. The syntax of this command follows:

flowcontrol hardware

For details about which signals to connect for hardware flow control, see your respective *Hardware Installation and Reference* publication.

Setting the Stop Bits

The **stopbits** SLIP line subcommand sets the stop bits per byte for improved performance.

stopbits *bits*

Specify the number of bits with the argument *bits*. The default value of 2 stop bits results in a performance degradation of roughly 12x25. The choices are 1 or 2 stop bits. The recommended stop bit is 1.

Example:

This example sets one stop bit on the SLIP line:

```
line 3
slip
stopbits 1
```

Configuring the Hold Queue

The **slip hold-queue** line subcommand specifies the limit of the SLIP output queue, which stores packets received from the network waiting to be sent to the SLIP client.

slip hold-queue *packets*

The argument *packets* is the maximum number of packets. The default is 2 packets; it is recommended that the queue size not exceed 10.

Example:

This command changes the packet queue length to 5 packets.

```
line 5
slip hold-queue 5
```

Configuring the MTU Size of Internet Packets

The **slip mtu** line subcommand specifies the size of the largest Internet packet that the SLIP support can handle.

slip mtu *bytes*

The argument *bytes* is the maximum number of bytes. The default is 1500 MTU.

You might want to change to a smaller MTU size if the SLIP application at the other end doesn't support packets of that size, or you want to assure a lower delay by using shorter packets. This can be desirable when the host Telnet echoing takes longer than 0.2 seconds. A 1500 byte packet takes about 1.5 seconds to transmit, so this delay would indicate that you want an MTU size of about 200. On the other hand, the MTU size can be negotiated by TCP regardless of what the terminal settings are, and this is the better way to do it.

Example:

These commands set the packet MTU size to 200 bytes.

```
line 5
slip
slip mtu 200
```

Specifying the IP Address Assigned to SLIP

The **slip address** line subcommand specifies the Internet address assigned to the SLIP client at the other end of the serial line connection. The command has this syntax:

```
slip address internet-address
```

The argument *internet-address* must be on the same network or subnet as the terminal server's network interface.

Example:

This example sets IP address 182.32.7.51 on line 2.

```
line 2
slip
slip address 182.32.7.51
```

Configuring the Modem Line as a Dedicated SLIP Line

The **slip dedicated** line subcommand puts the line in SLIP mode permanently. It has this simple syntax:

```
slip dedicated
```

The terminal server will not create an EXEC on this line, so it is not available for normal interactive use.

Configuring the Modem Line in Interactive Mode

The **slip interactive** line subcommand allows the line to be used in either SLIP mode or interactive mode.

```
slip interactive
```

The **slip interactive** subcommand is generally used to void a **slip dedicated** line subcommand. It is the equivalent of a **no slip dedicated** specification (although the **no** variation of the **slip dedicated** command does not exist). To put this line into SLIP mode, use the EXEC command **slip**; see "SLIP Connections" in this chapter.

Hanging up the modem or clearing the line puts the line back into interactive mode.

Setting Modem Lines to Revert to Interactive Mode

The **modem callin** and **modem cts-required** line subcommands are useful for SLIP operation.

These subcommands ensure that, when the line is hung up (**modem callin**) or CTS drops (**modem cts-required**), the line reverts from SLIP mode to normal interactive mode.

These subcommands do not work if you use the **slip dedicated** subcommand to put the line in SLIP mode permanently.

The modem control subcommands are described in “Configuring Modem Control Lines” in the “Configuring the System” chapter.

Specifying SLIP Access Lists

Access lists allow the system administrator to control the hosts which may be accessed by a PC running SLIP through a terminal server. In versions of the software prior to 8.3, turning on SLIP defeated any access lists that were defined for that line. As SLIP is different than a connection, separate access lists may be defined for SLIP and for normal connections. The software allows separate access lists to be defined for use when the line is running SLIP.

To configure an access list to be used on packets *from* the SLIP host, use this line subcommand:

slip access-class *number* in

When this command is entered, the IP destination address of each packet is run through the access list for acceptability, and dropped or passed. The argument *number* is the IP access list number. See the “Configuring IP Access Lists” section in the “Configuring TCP/IP” chapter for information about IP access lists.

