Cisco IOS Software

Cisco routers run the industry-leading Cisco Internetwork Operating System (Cisco IOS) software. This software ensures robust, reliable internetworks by supporting both LAN and WAN protocols, optimizing WAN services, and controlling internetwork access. In addition, Cisco IOS software allows centralized, integrated, and automated installation and management of all router products.

This chapter contains the following sections:

- Cisco IOS Software Benefits
  - Scalability
  - Reliable, Adaptive Routing
  - Remote Access and Protocol Translation Functionality
  - WAN Optimization
  - Management and Security
- Cisco IOS Software Packaging
  - Cisco IOS Feature Sets
  - Cisco IOS Release 11.2 Feature Sets
  - Feature Set Tables
- Cisco IOS Software Features
  - Protocols
  - Network Management
  - Multimedia and Quality of Service
  - Secure Data Transmission
  - IBM Support
  - IP Routing Protocols
  - Bridging
  - Protocol Translation Support
  - Packet Switching
  - NetFlow Switching

  - ATM
  - Dial-on-Demand Routing Support
  - Access Server Features
  - LAN Extension
- Software Distribution
- Software Ordering Examples
  - Cisco 2500 Series Examples
  - Cisco 7500 Series Examples

Cisco IOS Software Benefits

Cisco IOS software supports users and applications throughout the enterprise and provides security and data integrity for the internetwork. Cisco IOS software manages resources cost effectively by controlling and unifying complex, distributed network information. It also functions as a flexible vehicle for adding new services, features, and applications to the internetwork.

Cisco IOS software provides many internetwork benefits, which are described in the following sections:

- Scalability
- Reliable, Adaptive Routing
- Remote Access and Protocol Translation Functionality
- WAN Optimization
- Management and Security

Scalability

Scalability provides the flexibility required to address all of the key issues facing internetworks as organizations evolve. Cisco IOS software uses scalable routing protocols to avoid needless congestion, overcome inherent protocol limitations, and bypass many of the obstacles that result from the complex scope and geographical dispersion of an internetwork.

Cisco IOS software reduces network costs by efficiently using network bandwidth and resources while eliminating the need for static routes. Advanced Cisco IOS features such as route filtering, protocol termination and translation, smart broadcasts, and helper address services combine to create a flexible, scalable infrastructure that can keep pace with evolving network requirements.

Reliable, Adaptive Routing

Cisco IOS software is reliable and adaptive because it identifies the best network paths and routes traffic around network failures.

Policy-based Cisco IOS features such as route filtering and route redistribution save network resources by preventing data from being unnecessarily broadcast to nodes that do not need it. Priority output queuing and custom queuing grant priority to important sessions when network bandwidth is scarce. Load balancing uses every available path across the internetwork to preserve valuable bandwidth and improve network performance. Cisco IOS software also provides the most effective and efficient scaling available for network applications that require transparent or source-route bridging algorithms.

Increasingly, internetworks are incorporating new technologies such as Asynchronous Transfer Mode (ATM) and LAN switching. With CiscoFusion, Cisco's scalable architecture for switched internetworks, Cisco IOS software provides the framework for a new technology called multilayer switching, which fuses the ease of switching solutions with the power of routed solutions.

By distributing routing intelligence and switching functions to create "virtual LANs," CiscoFusion multilayer switching capabilities increase bandwidth while simplifying moves, additions, and changes across the enterprise. CiscoFusion extends the power and flexibility of Cisco IOS software beyond internetwork routers to include the ATM and LAN switches that are increasingly being deployed throughout today's internetworks.

Remote Access and Protocol Translation Functionality

Depending on the product you purchased, your Cisco device connects terminals, modems, microcomputers, and networks over serial lines to LANs or WANs. Cisco products provide network access to terminals, printers, workstations, and other networks.

On LANs, terminal services support TCP/IP on UNIX machines with Telnet and rlogin connections, IBM machines with TN3270 connections, and Digital machines with LAT connections. You can use the router or access server's protocol translation services to make connections between hosts and resources running different protocols including router and access server connections to X.25 machines using X.25 PAD.

Access servers provide remote configuration through Telnet and Digital Equipment Corporation's Maintenance Operation Protocol (MOP) connections to virtual ports.

