Wide-Area Networking Overview

Cisco IOS software provides a range of wide-area networking capabilities to fit almost every network environment need. Cisco offers cell relay via the Switched Multimegabit Data Service (SMDS), circuit switching via ISDN, packet switching via Frame Relay, and the benefits of both circuit and packet switching via Asynchronous Transfer Mode (ATM). LAN emulation (LANE) provides connectivity between ATM and other LAN types. The *Cisco IOS Wide-Area Networking Configuration Guide* presents a set of general guidelines for configuring the following software components:

This module gives a high-level description of each technology. For specific configuration information, see the appropriate module.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Frame Relay

The Cisco Frame Relay implementation currently supports routing on IP, DECnet, AppleTalk, XNS, Novell IPX, CLNS, Banyan VINES, and transparent bridging.

Although Frame Relay access was originally restricted to leased lines, dialup access is now supported. For more information, for dialer profiles or for legacy dial-on-demand routing (DDR) see the see the module Dial-on-Demand Routing Configuration.

To install software on a new router or access server by downloading software from a central server over an interface that supports Frame Relay, see the module Loading and Maintaining System Images.

To configure access between Systems Network Architecture (SNA) devices over a Frame Relay network, see the module Configuring SNA Frame Relay Access Support.

The Frame Relay software provides the following capabilities:

- Support for the three generally implemented specifications of Frame Relay Local Management Interfaces (LMIs):

  - The Frame Relay Interface joint specification produced by Northern Telecom, Digital Equipment Corporation, StrataCom, and Cisco Systems
  - The ANSI-adopted Frame Relay signal specification, T1.617 Annex D
  - The ITU-T-adopted Frame Relay signal specification, Q.933 Annex A

- Conformity to ITU-T I-series (ISDN) recommendation as I122, "Framework for Additional Packet Mode Bearer Services":

  - The ANSI-adopted Frame Relay encapsulation specification, T1.618
  - The ITU-T-adopted Frame Relay encapsulation specification, Q.922 Annex A

- Conformity to Internet Engineering Task Force (IETF) encapsulation in accordance with RFC 2427, except bridging.

- Support for a keepalive mechanism, a multicast group, and a status message, as follows:

  - The keepalive mechanism provides an exchange of information between the network server and the switch to verify that data is flowing.
  - The multicast mechanism provides the network server with a local data-link connection identifier (DLCI) and a multicast DLCI. This feature is specific to our implementation of the Frame Relay joint specification.
  - The status mechanism provides an ongoing status report on the DLCIs known by the switch.

- Support for both PVCs and SVCs in the same sites and routers.

SVCs allow access through a Frame Relay network by setting up a path to the destination endpoints only when the need arises and tearing down the path when it is no longer needed.

- Support for Frame Relay Traffic Shaping beginning with Cisco IOS Release 11.2. Traffic shaping provides the following:

  - Rate enforcement for individual circuits--The peak rate for outbound traffic can be set to the committed information rate (CIR) or some other user-configurable rate.
  - Dynamic traffic throttling on a per-virtual-circuit basis--When backward explicit congestion notification (BECN) packets indicate congestion on the network, the outbound traffic rate is automatically stepped down; when congestion eases, the outbound traffic rate is stepped up again.
  - Enhanced queueing support on a per-virtual circuit basis--Custom queueing, priority queueing, and weighted fair queueing can be configured for individual virtual circuits.

- Transmission of congestion information from Frame Relay to DECnet Phase IV and CLNS. This mechanism promotes forward explicit congestion notification (FECN) bits from the Frame Relay layer to upper-layer protocols after checking for the FECN bit on the incoming DLCI. Use this Frame Relay congestion information to adjust the sending rates of end hosts. FECN-bit promotion is enabled by default on any interface using Frame Relay encapsulation. No configuration is required.

- Support for Frame Relay Inverse ARP as described in RFC 1293 for the AppleTalk, Banyan VINES, DECnet, IP, and IPX protocols, and for native hello packets for DECnet, CLNP, and Banyan VINES. It allows a router running Frame Relay to discover the protocol address of a device associated with the virtual circuit.

- Support for Frame Relay switching, whereby packets are switched based on the DLCI--a Frame Relay equivalent of a Media Access Control (MAC)-level address. Routers are configured as a hybrid DTE switch or pure Frame Relay DCE access node in the Frame Relay network.

Frame Relay switching is used when all traffic arriving on one DLCI can be sent out on another DLCI to the same next-hop address. In such cases, the Cisco IOS software need not examine the frames individually to discover the destination address, and, as a result, the processing load on the router decreases.

The Cisco implementation of Frame Relay switching provides the following functionality:

- - Switching over an IP tunnel
  - Switching over Network-to-Network Interfaces (NNI) to other Frame Relay switches
  - Local serial-to-serial switching
  - Switching over ISDN B channels
  - Traffic shaping on switched PVCs
  - Congestion management on switched PVCs
  - Traffic policing on User-Network Interface (UNI) DCE
  - FRF.12 fragmentation on switched PVCs

- Support for *subinterfaces* associated with a physical interface. The software groups one or more PVCs under separate subinterfaces, which in turn are located under a single physical interface. See the Configuring Frame Relay module.

- Support for fast-path transparent bridging, as described in RFC 1490, for Frame Relay encapsulated serial and High-Speed Serial Interfaces (HSSIs) on all platforms.