To specify an access list to be used on packets being sent *to* the SLIP host, use this line subcommand:

slip access-class *number* out

When this command is entered, the IP source address is compared against the access list, and only those packets allowed by the access list are transmitted on the asynchronous line. The argument *number* is the IP access list number (see the “Configuring IP Access Lists” section in the “Configuring TCP/IP” chapter for information about IP access lists).

On the TRouter, it is also possible to use extended IP access lists on SLIP lines. In this case, the header of the packet is compared against the access list as appropriate.

Example:

This example assumes that SLIP users are restricted to certain servers designated as SLIP servers, but that normal terminal users can access anything on the local network:

```
! access list for normal connections
access-list 1 permit 131.108.0.0 0.0.255.255
!
! access list for SLIP packets.
access-list 2 permit 131.108.42.55
access-list 2 permit 131.108.111.1
access-list 2 permit 131.108.55.99
!
!Define all the lines with slip addresses and
!appropriate access lists
line 1 60
slip address dynamic
access-class 1 out
slip access-class 2 in
```

Routing SLIP on the TRouter

The Cisco combined terminal server/router (the TRouter) can route packets to networks connected via a SLIP line. (Earlier versions of TRouter software supported only end-nodes connected via SLIP.)

Example:

To route to a network on a SLIP line, use the **ip route** command in combination with the **slip address** line subcommand.

The following example creates a static route that is added to the router's routing table when the line enters SLIP mode. The route is deleted when SLIP is turned off on that line, such as when a modem hangs up.

```
line 5
slip address 130.107.4.40
ip route 10.0.0.0 130.107.4.40
```

Once the SLIP line is active, this route behaves identically to any other static route, and may be redistributed using any of the dynamic routing protocols. Refer to the *Cisco Router Products Configuration and Reference* publication for details on configuring dynamic routing protocols.

Note: Dynamic routing updates are not sent over the SLIP lines. In an average-size network, routing updates could overload a low speed SLIP line. This means that systems on the remote network must be configured with static routes to reach the main network.

SLIP Configuration Example

The following sample configuration assigns an Internet address to a SLIP line and puts the line in SLIP mode permanently. Setting the stop bits to 1 is a performance enhancement.

```
line 20
location Joe's computer
stopbits 1
speed 19200
slip address 182.32.7.51
slip dedicated
```

Maintaining SLIP

This section describes the EXEC commands for maintaining SLIP support on the terminal server.

Maintaining SLIP is a simple task on the terminal server and TRouter products. The **clear**

line EXEC command disables SLIP mode and starts an EXEC on a non-dedicated SLIP line. Enter this command at the EXEC prompt:

clear line *line-number*

The argument *line-number* specifies the line. This command is the only way to exit SLIP mode on a line without modem control.

Monitoring SLIP

Use the EXEC **show** commands described in this section to obtain displays of activity on the SLIP line.

Displaying the Mapped Internet Address

The **show ip aliases** command displays Internet addresses mapped to TCP ports (*aliases*) and SLIP addresses, which are treated similarly to the aliases. Enter this command at the EXEC prompt:

show ip aliases

To distinguish a SLIP address from a normal alias address, the command output uses the form SLIP TTY n for the “port” number, where n is the terminal number (in octal).

Sample output follows:

IP Address	Port
192.31.7.52	SLIP TTY35
192.31.7.53	SLIP TTY36
192.31.7.54	SLIP TTY37
192.31.7.55	SLIP TTY40

The display lists the IP address and corresponding port number.

Displaying the IP ARP Cache

The **show ip arp** EXEC command displays the Address Resolution Protocol (ARP) cache, where SLIP addresses appear as permanent ARP table entries. To display the IP ARP cache, use the following EXEC command:

show ip arp

This command displays the contents of the IP ARP (Address Resolution Protocol) cache. An Address Resolution Protocol establishes correspondences between network addresses (an IP address, for example) and LAN hardware addresses (Ethernet addresses). A record of each correspondence is kept in a cache for a predetermined amount of time and then discarded. Following is sample output. Table 1-1 describes the fields displayed.