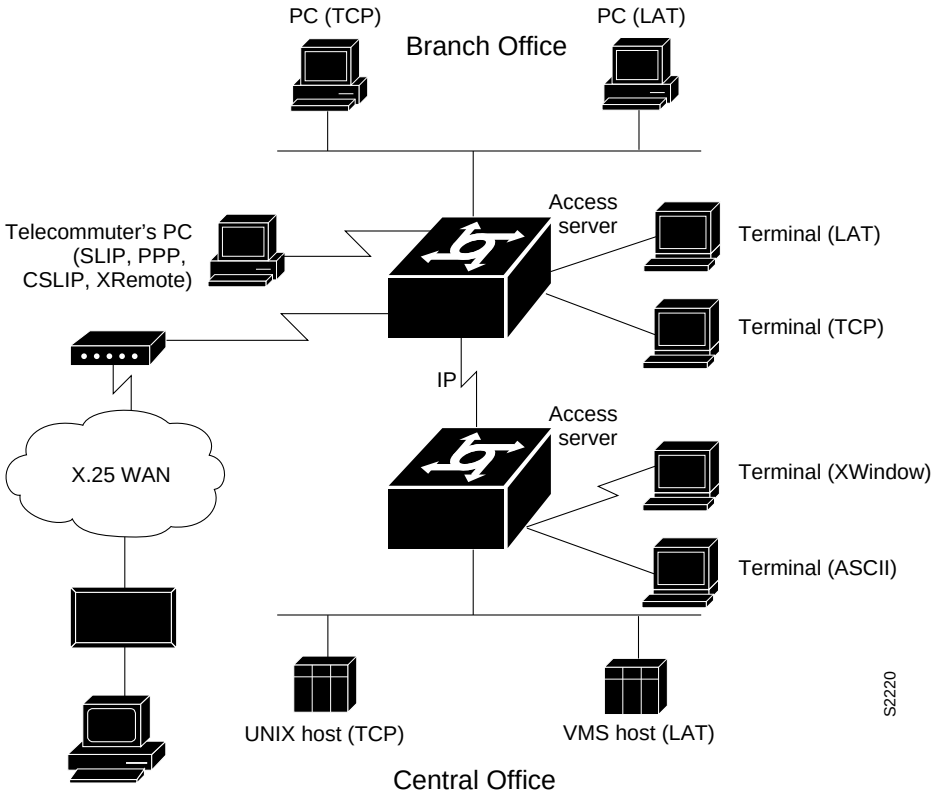
Cisco IOS software supports four types of server operation:

- Remote node services—Connect devices over a telephone network using AppleTalk Remote Access (ARA), Serial Line Internet Protocol (SLIP), compressed SLIP (CSLIP), Point-to-Point Protocol (PPP), and XRemote (NCD's X Windows terminal protocol). See Figure 2.

- Terminal services—Connect asynchronous devices to a LAN or WAN through network and terminal-emulation software including Telnet, rlogin, Digital's Local Area Transport (LAT) protocol, and IBM TN3270. See Figure 2.
- Protocol translation services—Convert one virtual terminal protocol into another protocol. See Figure 2.
- Asynchronous remote access routing—Enables full-featured Internet Protocol (IP), Novell Internet Packet Exchange (IPX), and AppleTalk routing over asynchronous interfaces.

Figure 2 illustrates these types of server functionality available on access servers: remote node service is demonstrated by the remote PC connection running SLIP, CSLIP, PPP, or XRemote; terminal service is shown between the terminals and hosts running the same protocol (LAT-to-LAT or TCP-to-TCP); protocol translation is shown between the terminals and hosts running unlike protocols (LAT-to-TCP or TCP-to-LAT); asynchronous IP routing is shown by the PC running SLIP or PPP, and between the two access servers.

Figure 2 Remote Access Functionality



WAN Optimization

Because most network costs are expended on WAN switching and bandwidth requirements, a cost-effective internetwork must optimize all WAN-related operations. Optimization increases network throughput while reducing delay time. It also reduces costs by eliminating unnecessary traffic and selecting the most economical WAN links available.

Cisco IOS software seamlessly accommodates circuit-switched WAN services such as Integrated Services Digital Network (ISDN), switched T1, and dial-up telephone lines. Cisco IOS software innovations such as dial-on-demand access and dial backup capabilities provide cost-effective alternatives to point-to-point switched leased lines. Support for advanced, packet-switched services such as X.25, Frame Relay, Switched Multimegabit Data Service (SMDS), and ATM extends the internetwork across the broad range of WAN interface alternatives now available.

In addition to remote node WAN connectivity with ARA, SLIP, PPP, or XRemote, other WAN services include dial-on-demand routing (DDR) of IP and IPX, X.25, Frame Relay, and SMDS.

Management and Security

Cisco IOS software provides an array of network management and security capabilities designed to meet the needs of today's large, complex internetworks. Integrated management simplifies administrative procedures and shortens the time required to diagnose and fix problems. Automated operations reduce hands-on tasks and make it possible to manage large, geographically dispersed internetworks with a small staff of experts located at a central site.

Cisco IOS software provides several important management features that are built into every Cisco router and access server. These management features include configuration services, which lower the cost of installing, upgrading, and reconfiguring routers and access servers, as well as comprehensive monitoring and diagnostic services. In addition, Cisco IOS software provides valuable information and services for router management applications developed by Cisco and its partners. Cisco applications, known collectively as CiscoWorks, offer administrators a wide-ranging suite of operational, design, and management capabilities that increase productivity and reduce costs.

Cisco IOS management services are matched by their security capabilities. Cisco IOS software includes a diverse tool kit for partitioning resources and prohibiting access to sensitive or confidential information and processes. Multidimensional filters prevent users from knowing that other users or resources are even on the network. Encrypted passwords, dial-in authentication, multilevel configuration permissions, and accounting and logging features provide protection from—and information about—unauthorized access attempts.

Cisco IOS Software Packaging

This section describes how Cisco IOS software is packaged, and helps you determine which Cisco IOS software features apply to the various Cisco Core and Access hardware platforms offered. It also introduces the new feature set packaging available with Cisco IOS Release 11.2.

Cisco IOS Feature Sets

Cisco IOS software for Cisco 7000 series, Cisco 7200 series, Cisco 7500 series, Cisco AS5100 access server, Cisco AS5200 access server, Cisco 4700-M, Cisco 4500-M, Cisco 4000-M, Cisco 2500 series, Cisco 1000 series, and the AccessPro PC card is packaged as feature sets. With feature set packaging, you can select the feature set that best meets your needs. If requirements change in the future, you can upgrade to a higher level feature set.

