

Dynamic Multiple Encapsulations for Dial-In over ISDN

This document describes the Dynamic Multiple Encapsulations for Dial-In over ISDN feature. It includes the following sections:

- Feature Overview, page 1
- Supported Platforms, page 8
- Supported Standards, MIBs, and RFCs, page 8
- Prerequisites, page 9
- Configuration Tasks, page 9
- Configuration Examples, page 11
- Command Reference, page 21
- Glossary, page 28

Feature Overview

The Dynamic Multiple Encapsulations feature allows incoming calls over ISDN to be assigned an encapsulation type such as Frame Relay, PPP, and X.25 based on calling line identification (CLID) or DNIS. It also allows various encapsulation types and per-user configurations on the same ISDN B channel at different times according to the type of incoming call.

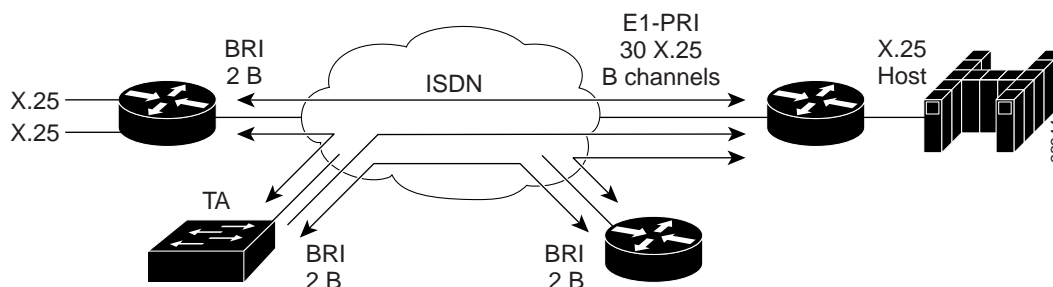
The Dynamic Multiple Encapsulations feature allows per-user configuration for each dial-in caller on any ingress ISDN B channel on which encapsulation can be run independently from other B channels on the same ISDN link. The caller is identified by CLID or DNIS to ensure that only incoming calls with authorization and valid user profiles are accepted. When PPP is used, authentication and profile binding can also be done by PPP name.

In addition, a large set of user profiles can be stored in dialer profiles locally or on a remote AAA server. (For large scale dial-in, storing user-specific configurations on a remote server becomes necessary for enhancing expandability and local memory efficiency.) However, whether stored locally or on a remote AAA server, the user-specific encapsulation and configuration can be applied to individual B channels dynamically and independently.

Dynamic multiple encapsulation is especially important in Europe where ISDN is relatively inexpensive and maximum use of all 30 B channels on the same ISDN link is desirable. Further, the feature removes the need to statically dedicate channels to a particular encapsulation and configuration type, and improves channel usage.

Figure 1 shows a typical configuration for an X.25 network in Europe. The Dynamic Multiple Encapsulations feature allows use of all 30 B channels, and supports calls that originate in diverse areas of the network and converge on the same ISDN PRI.

Figure 1 European X.25 Network



Although the Dynamic Multiple Encapsulations feature enhances large-scale dial-in functionality, the feature also works well in smaller-scale dial-in situations.

Dial-on-Demand Routing Software Enhancements

The following sections describe the enhancements to the dial-on-demand routing (DDR) software that enable the Dynamic Multiple Encapsulations feature.

Dynamic, Multiple Encapsulations

Before Cisco IOS software Release 12.0(7)T, encapsulation techniques such as Frame Relay, HDLC, LAPB-TA, and X.25 could support only one ISDN B-channel connection over the entire link. HDLC and PPP could support multiple B channels, but the entire ISDN link needed to use the same encapsulation. With the Dynamic Multiple Encapsulations feature, once CLID binding is completed, the topmost interface is always used for all configuration and data structures. The ISDN B channel becomes a forwarding device, and the configuration on the D channel is ignored, thereby allowing the different encapsulation types and per-user configurations.

For X.25 encapsulations, the configurations reside on the dialer profile. Dynamic multiple encapsulations provide support for PAD traffic and X.25 encapsulated and switched packets.

New Dialer Profile Model

In previous Cisco IOS software releases, dialer profiles in the same dialer pool needed encapsulation-specific configuration information entered under both the dialer profile interface and the ISDN interface. If any conflict arose between the logical and the physical interfaces, the dialer profile failed to work.

In the new dialer profile model introduced by the Dynamic Multiple Encapsulations feature, the configuration on the ISDN interface is ignored and only the configuration on the profile interface is used, unless PPP name binding is used. Before a successful bind by CLID occurs, no encapsulation type and configuration are assumed or taken from the physical interfaces.

When PPP is used and a CLID bind fails, a dialer profile still can be matched by PPP name authentication. In the new dialer profile model, multiple attempts are made to find a matching profile.

PPP encapsulation on an ISDN link is different from other encapsulation types because it runs on the B channel rather than the dialer profile interface. There are two possible configuration sources in a profile bind: the D and the dialer profile interfaces. Hence, a configuration conflict between the sources is possible. If a successful bind is accomplished by name authentication, the configuration used to bring PPP up is the one on the D interface. This is the name used to locate a dialer profile for the bind. The configuration on an ISDN interface goes under the D rather than a B channel, although B channels inherit the configuration from their D interface.

However, the configuration on this found dialer profile could be different from the one on the D interface. For example, the **ppp multilink** command is configured on the D interface, but not on the dialer profile interface. The actual per-user configuration is the one on the dialer profile interface. In this case, per-user configuration is not achieved unless LCP and authentication are renegotiated. Because PPP client software often does not accept renegotiation, this workaround is not acceptable. Therefore, the D interface configuration takes precedence over the dialer profile interface configuration. This is the only case where the configuration of the dialer profile is overruled.

New Virtual Profile Model

The changes to the virtual profile model are similar to those for the new dialer profile model. If a B interface is bound by CLID to a created virtual access interface cloned from a virtual profile or a virtual template interface, only the configuration from the virtual profile or the virtual template takes effect. The configuration on the D interface is ignored unless successful binding occurs by PPP name. Both the link and network protocols run on the virtual access interface instead of the B channel, unless the encapsulation is PPP.

Additionally, the old virtual profile model supported only PPP encapsulations. The new virtual profile model in Cisco IOS Release 12.0(7)T supports HDLC, LAPB, X.25, and Frame Relay encapsulations. Any commands for these encapsulations that can be configured under a serial interface can be configured under a virtual profile stored in a user file on an AAA server and a virtual profile virtual template configured locally. The AAA server daemon downloads the commands as text to the network access server, and is able to handle multiple download attempts.