- Support of the Frame Relay DTE MIB specified in RFC 1315. However, the error table is not implemented. To use the Frame Relay MIB, refer to your MIB publications.

- Support for Frame Relay fragmentation. Cisco has developed the following three types of Frame Relay fragmentation:

  - End-to-End FRF.12 Fragmentation

FRF.12 fragmentation is defined by the FRF.12 Implementation Agreement. This standard was developed to allow long data frames to be fragmented into smaller pieces (fragments) and interleaved with real-time frames. End-to-end FRF.12 fragmentation is recommended for use on PVCs that share links with other PVCs that are transporting voice and on PVCs transporting Voice over IP (VoIP).

- - Frame Relay Fragmentation Using FRF.11 Annex C

When VoFR (FRF.11) and fragmentation are both configured on a PVC, the Frame Relay fragments are sent in the FRF.11 Annex C format. This fragmentation is used when FRF.11 voice traffic is sent on the PVC, and it uses the FRF.11 Annex C format for data.

See the module Configuring Voice over Frame Relay in the *Cisco IOS Voice, Video, and Fax Configuration Guide* for configuration tasks and examples for Frame Relay fragmentation using FRF.11 Annex C.

- - Cisco Proprietary Fragmentation

Cisco proprietary fragmentation is used on data packets on a PVC that is also used for voice traffic.

See the module Configuring Voice over Frame Relay in the *Cisco IOS Voice, Video, and Fax Configuration Guide* for configuration tasks and examples for Cisco proprietary fragmentation.

Frame Relay-ATM Internetworking

Cisco IOS software supports the Frame Relay Forum implementation agreements for Frame Relay-ATM Interworking. Frame Relay-ATM Interworking enables Frame Relay and ATM networks to exchange data, despite differing network protocols. There are two types of Frame Relay-ATM Interworking.

FRF.5 Frame Relay-ATM Network Interworking

FRF.5 provides network interworking functionality that allows Frame Relay end users to communicate over an intermediate ATM network that supports FRF.5. Multiprotocol encapsulation and other higher-layer procedures are transported transparently, just as they would be over leased lines.

FRF.5 describes network interworking requirements between Frame Relay Bearer Services and Broadband ISDN (BISDN) permanent virtual circuit (PVC) services.

The FRF.5 standard is defined by the Frame Relay Forum Document Number FRF.5: *Frame Relay/ATM PVC Network Interworking Implementation Agreement.* For information about which sections of this implementation agreement are supported by Cisco IOS software, see Frame Relay-ATM Interworking Supported Standards.

FRF.8 Frame Relay-ATM Service Interworking

FRF.8 provides service interworking functionality that allows a Frame Relay end user to communicate with an ATM end user. Traffic is translated by a protocol converter that provides communication among dissimilar Frame Relay and ATM equipment.

FRF.8 describes a one-to-one mapping between a Frame Relay PVC and an ATM PVC.

The FRF.8 standard is defined by the Frame Relay Forum Document Number FRF.8: *Frame Relay/ATM PVC Network Service Interworking Implementation Agreement.* For information about which sections of this implementation agreement are supported by Cisco IOS software, see Frame Relay-ATM Interworking Supported Standards.

Layer 2 Virtual Private Network

L2VPN services are point-to-point. They provide Layer 2 point-to-point connectivity over either an MPLS or a pure IP (L2TPv3) core.

Layer 2 Tunneling Protocol Version 3

The Layer 2 Tunneling Protocol Version 3 feature expands Cisco's support of Layer 2 VPNs. Layer 2 Tunneling Protocol Version 3 (L2TPv3) is an IETF l2tpext working group draft that provides several enhancements to L2TP to tunnel any Layer 2 payload over L2TP. Specifically, L2TPv3 defines the L2TP protocol for tunneling Layer 2 payloads over an IP core network by using Layer 2 VPNs.

L2VPN Pseudowire Redundancy

L2VPNs can provide pseudowire resiliency through their routing protocols. When connectivity between end-to-end PE routers fails, an alternative path to the directed LDP session and the user data can take over. However, there are some parts of the network where this rerouting mechanism does not protect against interruptions in service. The L2VPN Pseudowire Redundancy feature provides the ability to ensure that the CE2 router in can always maintain network connectivity, even if one or all the failures in the figure occur.

The L2VPN Pseudowire Redundancy feature enables you to set up backup pseudowires. You can configure the network with redundant pseudowires (PWs) and redundant network elements.

Layer 2 Virtual Private Network Interworking

Layer 2 transport over MPLS and IP already exists for like-to-like attachment circuits, such as Ethernet-to-Ethernet or PPP-to-PPP. L2VPN Interworking builds on this functionality by allowing disparate attachment circuits to be connected. An interworking function facilitates the translation between the different Layer 2 encapsulations. The L2VPN Interworking feature supports Ethernet, 802.1Q (VLAN), Frame Relay, ATM AAL5, and PPP attachment circuits over MPLS and L2TPv3.

Layer 2 Local Switching

Local switching allows you to switch Layer 2 data between two interfaces of the same type (for example, ATM to ATM, or Frame Relay to Frame Relay) or between interfaces of different types (for example, Frame Relay to ATM) on the same router. The interfaces can be on the same line card or on two different cards. During these kinds of switching, the Layer 2 address is used, not any Layer 3 address. Same-port local switching allows you to switch Layer 2 data between two circuits on the same interface.