The AGS+ and earlier software releases for the Cisco 4000-M use a different type of packaging. For a description of the contents of this software, refer to Table 351 in the chapter "AGS+ Spares."

For the Catalyst 3000 series, Cisco IOS software is included with the software shipped with each system.

Note Some platforms only support one Cisco IOS feature set and do not offer an upgrade option.

Cisco IOS Release 11.2 Feature Sets

With the introduction of Cisco IOS Release 11.2, feature sets have been updated to make it easier to select the exact feature sets you need. Feature sets names are simplified and are more consistent across Cisco hardware platforms. In addition, you can add options to the standard feature set offerings. These options provide additional features and value based on the hardware platform selected. Cisco also continues to offer specialized feature sets for key applications.

Table 9 provides a matrix of the new feature set organization and lists which feature sets are available on the various hardware platforms. These feature sets only apply to Cisco IOS Release 11.2. Use the feature set tables later in this chapter to determine feature set availability for earlier Cisco IOS releases.

An explanation of the table entries follows:

- Basic. The basic feature set for the hardware platform.
- Plus. The basic feature set plus additional features depending on the hardware platform selected.
- Encryption. The addition of 40-bit (Plus 40) or 56-bit (Plus 56) data encryption feature sets.

Cisco IOS images with 40-bit Data Encryption Standard (DES) support may legally be distributed to any party eligible to receive Cisco IOS software. 40-bit DES is not a cryptographically strong solution and should not be used to protect sensitive data.

Cisco IOS images with 56-bit DES are subject to International Traffic in Arms Regulations (ITAR) controls, and have a limited distribution. Images to be installed outside the U.S. require an export license. Orders may be denied or subject to delays due to U.S. Government regulations. Contact your sales representative or distributor for more information, or send e-mail to export@cisco.com.

Table 9 Cisco IOS Release 11.2 Feature Set Matrix

	Cisco Hardware Platforms						
Feature Sets	**Cisco 1000 Series**	**Cisco 2500 Series and AS5100**	**Cisco 4000 Series**	**Cisco 7000 Series[1, 2]**	**Cisco 7200 Series[1]**	**Cisco 7500 Series[1]**	**Cisco AS5200**
Standard Feature Sets							
IP	Basic, Plus, and Encryption	Basic, Plus, and Encryption	Basic, Plus, and Encryption	Basic	Basic	Basic and Encryption	Basic and Plus
Desktop	–	Basic, Plus, and Encryption	Basic, Plus, and Encryption	Basic	Basic	Basic and Encryption	Basic and Plus
Enterprise	–	Basic, Plus, and Encryption	Basic, Plus, and Encryption	Basic	Basic	Basic and Encryption	Basic and Plus
Enterprise and APPN	–	Basic, Plus, and Encryption	Basic, Plus, and Encryption	Basic	Basic	Basic and Encryption	–
IP/IPX/IBM and APPN	–	Basic	Basic	–	–	–	–
Desktop/IBM and APPN	–	–	–	Basic	Basic	Basic	–
Cisco 1000 Series Only Feature Sets							
IP/IPX	Basic, Plus, and Encryption	–	–	–	–	–	–
IP/AppleTalk	Basic, Plus, and Encryption	–	–	–	–	–	–
IP/IPX/AppleTalk	Basic, Plus, and Encryption	–	–	–	–	–	–
IP/OSPF/PIM	Basic	–	–	–	–	–	–
IP/Asynch	Basic	–	–	–	–	–	–
IP/IPX/Asynch	Basic	–	–	–	–	–	–
Special Applications							
Layer 3 Bridging	–	–	–	–	Basic	–	–
CFRAD	–	Basic	–	–	–	–	–
LANFRAD	–	Basic	–	–	–	–	–
ISDN	–	Basic	–	–	–	–	–
Remote Access Server	–	Basic	–	–	–	–	–

1. Basic images for the Cisco 7000 series, 7500 series, and 7200 series include additional functionality not found in the basic feature sets offered on the other hardware platforms.
2. Both Versatile Interface Processor (VIP) and non-VIP options are available.

Feature Set Tables

To accompany the introduction of Cisco IOS Release 11.2, this catalog introduces a new look to the Cisco IOS feature set tables. The information has been reorganized into a matrix format and incorporates all currently supported Cisco IOS releases into one table per hardware product, or grouping of hardware product series. In one table, you can now see which features are available across up to five Cisco IOS releases.

The first column of the new tables lists the Cisco IOS software features. The features are grouped together in categories. These categories also appeared in the Cisco IOS tables of previous versions of this catalog. In the new tables, the features are listed in alphabetical order under their respective categories, which makes it easier to locate features, determine which features sets they belong to, and select the applicable Cisco IOS releases.

The new tables use the following conventions to identify features:

- : the feature is offered in the basic feature set
- – : the feature is not offered in the feature set
- Plus: the feature is offered only in the Plus feature sets, not in the basic feature set
- Encrypt: for the Cisco 7500 series, the feature is offered only in the encryption feature sets (Encryption 40, Plus 40, Encryption 56, or Plus 56), not in the basic feature set

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Note Encryption is not available on the Cisco AS5200, Cisco 7000 series, and Cisco 7200 series platforms.

Some Cisco platforms incorporate plus features into their basic feature sets.

