

X.25 and LAPB Commands

Use the commands in this chapter to configure Link Access Procedure, Balanced (LAPB), X.25, Defense Data Network (DDN) X.25, and the Blacker Front End (BFE). X.25 provides remote terminal access; encapsulation for the IP, DECnet, XNS, ISO CLNS, AppleTalk, Novell IPX, Banyan VINES, and Apollo Domain protocols; and bridging.

X.25 virtual circuits can also be switched as follows:

- Between interfaces—for local routing
- Between two routers—for remote routing or tunneling
- Over nonserial media—for Connection-Mode Network Service (CMNS).

To translate between X.25 and another protocol, refer to the “Protocol Translation Commands” chapter in the *Access Services Command Reference*.

For X.25 and LAPB configuration information and examples, refer to the “Configuring X.25 and LAPB” chapter in the *Wide-Area Networking Configuration Guide*.

access-class

To configure an incoming access class on virtual terminals, use the **access-class** line configuration command.

access-class *access-list-number* **in**

Syntax Description

<i>access-list-number</i>	An integer between 1 and 199 that you select for the access list.
in	Restricts incoming connections between a particular access server and the addresses in the access list.

Default

No incoming access class is defined.

Command Mode

Line configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.3.

The access list number is used for both incoming Transmission Control Protocol (TCP) access and incoming packet assembler/disassembler (PAD) access.

In the case of TCP access, the access server uses the Internet Protocol (IP) access list defined with the **access-list** command.

For incoming PAD connections, the same numbered X.29 access list is referenced. If you only want to have access restrictions on one of the protocols, you can create an access list that permits all addresses for the other protocol.

Example

The following example configures an incoming access class on virtual terminal line 4:

```
line vty 4
access-class 4 in
```

Related Commands

The dagger (†) indicates that the command is documented outside this chapter.

access-list †
line vty †
x29 access-list

bfe

To allow the router to participate in emergency mode or to end participation in emergency mode when the interface is configured for **x25 bfe-emergency decision** and **x25 bfe-decision ask**, use the **bfe EXEC** command.

```
bfe {enter | leave} type number
```

Syntax Description

enter	Causes the Cisco IOS software to send a special address translation packet that includes an enter emergency mode command to the Blacker Front End (BFE) if the emergency mode window is open. If the BFE is already in emergency mode, this command enables the sending of address translation information.
leave	Disables the sending of address translation information from the Cisco IOS software to the BFE when the BFE is in emergency mode.
<i>type</i>	Interface type.
<i>number</i>	Interface number.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.3.

Example

The following example enables an interface to participate in BFE emergency mode:

```
bfe enter serial 0
```

Related Commands

encapsulation x25 bfe
x25 bfe-decision
x25 bfe-emergency

clear x25-vc

To clear switched virtual circuits (SVCs) and to reset permanent virtual circuits (PVCs), use the **clear x25-vc** privileged EXEC command. To clear *all* X.25 virtual circuits at once by restarting the packet layer service, use this command without an *lcn* argument.

```
clear x25-vc type number [lcn]
```

Syntax Description

<i>type</i>	Interface type.
<i>number</i>	Interface number.
<i>lcn</i>	(Optional) Virtual circuit.

Command Mode

Privileged EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example illustrates how to clear all virtual circuits on an interface:

```
clear x25-vc serial 1
```

Related Command

x25 idle

cmns enable

To enable the Connection-Mode Network Service (CMNS) on a nonserial interface, use the **cmns enable** interface configuration command. To disable this capability, use the **no** form of this command.

cmns enable
no cmns enable

Syntax Description

This command has no arguments or keywords.

Default

The CMNS protocol is implicitly enabled whenever an X.25 encapsulation command is included with a serial interface configuration. A particular nonserial interface, however, must be explicitly configured to use CMNS.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

After this command is processed on the LAN interfaces—Ethernet, Fiber Distributed Data Interface (FDDI), and Token Ring—all the X.25-related interface configuration commands are made available.

Example

The following example enables CMNS on interface Ethernet 0:

```
interface ethernet 0
cmns enable
```

Related Command

x25 map cmns

encapsulation lapb

To exchange datagrams over a serial interface using LAPB encapsulation, use the **encapsulation lapb** interface configuration command.

```
encapsulation lapb [dte | dce] [multi | protocol]
```

Syntax Description

dte	(Optional) Specifies operation as a data terminal equipment (DTE) device. This is the default LAPB mode.
dce	(Optional) Specifies operation as a data communications equipment (DCE) device.
multi	(Optional) Specifies use of multiple local-area network (LAN) protocols to be carried on the LAPB line.
<i>protocol</i>	(Optional) A single protocol to be carried on the LAPB line. A single protocol can be one of the following: apollo , appletalk , clns (ISO CLNS), decnet , ip , ipx (Novell IPX), vines , and xns . IP is the default protocol.

Defaults

The default serial encapsulation is High-Level Data Link Control (HDLC). You must explicitly configure a LAPB encapsulation method.

DTE operation is the default LAPB mode. IP is the default protocol.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The **dte**, **dce**, and **multi** commands and the *protocol* argument first appeared in Cisco IOS Release 10.3

LAPB encapsulations are appropriate only for private connections, where you have complete control over both ends of the link. Connections to X.25 networks should use an X.25 encapsulation configuration, which operates the X.25 Layer 3 protocol above a LAPB Layer 2.

One end of the link must be a logical DCE, and the other end a logical DTE. (This assignment is independent of the interface's hardware DTE or DCE identity.)

Both ends of the LAPB link must specify the same protocol encapsulation.

LAPB encapsulation is supported on serial lines configured for dial-on-demand routing (DDR). It can be configured on DDR synchronous serial and Integrated Services Digital Network (ISDN) interfaces and on DDR dialer rotary groups. It is not supported on asynchronous dialer interfaces.

A single-protocol LAPB encapsulation exchanges datagrams of the given protocol, each in a separate LAPB information frame. You must configure the interface with the protocol-specific parameters needed—for example, a link that carries IP traffic will have an IP address defined for the interface.

A multiprotocol LAPB encapsulation can exchange any or all of the protocols allowed for a serial interface. It also exchanges datagrams, each in a separate LAPB information frame. Since two bytes of protocol identification data precede the protocol data, you do not need to configure the interface with all the protocol-specific parameters needed for each protocol carried.

Beginning with Cisco IOS Release 11.0, *multiprotocol* LAPB encapsulation supports transparent bridging. This feature requires use of the **encapsulation lapb multi** command followed by the **bridge-group** command, which identifies the bridge group associated with multiprotocol LAPB encapsulation. This feature does *not* support use of the **encapsulation lapb protocol** command with a **bridge** keyword.

Beginning with Release 10.3, LAPB encapsulation supports the priority and custom queueing features.

Example

The following example sets the operating mode as DTE and specifies that AppleTalk protocol traffic will be carried on the LAPB line:

```
interface serial 1
 encapsulation lapb dte appletalk
```

Related Command

The dagger (†) indicates that the command is documented outside this chapter.

bridge-group †

encapsulation x25

To specify a serial interface's operation as an X.25 device, use the **encapsulation x25** interface configuration command.

```
encapsulation x25 [dte | dce] [ddn | bfe] | [ietf]
```

Syntax Description

dte	(Optional) Specifies operation as a DTE. This is the default X.25 mode.
dce	(Optional) Specifies operation as a DCE.
ddn	(Optional) Specifies DDN encapsulation on an interface using DDN X.25 Standard Service.
bfe	(Optional) Specifies BFE encapsulation on an interface attached to a BFE device. Available for BFE operation only.
ietf	(Optional) Specifies that the interface's datagram encapsulation defaults to use of the Internet Engineering Task Force (IETF) standard method, as defined by RFC 1356.

Defaults

The default serial encapsulation is HDLC. You must explicitly configure an X.25 encapsulation method.

DTE operation is the default X.25 mode. Cisco's traditional X.25 encapsulation method is the default.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

One end of an X.25 link must be a logical DCE and the other end a logical DTE. (This assignment is independent of the interface's hardware DTE or DCE identity.) Typically, when connecting to a public data network (PDN), the customer equipment acts as the DTE and the PDN attachment acts as the DCE.

Cisco has long supported the encapsulation of a number of datagram protocols, using a standard means when available and a proprietary means when necessary. More recently the IETF adopted a standard, RFC 1356, for encapsulating most types of datagram traffic over X.25. X.25 interfaces use Cisco's traditional method unless explicitly configured for IETF operation; if the **ietf** keyword is specified, that standard is used unless Cisco's traditional method is explicitly configured. For details see the **x25 map** command.

When an X.25 interface is reconfigured, all the interface's X.25 parameters are initialized except the **x25 map** commands. The **x25 map** statements that are configured for an interface are not deleted when the encapsulation is changed, so they will be retained if the interface is later reconfigured for X.25 operation.

You can configure a router attaching to the Defense Data Network (DDN) or to a Blacker Front End (BFE) device to use their respective algorithms to convert between IP and X.121 addresses by using the **ddn** or **bfe** option, respectively. An IP address must be assigned to the interface, from which the algorithm will generate the interface's X.121 address. For proper operation, this X.121 address must not be modified.

A router DDN attachment can operate as either a DTE or a DCE device. A BFE attachment can operate only as a DTE device. The **ietf** option is not available if either the **ddn** or **bfe** option is selected.

Example

The following example configures the interface for connection to a BFE device:

```
interface serial 0
 encapsulation x25 bfe
```

Related Command

x25 map

lapb interface-outage

To specify a period during which a link will remain connected, even if a brief hardware outage occurs, use the **lapb interface-outage** interface configuration command.

lapb interface-outage *milliseconds*

Syntax Description

<i>milliseconds</i>	Number of milliseconds a hardware outage can last without having the protocol disconnect the service. The default is 0 ms, which disables this feature.
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Default

0 ms, which disables this feature.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

If a hardware outage lasts longer than the LAPB hardware outage period you select, normal protocol operations will occur. The link will be declared down and, when it is restored, a link setup will be initiated.

Example

The following example sets the interface outage period to 100 ms. The link remains connected for outages equal to or shorter than that period.

```
encapsulation lapb dte ip
lapb interface-outage 100
```

lapb k

To specify the maximum permissible number of outstanding frames, called the *window size*, use the **lapb k** interface configuration command.

lapb k *window-size*

Syntax Description

window-size Frame count. It can be a value from 1 to the modulo size minus 1 (the maximum is 7 if the modulo size is 8; it is 127 if the modulo size is 128). The default is 7 frames.

Default

7 frames

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

If the window size is changed while the protocol is up, the new value takes effect only when the protocol is reset. You will be informed that the new value will not take effect immediately.

When using the LAPB modulo 128 mode (extended mode), you must increase the window parameter k to send a larger number of frames before acknowledgment is required. This increase is the basis for the router's ability to achieve greater throughput on high-speed links that have a low error rate.

This configured value must match the value configured in the peer X.25 switch. Nonmatching values will cause repeated LAPB reject (REJ) frames.

Example

The following example sets the LAPB window size (the k parameter) to 10 frames:

```
interface serial 0
 lapb modulo
 lapb k 10
```

Related Command

lapb modulo

lapb modulo

To specify the LAPB basic (modulo 8) or extended (modulo 128) protocol mode, use the **lapb modulo** interface configuration command.

lapb modulo *modulus*

Syntax Description

modulus Either 8 or 128. The value 8 specifies LAPB's basic mode; the value 128 specifies LAPB's extended mode. The default is 8.

Default

Modulo 8

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The modulo parameter determines which of LAPB's two modes is to be used. The modulo values derive from the fact that basic mode numbers information frames between 0 and 7, whereas extended mode numbers them between 0 and 127. Basic mode is widely available and is sufficient for most links. Extended mode is an optional LAPB feature that may achieve greater throughput on high-speed links that have a low error rate.

The LAPB operating mode may be set on X.25 links as well as LAPB links. The X.25 modulo is independent of the LAPB layer modulo. Both ends of a link must use the same LAPB mode.

When using modulo 128 mode, you must increase the window parameter *k* to send a larger number of frames before acknowledgment is required. This increase is the basis for the router's ability to achieve greater throughput on high-speed links that have a low error rate.

If the modulo value is changed while the protocol is up, the new value takes effect only when the protocol is reset. You will be informed that the new value will not take effect immediately.

Example

The following example configures a high-speed X.25 link to use LAPB's extended mode:

```
interface serial 1
 encapsulation x25
 lapb modulo 128
 lapb k 40
 clock rate 2000000
```

Related Command

lapb k

lapb n1

To specify the maximum number of bits a frame can hold (the LAPB **n1** parameter), use the **lapb n1** interface configuration command.

lapb n1 bits

Syntax Description

bits Maximum number of bits in multiples of eight. The minimum and maximum range is dynamically set. Use the ? to view the range.

Defaults

The largest (maximum) value available for the particular interface is the default. The Cisco IOS software dynamically calculates **n1** whenever you change the maximum transmission unit (MTU), the L2/L3 modulo, or compression on a LAPB interface.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.



Caution The LAPB **n1** parameter provides little benefit beyond the interface MTU and can easily cause link failures if misconfigured. Cisco recommends that this parameter be left at its default value.

The Cisco IOS software uses the following formula to determine the minimum **n1** value:

$$(128 \text{ (default packet size)} + \text{LAPB overhead} + \text{X.25 overhead} + 2 \text{ bytes of CRC}) * 8$$

The Cisco IOS software uses the following formula to determine for the maximum **n1** value:

$$(\text{hardware MTU} + \text{LAPB overhead} + \text{X.25 overhead} + 2 \text{ bytes of CRC}) * 8$$

LAPB overhead is 2 bytes for modulo 8 and 3 bytes for modulo 128.

X.25 overhead is 3 bytes for modulo 8 and 4 bytes for modulo 128.

You need not set **n1** to an exact value to support a particular X.25 data packet size. The **n1** parameter prevents the processing of any huge frames that result from a “jabbering” interface, an unlikely event.