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
----------	---------	-----------	---------------	------	-----------

Internet	131.108.1.140	137	aa00.0400.6408	ARPA	Ethernet0
Internet	131.108.1.111	156	0800.2007.8866	ARPA	Ethernet0
Internet	131.108.1.115	33	0000.0c01.0509	ARPA	Ethernet0
Internet	192.31.7.24	5	0800.0900.46fa	ARPA	Ethernet2
Internet	192.31.7.26	41	aa00.0400.6508	ARPA	Ethernet2
Internet	192.31.7.27	-	aa00.0400.0134	ARPA	Ethernet2
Internet	192.31.7.28	67	0000.0c00.2c83	ARPA	Ethernet2
Internet	192.31.7.17	67	2424.c01f.0711	ARPA	Ethernet2
Internet	192.31.7.18	64	0000.0c00.6fbf	ARPA	Ethernet2
Internet	192.31.7.21	114	2424.c01f.0715	ARPA	Ethernet2
Internet	131.108.1.33	15	0800.2008.c52e	ARPA	Ethernet0
Internet	131.108.1.55	44	0800.200a.bbfe	ARPA	Ethernet0
Internet	131.108.1.6	89	aa00.0400.6508	ARPA	Ethernet0
Internet	131.108.7.1	-	0000.0c00.750f	ARPA	Ethernet3
Internet	131.108.1.1	-	aa00.0400.0134	ARPA	Ethernet0

Table 1-1 Show IP Arp Display Field Descriptions

Field	Description
Protocol	Protocol for network address in Address field
Address	The network address that corresponds to Hardware Addr
Age (min)	Age, in minutes, of the last update of the cache entry
Hardware Addr	LAN hardware address that corresponds to network address
Type	Type of ARP (Address Resolution Protocol): ARPA = Ethernet-type ARP SNAP = RFC 1042 ARP Probe = HP Probe Protocol

Displaying SLIP Line Status

The **show line** EXEC command displays SLIP status for a line running in SLIP mode. Enter this command at the EXEC prompt:

```
show line line-number
```

The argument *line-number* specifies the line.

Following is sample output:

Tty	Typ	Tx/Rx	A	Modem	Roty	AccO	AccI	Uses	Noise
0	CTY		-	-	-	-	-	1	0
1	SLIP	9600/9600	-	-	-	-	-	0	0
2	TTY	9600/9600	-	-	1	-	-	0	0
3	TTY	9600/9600	-	inout	1	-	-	0	0
4	TTY	9600/9600	-	-	-	-	-	0	0
*	5	TTY	9600/9600	-	-	-	-	1	0
6	SLIP	9600/9600	-	-	-	-	-	0	0
7	TTY	9600/9600	-	-	-	-	-	0	0
10	TTY	9600/9600	-	-	-	-	-	0	0
11	TTY	9600/9600	-	-	-	-	-	0	0
12	TTY	9600/9600	-	inout	-	-	-	0	0
13	TTY	9600/9600	-	-	-	-	-	0	0
14	TTY	9600/9600	-	-	-	-	-	0	0
15	TTY	9600/9600	-	-	-	-	-	0	0
16	TTY	9600/9600	-	-	-	-	-	0	0
17	TTY	9600/9600	-	-	-	-	-	0	0

Displaying the Status of SLIP-Configure Lines

The **show slip** EXEC command displays the status of all lines configured for SLIP support. Enter this command at the EXEC prompt:

show slip

Following is sample output:

Slip statistics:

Rcvd: 0 packets, 0 bytes, 0 escapes

0 format errors, 0 checksum errors, 0 overrun, 0 no buffer

Sent: 0 packets, 0 bytes, 0 escapes, 0 dropped

--More--

Tty	Mod	Address	Istate	Ostate	Qd	InPack	OutPac	Inerr	Dropped
35	i/o	192.31.7.52	IDLE	IDLE	0	0	0	0	0 1524 0
36	i/o	192.31.7.53	IDLE	IDLE	0	0	0	0	0 1524 0
37	i/o	192.31.7.54	IDLE	IDLE	0	0	0	0	0 1006 0
40	i/o	192.31.7.55	IDLE	IDLE	0	0	0	0	0 1006 0

Table 1-2 describes the fields displayed by this command.