The following tables provide feature set information by product:

- Cisco 7000 family of routers
  - Table 10 describes the contents of each feature set package for Cisco IOS Release 11.2, 11.1, and 11.0 for the Cisco 7000 series and Cisco 7500 series.
  - Table 11 describes the contents of each feature set package for Cisco IOS Release 11.2 and 11.1 for the Cisco 7200 series.
  - Table 12 describes optional feature set licenses.
- Cisco 4000 series, Cisco 2500 series, Cisco AS5100 access server, and AccessPro PC cards
  - Table 13 describes the contents of each feature set package for the Cisco 4700, Cisco 4700-M, Cisco 4500, Cisco 4500-M, Cisco 4000, Cisco 4000-M, Cisco 2500 series, and Access Pro PC cards for Cisco IOS Release 11.2, 11.1, 11.0, 10.3, and 10.2.
  - Table 14 and Table 16 describe Cisco AS5100 access server and Cisco 2500 series platform-specific feature sets for Cisco IOS Release 11.2, 11.1, 11.0, 10.3, and 10.2.
- Cisco AS5200 access server
  - Table 15 describes the Cisco AS5200 access server feature sets for Cisco IOS Release 11.2 and 11.1.

- Cisco 1001, Cisco 1003, Cisco 1004, and Cisco 1005
  - Table 17 describes Cisco 1003, Cisco 1004, and Cisco 1005 feature sets.
  - Table 18 describes Cisco 1005 platform-specific feature sets.
  - Table 19 describes the Cisco 1001 LAN extension client software.

For more information about the features, see the next section, “Cisco IOS Software Features.”

Table 10 Cisco IOS Release 11.2, 11.1, and 11.0 Feature Sets—Cisco 7000 Series and Cisco 7500 Series

	Cisco 7000 Series and Cisco 7500 Series Feature Sets										
Features	**IP Routing**			**IP/IPX/IBM[1]**		**Desktop/IBM[2]**			**Enterprise[2]**		
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**
LAN Support											
Apollo Domain	–	–	–	–	–	–	–	–			
AppleTalk 1 and 2[3]	–	–	–	–	–						
Banyan VINES	–	–	–	–	–	–	–	–			
Concurrent routing and bridging[4]											
DECnet IV	–	–	–	–	–						
DECnet V	–	–	–	–	–	–	–	–			
GRE											
Integrated routing and bridging (IRB)[5]		–	–	–	–		–	–		–	–
IP											
LAN extension host											
Multiring											
Novell IPX[6]	–	–	–								
OSI	–	–	–	–	–	–	–	–			
Transparent and translational bridging[7]											
XNS	–	–	–	–	–	–	–	–			
WAN Services											
ATM LAN emulation: DECnet routing and Banyan VINES support		–	–	–	–		–	–		–	–
ATM LAN emulation: Hot Standby Router Protocol (HSRP) and Simple Server Redundancy Protocol (SSRP)		–	–	–	–		–	–		–	–
ATM LAN emulation: Rate queues for SVC per subinterface		–	–	–	–		–	–		–	–
ATM LAN emulation: UNI 3.1 signaling for ATM		–	–	–	–		–	–		–	–
Combinet Packet Protocol (CPP)		–	–	–	–		–	–		–	–
Dialer profiles		–	–	–	–		–	–		–	–
Half bridge/half router for CPP and PPP		–	–	–	–		–	–		–	–
HDLC											
IPXWAN 2.0	–	–	–								
ISDN[8]											
Multichassis Multilink PPP (MMP)	–	–	–	–	–	–	–	–		–	–
PPP[9]											
Virtual Private Dial-up Network (VPDN)	–	–	–	–	–		–	–		–	–

	Cisco 7000 Series and Cisco 7500 Series Feature Sets										
Features	**IP Routing**			**IP/IPX/IBM[1]**		**Desktop/IBM[2]**			**Enterprise[2]**		
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**
WAN Optimization											
Bandwidth-on-demand											
Custom and priority queuing[10]											
Dial backup											
Dial-on-demand											
Header[11], link and payload compression[12]											
NetFlow Switching (NFS)[13]		–	–	–	–		–	–		–	–
Snapshot routing											
Weighted fair queuing[10]											
IP Routing											
Enhanced IGRP											
Enhanced IGRP Optimizations		–	–	–	–		–	–		–	–
ES-IS	–	–	–	–	–	–	–	–			
IGRP											
IS-IS	–	–	–	–	–	–	–	–			
Named IP Access Control List[14]		–	–	–	–		–	–		–	–
NHRP											
Network Address Translation (NAT)[15]		–	–	–	–		–	–		–	–
On Demand Routing (ODR)		–	–	–	–		–	–		–	–
OSPF											
OSPF Not-So-Stubby-Areas (NSSA)		–	–	–	–		–	–		–	–
OSPF On Demand Circuit (RFC 1793)		–	–	–	–		–	–		–	–
PIM											
Policy-based routing											
RIP											
RIP Version 2			–		–			–			–
Other Routing											
AURP	–	–	–	–	–						
IPX RIP	–	–	–								
NLSP	–	–	–								
RTMP	–	–	–	–	–						
SMRP	–	–	–	–	–						
SRTP	–	–	–	–	–	–	–	–			