Moreover, in the old virtual profile model, downloading a profile from an AAA server and creating and cloning a virtual access interface were always done after the PPP call answer and LCP up processes. The AAA download is part of authorization. But in the new model, these operations must be performed before the call is answered and the link protocol goes up. This is a new AAA nonauthenticated authorization step. The virtual profile code handles multiple download attempts, and identifies whether a virtual access interface was cloned from a downloaded virtual profile.

When a download succeeds through nonauthenticated authorization, and the configuration on the virtual profile has encapsulation PPP and PPP authentication, authentication is negotiated as a separate step after LCP comes up.

Frame Relay Support on the Dialer Interface

Table 1 lists the Frame Relay features that are supported by the Dynamic Multiple Encapsulations feature in Cisco IOS software release 12.0(7)T. This feature supports at least four Frame Relay PVCs on two dialer interfaces and subinterfaces.

Note Frame Relay encapsulations in the Dynamic Multiple Encapsulations feature do not support IETF or Cisco Encapsulation for IBM SNA. Frame Relay for SNA support is not applicable.

Table 1 Supported Frame Relay Feature Set

| Frame Relay Feature | Supported? |
|--|------------|
| Frame Relay Basic Features: | |
| Frame Relay MIBs (RFC 1315 and Cisco Proprietary) | Yes |
| Frame Relay PVC Support | Yes |
| Frame Relay Subinterface | Yes |
| Frame Relay Switching — Packet Forwarding | No |
| IP over Frame Relay (RFC 1490 and Cisco Encapsulation) | Yes |
| LMI — DTE Support | Yes |
| LMI — NNI, DCE Support | No |
| Syslog for Frame Relay DLCI and Subinterface Status Changes | Yes |
| Multiprotocol Support: | |
| ANSI T1.617 Encapsulation for X.25 (Annex G) | No |
| Frame Relay Inverse ARP for Multiprotocol (RFC 1293/2390) | Yes |
| Multiprotocol over Frame Relay (RFC 1490/2427 and Cisco Encapsulation) | Yes |
| PPP over Frame Relay (RFC 1973) | No |
| Frame Relay QOS Support: | |
| DE Bit Support | No |
| DLCI Prioritization | Yes |
| Enhanced Local Management Interface | No |
| Frame Relay Fragmentation (FRF. 12) | No |
| Frame Relay Router ForeSight (Same as CLLM) | No |
| Frame Relay Traffic Shaping | No |
| Frame Relay Compression: | |
| Cisco Proprietary Payload Compression | No |
| Frame Relay Payload Compression (FRF. 9) | No |
| Frame Relay RTP Header Compression (RFC 1889) | Yes |
| Frame Relay TCP/IP Header Compression | Yes |
| Frame Relay Dial Support: | |
| Frame Relay Interface/Subinterface Backup | No |
| Legacy DDR over Frame Relay | Yes |
| Frame Relay Utilities: | |
| AutoInstall over Frame Relay | No |
| Frame Relay Broadcast Queue | Yes |
| Frame Relay End-to-End Keepalive | No |
| Frame Relay Voice Support: | |
| Voice over Frame Relay (FRF. 11) | No |
| Frame Relay Switching: | |
| Advanced Frame Relay Switching with Traffic Management | No |
| Frame Relay Switching over IP Tunnels | No |

Table 1 Supported Frame Relay Feature Set (continued)

| Frame Relay Feature | Supported? |
|---|------------|
| Frame Relay and ATM Interworking: | |
| Frame Relay/ATM Network Interworking (FRF. 5) PVCs/Soft-VCs | No |
| Frame Relay/ATM Service Interworking (FRF. 8) PVCs/Soft-VCs | No |
| Frame Relay SVC Support: | |
| Frame Relay SVC Support for DTE | No |

See the sections “Frame Relay Encapsulation on a Main Interface” and “Frame Relay Encapsulation on a Subinterface” in “Configuration Examples” for examples of Frame Relay encapsulations with the Dynamic Multiple Encapsulations feature.

MLP Encapsulation Enhancements

Previously, when MLP was used in a dialer profile, a virtual access interface was always created as the bundle. It was bound to both the B channel and the dialer profile interfaces after creation and cloning. The dialer profile interface could act as the bundle without help from a virtual access interface. But with the current software enhancements available in Cisco IOS

Release 12.0(7)T, it is no longer the virtual access interface that is added into the connected group of the dialer profile, but the dialer profile itself. The dialer profile becomes a connected member of its own connected group.

More Efficient ISDN Call Screening

Before the Dynamic Multiple Encapsulations feature, calls were screened in the ISDN process. ISDN accepted all synchronous calls and performed some minimal CLID screening before accepting or rejecting a call. With the Dynamic Multiple Encapsulations feature, DDR provides a separate process that screens for the profile of the caller. The new screening process also checks that enough resources are available to accept the call and that the call conforms to predetermined rules. When the call is found acceptable, the screening process searches for a matching profile for the caller. The call is accepted only when there is a matching profile.

Fancy Queueing and Traffic Shaping

In the old dialer profile model, fancy queueing and traffic shaping were configured under the physical interfaces. For ISDN, this was the D interface. Thus, the same queueing or traffic shaping scheme needed to be applied to all users that were sharing the same ISDN link.

The new dialer profile model moves all the per-user encapsulation configuration to the dialer profile interfaces, separating it from hardware interfaces to make it dynamic and also to make per-user queueing and traffic shaping configuration possible. You need only configure the queueing and traffic shaping schemes you desire on the dialer profile interface and the interface will take precedence over those configured on the ISDN B-channel interface. Per-user fancy queueing and traffic shaping work with both process switching and fast switching in the new dialer profile model. However, Frame Relay Traffic Shaping (FRTS) is not supported on the new dialer profile model.

Outbound Circuit-Switched X.25 Support over a Dialer Interface

Cisco IOS software Release 12.0(5)T enabled circuit-switched X.25 clients—PAD, X.25 switching, and QLLC—to initiate calls and dynamically bring the X.25 context (which runs the X.25 protocol) up or down as needed. This capability allowed packet-switched traffic over a digital link like ISDN.

Before Release 12.0(5)T, X.25 circuit-switched clients were required to perform an X.25 route lookup to forward a call. If the lookup resulted in a route to a dialer interface, the client would check the X.25 protocol state on the dialer interface. If the interface was not already bound to run the X.25 protocol, the software would reroute the call instead of bringing up a link and running the X.25 protocol. With this new feature, the X.25 context is dynamically created on demand and then removed when the X.25 session is cleared on the dialer interface.

For dialer profile interfaces, the X.25 context is created on the dialer interface, because X.25 protocol functions run on the dialer interface itself. Member links act like forwarding devices, because their topmost interface runs the actual encapsulated protocol. But for legacy dialer interfaces, the X.25 context is created on the member links once they come up and bind to a dialer.