In addition, the various standards bodies specify that **n1** be given in bits rather than bytes. While some equipment can be configured in bytes or will automatically adjust for some of the overhead information present, Cisco devices are configured using the true value, in bits, of **n1**.

You cannot set the **n1** parameter to a value less than that required to support an X.25 data packet size of 128 bytes. All X.25 implementations must be able to support 128-byte data packets. Moreover, if you configure **n1** to be less than 2104 bits, you receive a warning message that X.25 might have problems because some nondata packets can use up to 259 bytes.

You cannot set the **n1** parameter to a value larger than the default unless the hardware MTU size is first increased.

The X.25 software accepts default packet sizes and calls that specify maximum packet sizes greater than those the LAPB layer supports, but negotiates the calls placed on the interface to the largest value that can be supported. For switched calls, the packet size negotiation takes place end-to-end through the router so the call will not have a maximum packet size that exceeds the capability of either of the two interfaces involved.

Examples

The following example shows how to use the **?** command to display the minimum and maximum **n1** value. In this example, X.25 encapsulation has both the LAPB and X.25 modulo set to 8. Any violation of this **n1** range results in an “Invalid input” error message.

```
interface serial 1
lapb n1 ?
<1080-12056> LAPB N1 parameter (bits; multiple of 8)
```

The following example sets the **n1** bits to 16440:

```
interface serial 0
lapb n1 16440
mtu 2048
```

Related Command

The dagger (†) indicates that the command is documented outside this chapter.

mtu †

lapb n2

To specify the maximum number of times a data frame can be transmitted (the LAPB **n2** parameter), use the **lapb n2** interface configuration command.

lapb n2 *tries*

Syntax Description

tries Transmission count. It can be a value from 1 to 255. The default is 20 transmissions.

Default

20 transmissions

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the **n2** tries to 50:

```
interface serial 0
lapb n2 50
```

lapb protocol

Use the **lapb protocol** interface configuration command to configure the protocol carried on the LAPB line.

lapb protocol *protocol*

Syntax Description

protocol

Protocol, entered by keyword. It can be one of the following:
appletalk, **apollo**, **clns** (ISO CLNS), **decnet**, **ip**, **ipx** (Novell IPX), **vines**, and **xns**.

Default

IP

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command is not available for multiprotocol LAPB encapsulation.

Example

The following example sets AppleTalk as the only protocol on the LAPB line:

```
interface serial 1
 encapsulation lapb
 lapb protocol appletalk
```

Related Commands

encapsulation lapb

encapsulation lapb dce

encapsulation lapb multi

lapb t1

To set the retransmission timer period (the LAPB T1 parameter), use the **lapb t1** interface configuration command.

lapb t1 *milliseconds*

Syntax Description

milliseconds Time in milliseconds. It can be a value from 1 to 64000. The default is 3000 ms.

Default

3000 ms

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The retransmission timer determines how long a transmitted frame can remain unacknowledged before the LAPB software polls for an acknowledgment. The design of the LAPB protocol specifies that a frame is presumed to be lost if it is not acknowledged within T1; a T1 value that is too small may result in duplicated control information, which can severely disrupt service.

To determine an optimal value for the retransmission timer, use the privileged EXEC command **ping** to measure the round-trip time of a maximum-sized frame on the link. Multiply this time by a safety factor that takes into account the speed of the link, the link quality, and the distance. A typical safety factor is 1.5. Choosing a larger safety factor can result in slower data transfer if the line is noisy. However, this disadvantage is minor compared to the excessive retransmissions and effective bandwidth reduction caused by a timer setting that is too small.

Example

The following example sets the T1 retransmission timer to 2000 ms:

```
interface serial 0
lapb t1 2000
```

lapb t4

To set the T4 idle timer, after which the Cisco IOS software sends out a Poll packet to determine whether the link has suffered an unsignaled failure, use the **lapb t4** interface configuration command.

lapb t4 *seconds*

Syntax Description

seconds Number of seconds between reception of the last frame and the transmission of the outgoing Poll. The default value is 0 seconds, which disables the T4 timer feature.

Defaults

0 seconds, which disables the T4 timer feature.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Any nonzero T4 duration must be greater than T1, the LAPB retransmission timer period.

Example

The following example will poll the other end of an active link if it has been 10 seconds since the last frame was received. If the far host has failed, the service will be declared down after **n2** tries are timed out.

```
interface serial0
encapsulation x25
lapb t4 10
```

Related Commands

lapb n2

lapb t1

service pad

To enable all packet assembler/disassembler (PAD) commands and connections between PAD devices and access servers, use the **service pad** global configuration command. Use the **no** form of this command to disable this service.

service pad
no service pad

Syntax Description

This command has no arguments or keywords.

Default

All PAD commands and associated connections are enabled.

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 11.1.

Examples

If **service pad** is disabled, the EXEC **pad** command and all PAD related configurations, such as X.29, are unrecognized, as shown in the following example:

```
Router(config)# no service pad
Router(config)# x29 ?
% Unrecognized command
Router(config)# exit
Router# pad ?
% Unrecognized command
```

If **service pad** is enabled, the EXEC **pad** command and access to an X.29 configuration is granted as shown in the following example:

```
Router# config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# service pad
Router(config)# x29 ?
access-list      Define an X.29 access list
inviteclear-time Wait for response to X.29 Invite Clear message
profile          Create an X.3 profile
Router# pad ?
WORD    X121 address or name of a remote system
```

Related Commands

x29 access-list
x29 profile

show cmns

To display X.25 Level 3 parameters for LAN interfaces (such as Ethernet or Token Ring) and other information pertaining to Connection-Mode Network Service (CMNS) traffic activity, use the **show cmns EXEC** command.

show cmns [*type number*]

Syntax Description

type (Optional) Interface type.

number (Optional) Interface number.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Sample Display

The following is sample output from the **show cmns** command for an Ethernet interface:

```
Router# show cmns
Ethernet1 is administratively down, line protocol is down
Hardware address is 0000.0c02.5f4c, (bia 0000.0c2.5f4c), state R1
Modulo 8, idle 0, timer 0, nvc 1
Window size: input 2, output 2, Packet size: input 128, output 128
Timer: TH 0
Channels: Incoming-only none, Two-way 1-4095, Outgoing-only none
RESTARTs 0/0 CALLs 0+0/0+0/0+0 DIAGs 0/0
```

Table 47 describes significant fields shown in the display.

Table 47 Show CMNS Field Descriptions

Field	Description
Ethernet1 is down	Interface is currently active and inserted into network (up) or inactive and not inserted (down), or disabled (administratively down).
line protocol is {up down}	Indicates whether the software processes that handle the line protocol recognize the interface as usable.
Hardware address	Media access control (MAC) address for this interface.
bia	Burned-in address.
state R1	State of the interface. R1 is normal ready state. (The state should always be R1.)
modulo 8	Modulo value; determines the packet sequence numbering scheme used.
idle 0	Number of minutes the Cisco IOS software waits before closing idle virtual circuits.
timer 0	Value of the interface time; should always be zero.

Table 47 Show CMNS Field Descriptions (Continued)

Field	Description
nvc 1	Maximum number of simultaneous virtual circuits permitted to and from a single host for a particular protocol.
Window size:	Default window sizes (in packets) for the interface. (CMNS cannot originate or terminate calls.)
input 2	Default input window size is two packets.
output 2	Default output window size is two packets.
Packet size:	Default packet sizes for the interface. (CMNS cannot originate or terminate calls).
input 128	Default input maximum packet size is 128 bytes.
output 128	Default output maximum packet size is 128 bytes.
TH 0	X.25 delayed acknowledgment threshold. Should always be zero.
Channels: Incoming-only: none, Two-way: 1-4095, Outgoing-only: none	Virtual circuit ranges for this interface per Logical Link Control, type 2 (LLC2) connection.
RESTARTs 0/0	Restarts sent/received.
CALLs 0+0/0+0/0+0	Successful calls + failed calls/calls sent + calls failed/calls received + calls failed.
DIAGs 0/0	Diagnostic messages sent and received.

Related Command

A dagger (†) indicates that the command is documented outside this chapter.

show interfaces serial[†]

show interfaces serial

To display information about a serial interface, use the **show interfaces serial EXEC** command.

show interfaces serial *number*

Syntax Description

number Interface port number.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Sample Displays

The following is a partial sample output from the **show interfaces serial** command for a serial interface using LAPB encapsulation:

```
Router# show interfaces serial 1

LAPB state is SABMSENT, T1 3000, N1 12056, N2 20, k7, Protocol ip
VS 0, VR 0, RCNT 0, Remote VR 0, Retransmissions 2
IFRAMEs 0/0 RNRs 0/0 REJs 0/0 SABMs 3/0 FRMRs 0/0 DISCs 0/0
```

Table 48 shows the fields relevant to all LAPB connections.

Table 48 Show Interfaces Serial Fields Descriptions When LAPB Is Enabled

Parameter	Description
LAPB state is	State of the LAPB protocol.
T1 3000, N1 12056,...	Current parameter settings.
Protocol	Protocol encapsulated on a LAPB link; this field is not present on interfaces configured for multiprotocol LAPB or X.25 encapsulations.
VS	Modulo 8 frame number of the next outgoing information frame.
VR	Modulo 8 frame number of the next information frame expected to be received.
RCNT	Number of received information frames that have not yet been acknowledged.
Remote VR	Number of the next information frame the remote device expects to receive.
Retransmissions	Count of current retransmissions due to expiration of T1.
Window is closed	No more frames can be transmitted until some outstanding frames have been acknowledged. This message should be displayed only temporarily.
IFRAMEs	Count of information frames in the form of sent/received.

Table 48 Show Interfaces Serial Fields Descriptions When LAPB Is Enabled (Continued)

Parameter	Description
RNRs	Count of Receiver Not Ready frames in the form of sent/received.
REJs	Count of Reject frames in the form of sent/received.
SABMs	Count of Set Asynchronous Balanced Mode commands in the form of sent/received.
FRMRs	Count of Frame Reject frames in the form of sent/received.
DISCs	Count of Disconnect commands in the form of sent/received.

The following is a partial sample output from the **show interfaces** command for a serial X.25 interface:

```
Router# show interfaces serial 1

X25 address 000000010100, state R1, modulo 8, idle 0, timer 0, nvc 1
  Window size: input 2, output 2, Packet size: input 128, output 128
  Timers: T20 180, T21 200, T22 180, T23 180, TH 0
  Channels: Incoming-only none, Two-way 1-1024, Outgoing-only none
(configuration on RESTART: modulo 8,
  Window size: input 2 output 2, Packet size: input 128, output 128
  Channels: Incoming-only none, Two-way 5-1024, Outgoing-only none)
  RESTARTs 3/2 CALLs 1000+2/1294+190/0+0/ DIAGs 0/0
```

The stability of the X.25 protocol requires that some parameters not be changed without a restart of the protocol. Any change to these parameters are held until a restart is sent or received. If any of these parameters changes, the configuration on restart information will be output as well as the values that are currently in effect.

Table 49 describes significant fields shown in the display.

Table 49 Show Interfaces X25 Field Descriptions

Field	Description
X25 address 000000010100	Address used to originate and accept calls.
state R1	State of the interface. Possible values are <ul style="list-style-type: none"> • R1 is the normal ready state • R2 is the DTE restarting state • R3 is the DCE restarting state If the state is R2 or R3, the interface is awaiting acknowledgment of a Restart packet.
modulo 8	Modulo value; determines the packet sequence numbering scheme used.
idle 0	Number of minutes the Cisco IOS software waits before closing idle virtual circuits that it originated or accepted.
timer 0	Value of the interface timer, which is zero unless the interface state is R2 or R3.
nvc 1	Default maximum number of simultaneous virtual circuits permitted to and from a single host for a particular protocol.
Window size: input 2, output 2	Default window sizes (in packets) for the interface. The x25 facility interface configuration command can be used to override these default values for the switched virtual circuits originated by the router.

Table 49 Show Interfaces X25 Field Descriptions (Continued)

Field	Description
Packet size: input 128, output 128	Default maximum packet sizes (in bytes) for the interface. The x25 facility interface configuration command can be used to override these default values for the switched virtual circuits originated by the router.
Timers: T20 180, T21 200, T22 180, T23 180	Values of the X.25 timers: <ul style="list-style-type: none"> • T10 through T13 for a DCE device • T20 through T23 for a DTE device
TH0	Packet acknowledgment threshold (in packets). This value determines how many packets are received before an explicit acknowledgment is sent. The default value (0) sends an explicit acknowledgment only when the incoming window is full.
Channels: Incoming-only none Two-way 5-1024 Outgoing-only none	Displays the virtual circuit ranges for this interface.
RESTARTs 3/2	Shows Restart packet statistics for the interface using the format Sent/Received.
CALLs 1000+2/1294+190/0+0	Successful calls sent + failed calls/calls received + calls failed/calls forwarded + calls failed. Calls forwarded are counted as calls sent.
DIAGs 0/0	Diagnostic messages sent and received.

Related Command

show cmns

show llc2

To display active Logical Link Control, type 2 (LLC2) connections, use the **show llc2 EXEC** command.

show llc2c

Syntax Description

This command has no arguments or keywords.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Sample Display

The following is sample output from the **show llc2** command:

```
Router# show llc2

TokenRing0 DTE=1000.5A59.04F9,400022224444 SAP=04/04, State=NORMAL
V(S)=5, V(R)=5, Last N(R)=5, Local Window=7, Remote Window=127
ack-max=3, n2=8, Next timer in 7768
xid-retry timer 0/60000 ack timer 0/1000
p timer 0/1000 idle timer 7768/10000
rej timer 0/3200 busy timer 0/9600
ack-delay timer 0/3200
CMNS Connections to:
Address 1000.5A59.04F9 via Ethernet2
Protocol is up
Interface type X25-DCE RESTARTS 0/1
Timers: T10 1 T11 1 T12 1 T13 1
```

The display includes a CMNS addendum, indicating that LLC2 is running with CMNS. When LLC2 is not running with CMNS, the **show llc2** command does not display a CMNS addendum.