	Cisco 7000 Series and Cisco 7500 Series Feature Sets										
Features	**IP Routing**			**IP/IPX/IBM[1]**		**Desktop/IBM[2]**			**Enterprise[2]**		
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**
Multimedia and Quality of Service											
Generic traffic shaping		–	–	–	–		–	–		–	–
Random Early Detection (RED)		–	–	–	–		–	–		–	–
Resource Reservation Protocol (RSVP)		–	–	–	–		–	–		–	–
Management											
AutoInstall											
Automatic modem configuration[16]			–		–			–			–
HTTP Server		–	–	–	–		–	–		–	–
RMON events and alarms			–		–			–			–
SNMP											
Telnet											
Security											
Access lists											
Access security											
Extended access lists											
Kerberized login	–	–	–	–	–	–	–	–			–
Kerberos V client support	–	–	–	–	–	–	–	–		–	–
Lock and Key			–		–			–			–
MD5 routing authentication											
Network layer encryption (export controlled 40-bit and 56-bit DES)[17]	Encrypt	–	–	–	–	Encrypt	–	–	Encrypt	–	–
RADIUS			–		–			–			–
Router authentication	Encrypt	–	–	–	–	Encrypt	–	–	Encrypt	–	–
TACACS+[18]											
IBM Support											
APPN (optional)[2]	–	–	–				–	–			
BAN for SNA Frame Relay support	–	–	–		–			–			–
Caching and filtering	–	–	–								
DLSW+[19, 20]	–	–	–								
Downstream PU concentration (DSPU)	–	–	–	–	–	–	–	–			
Frame Relay SNA support (RFC 1490)	–	–	–								
Native Client Interface Architecture (NCIA) Server	–	–	–	–	–		–	–		–	–
NetView Native Service Point	–	–	–								
QLLC	–	–	–								
Response Time Reporter (RTR)	–	–	–	–	–		–	–		–	–
SDLC integration	–	–	–								

	Cisco 7000 Series and Cisco 7500 Series Feature Sets										
Features	**IP Routing**			**IP/IPX/IBM[1]**		**Desktop/IBM[2]**			**Enterprise[2]**		
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**
SDLC transport (STUN)	–	–	–								
SDLC-to-LAN conversion (SDLLC)	–	–	–								
SNA and NetBIOS WAN optimization via local acknowledgment	–	–	–								
SRB/RSRB[21]	–	–	–								
SRT	–	–	–								
TG/COS	–	–	–	–	–	–	–	–			
TN3270 Server (CIP only)	–	–	–	–	–		–	–		–	–
VIP and HSA											
VIP and HSA[22]			–		–			–			–
VIP2[23]			–		–			–			–

1. The IP/IPX/IBM feature set was discontinued in Cisco IOS Release 11.2. All features in this feature set prior to Cisco IOS Release 11.2 are now available in the Desktop/IBM feature set, including APPN.
2. Desktop/IBM and Enterprise are available with APPN in a separate feature set. Use the product numbers that specify APPN. In Cisco IOS Release 11.2, APPN includes APPN Central Registration (CRR) and APPN over DLSw+.
3. Appletalk load balancing is available in Cisco IOS Release 11.2.
4. Concurrent routing and bridging feature only applies to transparent bridging, not source-route bridging (SRB).
5. IRB is not supported on the Cisco 7000 series. On the 7500 series, IRB supports IP, IPX, and AppleTalk; it is supported for transparent bridging, but not for SRB; it is supported on all media-type interfaces except X.25 and ISDN bridged interfaces; and IRB and concurrent routing and bridging (CRB) cannot operate at the same time.
6. In Cisco IOS Release 11.2, the Novell IPX feature includes display SAP by name, IPX Access Control List violation logging, and plain-English IPX access lists.
7. See the category “IBM Support” for information about SRB.
8. ISDN support includes calling line identification (ANI), X.25 over the B channel, ISDN subaddressing, and applicable WAN optimization features. Asynchronous ISDN Access (V.120) is only supported in the Enterprise feature set.
9. PPP includes support for LAN protocols supported by the feature set, address negotiation, PAP and CHAP authentication, and PPP compression.
10. Custom priority and queuing is not currently supported on SMIP or MIP cards
11. IPX header compression (RFC 1553) is available in the feature sets that support IPX in Cisco IOS Release 11.1(1) and later releases.
12. X.25 and Frame Relay payload compression.
13. NFS is supported on the Cisco 7500 series and Cisco 7000 series with a Route Switch Processor (RSP) only. In Cisco IOS Release 11.2, NFS supports IP over all interfaces with optimal performance on Ethernet, FDDI, and HDLC.
14. In Cisco IOS Release 11.2, named IP Access Control List can only be used by packet and route filters, it is not backward-compatible with earlier Cisco IOS releases, and is not supported with Distributed Fast Switching.
15. NAT is supported on the Cisco 7000 series routers with the RSP option only.
16. Automatic modem configuration is supported in all feature sets for Cisco IOS Release 11.1(2) and later releases. Supported only in Enterprise for Cisco IOS Release 11.1(1).
17. For more details on the new data encryption options, see the section “Cisco IOS Release 11.2 Feature Sets” earlier in this chapter. Data encryption options are only available on the Cisco 7500 series.
18. With Cisco IOS Release 11.2, TACACS+ Single Connection and TACACS+ SENDAUTH enhancements are supported.
19. DLSw+ over TCP/IP is supported.
20. Cisco IOS Release 11.2 introduces several DLSw+ enhancements. See the section “IBM Support” later in this chapter for more details.
21. With Cisco IOS Release 11.2, SRB/RSRB is fast switched. This enhancement is on by default, but can be disabled.
22. HSA support requires Cisco IOS Release 11.1(2) and later releases and is available on the Cisco 7500 series only.
23. VIP2 support requires Cisco IOS Release 11.1(5) and later releases, and the RSP7000 for the Cisco 7000 series.