See the section “Outbound Circuit-Switched X.25” in “Configuration Examples” for an example of how to set up this feature.

Load Balancing

The Dynamic Multiple Encapsulations feature continues to support load balancing for the HDLC and PPP encapsulations, but not for LAPB, X.25, or Frame Relay. Load balancing is a Cisco-proprietary feature that brings up additional channels to handle intense packet traffic when a traffic threshold is configured with the **dialer load-threshold** command.

Note Although the **dialer load-threshold** command is used to set thresholds for both load balancing and MLP, there is no need to configure load balancing with MLP because it provides its own type of load balancing by opening multiple B channels between a source and destination. MLP packets are fragmented into smaller pieces before transmission, whereas load balancing does not perform this step.

DNIS-Plus-ISDN-Subaddress Multiple Call Binding Strategy

Previous releases of the DDR software allowed only one bind between a dialer profile and an ISDN B channel. If DNIS binding was used over an ISDN link, and only one dialer profile interface was configured with this DNIS, no other ISDN B channels could bind to the dialer profile interface after it was bound to another B channel because DNIS is not a user identification.

To overcome this problem, Cisco IOS Release 12.0(4)T provided a new **dialer called** command that allows DNIS-plus-ISDN-subaddress binding for the dialer profile in which the ISDN subaddress is a user identification. DNIS binding is allowed only when the ISDN subaddress is present in an incoming call and configured in a dialer profile. ISDN subaddresses are used mainly in Europe and Australia.

The list of authorized CLIDs and DNIS-plus-ISDN-subaddresses for each user is stored in a local dialer profile. The highest binding priority is configured as follows:

- 1 CLID binding
- 2 DNIS-plus-ISDN-subaddress binding
- 3 Name binding
- 4 Default binding (for no security check)

Benefits

- Allows incoming calls over ISDN to be assigned an encapsulation type such as PPP, X.25, LAPB-TA, or Frame Relay based on CLID or DNIS.
- Allows various encapsulation types and per-user configurations on the same ISDN B channel at different times according to the type of incoming call.
- Allows storing a large set of user profiles in dialer profiles either locally or on a remote AAA server. User-specific encapsulation and configuration information can be applied to individual B channels dynamically and independently.
- Removes the need to statically dedicate channels to a particular encapsulation and configuration type, and improves channel usage. This capability is especially important in Europe, where allowing maximum use of all B channels on the same ISDN link is desired.
- Enhances large scale dial-in functionality by reducing channel assignment and management effort, and adds flexibility to the network.
- Works well in small-scale dial-in situations.

Restrictions

The Dynamic Multiple Encapsulations feature provides bidirectional support of all serial encapsulations except Frame Relay.

This feature also supports IP and IPX fast switching for HDLC and PPP encapsulations. There is no fast switching for LAPB, X.25, or Frame Relay; packets encapsulated by these protocols are always process switched.

Related Features and Technologies

The Dynamic Multiple Encapsulations feature changes the behavior of the DDR software functionality and serial line encapsulation. See the documents listed in the section “Related Documents” for background information about DDR and encapsulation methods.

Related Documents

For related information on the Dynamic Multiple Encapsulations feature, refer to the following documents:

- *Dial Solutions Configuration Guide* and *Dial Solutions Command Reference* publications, Cisco IOS Release 12.0
- *Cisco IOS Interface Configuration Guide* and *Cisco IOS Interface Command Reference* publications, Cisco IOS Release 12.0
- *Wide-Area Networking Configuration Guide* and *Wide-Area Networking Command Reference* publications, Cisco IOS Release 12.0

Supported Platforms

- Cisco 1003 routers
- Cisco 1004 routers
- Cisco 1005 routers
- Cisco 1600 routers
- Cisco 2500 series routers
- Cisco 2600 routers
- Cisco 3600 series routers
- Cisco 4000 and 4000-M series routers
- Cisco 7000 series routers
- Cisco 7200 series routers
- Cisco 7500 series routers
- Cisco AS5200 series access servers
- Cisco AS5300 series access servers
- Cisco AS5800 series access servers

Supported Standards, MIBs, and RFCs

Standards

None

MIBs

No new or modified MIBs are supported by this feature.

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB web site on CCO at <http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml>.

RFCs

None

Prerequisites

Before beginning the configuration tasks in this document, you must:

- Be familiar with how the old dialer profile model works and understand how to configure dialer profiles. This information is available in the Cisco IOS Release 12.0 *Dial Solutions Configuration Guide*, in the chapters “Configuring Peer-to-Peer DDR with Dialer Profiles” and “Enterprise Dial Scenarios & Configurations.”
- Have already configured encapsulation methods on your interfaces. This information is available in the Cisco IOS Release 12.0 *Cisco IOS Interface Configuration Guide*, in the chapter “Configuring Serial Interfaces.”

See the documents listed in the section “Related Documents” for additional references.

Configuration Tasks

The Dynamic Multiple Encapsulations feature requires no new command to configure. It introduces new dialer profile behaviors over ISDN, rather than new configuration tasks. The only command added, **dialer called**, is not for configuring the Dynamic Multiple Encapsulations feature, but for configuring DNIS-plus-ISDN-subaddress profile binding.

To understand how dialer profiles work and how to configure them, see the Cisco IOS Release 12.0 *Dial Solutions Configuration Guide* and its chapters “Configuring Peer-to-Peer DDR with Dialer Profiles” and “Enterprise Dial Scenarios & Configurations.” To understand the changes that the Dynamic Multiple Encapsulations feature and the Cisco IOS Release 12.0(4)T, 12.0(5)T, and 12.0(7)T software have made to the dialer profile model, see the section “Dial-on-Demand Routing Software Enhancements” earlier in this document.

To configure DNIS-plus-ISDN-subaddress binding, if appropriate for your network, perform the task described in the section “Configuring DNIS-plus-ISDN-Subaddress Binding” later in this document.

To verify that the Dynamic Multiple Encapsulations feature is operating, view the physical interface bindings in effect as a result of the Dynamic Multiple Encapsulations feature. This task is described in the section “Verifying the Dynamic Multiple Encapsulations Feature” later in this document.