Table 50 describes significant fields shown in the display.

Table 50 Show LLC2 Field Descriptions

Field	Description
TokenRing0	Name of interface on which the session is established.
DTE=1000.5A59.04F9,400022224444	Address of the station to which the router is transmitting on this session. (The address is the MAC address of the interface on which the connection is established, except when Local Acknowledgment or SDLLC is used, in which case the address used by the router is shown as in this example, following the DTE address and separated by a comma.)
SAP=04/04	Other station's and router's (remote/local) service access point (SAP) for this connection. The SAP is analogous to a "port number" on the router and allows for multiple sessions between the same two stations.

Table 50 Show LLC2 Field Descriptions (Continued)

Field	Description
State=	<p>Current state of the LLC2 session, which can be any of the following:</p> <ul style="list-style-type: none"> • ADM—Asynchronous Disconnect Mode—A connection is not established, and either end can begin one. • SETUP—Request to begin a connection has been sent to the remote station, and this station is waiting for a response to that request. • RESET—A previously open connection has been reset because of some error by this station, and this station is waiting for a response to that reset command. • D_CONN—This station has requested a normal, expected end of communications with the remote station, and is waiting for a response to that disconnect request. • ERROR—This station has detected an error in communications and has told the other station about it. This station is waiting for a reply to its posting of this error. • NORMAL—Connection between the two sides is fully established, and normal communication is occurring. • BUSY—Normal communication state exists, except that busy conditions on this station prevent this station from receiving information frames from the other station at this time. • REJECT—Out-of-sequence frame has been detected on this station, and this station has requested that the other resend this information • AWAIT—Normal communication exists, but this station has had a timer expire, and is trying to recover from it (usually by resending the frame that started the timer). • AWAIT_BUSY—A combination of the AWAIT and BUSY states. • AWAIT_REJ—A combination of the AWAIT and REJECT states.
V(S)=5	Sequence number of the next information frame this station will send.
V(R)=5	Sequence number of the next information frame this station expects to receive from the other station.
Last N (R)=5	Last sequence number of this station’s transmitted frames acknowledged by the remote station.
Local Window=7	Number of frames this station may send before requiring an acknowledgment from the remote station.
Remote Window=127	Number of frames this station can accept from the remote station.
ack-max=3, n2=8	Value of these parameters, as given in the previous configuration section.
Next timer in 7768	Number of milliseconds before the next timer, for any reason, goes off.
xid-retry timer 0/60000	A series of timer values in the form of next-time/time-between, where “next-time” is the next time, in milliseconds, that the timer will wake, and “time-between” is the time, in milliseconds, between each timer wakeup. A “next-time” of zero indicates that the given timer is not enabled, and will never wake.

Table 50 Show LLC2 Field Descriptions (Continued)

Field	Description
CMNS Connections to	<p data-bbox="657 325 1421 388">CMNS addendum when LLC2 is running with the CMNS protocol contains the following:</p> <ul data-bbox="657 399 1421 730" style="list-style-type: none"><li data-bbox="657 399 1421 430">• Address 1000.5A59.04F9 via Ethernet2—MAC address of remote station.<li data-bbox="657 441 1421 525">• Protocol is up—Up indicates the LLC2 and X.25 protocols are in a state in which incoming and outgoing Call Requests can be made on this LLC2 connection.<li data-bbox="657 535 1421 598">• Interface type X25-DCE—One of the following: X25-DCE, X25-DTE, or X25-DXE (either DTE or DCE).<li data-bbox="657 609 1421 640">• RESTARTS 0/1—Restarts sent/received on this LLC2 connection.<li data-bbox="657 651 1421 730">• Timers:—T10, T11, T12, T13 (or T20, T21, T22, T23 for DTE). These are Request packet timers and are similar in function to X.25 parameters of the same name.

show x25 map

To display information about configured address maps, use the **show x25 map** EXEC command.

```
show x25 map
```

Syntax Description

This command has no arguments or keywords.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The **show x25 map** command shows information about the following:

- Configured maps (defined by the **x25 map** command)
- Maps implicitly defined by encapsulation PVCs (defined by the **x25 pvc** command)
- Dynamic maps (from the X.25 DDN or BFE operations)
- Temporary maps (from unconfigured CMNS endpoints)

Sample Display

The following is sample output from the **show x25 map** command:

```
Router# show x25 map

Serial0: X.121 1311001 <--> ip 172.20.170.1
        PERMANENT, BROADCAST, 2 VCS: 3 4*
Serial0: X.121 1311005 <--> appletalk 128.1
        PERMANENT
Serial1: X.121 1311005 <--> bridge
        PERMANENT, BROADCAST
Serial2: X.121 001003 <--> apollo 1.3,
        appletalk 1.3,
        ip 172.20.1.3,
        decnet 1.3,
        novell 1.0000.0c04.35df,
        vines 00000001:0003,
        xns 1.0000.0c04.35df,
        clns
        PERMANENT, NVC 8, 1 VC: 1024
```

The display shows that four maps have been configured for a router: two for serial interface 0, one for serial interface 1, and one for the serial interface 2 (which maps eight protocols to the host).

Table 51 describes fields shown in the display.

Table 51 Show X25 Map Field Descriptions

Field	Description
Serial0	Interface on which this map is configured.

Table 51 Show X25 Map Field Descriptions (Continued)

Field	Description
X.121 1311001	X.121 address of the mapped encapsulation host.
ip 172.20.170.1	Type and address of the higher-level protocol(s) mapped to the remote host. Bridge maps do not have a higher-level address; all bridge datagrams are sent to the mapped X.121 address. CLNS maps refer to a configured neighbor as identified by the X.121 address.
PERMANENT	Address-mapping type that has been configured for the interface in this entry. Possible values include the following: <ul style="list-style-type: none"> • CONSTRUCTED—Derived with the DDN or BFE address conversion scheme. • PERMANENT—Map was entered with the x25 map interface configuration command. • PVC—Map was configured with the x25 pvc interface command. • TEMPORARY—A temporary map was created for an incoming unconfigured CMNS connection.
BROADCAST	If any options are configured for an address mapping, they are listed; the example shows a map that is configured to forward datagram broadcasts to the mapped host.
2 VCs:	If the map has any active virtual circuits, they are identified.
3 4*	Identifies the circuit number of the active virtual circuits. The asterisk (*) marks the virtual circuit last used to send data. Note that a single protocol virtual circuit can be associated with a multiprotocol map.

show x25 remote-red

To display the one-to-one mapping of the host IP addresses and the remote BFE device's IP addresses, use the **show x25 remote-red EXEC** command.

show x25 remote-red

Syntax Description

This command has no arguments or keywords.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Sample Display

The following is sample output from the **show x25 remote-red** command:

```
Router# show x25 remote-red
Entry      REMOTE-RED    REMOTE-BLACK  INTERFACE
1          21.0.0.3      21.0.0.7      serial3
2          21.0.0.10     21.0.0.6      serial11
3          21.0.0.24     21.0.0.8      serial13
```

Table 52 describes significant fields shown in the display.

Table 52 Show X25 Remote-Red Display Field Descriptions

Field	Description
Entry	Address mapping entry.
REMOTE-RED	Host IP address.
REMOTE-BLACK	IP address of the remote BFE device.
INTERFACE	Name of interface through which communication with the remote BFE device will take place.

show x25 route

To display the X.25 routing table, use the **show x25 route** EXEC command.

```
show x25 route
```

Syntax Description

This command has no arguments or keywords.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Sample Display

The following is sample output from the **show x25 route** command:

```
Router# show x25 route

Number      X.121      CUD      Forward To
1           1311001
2           1311002      172.20.170.10, 0 uses
3           1311003      00      alias Serial0, 2 uses
```

Table 53 describes significant fields shown in the display.

Table 53 Show X25 Route Display Field Descriptions

Field	Description
Number	Number identifying the entry in the X.25 routing table.
X.121 address	X.121 address pattern associated with this entry.
CUD	Call user data, if any, that has been configured for this route.
Forward To	Interface or IP address to which the router will forward a call destined for the X.121 address pattern in this entry. This field also includes the number of uses of this route.

Related Command

x25 route

show x25 vc

To display information about active switched virtual circuits (SVCs) and permanent virtual circuits (PVCs), use the **show x25 vc EXEC** command.

```
show x25 vc [lcn]
```

Syntax Description

lcn (Optional) Logical channel number (LCN).

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

To examine a particular virtual circuit, add an LCN argument to the **show x25 vc** command.

This command displays information about virtual circuits that are used for any of the following:

- Encapsulation traffic
- Locally switched traffic
- Remotely switched traffic
- CMNS switched traffic

The connectivity information displayed will vary according to the traffic carried by the virtual circuit. For multiprotocol circuits, the output varies depending on the number and identity of the protocols mapped to the X.121 address and the encapsulation method selected for the circuit.

Sample Displays

This section provides three sample displays and tables that describe the fields in each display.

The following sample display shows a virtual circuit that is being used to encapsulate traffic between the router and a remote host:

```
Router# show x25 vc 1024

SVC 1024, State: D1, Interface: Serial0
Started 0:00:31, last input 0:00:31, output 0:00:31
Connects 170090 <-->
  compressedtcp 172.20.170.90
  ip 172.20.170.90
multiprotocol CUD PID, standard Tx data PID, Reverse charged
Window size input: 2, output: 2
Packet size input: 128, output: 128
PS: 5 PR: 5 ACK: 4 Remote PR: 5 RCNT: 1 RNR: FALSE
Window is closed
Retransmits: 0 Timer (secs): 0 Reassembly (bytes): 0
Held Fragments/Packets: 0/0
Bytes 505/505 Packets 5/5 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

Table 54 describes the general fields shown in the output; Table 55 describes the fields specific to encapsulation virtual circuits shown in the output.

Table 54 Show X25 VC Field Descriptions

Field	Description
SVC 1024	Identifies the type (switched or permanent) and the number of the virtual circuit.
State	State of the virtual circuit (which is independent of the states of other virtual circuits); D1 is the normal ready state. See the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) ¹ X.25 Recommendation for a description of virtual circuit states.
Interface	Interface or subinterface on which the virtual circuit is established.
Started	Time elapsed since the virtual circuit was created.
last input	Time of last input.
output	Shows time of last output.
Connects...<-->...	Describes the traffic-specific connection information. See Table 55, Table 56, and Table 57 for more information.
Window size	Window sizes for the virtual circuit.
Packet size	Maximum packet sizes for the virtual circuit.
PS	Current send sequence number.
PR	Current receive sequence number.
ACK	Last acknowledged incoming packet.
Remote PR	Last receive sequence number received from the other end of the circuit.
RCNT	Count of unacknowledged input packets.
RNR	State of the Receiver Not Ready flag; this field is true if the network sends a Receiver-not-Ready packet.
Window is closed	This line appears if the router cannot transmit any more packets until the X.25 Layer 3 peer has acknowledged some outstanding packets.
Retransmits	Number of times a supervisory packet (Reset or Clear) has been retransmitted.
Timer	A nonzero time value indicates that a control packet has not been acknowledged yet or that the virtual circuit is being timed for inactivity.
Reassembly	Number of bytes received and held for reassembly. Packets with the M-bit set are reassembled into datagrams for encapsulation virtual circuits; switched X.25 traffic is not reassembled.
Held Fragments/Packets	Number of X.25 data fragments to transmit to complete an outgoing datagram, and the number of datagram packets waiting for transmission.
Bytes	Total number of bytes sent and received. The Packets, Resets, RNRs, REJs, and INTs fields show the total sent and received packet counts of the indicated types. (RNR is Receiver Not Ready, REJ is Reject, and INT is Interrupt.)

1. The ITU-T carries out the functions of the former Consultative Committee for International Telegraph and Telephone (CCITT).

Table 55 describes the connection description fields for virtual circuits carrying encapsulation traffic.

Table 55 Show X25 VC Encapsulation Traffic Field Descriptions

Field	Description
170090	The X.121 address of the remote host.
ip 172.20.170.90	The higher-level protocol and address values that are mapped to the virtual circuit.
multiprotocol CUD PID	Identifies the method used for the protocol identification (PID) in the Call User Data (CUD) field. Since PVCs are not set up using a Call packet, this field is not displayed for encapsulation PVCs. The available methods are as follows: <ul style="list-style-type: none"> • cisco—Cisco’s traditional method was used to set up a single protocol virtual circuit. • ietf—The IETF’s standard RFC 1356 method was used to set up a single protocol virtual circuit. • snap—The IETF’s Subnetwork Access Protocol (SNAP) method for IP encapsulation was used. • multiprotocol—the IETF’s multiprotocol encapsulation method was used.
standard Tx data PID	Identifies the method used for protocol identification (PID) when sending datagrams. The available methods are as follows: <ul style="list-style-type: none"> • no—The virtual circuit is a single-protocol virtual circuit; no PID is used. • standard—The IETF’s standard RFC 1356 method for identifying the protocol is used. • snap—The IETF’s SNAP method for identifying IP datagrams is used.
Reverse charged	Some important virtual circuit information might be displayed as needed; a DDN IP precedence encapsulation value, reverse charged virtual circuits, and virtual circuits that allow the D-bit procedure.

The following sample display shows virtual circuits carrying locally switched X.25 traffic:

```
Router# show x25 vc
PVC 1, State: D1, Interface: Serial2
  Started 0:01:26, last input never, output never
  PVC <--> Serial1 PVC 1 connected
  Window size input: 2, output: 2
  Packet size input: 128, output: 128
  PS: 0 PR: 0 ACK: 0 Remote PR: 0 RCNT: 0 RNR: FALSE
  Retransmits: 0 Timer (secs): 0 Reassembly (bytes): 0
  Held Fragments/Packets: 0/0
  Bytes 0/0 Packets 0/0 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0

SVC 5, State: D1, Interface: Serial2
  Started 0:00:16, last input 0:00:15, output 0:00:15
  Connects 170093 <--> 170090 from Serial1 VC 5
  Window size input: 2, output: 2
  Packet size input: 128, output: 128
  PS: 5 PR: 5 ACK: 4 Remote PR: 5 RCNT: 1 RNR: FALSE
  Retransmits: 0 Timer (secs): 0 Reassembly (bytes): 0
  Held Fragments/Packets: 0/0
  Bytes 505/505 Packets 5/5 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

Table 56 lists the connection description fields for virtual circuits carrying locally switched X.25 traffic.