Table 11 Cisco IOS Release 11.2 and 11.1 Feature Sets—Cisco 7200 Series

	Cisco 7200 Series Feature Sets						
Features	**Network Layer 3 Switching**		**IP Routing[1]**	**Desktop/IBM[,2]**		**Enterprise[2]**	
Cisco IOS Release	**11.2**	**11.1[3]**	**11.2**	**11.2**	**11.1[3]**	**11.2**	**11.1[3]**
LAN Support							
Apollo Domain	–	–	–	–	–		
AppleTalk 1 and 2[4]	–	–					
Banyan VINES	–	–	–	–	–		
Concurrent routing and bridging[5]							
DECnet IV	–	–					
DECnet V	–	–	–	–	–		
GRE	–	–					
Integrated routing and bridging (IRB)[6]		–			–		–
IP							
LAN extension host							
Multiring							
Novell IPX[7]							
OSI	–	–	–	–	–		
Transparent and translational bridging[8]							
XNS	–	–	–	–	–		
WAN Services							
ATM LAN emulation: Rate queues for SVC per subinterface	–	–	–	–	–		–
Combinet Packet Protocol		–			–		–
Dialer profiles		–			–		–
Half bridge/half router for CPP and PPP		–			–		–
HDLC							
IPXWAN 2.0							
ISDN[9]	–	–					
Multichassis Multilink PPP (MMP)	–	–	–	–	–		–
PPP[10]	–	–					
Virtual Private Dial-up Network (VPDN)	–	–	–		–		–
WAN Optimization							
Bandwidth-on-demand	–	–					
Custom and priority queuing	–	–					
Dial backup	–	–					
Dial-on-demand	–	–					
Header[11], link and payload compression[12]	–	–					
NetFlow Switching (NFS)[13]	–	–			–		–
Snapshot routing							

	Cisco 7200 Series Feature Sets						
Features	**Network Layer 3 Switching**		**IP Routing[1]**	**Desktop/IBM[1,2]**		**Enterprise[2]**	
Cisco IOS Release	**11.2**	**11.1[3]**	**11.2**	**11.2**	**11.1[3]**	**11.2**	**11.1[3]**
Weighted fair queuing	–						
IP Routing							
Enhanced IGRP							
Enhanced IGRP Optimizations		–			–		–
ES-IS	–	–	–	–	–		
IGRP							
IS-IS	–	–	–	–	–		
Named IP Access Control List[14]	–	–			–		–
Network Address Translation (NAT)		–			–		–
NHRP							
On Demand Routing (ODR)		–			–		–
OSPF							
OSPF Not-So-Stubby-Areas (NSSA)		–			–		–
OSPF On Demand Circuit (RFC 1793)		–			–		–
PIM							
Policy-based routing							
RIP							
RIP Version 2							
Other Routing							
AURP	–	–	–				
IPX RIP							
NLSP							
RTMP							
SMRP							
SRTP	–	–	–	–	–		
Multimedia and Quality of Service							
Generic traffic shaping		–			–		–
Random Early Detection (RED)		–			–		–
Resource Reservation Protocol (RSVP)		–			–		–
Management							
AutoInstall							
HTTP Server		–			–		–
RMON events and alarms							
SNMP							
Telnet							

	Cisco 7200 Series Feature Sets						
Features	**Network Layer 3 Switching**		**IP Routing[1]**	**Desktop/IBM[,2]**		**Enterprise[2]**	
Cisco IOS Release	**11.2**	**11.1[3]**	**11.2**	**11.2**	**11.1[3]**	**11.2**	**11.1[3]**
Security							
Access lists							
Access security							
Extended access lists							
Kerberized login	–	–	–	–	–		
Kerberos V client support	–	–	–	–	–		–
Lock and key							
MD5 routing authentication							
RADIUS							
TACACS+[15]							
IBM Support							
APPN (optional)[2]	–	–	–		–		
BAN for SNA Frame Relay support	–	–	–			–	–
Caching and filtering	–	–	–				
DLSw+[16, 17]	–	–	–				
Downstream PU concentration (DSPU)	–	–	–	–	–		
Frame Relay SNA support (RFC 1490)	–	–	–				
Native Client Interface Architecture (NCIA) Server	–	–	–		–		–
NetView Native Service Point	–	–	–				
Response Time Reporter (RTR)	–	–	–		–		–
QLLC	–	–	–				
SDLC integration	–	–	–				
SDLC transport (STUN)	–	–	–				
SDLC-to-LAN conversion (SDLLC)	–	–	–				

	Cisco 7200 Series Feature Sets						
Features	**Network Layer 3 Switching**		**IP Routing[1]**	**Desktop/IBM[2]**		**Enterprise[2]**	
Cisco IOS Release	**11.2**	**11.1[3]**	**11.2**	**11.2**	**11.1[3]**	**11.2**	**11.1[3]**
SNA and NetBIOS WAN optimization via local acknowledgment	–	–	–				
SRB/RSRB[18, 19]			–				
SRT		–	–				
TG/COS	–	–	–	–	–		