Configuring DNIS-plus-ISDN-Subaddress Binding

To configure DNIS-plus-ISDN-subaddress binding, use the following command in dial-on-demand routing mode, which allows multiple binds between a dialer profile and an ISDN B channel. This configuration requires an ISDN subaddress, which is used in Europe and Australia.

| Command | Purpose |
|---|-------------------------------------|
| Router(config)# dialer called <i>DNIS:subaddress</i> | Binds a DNIS to an ISDN subaddress. |

Verifying the Dynamic Multiple Encapsulations Feature

To verify dialer interfaces configured for binding and see statistics on each physical interface bound to the dialer interface, use the **show interfaces EXEC** command. Look for the reports “Bound to:” and “Interface is bound to...” and remember that this feature only applies to ISDN.

```
Router# show interfaces dialer0

Dialer0 is up, line protocol is up
  Hardware is Unknown
  Internet address is 21.1.1.2/8
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set
  DTR is pulsed for 1 seconds on reset
  Interface is bound to BRI0:1
  Last input 00:00:38, output never, output hang never
  Last clearing of "show interface" counters 00:05:36
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    38 packets input, 4659 bytes
    34 packets output, 9952 bytes
Bound to:
BRI0:1 is up, line protocol is up
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive not set
  Interface is bound to Dialer0 (Encapsulation PPP)
  LCP Open, multilink Open
  Last input 00:00:39, output 00:00:11, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    78 packets input, 9317 bytes, 0 no buffer
  Received 65 broadcasts, 0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  93 packets output, 9864 bytes, 0 underruns
  0 output errors, 0 collisions, 7 interface resets
  0 output buffer failures, 0 output buffers swapped out
  4 carrier transitions
```

At the end of Dialer0 display, the **show interfaces** command is executed on each physical interface bound to it.

In the next example, the physical interface is the B1 channel of the BRI0 link. This example also illustrates that the output under the B channel keeps all hardware counts that are not displayed under any logical or virtual access interface. The line in the report that states “Interface is bound to Dialer0 (Encapsulation LAPB)” indicates that this B interface is bound to the dialer 0 interface and the encapsulation running over this connection is LAPB, not PPP, which is the encapsulation configured on the D interface and inherited by the B channel.

```
Router# show interfaces bri0:1

BRI0:1 is up, line protocol is up
Hardware is BRI
MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
Encapsulation PPP, loopback not set, keepalive not set
Interface is bound to Dialer0 (Encapsulation LAPB)
LCP Open, multilink Open
Last input 00:00:31, output 00:00:03, output hang never
Last clearing of "show interface" counters never
Queueing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 1 packets/sec
5 minute output rate 0 bits/sec, 1 packets/sec
 110 packets input, 13994 bytes, 0 no buffer
  Received 91 broadcasts, 0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
 135 packets output, 14175 bytes, 0 underruns
   0 output errors, 0 collisions, 12 interface resets
   0 output buffer failures, 0 output buffers swapped out
   8 carrier transitions
```

Any protocol configuration and states should be displayed from the dialer 0 interface.

Configuration Examples

This section provides the following configuration examples:

- Multiple Encapsulations over ISDN
- Outbound Circuit-Switched X.25
- Frame Relay Encapsulation on a Main Interface
- Frame Relay Encapsulation on a Subinterface

Multiple Encapsulations over ISDN

In the following configuration example, a network access server named NAS1 has dialer profiles, and LAPB, X.25, and PPP encapsulations configured. Although the BRI0 D interface uses X.25 encapsulation, the actual encapsulations running over the ISDN B channels are determined by the encapsulations configured on the profile interfaces bound to them.

When an ISDN B channel connects to remote user RU2 using CLID 60043, Dialer1 is bound to this ISDN B channel by CLID binding. The protocol used is PPP; the X.25 configuration on the D interface has no effect. Because the **ppp authentication chap command** is configured, even though the binding is done by CLID, PPP authentication is still performed over the name RU2 before the protocol is allowed to proceed.

The Dialer2 interface uses DNIS-plus-ISDN-subaddress binding, and is bound to a B channel with an incoming call with DNIS 60045 and ISDN subaddress 12345. Also note that the HDLC encapsulation has no username associated. It is no longer necessary to configure the **dialer remote-name** command, as in the previous dialer profile model.

When there is an ISDN B-channel connection to remote user RU1 using CLID 60036, LAPB encapsulation will run on this connection once CLID binding to Dialer0 takes place. This connection will operate as a standalone link independent of other activities over other ISDN B channels.

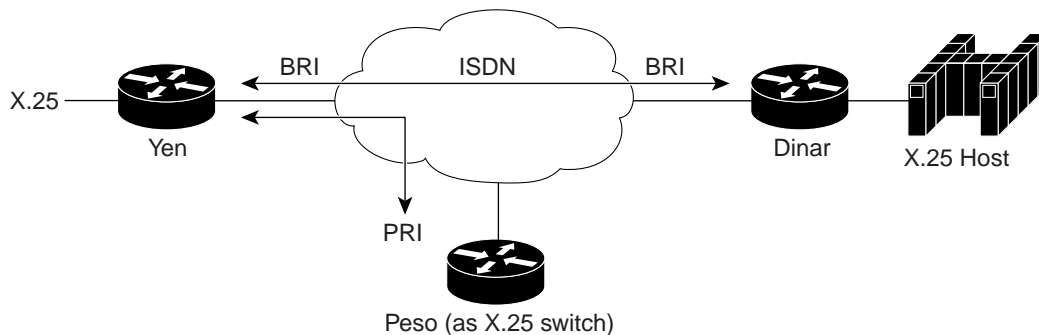
```
!
version 12.0(4)T
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
service udp-small-servers
service tcp-small-servers
!
virtual-profile virtual-template 1
virtual-profile aaa
!
hostname NAS1
!
aaa new-model
aaa authentication ppp default radius
aaa authorization network radius
enable secret 5 $1$0Ced$YYJJ12p8f94lc/.JSgw8n1
enable password 7 153D19270D2E
!
username RU1 password 7 11260B2E1E16
username RU2 password 7 09635C221001
no ip domain-lookup
ip domain-name cisco.com
ip name-server 198.92.30.32
ip name-server 171.69.2.132
isdn switch-type basic-5ess
!
int Virtual-Template 1
encapsulation ppp
ppp authentication chap
!
interface Ethernet0
 ip address 172.21.17.11 255.255.255.0
 no ip mroute-cache
 no cdp enable
!
interface Serial0
 ip address 2.2.2.1 255.0.0.0
 shutdown
 clockrate 56000
 ppp authentication chap
!
interface Serial1
 ip address 10.0.0.1 255.0.0.0
 shutdown
!
interface BRI0
 description PBX 60035
 no ip address
 encapsulation x25
 no ip mroute-cache
 no keepalive
 dialer pool-member 1
 dialer pool-member 2
!
```

```
interface Dialer0
 ip address 21.1.1.1 255.0.0.0
 encapsulation lapb dce multi
 no ip route-cache
 no ip mroute-cache
 no keepalive
 dialer remote-name RU1
 dialer idle-timeout 300
 dialer string 60036
 dialer caller 60036
 dialer pool 1
 dialer-group 1
 no fair-queue
!
interface Dialer1
 ip address 22.1.1.1 255.0.0.0
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 dialer remote-name RU2
 dialer string 60043
 dialer caller 60043
 dialer pool 2
 dialer-group 1
 no fair-queue
 no cdp enable
 ppp authentication chap
!
interface Dialer2
 ip address 23.1.1.1 255.0.0.0
 encapsulation hdlc
 dialer called 60045:12345
 dialer pool 1
 dialer-group 1
 fair-queue
!
radius-server host 171.69.61.87
radius-server key foobar
snmp-server community public RO
!
line con 0
 exec-timeout 0 0
line aux 0
 transport input all
line vty 0 4
 password 7 10611B320C13
 login
!
end
```

Outbound Circuit-Switched X.25

The following example shows how to configure dynamic X.25 on an ISDN interface. Figure 2 illustrates the configuration.