Table 56 Show X25 VC Local Traffic Field Descriptions

Field	Description
PVC	Flags PVC information.
Serial1 PVC 1	Identifies the other half of a local PVC connection.
connected	Identifies the state of the PVC. If the PVC is not connected, the status of the PVC is also displayed. See Table 58 for PVC status messages.
170093	Identifies the Calling (source) Address of the connection. If a Calling Address Extension was encoded in the call facilities, it is also displayed. If the source host is a CMNS host, its MAC address is also displayed.
170090	Identifies the Called (destination) Address of the connection. If a Called Address Extension was encoded in the call facilities, it is also displayed. If the destination host is a CMNS host, its MAC address is also displayed.
from Serial1 VC 5	Indicates the direction of the call (“from” or “to”) and the connecting interface and virtual circuit number.

The following sample display shows virtual circuits carrying remotely switched X.25 traffic:

```
Router# show x25 vc
PVC 2, State: D1, Interface: Serial2
  Started 0:01:25, last input never, output never
  PVC <--> [172.20.165.92] Serial2/0 PVC 1 connected
  XOT between 171.20.165.91, 1998 and 172.20.165.92, 27801
  Window size input: 2, output: 2
  Packet size input: 128, output: 128
  PS: 0 PR: 0 ACK: 0 Remote PR: 0 RCNT: 0 RNR: FALSE
  Retransmits: 0 Timer (secs): 0 Reassembly (bytes): 0
  Held Fragments/Packets: 0/0
  Bytes 0/0 Packets 0/0 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0

SVC 6, State: D1, Interface: Serial2
  Started 0:00:04, last input 0:00:04, output 0:00:04
  Connects 170093 <--> 170090 from
  XOT between 172.20.165.91, 1998 and 172.20.165.92, 27896
  Window size input: 2, output: 2
  Packet size input: 128, output: 128
  PS: 5 PR: 5 ACK: 4 Remote PR: 5 RCNT: 1 RNR: FALSE
  Retransmits: 0 Timer (secs): 0 Reassembly (bytes): 0
  Held Fragments/Packets: 0/0
  Bytes 505/505 Packets 5/5 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

Table 57 lists the connection description fields for virtual circuits carrying remotely switched X.25 traffic.

Table 57 Show X25 VC Remote X.25 Traffic Field Descriptions

Field	Description
PVC	Flags PVC information.
[172.20.165.92]	Indicates the IP address of the router remotely connecting the PVC.

Table 57 Show X25 VC Remote X.25 Traffic Field Descriptions (Continued)

Field	Description
Serial 2/0 PVC 1	Identifies the remote interface and PVC number.
connected	Identifies the state of the PVC. If the PVC is not connected, the status of the PVC is also displayed. See Table 58 for the PVC status messages.
170093	Identifies the Calling (source) Address of the connection. If a Calling Address Extension was encoded in the call facilities, it is also displayed.
170090	Identifies the Called (destination) Address of the connection. If a Called Address Extension was encoded in the call facilities, it is also displayed.
from	Indicates the direction of the call (“from” or “to”).
XOT between...	Identifies the IP addresses and port numbers of the X.25-over-TCP (XOT) connection.

Table 58 lists the PVC states that can be reported. These states are also reported by the **debug x25** command in PVC-SETUP packets (for remote PVCs only) as well as in the PVCBAD system error message. Some states apply only to remotely switched PVCs.

Table 58 X.25 PVC States

Status Message	Description
waiting to connect	The PVC is waiting to be processed for connecting.
dest. disconnected	The other end disconnected the PVC.
PVC/TCP connection refused	A remote PVC XOT TCP connection was tried and refused.
PVC/TCP routing error	A remote PVC XOT TCP connection routing error was reported.
PVC/TCP connect timed out	A remote PVC XOT TCP connection attempt timed out.
trying to connect via TCP	A remote PVC XOT TCP connection is established and is in the process of connecting.
awaiting PVC-SETUP reply	A remote PVC has initiated an XOT TCP connection and is waiting for a reply to the setup message.
connected	The PVC is up.
no such dest. interface	The remote destination interface was reported to be in error by the remote router.
dest interface is not up	The target interface’s X.25 service is down.
non-X.25 dest. interface	The target interface is not configured for X.25.
no such dest. PVC	The targeted PVC does not exist.
dest PVC config mismatch	The targeted PVC is already connected.
mismatched flow control values	The configured flow control values do not match.
can’t support flow control values	The window sizes or packet sizes of the PVC cannot be supported by one of its two interfaces.

x25 accept-reverse

To configure the Cisco IOS software to accept all reverse charge calls, use the **x25 accept-reverse** interface configuration command. To disable this facility, use the **no** form of this command.

```
x25 accept-reverse  
no x25 accept-reverse
```

Syntax Description

This command has no arguments or keywords.

Default

Disabled

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command causes the interface to accept reverse charge calls by default. You can also configure this behavior for each peer with the **x25 map** interface configuration command.

Example

The following example sets acceptance of reverse charge calls:

```
interface serial 0  
x25 accept-reverse
```

Related Command

x25 map

x25 address

To set the X.121 address of a particular network interface, use the **x25 address** interface configuration command.

```
x25 address x121-address
```

Syntax Description

<i>x121-address</i>	Variable-length X.121 address. The address is assigned by the X.25 network service provider.
---------------------	--

Default

DDN and BFE encapsulations have a default interface address generated from the interface IP address; for proper DDN or BFE operation, this generated X.121 address must not be changed. Standard X.25 encapsulations do not have a default.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

When you are connecting to a public data network (PDN), the PDN administrator will assign the X.121 address to be used. Other applications (for example, a private X.25 service), may assign arbitrary X.121 addresses as required by the network and service design. X.25 interfaces that engage in X.25 switching only do not need to assign an X.121 address.

Example

The following example sets the X.121 address for the interface:

```
interface serial 0
encapsulation x25
x25 address 00000123005
```

The address must match that assigned by the X.25 network service provider.

x25 bfe-decision

To specify how a router configured for **x25 bfe-emergency decision** will participate in emergency mode, use the **x25 bfe-decision** interface configuration command.

```
x25 bfe-decision {no | yes | ask}
```

Syntax Description

no	Prevents the router from participating in emergency mode and from sending address translation information to the BFE device.
yes	Allows the router to participate in emergency mode and to send address translation information to the BFE when the BFE enters emergency mode. This information is obtained from the table created by the x25 remote-red command.
ask	Configures the Cisco IOS software to prompt you to enter the bfe EXEC command.

Default

The router does not participate in emergency mode.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example configures interface Serial 0 to require an EXEC command from you before it participates in emergency mode. The host IP address is 21.0.0.12, and the address of the remote BFE unit is 21.0.0.1. When the BFE enters emergency mode, the Cisco IOS software prompts you for the EXEC command **bfe enter** to direct the router to participate in emergency mode.

```
interface serial 0
x25 bfe-emergency decision
x25 remote-red 21.0.0.12 remote-black 21.0.0.1
x25 bfe-decision ask
```

Related Commands

bfe
x25 bfe-emergency
x25 remote-red

x25 bfe-emergency

To configure the circumstances under which the router participates in emergency mode, use the **x25 bfe-emergency** interface configuration command.

```
x25 bfe-emergency { never | always | decision }
```

Syntax Description

never	Prevents the router from sending address translation information to the Blacker Front End (BFE). If it does not receive address translation information, the BFE cannot open a new connection for which it does not know the address.
always	Allows the router to pass address translations to the BFE when it enters emergency mode and an address translation table has been created.
decision	Directs the router to wait until it receives a diagnostic packet from the BFE device indicating that the emergency mode window is open. The window is only open when a condition exists that allows the BFE to enter emergency mode. When the diagnostic packet is received, the participation in emergency mode depends on how the router is configured with the x25 bfe-decision command.

Default

No address translation information is sent to the BFE.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example configures interface Serial 0 to require an EXEC command from you before it participates in emergency mode. The host IP address is 21.0.0.12, and the address of the remote BFE unit is 21.0.0.1. When the BFE enters emergency mode, the Cisco IOS software prompts you for the EXEC command **bfe enter** to direct the router to participate in emergency mode.

```
interface serial 0
x25 bfe-emergency decision
x25 remote-red 21.0.0.12 remote-black 21.0.0.1
x25 bfe-decision ask
```

Related Commands

bfe
x25 bfe-decision

x25 default

To set a default protocol, use the **x25 default** interface configuration command. To remove the default protocol specified, use the **no** form of this command.

```
x25 default protocol  
no x25 default protocol
```

Syntax Description

protocol Specifies the protocol to assume; may be **ip** or **pad**.

Default

No default protocol is set.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command specifies the protocol assumed by the Cisco IOS software for incoming calls with unknown or missing call user data (CUD). If you do not use the **x25 default** interface configuration command, the software clears any incoming calls with unrecognized CUD.

Example

The following example establishes IP as the default protocol for X.25 calls:

```
interface serial 0  
x25 default ip
```

Related Command

x25 map

x25 facility

To force facilities on a per-call basis for calls originated by the router (switched calls are not affected), use the **x25 facility** interface configuration command. To disable a facility, use the **no** form of this command.

x25 facility *facility-keyword value*
no x25 facility *facility-keyword value*

Syntax Description

facility-keyword User facility.

value Facility value; see Table 59 for a list of supported facilities and their values.

Default

No facility is sent.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Table 59 lists X.25 user facilities.

Table 59 X.25 User Facilities

User Facility	Description
cug number	Specifies a closed user group (CUG) number; CUGs 1 to 99 are allowed. CUGs can be used by a public data network (PDN) to create a virtual private network within the larger network and to restrict access.
packetsize <i>in-size out-size</i>	Proposes input maximum packet size (<i>in-size</i>) and output maximum packet size (<i>out-size</i>) for flow control parameter negotiation. Both values must be one of the following values: 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096.
window size <i>in-size out-size</i>	Proposes the packet count for input windows (<i>in-size</i>) and output windows (<i>out-size</i>) for flow control parameter negotiation. Both values must be in the range 1 to 127 and must not be greater than or equal to the value set for the x25 modulo command.
reverse	Specifies reverses charging on all calls originated by the interface.
throughput <i>in out</i>	Sets the requested throughput class negotiation values for input (<i>in</i>) and output (<i>out</i>) throughput across the network. Values for <i>in</i> and <i>out</i> are in bits per second (bps) and range from 75 to 64000 bps.
transit-delay <i>value</i>	Specifies a network transit delay for the duration of outgoing calls for networks that support transit delay. The transit delay value can be between 0 and 65534 milliseconds.

Table 59 X.25 User Facilities (Continued)

User Facility	Description
<i>rpoa name</i>	Specifies the name defined by the x25 rpoa command for a list of transit Recognized Private Operation Agencies (RPOAs) to use in outgoing Call Request packets.

Examples

The following example specifies a transit delay value in an X.25 configuration:

```
interface serial 0
x25 facility transit-delay 24000
```

The following example sets an RPOA name and then sends the list via the X.25 user facilities:

```
x25 rpoa green_list 23 35 36
interface serial 0
x25 facility rpoa green_list
```

Related Command

x25 rpoa

x25 hic

To set the highest incoming-only virtual circuit number, use the **x25 hic** interface configuration command.

x25 hic *circuit-number*

Syntax Description

circuit-number Virtual circuit number from 1 to 4095, or 0 if there is no incoming-only virtual circuit range. The default is 0.

Default

0

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command is applicable only if you have the X.25 switch configured for an incoming-only virtual circuit range. *Incoming* is from the perspective of the X.25 DTE. If you do not want any outgoing calls from your DTE, configure both ends to disable the two-way range (set the values of **x25 ltc** and **x25 htc** to 0) and configure an incoming-only range. Any incoming-only range must come before (that is, must be numerically less than) any two-way range. Any two-way range must come before any outgoing-only range.

Example

The following example sets a valid incoming-only virtual circuit range of 1 to 5:

```
interface serial 0
x25 lic 1
x25 hic 5
```

Related Command

x25 lic

x25 hoc

To set the highest outgoing-only virtual circuit number, use the **x25 hoc** interface configuration command.

```
x25 hoc circuit-number
```

Syntax Description

circuit-number Virtual circuit number from 1 to 4095, or 0 if there is no outgoing-only virtual circuit range. The default is 0.

Default

0

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command is applicable only if you have the X.25 switch configured for an outgoing-only virtual circuit range. *Outgoing* is from the perspective of the X.25 DTE. If you do not want any incoming calls on your DTE, disable the two-way range (set the values of **x25 ltc** and **x25 htc** to 0) and configure an outgoing-only range. Any outgoing-only range must come after (that is, be numerically greater than) any other range.

Example

The following example sets a valid outgoing-only virtual circuit range of 2000 to 2005:

```
interface serial 0
  x25 loc 2000
  x25 hoc 2005
```

Related Command

x25 loc

x25 hold-queue

To set the maximum number of packets to hold until a virtual circuit is able to transmit, use the **x25 hold-queue** interface configuration command. To remove this command from the configuration file and restore the default value, use the **no** form of this command without an argument.

```
x25 hold-queue packets  
no x25 hold-queue [packets]
```

Syntax Description

<i>packets</i>	Number of packets. A hold queue value of 0 allows an unlimited number of packets in the hold queue. This argument is optional for the no form of this command. The default is 10 packets.
----------------	--

Default

10 packets

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

If you set the *queue-size* to 0 when using the **no x25 hold-queue** command, there will be no hold queue limit. While this setting will prevent drops until the router runs out of memory, it is only rarely appropriate. A virtual circuit hold queue value is determined when it is created; changing this parameter will not affect the hold queue limits of the existing virtual circuits.

Example

The following example sets the X.25 hold queue to hold 25 packets:

```
interface serial 0  
x25 hold-queue 25
```

Related Commands

A dagger (†) indicates that the command is documented outside this chapter.