Table 1-2 Slip Statistics Display Field Descriptions

Field	Description
Rcvd:	Statistics on packets received.
packets	Packets received.
bytes	Total number of bytes.
escapes	Count of escape character sent.
format errors	Packets with a bad IP header, even before the checksum is calculated.
checksum errors	Count of checksum errors.
overrun	Number of giants received.
no buffer	Number of packets received when no buffer was available.
Sent	Statistics on packets sent.
dropped	Number of packets dropped.
Tty mod	Type of modem control.
IState and OState	Used by Cisco engineers for troubleshooting.
Qd	Number of packets on hold queue (Qsz is max).
InPack	Number of packets input for asynchronous line.
OutPac	Number of packets sent to asynchronous line.
Inerr	Number of total input errors; sum of format errors, checksum errors, overruns and no buffers.
Dropped	Number of packets received that wouldn't fit on the hold queue (time to either fix the hosts' TCPs, or increase the hold queue size).
*	An asterisk indicates a line currently in SLIP mode.

Debugging SLIP

The privileged-mode EXEC **debug** commands described in this section are used to troubleshoot line in SLIP mode. Generally, you enter these commands during troubleshooting sessions with Cisco staff.

For each **debug** command, there is a corresponding **undebug** command that turns the display off. Entering the **debug** commands will affect performance of the SLIP feature.

debug slip

The **debug slip** EXEC command enables logging of all SLIP activity. The high volume of SLIP debugging output, which amounts to several lines per packet, noticeably affects overall system performance.

debug slip-event

The **debug slip-event** EXEC command enables logging of selected SLIP events, such as various types of errors, enabling and disabling of SLIP mode on a line, and so on. The volume of output for this command is much lower than that for the **debug slip** command.

Note: For complete SLIP debugging output, use both the **debug slip** and the **debug slip-event** commands.

SLIP Line Subcommand Configuration Summary

This section provides an alphabetically arranged summary of the SLIP line subcommands.

flowcontrol hardware

Sets hardware flow control on the line, which improves line performance if the SLIP client also supports hardware flow control. For details about which signals to connect for hardware flow control, see the *Cisco Systems Hardware Products Installation Guide*.

no slip

Disables SLIP mode on the assigned line.

slip address *internet-address*

Specifies the Internet address assigned to the SLIP client at the other end of the serial line connection. The argument *internet-address* must be on the same network or subnet as the terminal server's network interface.

slip address dynamic

Allows the IP address associated with a SLIP line to be assigned when a user issues the **slip EXEC** command, rather than when the terminal server is configured. This subcommand allows flexibility when the lines are in a rotary configuration, when you cannot predict which line a user will be connected to. This feature is supported when a TACACS server is used.

slip dedicated

Puts the line in SLIP mode permanently. The terminal server will not create an EXEC on this line, so it is not available for normal interactive use.

slip hold-queue *packets*

Specifies the limit of the SLIP output queue, which stores packets received from the network waiting to be sent to the SLIP client. The argument *packets* is the maximum number of packets. Default is 2 packets.

slip interactive

Allows the line to be used in either SLIP mode or interactive mode. To put this line into SLIP mode, use the EXEC command **slip**. Hanging up the modem or clearing the line puts the line back into interactive mode.

slip mtu *bytes*

Specifies the size of the largest Internet packet that the SLIP support can handle. The argument *bytes* is the maximum number of bytes. Default is 1500 bytes.

speed *baud*

Sets the transmit and receive speeds for the line. The argument *baud* is 100, 1200, 2400, 4800, 9600, 19200, or 38400. Whether or not a higher baud rate improves performance depends on the SLIP client's ability to handle the interrupt load.

stopbits *bits*

Sets the terminal server to transmit the number of stop bits defined by the *bits* argument per byte for improved performance. The choices are one or two stop bits. The default value of 2 stop bits results in a performance degradation of roughly 12x25.