Figure 2 Dynamic X.25 over ISDN



Configuration for Yen:

```

version 12.0(5)T
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
service udp-small-servers
service tcp-small-servers
!
hostname yen
!
enable secret 5 $1$K32j$4AZW2oMDivpUeuMa/Fdcd.
enable password poPpee
!
username mark password 0 cisco
username dinar password 0 cisco
ip subnet-zero
no ip domain-lookup
ip domain-name cicso.com
ip name-server 171.69.1.148
!
isdn switch-type basic-5ess
x25 routing
!
interface Loopback0
no ip address
no ip directed-broadcast
no ip mroute-cache
!
interface Ethernet0
ip address 172.21.75.2 255.255.255.0
no ip directed-broadcast
no ip mroute-cache
media-type 10BaseT
!
interface BRI1
no ip address
no ip directed-broadcast
no ip mroute-cache
dialer pool-member 1
isdn switch-type basic-5ess
no fair-queue
    
```

25087

```

!
interface Dialer0
ip address 2.1.1.1 255.0.0.0
no ip directed-broadcast
encapsulation x25
no ip mroute-cache
dialer remote-name dinar
dialer idle-timeout 180
dialer string 81060
dialer caller 81060
dialer max-call 1
dialer pool 1
dialer-group 1
x25 address 11111
x25 map ip 2.1.1.2 22222
!
ip default-gateway 172.21.75.1
no ip classless
ip route 0.0.0.0 0.0.0.0 172.21.75.1
no ip http server
!
access-list 101 permit ip any any
dialer-list 1 protocol ip list 101
!
x25 route 22222 interface Dialer0
x25 route 33333 interface Dialer0
!
line con 0
exec-timeout 0 0
transport input none
line aux 0
transport input all
line vty 0 4
password cisco
login
line vty 5 100
password cisco
login
!
end

```

Configuration for Peso Acting as X.25 Switch:

```

version 12.0(5)T
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname peso
!
enable secret 5 $1$.Q00$h3vIhbOwO1fPvA2LYx2gE.
enable password cisco
!
ip subnet-zero
!
isdn switch-type primary-5ess
x25 routing
!
controller T1 0
cablelength short
cablelength short 133
!

```

```
controller T1 1
framing esf
clock source line primary
pri-group timeslots 1-24
!
controller T1 2
cablelength short
cablelength short 133
!
controller T1 3
cablelength short
cablelength short 133
!
interface Ethernet0
ip address 172.21.75.3 255.255.255.0
no ip directed-broadcast
!
interface Serial1:23
no ip address
no ip directed-broadcast
encapsulation ppp
dialer pool-member 1
isdn switch-type primary-5ess
isdn incoming-voice modem
no fair-queue
no cdp enable
ppp authentication chap
!
interface Dialer0
no ip address
no ip directed-broadcast
encapsulation x25 dce
no ip mroute-cache
dialer remote-name yen
dialer idle-timeout 180
dialer string 61401
dialer caller 61401
dialer max-call 1
dialer pool 1
x25 address 33333
!
interface Dialer1
no ip address
no ip directed-broadcast
encapsulation x25 dce
no ip mroute-cache
dialer remote-name dinar
dialer idle-timeout 180
dialer string 61403
dialer caller 61403
dialer max-call 1
dialer pool 1
x25 address 44444
!
ip default-gateway 172.21.75.1
no ip classless
ip route 0.0.0.0 0.0.0.0 172.21.75.1
no ip http server
!
x25 route 11111 interface Dialer0
x25 route 22222 interface Dialer1
x25 route source 11111 interface Dialer1
x25 route input-interface Dialer0 interface Dialer1
!
```

```

line con 0
transport input none
line 1 48
line aux 0
line vty 0 4
password cisco
login
line vty 5 100
password cisco
login
!
end

```

Configuration for Dinar:

```

version 12.0(5)T
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname dinar
!
logging buffered 16384 debugging
enable secret 5 $1$8EjF$4.S0AoMOVa50IAYEMrrFI/
enable password cisco
!
username yen password 0 cisco
username 7701
username drachma password 0 cisco
username AODI password 0 cisco
ip subnet-zero
ip rcmd rcp-enable
ip rcmd rsh-enable
ip rcmd remote-username atirumal
!
isdn switch-type basic-5ess
x25 routing
!
controller T1 0/0
!
interface BRI3/1
no ip address
no ip directed-broadcast
no ip mroute-cache
dialer pool-member 1
isdn switch-type basic-5ess
no fair-queue
!
interface Dialer0
ip address 2.1.1.2 255.0.0.0
no ip directed-broadcast
encapsulation x25
no ip mroute-cache
dialer remote-name yen
dialer idle-timeout 180
dialer string 81060
dialer caller 81060
dialer max-call 1
dialer pool 1
dialer-group 1
x25 address 22222
x25 map ip 2.1.1.1 11111
!