```
ip mtu †  
x25 ips  
x25 ops
```

x25 hold-vc-timer

To start the timer that prevents additional calls to a destination for a given period of time (thus preventing overruns on some X.25 switches caused by Call Request packets), use the **x25 hold-vc-timer** interface configuration command. To restore the default value for the timer, use the **no** form of this command.

```
x25 hold-vc-timer minutes  
no x25 hold-vc-timer
```

Syntax Description

minutes Number of minutes to prevent calls from going to a previously failed destination. Incoming calls are still accepted. The default is 0 minutes.

Default

0 minutes

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Only Call Requests that the router originates are held down; routed X.25 Call Requests are not affected by this parameter.

Upon receiving a Clear Request for an outstanding Call Request, the X.25 support code immediately tries another Call Request if it has more traffic to send, and this action might cause overrun problems.

The failed virtual circuits can be observed with the **show x25 vc** command; they are renumbered to the illegal value 4096 and have the nonstandard state X1.

Example

The following example sets this timer to 3 minutes:

```
interface serial 0  
x25 hold-vc-timer 3
```

x25 host

To define a static host name-to-address mapping, use the **x25 host** global configuration command. Use the **no** form of the command to remove the host name.

```
x25 host name x121-address [cud call-user-data]  
no x25 host name
```

Syntax Description

<i>name</i>	Host name.
<i>x121-address</i>	The X.121 address.
cud <i>call-user-data</i>	(Optional) Sets the Call User Data (CUD) field in the X.25 Call Request packet.

Default

No static host name-to-address mapping is defined.

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Examples

The following example specifies a static address mapping:

```
x25 host Willard 4085551212
```

The following example removes a static address mapping:

```
no x25 host Willard
```

x25 htc

To set the highest two-way virtual circuit number, use the **x25 htc** interface configuration command.

x25 htc *circuit-number*

Syntax Description

circuit-number Virtual circuit number from 1 to 4095, or 0 if there is no two-way virtual circuit range. The default is 1024 for X.25 network service interfaces; 4095 for CMNS network service interfaces.

Defaults

1024 for X.25 network service interfaces; 4095 for CMNS network service interfaces.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command is applicable if the X.25 switch is configured for a two-way virtual circuit range. Any two-way virtual circuit range must come after (that is, be numerically larger than) any incoming-only range, and must come before any outgoing-only range.

Example

The following example sets a valid two-way virtual circuit range of 5 to 25:

```
interface serial 0
x25 ltc 5
x25 htc 25
```

Related Commands

cmns enable

x25 ltc

x25 idle

To define the period of inactivity after which the router can clear a switched virtual circuit (SVC), use the **x25 idle** interface configuration command.

x25 idle *minutes*

Syntax Description

minutes Idle period in minutes. The default is 0, which causes the router to keep the SVC open indefinitely.

Default

0 (the SVC is kept open indefinitely)

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Calls originated and terminated by the router are cleared; PAD and switched virtual circuits are not affected. To clear one or all virtual circuits at once, use the privileged EXEC command **clear x25-vc**.

Example

The following example sets a 5-minute wait period before an idle circuit is cleared:

```
interface serial 2
x25 idle 5
```

Related Command

clear x25-vc

x25 ip-precedence

To enable the Cisco IOS software to use the IP precedence value when it opens a new virtual circuit, use the **x25 ip-precedence** interface configuration command. To cause the Cisco IOS software to ignore the precedence value when opening virtual circuits, use the **no** form of this command.

```
x25 ip-precedence  
no x25 ip-precedence
```

Syntax Description

This command has no arguments or keywords.

Default

The router opens one virtual circuit for all types of service.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This feature is useful only for DDN or BFE encapsulations, because only these methods have an IP precedence facility defined to allow the source and destination devices to both use the virtual circuit for traffic of the given IP priority.

Verify that your host does not send nonstandard data in the IP type of service (TOS) field because it can cause multiple wasteful virtual circuits to be created.

Four virtual circuits may be opened based on IP precedence to encapsulate routine, priority, immediate, and all higher precedences.

The **x25 map nvc** limit or the default **x25 nvc** limit still applies.

Example

The following example allows new IP encapsulation virtual circuits based on the IP precedence:

```
interface serial 3  
x25 ip-precedence
```

x25 ips

To set the interface default maximum input packet size to match that of the network, use the **x25 ips** interface configuration command.

x25 ips *bytes*

Syntax Description

bytes Byte count. It can be one of the following values: 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096. The default is 128 bytes.

Default

128 bytes

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

X.25 network connections have a default maximum input packet size set by the network administrator. Larger packet sizes require less overhead processing. To send a packet larger than the X.25 packet size over an X.25 virtual circuit, the Cisco IOS software must break the packet into two or more X.25 packets with the more data bit (M-bit) set. The receiving device collects all packets with the M-bit set and reassembles the original packet.

Note Set the **x25 ips** and **x25 ops** commands to the same value unless your network supports asymmetric input and output packet sizes.

Example

The following example sets the default maximum packet sizes to 512:

```
interface serial 1
x25 ips 512
x25 ops 512
```

Related Commands

x25 facility

x25 ops

x25 lic

To set the lowest incoming-only virtual circuit number, use the **x25 lic** interface configuration command.

```
x25 lic circuit-number
```

Syntax Description

circuit-number Virtual circuit number from 1 to 4095, or 0 if there is no incoming-only virtual circuit range.

Default

0

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command is applicable only if you have the X.25 switch configured for an incoming-only virtual circuit range. *Outgoing* is from the perspective of the X.25 DTE. If you do not want any incoming calls on your DTE, disable the two-way range (set the values of **x25 ltc** and **x25 htc** to 0) and configure an outgoing-only range. Any outgoing-only range must come after (that is, be numerically greater than) any other range.

Usage Guidelines

This command is applicable if you have the X.25 switch configured for two-way virtual circuit range.

Example

The following example sets a valid incoming-only virtual circuit range of 1 to 5 and sets the lowest two-way virtual circuit number:

```
interface serial 0
x25 lic 1
x25 hic 5
x25 ltc 6
```

Related Command

x25 hic

x25 linkrestart

To force X.25 Level 3 (packet level) to restart when Level 2 (LAPB, the link level) resets, use the **x25 linkrestart** interface configuration command. To disable this function, use the **no** form of this command.

```
x25 linkrestart  
no x25 linkrestart
```

Syntax Description

This command has no arguments or keywords.

Default

Forcing packet-level restarts is the default and is necessary for networks that expect this behavior.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example disables the link-level restart:

```
interface serial 3  
no x25 linkrestart
```

x25 loc

To set the lowest outgoing-only virtual circuit number, use the **x25 loc** interface configuration command.

```
x25 loc circuit-number
```

Syntax Description

circuit-number Virtual circuit number from 1 to 4095, or 0 if there is no outgoing-only virtual circuit range. The default is 0.

Default

0

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command is applicable only if you have the X.25 switch configured for an outgoing-only virtual circuit range. *Outgoing* is from the perspective of the X.25 DTE. If you do not want any incoming calls from your DTE, configure the values of **x25 loc** and **x25 hoc** and set the values of **x25 ltc** and **x25 htc** to 0.

Example

The following example sets a valid outgoing-only virtual circuit range of 2000 to 2005:

```
interface serial 0
  x25 loc 2000
  x25 hoc 2005
```

Related Command

x25 hoc

x25 ltc

To set the lowest two-way virtual circuit number, use the **x25 ltc** interface configuration command.

x25 ltc *circuit-number*

Syntax Description

circuit-number Virtual circuit number from 1 to 4095, or 0 if there is no two-way virtual circuit range. The default is 1.

Default

1

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command is applicable if you have the X.25 switch configured for a two-way virtual circuit range. Any two-way virtual circuit range must come after (that is, be numerically larger than) any incoming-only range, and must come before any outgoing-only range.

Example

The following example sets a valid two-way virtual circuit range of 5 to 25:

```
interface serial 0
x25 ltc 5
x25 htc 25
```

Related Command

x25 htc

x25 map

To set up the LAN protocols-to-remote host mapping, use the **x25 map** interface configuration command. To retract a prior mapping, use the **no** form of this command with the appropriate network protocol(s) and X.121 address argument.

```
x25 map protocol address [protocol2 address2[...[protocol9 address9]]] x121-address [option]
no x25 map protocol address x121-address
```

Syntax Description

<i>protocol</i>	Protocol type, entered by keyword. Supported protocols are entered by keyword, as listed in Table 60. As many as nine protocol and address pairs can be specified in one command line.
<i>address</i>	Protocol address.
<i>x121-address</i>	X.121 address of the remote host.
<i>option</i>	(Optional) Additional functionality that can be specified for originated calls. Can be any of the options listed in Table 61.

Default

No LAN protocol-to-remote host mapping is set up.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Because no defined protocol can dynamically determine LAN protocol-to-remote host mappings, you must enter all the information for each host with which the router may exchange X.25 encapsulation traffic.

Two methods are available to encapsulate traffic, Cisco's long-available encapsulation method and the IETF's standard method (defined in RFC 1356); the latter allows hosts to exchange several protocols over a single virtual circuit. Cisco's encapsulation method is the default (for backward compatibility) unless the interface configuration command specifies **ietf**.

When you configure multiprotocol maps, you can specify a maximum of nine protocol and address pairs in an **x25 map** command. However, you can specify a protocol only once. For example, you can specify the IP protocol and an IP address, but you cannot specify another IP address. If **compressedtcp** and **ip** are both specified, the same IP address must be used.

Bridging is supported only if you are using Cisco's traditional encapsulation method. For correct operation, bridging maps must specify the **broadcast** option.

Since most datagram routing protocols rely on broadcasts or multicasts to send routing information to their neighbors, the **broadcast** keyword is needed to run such routing protocols over X.25.

Encapsulation maps might also specify that traffic between the two hosts should be compressed, thus increasing the effective bandwidth between them at the expense of memory and computation time. Because each compression virtual circuit requires memory and computation resources, compression must be used with care and monitored to maintain acceptable resource usage and overall performance.

OSPF treats a nonbroadcast, multiaccess network such as X.25 in much the same way as it treats a broadcast network by requiring the selection of a designated router. In previous releases, this required manual assignment in the OSPF configuration using the **neighbor** router configuration command. When the **x25 map** command is included in the configuration with the broadcast, and the **ip ospf network** command (with the **broadcast** keyword) is configured, there is no need to configure any neighbors manually. OSPF will now run over the X.25 network as a broadcast network. (Refer to the **ip ospf network** interface configuration command for more detail.)

Note The OSPF broadcast mechanism assumes that IP class D addresses are never used for regular traffic over X.25.

You can modify the options of an **x25 map** command by restating the complete set of protocols and addresses specified for the map, followed by the desired options. To delete a map command, you must also specify the complete set of protocols and addresses; the options can be omitted when deleting a map.

Once defined, a map's protocols and addresses cannot be changed. This requirement exists because the Cisco IOS software cannot determine whether you want to add to, delete from, or modify an existing map's protocol and address specification, or simply mistyped the command. To change a map's protocol and address specification, you must delete it and create a new map.

A given protocol-address pair cannot be used in more than one map on the same interface.

Table 60 lists the protocols supported by X.25.

Table 60 Protocols Supported by X.25

Keyword	Protocol
apollo	Apollo Domain
appletalk	AppleTalk
bridge	Bridging ¹
clns	ISO Connectionless Network Service
cmns	ISO Connection-Mode Network Service ²
compressedtcp	TCP/IP header compression
decnet	DECnet
ip	IP
ipx	Novell IPX
pad	PAD links ³

Table 60 Protocols Supported by X.25 (Continued)

Keyword	Protocol
qllc	System Network Architecture (SNA) encapsulation in X.25 ⁴
vines	Banyan VINES
xns	XNS

1. Bridging traffic is supported only for Cisco's traditional encapsulation method, so a bridge map cannot specify other protocols.
2. CMNS maps implicitly define routing information so that an incoming call is directed to the interface and host that best match the call's destination network service access point (NSAP); CMNS maps cannot specify other protocols or any map options. Refer to the **x25 map cmns** command for details.
3. Packet Assembly/Disassembly (PAD) maps are used to configure session and protocol translation access, therefore, this protocol is not available for multiprotocol encapsulation.
4. Qualified Logical Link Control (QLLC) is not available for multiprotocol encapsulation.

Table 61 lists the map options supported by X.25.

Table 61 X.25 Map Options

Option	Description
compress	Specifies that X.25 payload compression be used for mapping the traffic to this host. Each virtual circuit established for compressed traffic uses a significant amount of memory (for a table of learned data patterns) and for computation (for compression and decompression of all data). Cisco recommends that compression be used with careful consideration to its impact on overall performance.
method { cisco ietf snap multi }	Specifies the encapsulation method. The choices are as follows: <ul style="list-style-type: none"> • cisco—Cisco's proprietary encapsulation; not available if more than one protocol is to be carried. • ietf—Default RFC 1356 operation: protocol identification of single-protocol virtual circuits and protocol identification within multiprotocol virtual circuits use the standard encoding, which is compatible with RFC 877. Multiprotocol virtual circuits are used only if needed. • snap—RFC 1356 operation where IP is identified with SNAP rather than the standard IETF method (the standard method is compatible with RFC 877). • multi—Forces a map that specifies a single protocol to set up a multiprotocol virtual circuit when a call is originated; also forces a single-protocol PVC to use multiprotocol data identification methods for all datagrams sent and received.
no-incoming	Use the map only to originate calls.
no-outgoing	Do not originate calls when using the map.
idle <i>minutes</i>	Specifies an idle timeout for calls other than the interface default; 0 minutes disables the idle timeout.
reverse	Specifies reverse charging for outgoing calls.
accept-reverse	Causes the Cisco IOS software to accept incoming reverse-charged calls. If this option is not present, the Cisco IOS software clears reverse-charged calls unless the interface accepts all reverse-charged calls.

Table 61 X.25 Map Options (Continued)

Option	Description
broadcast	Causes the Cisco IOS software to direct any broadcasts sent through this interface to the specified X.121 address. This option also simplifies the configuration of OSPF; see “Usage Guidelines” for more detail.
cug <i>group-number</i>	Specifies a closed user group number (from 1 to 99) for the mapping in an outgoing call.
nvc <i>count</i>	Sets the maximum number of virtual circuits for this map or host. The default <i>count</i> is the x25 nvc setting of the interface. A maximum number of eight virtual circuits can be configured for each map. Compressed TCP may use only 1 virtual circuit.
packetsize <i>in-size out-size</i>	Proposes maximum input packet size (<i>in-size</i>) and maximum output packet size (<i>out-size</i>) for an outgoing call. Both values typically are the same and must be one of the following values: 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096.
window size <i>in-size out-size</i>	Proposes the packet count for input window (<i>in-size</i>) and output window (<i>out-size</i>) for an outgoing call. Both values typically are the same, must be in the range 1 to 127, and must be less than the value set by the x25 modulo command.
throughput <i>in out</i>	Sets the requested throughput class values for input (<i>in</i>) and output (<i>out</i>) throughput across the network for an outgoing call. Values for <i>in</i> and <i>out</i> are in bits per second (bps) and range from 75 to 48000 bps.
transit-delay <i>milliseconds</i>	Specifies the transit delay value in milliseconds (0 to 65534) for an outgoing call, for networks that support transit delay.
nuid <i>username password</i>	Specifies that a network user ID (NUID) facility be sent in the outgoing call with the specified Terminal Access Controller Access Control System (TACACS) username and password (in a format defined by Cisco). This option should be used only when connecting to another Cisco router. The combined length of the username and password should not exceed 127 characters. This option only works if the router is configured as an X.25 DTE.
nudata <i>string</i>	Specifies the network user identification in a format determined by the network administrator (as allowed by the standards). This option is provided for connecting to non-Cisco equipment that requires an NUID facility. The string should not exceed 130 characters and must be enclosed in quotation marks (“”) if there are any spaces present. This option only works if the router is configured as an X.25 DTE.
rpoa <i>name</i>	Specifies the name defined by the x25 rpoa command for a list of transit Recognized Private Operating Agencies (RPOAs) to use in outgoing Call Request packets.
passive	Specifies that the X.25 interface should send compressed outgoing TCP datagrams only if they were already compressed when they were received. This option is available only for compressed TCP maps.

Examples

The following example maps IP address 172.20.2.5 to X.121 address 000000010300. The **broadcast** keyword directs any broadcasts sent through this interface to the specified X.121 address.