```

```
interface Dialer1
ip address 6.1.1.10 255.0.0.0
no ip directed-broadcast
no ip mroute-cache
dialer in-band
dialer-group 1
no fair-queue
!
ip default-gateway 172.21.75.1
no ip classless
ip route 0.0.0.0 0.0.0.0 172.21.75.1
no ip http server
!
access-list 101 permit ip any any
dialer-list 1 protocol ip list 101
!
x25 route 11111 interface Dialer0
x25 route 44444 interface Dialer0
!
```

Frame Relay Encapsulation on a Main Interface

The following example shows a configuration for Frame Relay encapsulation on a main interface.

```
version 12.0(7)T
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname honda
!
ip subnet-zero
ip domain-name cisco.com
ip name-server 171.69.2.132
ip name-server 198.92.30.32
!
isdn switch-type basic-5ess
!
interface Loopback1
no ip address
no ip directed-broadcast
!
interface Ethernet0
ip address 172.21.17.18 255.255.255.0
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
media-type 10BaseT
no cdp enable
!
interface BRI0
description PBX 60043
no ip address
no ip directed-broadcast
no keepalive
dialer pool-member 10 max-link 1
isdn switch-type basic-5ess
no fair-queue
!
```

```

interface Dialer10
ip address 8.1.1.1 255.255.255.0
no ip directed-broadcast
encapsulation frame-relay
dialer remote-name audi
dialer string 60035
dialer caller 60035
dialer max-call 1
dialer pool 10
dialer-group 1
no fair-queue
pulse-time 0
frame-relay map ip 8.1.1.2 200
!
dialer-list 1 protocol ip permit
dialer-list 1 protocol ipx permit
!
ip default-gateway 172.21.17.1
ip classless
ip route 0.0.0.0 0.0.0.0 172.21.17.1
no ip http server
!
line con 0
transport input none
line aux 0
line vty 0 4
login
!
end

```

Frame Relay Encapsulation on a Subinterface

The following example shows a configuration for Frame Relay encapsulation on a subinterface.

```

!
version 12.0(7)T
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname honda
!
interface Loopback1
no ip address
no ip directed-broadcast
!
interface Ethernet0
ip address 172.21.17.18 255.255.255.0
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
media-type 10BaseT
no cdp enable
!
interface BRI0
description PBX 60043
no ip address
no ip directed-broadcast
no keepalive
dialer pool-member 10 max-link 1
isdn switch-type basic-5ess
no fair-queue
no cdp enable

```

Frame Relay Encapsulation on a Subinterface

```
!  
interface Dialer10  
ip address 8.1.1.1 255.0.0.0  
no ip directed-broadcast  
encapsulation frame-relay  
dialer remote-name audi  
dialer string 60035  
dialer caller 60035  
dialer max-call 1  
dialer pool 10  
dialer-group 1  
no fair-queue  
pulse-time 0  
!  
interface Dialer10.1 point-to-point  
ip address 1.1.1.1 255.0.0.0  
no ip directed-broadcast  
frame-relay interface-dlci 100  
!  
interface Dialer10.2 multipoint  
ip address 2.1.1.1 255.0.0.0  
no ip directed-broadcast  
frame-relay interface-dlci 200  
!  
ip default-gateway 172.21.17.1  
ip classless  
ip route 0.0.0.0 0.0.0.0 172.21.17.1  
no ip http server  
!  
dialer-list 1 protocol ip permit  
dialer-list 1 protocol ipx permit  
!  
line con 0  
transport input none  
line aux 0  
line vty 0 4  
login  
!  
end
```

Command Reference

This section documents the following new and modified commands that configure the Dynamic Multiple Encapsulations feature. All other commands used with this feature are documented in the Cisco IOS Release 12.0 command reference publications.

- **dialer called**
- **show interfaces**
- **virtual-profile aaa**

In Cisco IOS Release 12.0(1)T or later, you can search and filter the output for **show** and **more** commands. This functionality is useful when you need to sort through large amounts of output, or if you want to exclude output that you do not need to see.

To use this functionality, enter a **show** or **more** command followed by the “pipe” character (`|`), one of the keywords **begin**, **include**, or **exclude**, and an expression that you want to search or filter on:

command / {begin | include | exclude} regular-expression

Following is an example of the **show atm vc** command in which you want the command output to begin with the first line where the expression “PeakRate” appears:

show atm vc / begin PeakRate

For more information on the search and filter functionality, refer to the Cisco IOS Release 12.0(1)T feature module titled *CLI String Search*.

dialer called

To configure dial-on-demand routing (DDR) to perform DNIS-plus-ISDN-subaddress binding for dialer profile interfaces, use the **dialer called** dial-on-demand routing configuration command. To disable DNIS-plus-ISDN-subaddress binding, use the **no** form of this command.

dialer called *DNIS:subaddress*

no dialer called *DNIS:subaddress*

Syntax Description

DNIS:subaddress Dialed Number Identification Service, or the called party number, a colon, and the ISDN subaddress.

Defaults

No default behavior or values.

Command Modes

Dial-on-demand routing

Command History

| Release | Modification |
|----------|------------------------------|
| 12.0(4)T | This command was introduced. |

Usage Guidelines

If you have more than one DNIS-plus-ISDN-subaddress number to configure under the same dialer profile interface, you can configure multiple **dialer called** commands.

The parser accepts a **dialer called** command with a DNIS and without the subaddress; however, the call will fail. For a successful call, enter the DNIS, a colon, and the ISDN subaddress after the **dialer called** command.

Examples

The following example configures a dialer profile for a receiver with DNIS 12345 and ISDN subaddress 6789:

```
dialer called 12345:6789
```

Related Commands

| Command | Description |
|--------------------|---|
| dial caller | Configures caller ID screening and enables ISDN caller ID callback for the dialer profiles DDR feature. |

show interfaces

To display statistics for all interfaces configured on the router or access server, use the **show interfaces EXEC** command. The resulting output varies, depending on the network for which an interface has been configured.

show interfaces [*type number*] [*first*] [*last*] [**accounting**]

show interfaces [*type slot/port*] [**accounting**] (for Cisco 7200 series routers, and for Cisco 7500 series routers with a Packet-over-SONET Interface Processor)

show interfaces [*type slot/port-adapter/port*] [**ethernet** | **serial**] (for ports on a Versatile Interface Processor (VIP) in Cisco 7500 series routers)

Syntax Description

| | |
|---------------------|--|
| <i>type</i> | (Optional) Interface type. Allowed values for <i>type</i> include async , bri0 , dialer , ethernet , fastethernet , fdi , hssi , loopback , null , serial , tokenring , and tunnel . For Cisco 4000 series routers, <i>type</i> can be e1 , ethernet , fastethernet , fdi , serial , t1 , and token . For Cisco 4500 series routers, <i>type</i> can also include atm . For Cisco 7000 series routers, <i>type</i> can be atm , e1 , ethernet , fastethernet , fdi , serial , t1 , and tokenring . For Cisco 7500 series routers, <i>type</i> can also include pos . |
| <i>number</i> | (Optional) Port number on the selected interface. |
| <i>first last</i> | (Optional) For Cisco 2500 and 3000 series routers, ISDN BRI only. The argument <i>first</i> can be either 1 or 2. The argument <i>last</i> can only be 2, indicating B channels 1 and 2. D-channel information is obtained by using the show interfaces command without the optional arguments. |
| accounting | (Optional) Displays the number of packets of each protocol type that have been sent through the interface. |
| <i>slot/port</i> | (Optional) Refer to the appropriate hardware manual for slot and port information. |
| <i>port-adapter</i> | (Optional) Refer to the appropriate hardware manual for port adapter compatibility information. |

Defaults

Statistical display of all network interfaces.

Command Modes

EXEC

Command History

| Release | Modification |
|----------------------------|---|
| Cisco IOS Release 10.0 | This command was introduced. |
| Cisco IOS Release 12.0(4)T | The display was enhanced to report dialer bound interfaces. |

Usage Guidelines

The report from this command for the Cisco 7200 series routers shows the interface processors in slot order. If you add interface processors after booting the system, they will appear at the end of the list, in the order in which they were inserted.

If you use the **show interfaces** command on the Cisco 7200 series routers without the *slot/port* arguments, information for all interface types will be shown. For example, if you use **show interfaces ethernet** you will receive information for all Ethernet, FDDI, serial, and Token Ring interfaces. Only by adding the *type slot/port* argument can you specify a particular interface.

If you use the **show interfaces** command for an interface type that has been removed from the router or access server, interface statistics will be displayed accompanied by the following text: "Hardware has been removed."

If you use the **show interfaces** command on a router or access server for which interfaces are configured to use weighted fair queueing through the **fair-queue** interface command, additional information is displayed containing the current and high-water mark number of flows.

If you use the **show interfaces** command on dialer interfaces configured for binding, the display will report statistics on each physical interface bound to the dialer interface; see the following examples for more information.

You will use the **show interfaces** command frequently while configuring and monitoring devices. The various forms of the **show interfaces** commands are described in detail in the following sections.

Examples

The following is sample output from the **show interfaces** command. Because your display will depend on the type and number of interface cards in your router or access server, only a portion of the output is shown.

```
Router# show interfaces

Ethernet 0 is up, line protocol is up
  Hardware is MCI Ethernet, address is 0000.0c00.750c (bia 0000.0c00.750c)
  Internet address is 131.108.28.8, subnet mask is 255.255.255.0
  MTU 1500 bytes, BW 10000 Kbit, DLY 100000 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 4:00:00
  Last input 0:00:00, output 0:00:00, output hang never
  Last clearing of "show interface" counters 0:00:00
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  Five minute input rate 0 bits/sec, 0 packets/sec
  Five minute output rate 2000 bits/sec, 4 packets/sec
    1127576 packets input, 447251251 bytes, 0 no buffer
    Received 354125 broadcasts, 0 runts, 0 giants
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    5332142 packets output, 496316039 bytes, 0 underruns
    0 output errors, 432 collisions, 0 interface resets, 0 restarts
  ---More---
```

Sample Output with DNIS Binding

When the **show interfaces** command is issued on an unbound dialer interface, the output looks as follows:

```
Router# show interfaces dialer0

Dialer0 is up (spoofing), line protocol is up (spoofing)
  Hardware is Unknown
  Internet address is 21.1.1.2/8
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 3/255
  Encapsulation PPP, loopback not set
  DTR is pulsed for 1 seconds on reset
  Last input 00:00:34, output never, output hang never
  Last clearing of "show interface" counters 00:05:09
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 1000 bits/sec, 0 packets/sec
    18 packets input, 2579 bytes
    14 packets output, 5328 bytes
```

But when the **show interfaces** command is issued on a bound dialer interface, you will get an additional report indicating the binding relationship. The output looks as follows:

```
Router# show interfaces dialer0

Dialer0 is up, line protocol is up
  Hardware is Unknown
  Internet address is 21.1.1.2/8
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set
  DTR is pulsed for 1 seconds on reset
  Interface is bound to BRI0:1
  Last input 00:00:38, output never, output hang never
  Last clearing of "show interface" counters 00:05:36
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    38 packets input, 4659 bytes
    34 packets output, 9952 bytes
Bound to:
BRI0:1 is up, line protocol is up
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive not set
  Interface is bound to Dialer0 (Encapsulation PPP)
  LCP Open, multilink Open
  Last input 00:00:39, output 00:00:11, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    78 packets input, 9317 bytes, 0 no buffer
  Received 65 broadcasts, 0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  93 packets output, 9864 bytes, 0 underruns
  0 output errors, 0 collisions, 7 interface resets
  0 output buffer failures, 0 output buffers swapped out
  4 carrier transitions
```

At the end of Dialer0 output, the **show interfaces** command is executed on each physical interface bound to it.

In the next example, the physical interface is the B1 channel of the BRI0 link. This example also illustrates that the output under the B channel keeps all hardware counts that are not displayed under any logical or virtual access interface. The line in the report that states “Interface is bound to Dialer0 (Encapsulation LAPB)” indicates that this B interface is bound to Dialer0 and the encapsulation running over this connection is LAPB, not PPP, which is the encapsulation configured on the D interface and inherited by the B channel.

```
Router# show interfaces bri0:1

BRI0:1 is up, line protocol is up
Hardware is BRI
MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
Encapsulation PPP, loopback not set, keepalive not set
Interface is bound to Dialer0 (Encapsulation LAPB)
LCP Open, multilink Open
Last input 00:00:31, output 00:00:03, output hang never
Last clearing of "show interface" counters never
Queueing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 1 packets/sec
5 minute output rate 0 bits/sec, 1 packets/sec
 110 packets input, 13994 bytes, 0 no buffer
  Received 91 broadcasts, 0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
 135 packets output, 14175 bytes, 0 underruns
  0 output errors, 0 collisions, 12 interface resets
  0 output buffer failures, 0 output buffers swapped out
  8 carrier transitions
```

Any protocol configuration and states should be displayed from the Dialer0 interface.

virtual-profile aaa

To enable virtual profiles by authentication, authorization, and accounting (AAA) configuration, use the **virtual-profile aaa** global configuration command. To disable virtual profiles, use the **no** form of this command.

virtual-profile aaa

no virtual-profile aaa

Syntax Description

This command has no arguments or keywords.

Defaults

Disabled

Command Modes

Global configuration

Command History

| Release | Modification |
|----------|---|
| 11.2 F | This command was introduced. |
| 12.0(7)T | This command was enhanced to allow virtual profiles to be downloaded from an AAA server using the HDLC, LAPB-TA, X.25, and Frame Relay encapsulations, in addition to the originally supported PPP encapsulation. |

Usage Guidelines

Effect of this command for any specific user depends on the router being configured for AAA and the AAA server being configured for the specific configuration information of that user.

Examples

The following example configures virtual profiles by AAA configuration only:

```
virtual-profile aaa
```

Related Commands

| Command | Description |
|---|---|
| aaa authentication | Enables AAA authentication. |
| virtual-profile virtual-template | Enables virtual profiles by virtual interface template. |

Glossary

AAA—authentication, authorization, and accounting. Suite of network security services that provide the primary framework through which access control can be set up on your Cisco router or access server.