```
interface serial 0
x25 map ip 171.20.2.5 000000010300 broadcast
```

The following example specifies an RPOA name to be used for originating connections:

```
x25 rpoa green_list 23 35 36
interface serial 0
x25 map ip 172.20.170.26 10 rpoa green_list
```

The following example specifies a network user ID (NUID) facility to send on calls originated for the address map:

```
interface serial 0
x25 map ip 172.20.174.32 2 nudata "Network User ID 35"
```

Strings can be quoted, but quotation marks are not required unless embedded blanks are present.

Related Commands

A dagger (†) indicates that the command is documented outside this chapter.

- ip ospf network[†]**
- show x25 map**
- x25 facility**
- x25 map bridge**
- x25 map cmns**
- x25 map compressedtcp**
- x25 map pad**
- x25 rpoa**

x25 map bridge

To configure an Internet-to-X.121 address mapping for bridging over X.25, use the **x25 map bridge** interface configuration command.

x25 map bridge *x121-address* **broadcast** [*option*]

Syntax Description

<i>x121-address</i>	The X.121 address.
broadcast	Required keyword for bridging over X.25.
<i>option</i>	(Optional) Services that can be added to this map; the same options as the x25 map command; see Table 61.

Default

No bridging over X.25 is configured.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example configures bridging of X.25 frames using a maximum of six virtual circuits:

```
interface serial 1
x25 map bridge 000000010300 broadcast nvc 6
```

Related Command

x25 map

x25 map cmns

To map network service access point (NSAP) addresses to either MAC-layer addresses or X.121 addresses after enabling CMNS on a nonserial interface, use the **x25 map cmns** interface configuration command. To retract a mapping, use the **no** form of this command with the appropriate address arguments.

```
x25 map cmns nsap mac-address
no x25 map cmns nsap mac-address

x25 map cmns nsap [x121-address]
no x25 map cmns nsap [x121-address]
```

Syntax Description

<i>nsap</i>	NSAP address. The NSAP can be either the actual DTE NSAP address or the prefix of the NSAP address. The NSAP prefix is sufficient for a best match to route a call.
<i>mac-address</i>	MAC-level address.
<i>x121-address</i>	(Optional) X.121 address.

Default

No mapping is configured.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The address arguments specify the NSAP address-to-MAC address or NSAP address-to-X.121 address mappings. A mapping to a MAC address is valid only on a nonserial interface. A mapping to an X.121 address is valid only on a serial interface.

If a received call has a destination NSAP, the list of CMNS hosts is consulted. If an NSAP (or NSAP preamble) match is found, the call is routed according to the best fit (which, depending on the map configuration, may be out either a CMNS or an X.25 interface). If no NSAP match is found, the call is handled according to its X.121 address for routing or acceptance as an encapsulation call.

Example

The following example switches traffic intended for any NSAP address with prefix 38.8261.17 to MAC address 0000.0C02.5F56 over interface Ethernet 0:

```
interface ethernet 0
  cmns enable
  x25 map cmns 38.8261.17 0000.0C02.5F56
```

Related Commands

cmns enable

x25 map

x25 map compressedtcp

To map compressed TCP traffic to an X.121 address, use the **x25 map compressedtcp** interface configuration command. To delete a TCP/IP header compression map for the link, use the **no** form of this command.

```
x25 map compressedtcp ip-address [protocol2 address 2 [...[protocol9 address9]]]
    x121-address [option]
no x25 map compressedtcp address [protocol2 address 2 [...[protocol9 address9]]]
    x121-address
```

Syntax Description

<i>ip-address</i>	IP address.
<i>protocol</i>	(Optional) Protocol type, entered by keyword. Supported protocols are entered by keyword, as listed in Table 60. As many as nine protocol and address pairs can be specified in one command line.
<i>address</i>	(Optional) Protocol address.
<i>x121-address</i>	X.121 address.
<i>option</i>	(Optional) The same options as those for the x25 map command; see Table 61.

Default

No mapping is configured.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Cisco supports RFC 1144 TCP/IP header compression (THC) on serial lines using HDLC and X.25 encapsulation. THC encapsulation is only slightly different from other encapsulation traffic, but these differences are worth noting. The implementation of compressed TCP over X.25 uses one virtual circuit to pass the compressed packets. Any IP traffic (including standard TCP) is separate from TCH traffic; it is carried over separate IP encapsulation virtual circuits or identified separately in a multiprotocol virtual circuit.

Note If you specify both **ip** and **compressedtcp** in the same **x25 map compressedtcp** command, they must both specify the same IP address.

The **nvc** map option cannot be used for TCP/IP header compression, because only one virtual circuit can carry compressed TCP/IP header traffic to a given host.

Example

The following example establishes a map for TCP/IP header compression on interface serial 4:

```
interface serial 4
ip tcp header-compression
x25 map compressedtcp 172.20.2.5 000000010300
```

Related Command

x25 map

x25 map pad

To configure an X.121 address mapping for packet assembler/disassembler (PAD) access over X.25, use the **x25 map pad** interface configuration command.

```
x25 map pad x.121-address [option]
```

Syntax Description

<i>x.121-address</i>	X.121 address of the interface.
<i>option</i>	(Optional) Services that can be added to this map—the same options as the x25 map command (see Table 61).

Default

No specific options are used for PAD access.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.2.

Use a PAD map to configure optional X.25 facility use for PAD access. When used with the **x25 pad-access** interface configuration command, the **x25 map pad** command restricts incoming PAD access to those mapped hosts.

Example

The following example configures an X.25 interface to restrict incoming PAD access to the single mapped host. This example requires that both incoming and outgoing PAD access use the network user identification (NUID) user authentication.

```
interface serial 1
x25 pad-access
x25 map pad 000000010300 nuid johndoe secret
```

Related Command

x25 map

x25 pad-access

x25 modulo

To set the window modulus, use the **x25 modulo** interface configuration command.

x25 modulo *modulus*

Syntax Description

modulus

Either 8 or 128. The value of the modulo parameter must agree with that of the device on the other end of the X.25 link. The default is 8.

Default

8

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

X.25 supports flow control with a sliding window sequence count. The window counter restarts at zero upon reaching the upper limit, which is called the *window modulus*. Modulo 128 operation is also referred to as *extended packet sequence numbering*, which allows larger packet windows.

Example

The following example sets the window modulus to 128:

```
interface serial 0
x25 modulo 128
```

Related Commands

x25 facility

x25 win

x25 wout

x25 nvc

To specify the maximum number of switched virtual circuits (SVCs) that a protocol can have open simultaneously to one host, use the **x25 nvc** interface configuration command. To increase throughput across networks, you can establish up to eight switched virtual circuits to a host and protocol.

x25 nvc *count*

Syntax Description

count

Circuit count from 1 to 8. A maximum of eight virtual circuits can be configured for each protocol-host pair. Protocols that do not tolerate out-of-order delivery, such as encapsulated TCP/IP header compression, will use only one virtual circuit despite this value. The default is 1. Permitting more than one SVC may help throughput on slow networks.

Default

1

Command Mode

Interface configuration

Usage Guidelines

This command first appeared prior to Cisco IOS Release 10.0.

When the windows and output queues of all existing connections to a host are full, a new virtual circuit will be opened to the designated circuit count. If a new connection cannot be opened, the data is dropped.

Note The *count* value specified for **x25 nvc** affects the default value for the number of SVCs. It does not affect the **nvc** option for any **x25 map** commands that are configured.

Example

The following example sets the default maximum number of SVCs that each map can open simultaneously to 4:

```
interface serial 0
x25 nvc 4
```

x25 ops

To set the interface default maximum output packet size to match that of the network, use the **x25 ops** interface configuration command.

x25 ops *bytes*

Syntax Description

bytes Byte count that is one of the following: 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096. The default is 128 bytes.

Default

128 bytes

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

X.25 networks use maximum output packet sizes set by the network administrator. Larger packet sizes are better because smaller packets require more overhead processing. To send a packet larger than the X.25 packet size over an X.25 virtual circuit, the Cisco IOS software must break the packet into two or more X.25 packets with the more data bit (M-bit) set. The receiving device collects all packets with the M-bit set and reassembles the original packet.

Note Set the **x25 ips** and **x25 ops** commands to the same value unless your network supports asymmetry between input and output packets.

Example

The following example sets the default maximum packet sizes to 512:

```
interface serial 1
x25 ips 512
x25 ops 512
```

Related Command

x25 ips

x25 pad-access

Use the **x25 pad-access** interface configuration command to cause the packet assembler/disassembler (PAD) software to accept PAD connections only from statically mapped X.25 hosts.

```
x25 pad-access  
no x25 pad-access
```

Syntax Description

This command has no arguments or keywords.

Default

Accept PAD connections from any host.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.2.

By default, all PAD connection attempts are processed for session creation or protocol translation, subject to the configuration of those functions. If you use the **x25 pad-access** command, PAD connections are processed only for incoming calls with a source address that matches a statically mapped address configured with the **x25 map pad** interface configuration command. PAD connections are refused for any incoming calls with a source address that has not been statically mapped.

Example

The following example restricts incoming PAD access on the interface to attempts from the host with the X.121 address 000000010300:

```
interface serial 1  
x25 pad-access  
x25 map pad 000000010300
```

Related Commands

```
service pad  
x25 map pad  
x29 access-list  
x29 profile
```

x25 pvc (encapsulating)

To establish an encapsulation permanent virtual circuit (PVC), use the encapsulating version of the **x25 pvc** interface configuration command. To delete the PVC, use the **no** form of this command with the appropriate channel number.

```
x25 pvc circuit protocol address [protocol2 address2[...[protocol9 address9]]] x121-address  
[option]  
no x25 pvc circuit
```

Syntax Description

<i>circuit</i>	Virtual-circuit channel number, which must be less than the virtual circuits assigned to the switched virtual circuits (SVCs).
<i>protocol</i>	Protocol type, entered by keyword. Supported protocols are listed in Table 62. As many as nine protocol and address pairs can be specified in one command line.
<i>address</i>	Protocol address of the host at the other end of the PVC.
<i>x121-address</i>	X.121 address.
<i>option</i>	(Optional) Provides additional functionality or allows X.25 parameters to be specified for the PVC. Can be any of the options listed in Table 63.

Default

No encapsulation PVC is established. The PVC window and maximum packet sizes default to the interface default values.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

PVCs are not supported for ISO CMNS.

You no longer need to specify a datagram protocol-to-address mapping before you can set up a PVC; a map is implied from the PVC configuration. Configurations generated by the router will no longer specify a map for encapsulating PVCs.

An X.121 address must be specified for the PVC, much as is done for an **x25 map** command, although the address does not appear in the PVC data exchange. When configuring a PVC to carry CLNS traffic, use the X.121 address as the subnetwork point of attachment (SNPA) to associate the PVC with a CLNS neighbor configuration.

Table 62 lists supported protocols.

Table 62 Protocols Supported by X.25 PVCs

Keyword	Protocol
apollo	Apollo Domain
appletalk	AppleTalk
bridge	Bridging ¹
clns	OSI Connectionless Network Service
compressedtcp	TCP/IP header compression
decnet	DECnet
ip	IP
ipx	Novell IPX
qllc	SNA encapsulation in X.25 ²
vines	Banyan VINES
xns	XNS

1. Bridging traffic is supported only for Cisco's traditional encapsulation method, so a bridge PVC cannot specify other protocols.
2. QLLC is not available for multiprotocol encapsulation.

Table 63 lists supported X.25 PVC options.

Table 63 X.25 PVC Options

Option	Description
broadcast	Causes the Cisco IOS software to direct any broadcasts sent through this interface to this PVC. This option also simplifies the configuration of OSPF.
method { cisco ietf snap multi }	Specifies the encapsulation method. The choices are as follows: <ul style="list-style-type: none"> • cisco—Single protocol encapsulation; not available if more than one protocol is carried. • ietf—Default RFC 1356 operation; single-protocol encapsulation unless more than one protocol is carried, and protocol identification when more than one protocol is carried. • snap—RFC 1356 operation where IP is identified when more than one protocol is carried using the SNAP encoding. • multi—Multiprotocol encapsulation used on the PVC.
packetsize in-size out-size	Maximum input packet size (<i>in-size</i>) and output packet size (<i>out-size</i>) for the PVC. Both values are typically the same and must be one of the following values: 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096.
passive	Specifies that transmitted TCP datagrams will be compressed only if they were received compressed. This option is available only for PVCs carrying compressed TCP/IP header traffic.
window size in-size out-size	Packet count for input window (<i>in-size</i>) and output window (<i>out-size</i>) for the PVC. Both values are typically the same, must be in the range 1 to 127, and must be less than the value set for the x25 modulo command.

Example

The following example establishes a PVC on channel 2 to encapsulate VINES and IP with the far host:

```
interface serial 0
x25 ltc 5
x25 pvc 2 vines 60002A2D:0001 ip 172.20.170.91 11110001
```

Related Command

x25 map

x25 pvc (switched)

To configure a switched permanent virtual circuit (PVC) for a given interface, use the switched version of the **x25 pvc** interface configuration command.