Asynchronous Transfer Mode—See ATM.

ATM—Asynchronous Transfer Mode. International standard for cell relay in which multiple service types (such as voice, video, or data) are conveyed in fixed-length (53-byte) cells. Fixed-length cells allow cell processing to occur in hardware, thereby reducing transit delays. ATM is designed to take advantage of high-speed transmission media such as E3, SONET, and T3.

authentication, authorization, and accounting—See AAA.

calling line identification—See CLID.

CLID—calling line identification. A unique number that informs the called party of the phone number identification of the calling party. Also known as caller ID.

data circuit-terminating equipment—See DCE.

data terminal equipment—See DTE.

DCE—data circuit-terminating equipment (ITU-T expansion). Devices and connections of a communications network that comprise the network end of the user-to-network interface. The DCE provides a physical connection to the network, forwards traffic, and provides a clocking signal used to synchronize data transmission between DCE and DTE devices. Modems and interface cards are examples of DCE.

DDR—dial-on-demand routing. Technique whereby a router can automatically initiate and close a circuit-switched session as transmitting stations demand. The router spoofs keepalive messages so that end stations treat the session as active. DDR permits routing over ISDN or telephone lines using an external ISDN terminal adapter or modem.

DE bit—discard eligible bit. ATM cells can have this bit set to determine the probability of a cell being dropped if the network becomes congested.

Dialed Number Identification Service—See DNIS.

dialer profile—Dialer profiles allow the configuration of physical interfaces to be separated from the logical configuration required for a call, and they also allow the logical and physical configurations to be bound together dynamically on a per-call basis. A dialer profile has the following elements: a dialer interface (a logical entity) configuration including one or more dial strings (each of which is used to reach one destination subnetwork), a dialer map class that defines all the characteristics for any call to the specified dial string, and an ordered dialer pool of physical interfaces to be used by the dialer interface.

dial-on-demand routing—See DDR.

DNIS—Dialed Number Identification Service. The called party number. Typically, this is a number used by call centers or a central office where different numbers are each assigned to a specific service.

DTE—data terminal equipment. Device at the user end of a user-network interface that serves as a data source, destination, or both. DTE connects to a data network through a DCE device (for example, a modem) and typically uses clocking signals generated by the DCE. DTE includes such devices as computers, protocol translators, and multiplexers.

Frame Relay—Industry-standard, switched data link layer protocol that handles multiple virtual circuits using HDLC encapsulation between connected devices. Frame Relay is more efficient than X.25, the protocol for which it is generally considered a replacement.

HDLC—High-Level Data Link Control. Popular ISO standard bit-oriented, link-layer protocol derived from the Synchronous Data Link Control Protocol. HDLC specifies an encapsulation method of data on synchronous serial data links.

High-Level Data Link Control—See HDLC.

Integrated Services Digital Network—See ISDN.

ISDN—Integrated Services Digital Network. Communication protocol, offered by telephone companies, that permits telephone networks to carry data, voice, and other source traffic.

LAPB-TA—Link Access Procedure, Balanced-terminal adapter. LAPB is a bit-oriented protocol derived from HDLC.

LCP—Link Control Protocol. Protocol that establishes, configures, and tests data-link connections for use by PPP.

Link Access Procedure, Balanced-terminal adapter—See LAPB-TA.

Link Control Protocol—See LCP.

LMI—Local Management Interface. Set of enhancements to the basic Frame Relay specification. LMI includes support for a keepalive mechanism, which verifies that data is flowing; a multicast mechanism, which provides the network server with its local DLCI and the multicast DLCI; global addressing, which gives DLCIs global rather than local significance in Frame Relay networks; and a status mechanism, which provides an ongoing status report on the DLCIs known to the switch. Known as LMT in ANSI terminology.

Local Management Interface—See LMI.

MLP—Multilink PPP. Method of splitting, recombining, and sequencing datagrams across multiple logical data links.

Multilink PPP—See MLP.

NCP—Network Control Protocol. Series of protocols for establishing and configuring different network layer protocols, such as for AppleTalk over PPP.

Network Control Protocol—See NCP.

packet assembler/disassembler—See PAD.

PAD—packet assembler/disassembler. Device used to connect simple devices (like character-mode terminals) that do not support the full functionality of a particular protocol to a network. PADs buffer data and assemble and disassemble packets sent to such end devices.

permanent virtual circuit—See PVC.

per-user configuration—Ties together virtual interfaces configuration, AAA per-user security, and virtual profiles to provide a flexible, scalable, easily maintained solution for large-scale dial-in networks.

Point-to-Point Protocol—See PPP.

PPP—Point-to-Point Protocol. Provides router-to-router and host-to-network connections over synchronous and asynchronous circuits. PPP also has built-in security mechanisms, such as the Challenge Handshake Authentication Protocol (CHAP) and Password Authentication Protocol (PAP). PPP relies on two protocols: LCP and NCP.

PVC—permanent virtual circuit or permanent virtual connection. Virtual circuit that is permanently established. PVCs save bandwidth associated with circuit establishment and tear down in situations where certain virtual circuits must exist all the time. In ATM terminology, called a permanent virtual connection.

Qualified Logical Link Control—See QLLC.

QLLC—Qualified Logical Link Control. Data link layer protocol defined by IBM that allows SNA data to be transported across X.25 networks.

RTP header compression—Real-Time Transport Protocol header compression. Compresses the IP/UDP/RTP header in an RTP data packet from 40 bytes to approximately 2 to 5 bytes. It is a hop-by-hop compression scheme similar to RFC 1144 for TCP header compression. RTP header compression is supported on serial lines using Frame Relay, HDLC, or PPP encapsulation. It is also supported over ISDN interfaces.

virtual access interface—Instance of a unique virtual interface that is created dynamically and exists temporarily. Virtual access interfaces can be created and configured differently by different applications, such as virtual profiles and virtual dialup networks.

virtual interface template—Generic configuration of an interface for a certain purpose or configuration common to certain users, plus router-dependent information. This configuration takes the form of a list of Cisco IOS interface commands to be applied to the virtual interface as needed. Several applications can apply virtual templates, but generally each application uses a single template. Each virtual template is identified by number.

virtual profile—A virtual profile defines and applies per-user configuration information for users that dial in to a router. Virtual profiles allow user-specific configuration information to be applied irrespective of the media used for the dial-in call. The configuration information for virtual profiles can come from a virtual interface template, per-user configuration information stored on an AAA server, or both, depending on how the router and AAA server are configured.

X.25—ITU-T standard that defines how connections between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) are maintained for remote terminal access and computer communications in public data networks (PDNs). X.25 specifies LAPB, a data link layer protocol, and packet level protocol (PLP), a network layer protocol.