```
x25 pvc number1 interface type number pvc number2 [option]
```

Syntax Description

<i>number1</i>	PVC number that will be used on the local interface (as defined by the primary interface command).
interface	Required keyword to specify an interface.
<i>type</i>	Remote interface type.
<i>number</i>	Remote interface number.
pvc	Required keyword to specify a switched PVC.
<i>number2</i>	PVC number that will be used on the remote interface.
<i>option</i>	(Optional) Adds certain features to the mapping specified; can be either option listed in Table 64.

Default

No switched PVC is configured. The PVC window and maximum packet sizes default to the interface default values.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

You can configure X.25 PVCs in the X.25 switching software. As a result, DTEs that require permanent circuits can be connected to the router acting as an X.25 switch and have a properly functioning connection. X.25 resets will be sent to indicate when the circuit comes up or goes down.

PVC circuit numbers must come before (that is, be numerically smaller than) the circuit numbers allocated to any SVC range.

Table 64 lists the switched PVC options supported by X.25.

Table 64 Switched PVC Options

Option	Description
packetsize <i>in-size out-size</i>	Maximum input packet size (<i>in-size</i>) and output packet size (<i>out-size</i>) for the PVC. Both values must be one of the following values: 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096.

Table 64 Switched PVC Options (Continued)

Option	Description
window <i>size in-size out-size</i>	Packet count for input window (<i>in-size</i>) and output window (<i>out-size</i>) for the PVC. Both values should be the same, must be in the range 1 to 127, and must not be greater than the value set for the x25 modulo command.

Example

The following example configures a PVC connected between two serial interfaces on the same router. In this type of interconnection configuration, the alternate interface must be specified along with the PVC number on that interface. To make a working PVC connection, two commands must be specified, each pointing to the other, as this example illustrates.

```
interface serial 0
encapsulation x25
x25 ltc 5
x25 pvc 1 interface serial 1 pvc 1
interface serial 1
encapsulation x25
x25 ltc 5
x25 pvc 1 interface serial 0 pvc 1
```

x25 pvc (tunnel)

To connect two permanent virtual circuits (PVCs) across a TCP/IP LAN, use the tunnel version of the **x25 pvc** interface configuration command.

```
x25 pvc number1 tunnel address interface serial string pvc number2 [option]
```

Syntax Description

<i>number1</i>	PVC number of the connecting device.
tunnel	Indicates two PVCs will be connected across a TCP/IP LAN.
<i>address</i>	IP address of the device to which you are connecting.
interface serial	Indicates the interface is serial.
<i>string</i>	Serial interface specification that accepts either a number or a string in model 7000 format (<i>number/number</i>) to denote the serial interface.
pvc	Indicates a PVC.
<i>number2</i>	Remote PVC number on the target interface.
<i>option</i>	(Optional) Adds certain features for the connection; can be either option listed in Table 65.

Default

No PVCs are connected across a TCP/IP LAN. The PVC window and packet sizes default to the interface default values.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.3.

Use the PVC tunnel commands to tell the Cisco IOS software what the far end of the PVC is connected to. The incoming and outgoing packet sizes and window sizes must match the remote PVC outgoing and incoming sizes.

Each X.25-over-TCP (XOT) connection relies on a TCP session to carry traffic. To ensure that these TCP sessions remain connected in the absence of XOT traffic, use the **service tcp-keepalives-in** and **service tcp-keepalives-out** global configuration commands. If TCP keepalives are not enabled, XOT permanent virtual circuits (PVCs) might encounter problems if one end of the connection is reloaded. When the reloaded host attempts to establish a new connection, the other host refuses the new connection because it has not been informed that the old session is no longer active. Recovery from this state requires the other host to be informed that its TCP session is no longer viable so that it attempts to reconnect the PVC.

Also, TCP keepalives inform a router when an XOT switched virtual circuit (SVC) session is not active, thus freeing the router's resources.

Table 65 lists the PVC tunnel options supported by X.25.

Table 65 X.25 PVC Tunnel Options

Option	Description
packetsize <i>in-size out-size</i>	Maximum input packet size (<i>in-size</i>) and output packet size (<i>out-size</i>) for the PVC. Both values must be one of the following values: 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096.
windowsize <i>in-size out-size</i>	Packet count for input window (<i>in-size</i>) and output window (<i>out-size</i>) for the PVC. Both values should be the same, must be in the range 1 to 127, and must not be greater than or equal to the value set for the x25 modulo command.

Examples

The following example enters the parameters for one side of a connection destined for a platform other than the Cisco 7000 series:

```
service tcp-keepalives-in
service tcp-keepalives-out
interface serial 0
x25 pvc 1 tunnel 172.20.1.2 interface serial 1 pvc 2
```

The following example enters the parameters for one side of a connection destined for the Cisco 7000 series:

```
service tcp-keepalives-in
service tcp-keepalives-out
interface serial 0
x25 pvc 1 tunnel 172.20.1.2 interface serial 1/1 pvc 2
```

See the section “X.25 and LAPB Configuration Examples” in the *Wide-Area Networking Configuration Guide* for more complete configuration examples.

Related Commands

A dagger (†) indicated that a command is documented outside this chapter.

service tcp-keepalives-in †
service tcp-keepalives-out †

x25 remote-red

To set up the table that lists the Blacker Front End (BFE) nodes (host or gateways) to which the router will send packets, use the **x25 remote-red** interface configuration command.

```
x25 remote-red host-ip-address remote-black blacker-ip-address
```

Syntax Description

<i>host-ip-address</i>	IP address of the host or router that the packets are being sent to.
remote-black	Delimits the addresses for the table being built.
<i>blacker-ip-address</i>	IP address of the remote BFE device in front of the host to which the packet is being sent.

Default

No table is set up.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The table that results from this command provides the address translation information the router sends to the BFE when it is in emergency mode.

Example

The following example sets up a short table of BFE nodes for interface serial 0:

```
interface serial 0
x25 remote-red 172.20.9.3 remote-black 172.20.9.13
x25 remote-red 192.108.15.1 remote-black 192.108.15.26
```

Related Commands

show x25 remote-red
x25 bfe-decision

x25 route

To create an entry in the X.25 routing table, use an appropriate form of the **x25 route** global configuration command. To remove an entry from the table, use a **no** form of the command.

```

x25 route [#position] x121-address [ cud pattern] interface type number
no x25 route [#position] x121-address [ cud pattern] interface type number

x25 route [#position] x121-address [ cud pattern] ip ip-address [ip-address2... ip-address6]
    [xot-source type number]
no x25 route [# position] x121-address [ cud pattern] ip ip-address [xot-source type number]

x25 route [#position] x121-address [ cud pattern] interface type number [xot-keepalive-period
n | xot-keepalive-tries p]

x25 route [#position] x121-address [ cud pattern] ip ip-address [ip-address2... ip-address6]
    [xot-keepalive period p | xot-keepalive-tries p]

x25 route [#position] x121-address [ cud pattern] alias type number
no x25 route [#position] x121-address [ cud pattern] alias type number

x25 route [#position] x121-address [ substitute-source rewrite-pattern]
    [ substitute-dest rewrite-pattern] [ cud pattern] interface type number
no x25 route [#position] x121-address [ substitute-source rewrite-pattern]
    [ substitute-dest rewrite-pattern] [ cud pattern] interface type number

```

Note For typographical reasons, the last two commands are shown on two lines. When using the optional keywords in this variation of the **x25 route** command, make sure that the **substitute-source** keyword precedes the **substitute-dest** keyword, and that both precede the **cud** keyword. The entire command must be entered on one line.

Syntax Description

<i>#position</i>	(Optional) A pound sign (#) followed by a number to designate a positional parameter at which to insert the new entry. If no <i>position</i> parameter is given, the entry is appended to the end of the routing table.
<i>x121-address</i>	Called X.121 address pattern. This argument can be either an actual X.121 destination address or a regular expression such as <i>1111*</i> , representing a group of X.121 addresses.
<i>cud pattern</i>	(Optional) Call user data (CUD) pattern, which is specified as a regular expression of ASCII text. The CUD field may be present in a call packet. The first few bytes (commonly 4 bytes long) identify a protocol; the specified pattern is applied to any user data after the protocol identification.
interface <i>type number</i>	Keyword and destination interface type and unit or port number—for example, interface Serial 0.
ip <i>ip-address</i>	Keyword and IP address of the XOT destination for connections routed through a LAN. Optionally, up to five alternate IP addresses can be listed. Each address will be tried if the first destination fails, thus allowing alternate routes and decreasing the likelihood of failure.

xot-source <i>type number</i>	(Optional) X.25-over-TCP (XOT). Keyword and interface type unit or port number (for example, Loopback 0) to be used as the source address of a TCP connection, allowing the connection to move to a backup interface without terminating the TCP session.
xot-keepalive-period <i>n</i>	X.25-over-TCP (XOT). Specifies the TCP keepalive period. <i>n</i> is the number of seconds between keepalives. 60 seconds is the default. If specified with the x25 route x121-address interface command, this option controls the keepalive behavior of TCP received calls. If specified with x25 route x121-address ip command, this option controls the keepalive behavior of calls sent to the TCP.
xot-keepalive-tries <i>p</i>	X.25-over-TCP (XOT). <i>p</i> specifies the number of times keepalives should be sent before dropping the connection. The default for <i>p</i> is 4. If specified with the x25 route x121-address interface command, this option controls the behavior of TCP received calls. If specified with x25 route x121-address ip command, this option controls the behavior of calls sent to the TCP.
alias <i>type number</i>	Keyword and interface type and the unit or port number of the interface alias. Encapsulation calls are normally accepted when the destination address is that of the interface (or the zero-length X.121 address). Aliases allow the specified interface to accept calls with other destination addresses.
substitute-source <i>rewrite-pattern</i>	(Optional) See Table 66 and Table 67 for summaries of pattern and character matching, respectively.
substitute-dest <i>rewrite-pattern</i>	(Optional) Specifies the called X.121 address to replace in locally routed X.25 calls. (For backward compatibility, the substitute keyword is accepted as substitute-dest and written to nonvolatile memory in the new format.) The backslash (\) character is treated specially in the argument <i>rewrite-pattern</i> ; it indicates that the digit immediately following it selects a portion of the original called address to be inserted into the new called address. See Table 68 for a summary of pattern rewrite elements.

Default

No entry is created in the X.25 routing table.

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The **xot-source** *type number* command first appeared in Cisco IOS Release 10.3.

The **alias** *type number* command first appeared in Cisco IOS Release 11.1.

The X.25 routing table is consulted when an incoming call is received that should be forwarded to its destination. Two fields are used to determine the route: the called X.121 network interface address (or destination host address), and the X.25 packet's Called User Data (CUD) field. When the destination address and the CUD of the incoming packet fit the X.121 and CUD patterns in the routing table, the call is forwarded.

The order in which X.25 routing table entries are specified is significant; the list is scanned for the first match. The optional argument *# position* (# followed by a number) designates the line number at which to insert the new route. If no *position* parameter is given, the entry is appended to the end of the routing table.

The argument *x121-address* can be either an actual X.121 destination address or a regular expression such as 1111*, representing a group of X.121 addresses.

The optional CUD pattern can be specified as a printable ASCII string. Both the X.121 address and CUD can be written using UNIX-style, regular expressions. The CUD field is matched against any data in the call, which is commonly 4 bytes long.

X.121 address and CUD are used to find a matching routing table entry. The list is scanned from the beginning to the end, and each entry is pattern-matched with the incoming X.121 address and CUD to the X.121 and CUD in the routing table entry. If the pattern match for both entries succeeds, that route is used. If the incoming call has no CUD, only the X.121 address pattern needs to match an entry that only contains an X.121 pattern. If CUD is present and a route is found during scanning that matches the X.121 address but does not match a CUD pattern, that route is used when a dual match cannot be found. Regular expressions are used to allow pattern-matching operations on the X.121 addresses and CUD. A common operation is to do prefix matching on the X.121 DNIC field and route accordingly. For example, the pattern ^3306 will match all X.121 addresses with a DNIC of 3306. The caret (^) is a special regular expression character that anchors the match at the beginning of the pattern.

If a matching route is found, the incoming call is forwarded to the *next hop* depending on the routing entry. If no match is found, the call is cleared. If the route specifies a serial interface running X.25, the router will attempt to forward the call over that interface. If the interface is not operational the remaining routes will be checked for forwarding to an operational interface. If the interface is operational but out of available virtual circuits, the call will be cleared. Otherwise, the expected Clear Request or Call Accepted message will be forwarded back toward the originator. The "null 0" interface can be used as the destination to refuse calls to specific locations. A call cannot be forwarded out the interface it arrived on.

If the matching route specifies an IP address, a TCP connection will be established to port 1998 at the specified IP address, which must be another Cisco router. The Call Request packet will be forwarded to the remote router, where it will be processed in a similar fashion. If a routing table entry is not present or the serial interface is down or out of virtual circuits, a Clear Request will be sent back and the TCP connection will be closed. Otherwise, the call will be forwarded over the serial interface and the expected Clear Request or Call Accepted packet will be returned. Incoming calls received via TCP connections that match a routing entry specifying an IP address will be cleared. This restriction prevents Cisco routers from establishing a TCP connection to another router that would establish yet another TCP connection. A router must always connect to the remote router with the destination DTE directly attached.

See Table 66, Table 67, and Table 68 for summaries of pattern matching, character matching, and pattern rewrite elements. A more complete description of the pattern-matching characters is found in the “Regular Expressions” appendix in the *Access Services Command Reference*.

Note that address substitution is performed only on routes to an interface. When X.25 is running over IP, address substitution can be performed on the destination IP system if the destination system is configured with the appropriate X.25 routing commands.

Table 66 Pattern Matching

Pattern	Description
*	Matches 0 or more sequences of the regular expressions.
+	Matches 1 or more sequences of the regular expressions.
?	Matches 0 or 1 sequences of the regular expression. ¹

1. Precede the question mark with Ctrl-V to prevent the question mark from being interpreted as a help command.

Table 67 Character Matching

Character	Description
^	Matches the beginning of the input string.
\$	Matches the end of the input string.
\char	Matches the single character <i>char</i> specified.
.	Matches any single character.

Table 68 Pattern Rewrite Elements

Pattern	Description
\0	Replaces the entire original address.
\1...9	Replaces strings that match the first through ninth parenthetical part of the X.121 address.

Examples

The following example uses regular expression pattern matching characters to match just the initial portion of the complete X.25 address:

```
x25 route ^3107 interface serial 0
```

In the following example, if a call comes in on interface serial 0 and matches any X.121 address pattern, the call will be accepted for encapsulating traffic configured for the interface using X.25 map commands:

```
x25 route .* alias serial 0
```

In the following example, a call will be accepted if destined for either the VAX X.121 address or the address given in the **x25 address** interface command:

```
x25 route vax-x121-address alias serial 0
```

x25 route

The following example configures alternate IP addresses for the routing entry. If the first address listed is not available, subsequent addresses are tried until a connection is made.

```
x25 route ^3106 ip 172.20.2.5 172.20.7.10 172.10.7.9
```

Related Command

show x25 route

x25 routing

To enable X.25 switching or tunneling, use the **x25 routing** global configuration command. To disable the forwarding of X.25 calls, use the **no** form of this command.

```
x25 routing [use-tcp-if-defs]  
no x25 routing
```

Syntax Description

use-tcp-if-defs (Optional) May be used to modify the acceptance of calls received over TCP.

Default

Disabled

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The **x25 routing** command enables local switching and remote switching (also called *tunneling*, which routes X.25 traffic between two routers via a TCP connection). X.25 calls will not be forwarded until this command is issued.

The **use-tcp-if-defs** keyword may be needed for receiving remotely routed calls from routers using older software versions. Normally, calls received over a TCP connection (remote routing reception) will have the flow control parameters (window sizes and maximum packet sizes) indicated, because proper operation of routed X.25 requires that these values match at both ends of the connection.

Some previous versions of our software, however, do not ensure that these values are present in all calls. In this case, the Cisco IOS software normally forces universally acceptable flow control values (window sizes of 2 and maximum packet sizes of 128) on the connection. Because some equipment disallows modification of the flow control values in the call confirm, the **use-tcp-if-defs** keyword causes the router to use the default flow control values of the outgoing interface and indicate the resulting values in the call confirm. This modified behavior may allow easier migration to newer versions of the Cisco IOS software.

Example

The following example enables X.25 switching:

```
x25 routing
```

x25 rpoa

To specify a sequence of packet network carriers, use the **x25 rpoa** global configuration command. To remove the specified name, use the **no** form of this command.

```
x25 rpoa name number  
no x25 rpoa name
```

Syntax Description

<i>name</i>	Recognized Private Operating Agency (RPOA), which must be unique with respect to all other RPOA names. It is used in the x25 facility and x25 map interface configuration commands.
<i>number</i>	A sequence of 1 or more numbers used to describe an RPOA; up to 10 numbers are accepted.

Default

No packet network carriers are specified.

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command specifies a list of transit RPOAs to use, referenced by name.

Example

The following example sets an RPOA name and then sends the list via the X.25 user facilities:

```
x25 rpoa green_list 23 35 36  
interface serial 0  
x25 facility rpoa green_list  
x25 map ip 172.20.170.26 10 rpoa green_list
```

Related Commands

x25 facility
x25 map

x25 suppress-called-address

To omit the destination address in outgoing calls, use the **x25 suppress-called-address** interface configuration command. To reset this command to the default state, use the **no** form of this command.

```
x25 suppress-called-address  
no x25 suppress-called-address
```

Syntax Description

This command has no arguments or keywords.

Default

The called address is sent.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command omits the called (destination) X.121 address in Call Request packets and is required for networks that expect only subaddresses in the Called Address field.

Example

The following example suppresses or omits the called address in Call Request packets:

```
interface serial 0  
x25 suppress-called-address
```

x25 suppress-calling-address

To omit the source address in outgoing calls, use the **x25 suppress-calling-address** interface configuration command. To reset this command to the default state, use the **no** form of this command.

```
x25 suppress-calling-address  
no x25 suppress-calling-address
```

Syntax Description

This command has no arguments or keywords.

Default

The calling address is sent.

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command omits the calling (source) X.121 address in Call Request packets and is required for networks that expect only subaddresses in the Calling Address field.

Example

The following example suppresses or omits the calling address in Call Request packets:

```
interface serial 0  
x25 suppress-calling-address
```

x25 t10

Use the **x25 t10** interface configuration command to set the value of the Restart Indication retransmission timer (T10) on DCE devices.

x25 t10 *seconds*

Syntax Description

seconds Time in seconds. The default is 60 seconds.

Default

60 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T10 timer to 30 seconds:

```
interface serial 0
x25 t10 30
```

x25 t11

To set the value of the Incoming Call timer (T11) on DCE devices, use the **x25 t11** interface configuration command.

x25 t11 *seconds*

Syntax Description

seconds Time in seconds. The default is 180 seconds.

Default

180 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T11 timer to 90 seconds:

```
interface serial 0
x25 t11 90
```

x25 t12

To set the value of the Reset Indication retransmission timer (T12) on DCE devices, use the **x25 t12** interface configuration command.

x25 t12 *seconds*

Syntax Description

seconds Time in seconds. The default is 60 seconds.

Default

60 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T12 timer to 30 seconds:

```
interface serial 0
x25 t12 30
```

x25 t13

To set the value of the Clear Indication retransmission timer (T13) on DCE devices, use the **x25 t13** interface configuration command.

x25 t13 *seconds*

Syntax Description

seconds Time in seconds. The default is 60 seconds.

Default

60 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T13 timer to 30 seconds:

```
interface serial 0
x25 t13 30
```

x25 t20

To set the value of the Restart Request retransmission timer (T20) on DTE devices, use the **x25 t20** interface configuration command.

x25 t20 *seconds*

Syntax Description

seconds Time in seconds. The default is 180 seconds.

Default

180 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T20 timer to 90 seconds:

```
interface serial 0
x25 t20 90
```

x25 t21

To set the value of the Call Request timer (T21) on DTE devices, use the **x25 t21** interface configuration command.

x25 t21 *seconds*

Syntax Description

seconds Time in seconds. The default is 200 seconds.

Default

200 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T21 timer to 100 seconds:

```
interface serial 0
x25 t21 100
```

x25 t22

To set the value of the Reset Request retransmission timer (T22) on DTE devices, use the **x25 t22** interface configuration command.

x25 t22 *seconds*

Syntax Description

seconds Time in seconds. The default is 180 seconds.

Default

180 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T22 timer to 90 seconds:

```
interface serial 0
x25 t22 90
```

x25 t23

To set the value of the Clear Request retransmission timer (T23) on DTE devices, use the **x25 t23** interface configuration command.

x25 t23 *seconds*

Syntax Description

seconds Time in seconds. The default is 180 seconds.

Default

180 seconds

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Example

The following example sets the T23 timer to 90 seconds:

```
interface serial 0
x25 t23 90
```

x25 th

To set the data packet acknowledgment threshold, use the **x25 th** interface configuration command.

x25 th *delay-count*

Syntax Description

delay-count Value between zero and the input window size. A value of 1 sends one Receiver Ready acknowledgment per packet. The default is 0, which disables the acknowledgment threshold.

Default

0 (which disables the acknowledgment threshold)

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count.

The router sends an acknowledgment packet when the number of input packets reaches the count you specify, providing there are no other packets to send. For example, if you specify a count of 1, the router will send an acknowledgment per input packet if unable to “piggyback” the acknowledgment of an outgoing data packet. This command improves line responsiveness at the expense of bandwidth.

This command only applies to encapsulated traffic over X.25 (datagram transport), not to routed traffic (local or remote).

Example

The following example sends an explicit Receiver Ready acknowledgment when it has received 5 data packets that it has not acknowledged:

```
interface serial 1
x25 th 5
```

Related Commands

x25 win

x25 wout

x25 use-source-address

To override the X.121 addresses of outgoing calls forwarded over a specific interface, use the **x25 use-source-address** interface configuration command. Use the **no** form of this command to prevent updating the source addresses of outgoing calls.

```
x25 use-source-address  
no x25 use-source-address
```

Syntax Description

This command has no arguments or keywords.

Default

Disabled

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

Some X.25 calls, when forwarded by the X.25 switching support, need the calling (source) X.121 address updated to that of the outgoing interface. This update is necessary when you are forwarding calls from private data networks to public data networks (PDNs).

Example

The following example shows how to prevent updating the source addresses of outgoing X.25 calls on interface serial 0 once calls have been forwarded:

```
interface serial 0  
no x25 use-source-address
```

x25 win

To change the default incoming window size to match that of the network, use the **x25 win** interface configuration command.

x25 win *packets*

Syntax Description

packets Packet count that can range from 1 to one less than the window modulus.

Default

2 packets

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command determines the default number of packets a virtual circuit can receive before sending an X.25 acknowledgment. To maintain high bandwidth utilization, assign this limit the largest number that the network allows.

Note Set **x25 win** and **x25 wout** to the same value unless your network supports asymmetric input and output window sizes.

Example

The following example specifies that 5 packets may be received before an X.25 acknowledgment is sent:

```
interface serial 1
x25 win 5
```

Related Commands

x25 modulo

x25 th

x25 wout

x25 wout

To change the default outgoing window size to match that of the network, use the **x25 wout** interface configuration command.

x25 wout *packets*

Syntax Description

packets Packet count that can range from 1 to one less than the window modulus.

Default

2 packets

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command determines the default number of packets a virtual circuit can send before waiting for an X.25 acknowledgment. To maintain high bandwidth utilization, assign this limit the largest number that the network allows.

Note Set **x25 win** and **x25 wout** to the same value unless your network supports asymmetric input and output window sizes.

Example

The following example specifies a default limit of 5 for the number of outstanding unacknowledged packets for virtual circuits:

```
interface serial 1
x25 wout 5
```

Related Commands

x25 modulo

x25 th

x25 win

x29 access-list

To limit access to the access server from certain X.25 hosts, use the **x29 access-list** global configuration command. To delete an entire access list, use the **no** form of this command.

```
x29 access-list access-list-number {deny | permit} x121-address  
no x29 access-list access-list-number
```

Syntax Description

<i>access-list-number</i>	Number of the access list. It can be a value between 1 and 199.
deny	Denies access and clears call requests immediately.
permit	Permits access to the protocol translator.
<i>x121-address</i>	X.121 address that can or cannot have access (with or without regular expression pattern-matching characters). The X.121 address is the source address of the incoming packet.

Default

No access lists are defined.

Command Mode

Global

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

An access list can contain any number of access list items. The list items are processed in the order in which you entered them, with the first match causing the permit or deny condition. If an X.121 address does not match any of the regular expressions in the access list, access is denied.

Access lists take advantage of the message field defined by Recommendation X.29, which describes procedures for exchanging data between two PADs, or between a PAD and a DTE device.

The UNIX-style regular expression characters allow for pattern matching of characters and character strings in the address. Various pattern-matching constructions are available that allow many addresses to be matched by a single regular expressions. For more information, refer to the "Regular Expressions" appendix in the *Access Services Command Reference*.

The access lists must be applied to a vty with the **access-class** command.

Example

The following example permits connections to hosts with addresses beginning with the string 31370:

```
x29 access-list 2 permit ^31370
```

x29 profile

To create a PAD profile script for use by the **translate** command, use the **x29 profile** global configuration command.

```
x29 profile name parameter:value [parameter:value]
```

Syntax Description

<i>name</i>	Name of the PAD profile script.
<i>parameter:value</i>	X.3 PAD parameter number and value separated by a colon. You can specify multiple parameter-value pairs.

Default

No PAD profile script is created.

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

When an X.25 connection is established, the access server acts as if an X.29 Set Parameter packet had been sent containing the parameters and values set by the **x29 profile** command and sets the access server accordingly.

Example

The following profile script turns local edit mode on when the connection is made and establishes local echo and line termination upon receipt of a Return packet. The name *linemode* is used with the **translate** command to effect use of this script.

```
x29 profile linemode 2:1 3:2 15:1
```

Related Command

A dagger (†) indicates that the command is documented outside this chapter.

translate †