1. The IP routing feature set is new in Cisco IOS Releases 11.2.
2. Desktop/IBM and Enterprise are available with APPN in a separate feature set. Use the product numbers that specify APPN. In Cisco IOS Release 11.2, APPN includes APPN Central Registration (CRR) and APPN over DLSw+.
3. Cisco IOS Release 11.1(5) and later releases required.
4. Appletalk load balancing is available in Cisco IOS Release 11.2.
5. Concurrent routing and bridging feature only applies to transparent bridging, not source-route bridging (SRB).
6. IRB supports IP, IPX, and AppleTalk; it is supported for transparent bridging, but not for SRB; it is supported on all media-type interfaces except X.25 and ISDN bridged interfaces; and IRB and concurrent routing and bridging (CRB) cannot operate at the same time.
7. In Cisco IOS Release 11.2, the Novell IPX feature includes display SAP by name, IPX Access Control List violation logging, and plain-English IPX access lists.
8. See the category “IBM Support” for information about SRB.
9. ISDN support includes calling line identification (ANI), X.25 over the B channel, ISDN subaddressing, and applicable WAN optimization features. Asynchronous ISDN Access (V.120) is only supported in the Enterprise feature set.
10. PPP includes support for LAN protocols supported by the feature set, address negotiation, PAP and CHAP authentication, and PPP compression.
11. IPX header compression (RFC 1553) is available in the feature sets that support IPX in Cisco IOS Release 11.1(1) and later releases.
12. X.25 and Frame Relay payload compression.
13. In Cisco IOS Release 11.2, NFS supports IP over all interfaces with optimal performance on Ethernet, FDDI, and HDLC.
14. In Cisco IOS Release 11.2, named IP Access Control List can only be used by packet and route filters, it is not backward-compatible with earlier Cisco IOS releases, and is not supported with distributed fast switching.
15. With Cisco IOS Release 11.2, TACACS+ Single Connection and TACACS+ SENDAUTH enhancements are supported.
16. DLSw+ over TCP/IP is supported.
17. Cisco IOS Release 11.2 introduces several DLSw+ enhancements. See the section “IBM Support” later in this chapter for more details.
18. SRB/RSRB and SRT are available in the Network Layer 3 feature set in Cisco IOS Release 11.1(6) and later releases.
19. With Cisco IOS Release 11.2, SRB/RSRB is fast switched. This enhancement is on by default, but can be disabled.

Table 12 Cisco IOS Release 11.2, 11.1, and 11.0 Optional Feature Set Licenses—Cisco 7000 Series, Cisco7200 Series, and Cisco 7500 Series

	Cisco 7000 Series, Cisco7200 Series, and Cisco 7500 Series		
	Cisco IOS Release		
Optional Feature Set Licenses	**11.2**	**11.1**	**11.0**
WAN Packet Protocols			
ATM DXI			
Frame Relay			
Frame Relay switching			
Frame Relay SVC support (DTE)		–	–
Frame Relay traffic shaping		–	–
SMDS over ATM			
X.25			
X.25 switching			
Interdomain Routing[1]			
BGP			
BGP4[2]		–	–
EGP for Internet scale routing			
VIP/VIP2 support[3]			
Included automatically with VIP order			
CIP Support[3, 4]			
SNA support			
TCP/IP offload			
NetFlow Switching[5]			
NetFlow Switching software			

1. Interdomain routing is automatically included with all Cisco 7000 series RPs with 16-MB RAM. However, this option is appropriate for all other Cisco 7000, 7200, and 7500 series system processors.
2. BGP4 includes soft configuration, multipath support, and prefix filtering with inbound route maps.
3. Cisco 7000 and 7500 series only.
4. CIP orders must include one or both of the licenses.
5. Cisco 7200 series only.

Table 13 Cisco IOS Release 11.2, 11.1, 11.0, 10.3, and 10.2 Feature Sets—Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Cards

	Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Card Feature Sets																			
Features	**IP Routing**					**IP/IPX/ IBM/ APPN[1]**	**IP/IPX Routing[2]**				**Desktop (IP/IPX/Appletalk/DEC)**					**Enterprise[3]**				
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
LAN Support																				
Apollo Domain	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
AppleTalk 1 and 2[4]	–	–	–	–	–	–	–	–	–	–										
Banyan VINES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
Concurrent routing and bridging				–	–				–	–				–	–				–	–
DECnet IV	–	–	–	–	–	–	–	–	–	–										
DECnet V	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
GRE																				
Integrated routing and bridging (IRB)[5]		–	–	–	–	–	–	–	–	–		–	–	–	–		–	–	–	–
IP																				
LAN extension host																				
Multiring					–					–					–					–
Novell IPX[6]	–	–	–	–	–															
OSI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
Source-route bridging[7]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Transparent and translational bridging[7]																				
XNS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
WAN Services																				
ATM LAN emulation: DECnet routing and Banyan VINES support (Cisco 4500 and 4700 only)[8]	Plus	–	–	–	–	–	–	–	–	–	Plus	–	–	–	–	Plus	–	–	–	–
ATM LAN emulation: Hot Standby Router Protocol (HSRP) and Simple Server Redundancy Protocol (SSRP) (Cisco 4500 and 4700 only)	Plus	–	–	–	–	–	–	–	–	–	Plus	–	–	–	–	Plus	–	–	–	–

	Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Card Feature Sets																			
Features	**IP Routing**					**IP/IPX/ IBM/ APPN[1]**	**IP/IPX Routing[2]**				**Desktop (IP/IPX/Appletalk/DEC)**					**Enterprise[3]**				
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
ATM LAN emulation: Rate queues for SVC per subinterface (Cisco 4500 and 4700 only)	Plus	–	–	–	–	–	–	–	–	–	Plus	–	–	–	–	Plus	–	–	–	–
ATM LAN emulation: UNI 3.1 signaling for ATM (Cisco 4500 and 4700 only)	Plus	–	–	–	–	–	–	–	–	–	Plus	–	–	–	–	Plus	–	–	–	–
Combinet Packet Protocol (CPP)		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Dialer profiles		–	–	–	–	–	–	–	–	–		–	–	–	–		–	–	–	–
Frame Relay																				
Frame Relay SVC Support (DTE)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
Frame Relay traffic shaping	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
Half bridge/half router for CPP and PPP		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
HDLC																				
IPXWAN 2.0	–	–	–	–	–															
ISDN[9]																				
Multichassis Multilink PPP (MMP)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
PPP[10]																				
SMDS																				
Switched 56																				
Virtual Private Dial-up Network (VPDN)	–	–	–	–	–	–	–	–	–	–		–	–	–	–		–	–	–	–
X.25[11]																				
WAN Optimization																				
Bandwidth-on-demand																				
Custom and priority queuing																				
Dial backup																				
Dial-on-demand																				
Header[12], link and payload compression[13]																				

	Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Card Feature Sets																			
Features	**IP Routing**					**IP/IPX/ IBM/ APPN[1]**	**IP/IPX Routing[2]**				**Desktop (IP/IPX/Appletalk/DEC)**					**Enterprise[3]**				
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
Snapshot routing																				
Weighted fair queuing				–	–				–	–				–	–				–	–
IP Routing																				
BGP																				
BGP4[14]		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
EGP																				
Enhanced IGRP																				
Enhanced IGRP Optimizations		–	–	–	–	–	–	–	–	–		–	–	–	–		–	–	–	–
ES-IS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
IGRP																				
IS-IS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
Named IP Access Control List		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Network Address Translation (NAT)	Plus	–	–	–	–	–	–	–	–	–	Plus	–	–	–	–	Plus	–	–	–	–
NHRP					–					–					–					–
On Demand Routing (ODR)		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
OSPF																				
OSPF Not-So-Stubby-Areas (NSSA)		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
OSPF On Demand Circuit (RFC 1793)		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
PIM																				
Policy-based routing				–	–				–	–				–	–					
RIP																				
RIP Version 2			–	–	–			–	–	–			–	–	–			–	–	–
Other Routing																				
AURP	–	–	–	–	–	–	–	–	–	–										
IPX RIP	–	–	–	–	–															
NLSP[15]	–	–	–	–	–					–					–					–
RTMP	–	–	–	–	–	–	–	–	–	–										

	Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Card Feature Sets																			
Features	**IP Routing**					**IP/IPX/ IBM/ APPN[1]**	**IP/IPX Routing[2]**				**Desktop (IP/IPX/Appletalk/DEC)**					**Enterprise[3]**				
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
SMRP	–	–	–	–	–	–	–	–	–	–				–	–				–	–
SRTP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
Multimedia and Quality of Service																				
Generic traffic shaping		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Random Early Detection (RED)[16]		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Resource Reservation Protocol (RSVP)[16]		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Management																				
AutoInstall																				
Automatic modem configuration[17]			–	–	–			–	–	–			–	–	–			–	–	–
HTTP Server		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
RMON events and alarms[18]	Plus		–	–	–			–	–	–	Plus		–	–	–	Plus		–	–	–
RMON full (Cisco 2500 only)	Plus	–	–	–	–	Plus	–	–	–	–	Plus	–	–	–	–	Plus	–	–	–	–
SNMP																				
Telnet																				
Security																				
Access lists																				
Access security																				
Extended access lists																				
Kerberized login	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			–	–	–
Kerberos V client support	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
Lock and key		–	–	–	–	–	–	–	–	–	–	–	–	–	–			–	–	–
MAC security for hubs[19]			–	–	–			–	–	–			–	–	–			–	–	–
MD5 routing authentication				–	–				–	–				–	–				–	–
Network layer encryption (export controlled 40-bit and 56-bit DES)[20]	Encrypt	–	–	–	–	–	–	–	–	–	Encrypt	–	–	–	–	Encrypt	–	–	–	–
RADIUS			–	–	–			–	–	–			–	–	–			–	–	–
Router authentication	Encrypt	–	–	–	–	–	–	–	–	–	Encrypt	–	–	–	–	Encrypt	–	–	–	–
TACACS+[21]																				

	Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Card Feature Sets																			
Features	**IP Routing**					**IP/IPX/ IBM/ APPN[1]**	**IP/IPX Routing[2]**				**Desktop (IP/IPX/Appletalk/DEC)**					**Enterprise[3]**				
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
IBM Support (Optional)																				
APPN (optional)[3]	–	–	–	–	–				–	–	–	–	–	–	–				–	–
BAN for SNA Frame Relay support	Plus			–	–				–	–	Plus			–	–				–	–
Bisync[22]	Plus			–	–				–	–	Plus			–	–				–	–
Caching and filtering	Plus										Plus									
DLSw+ [23]	Plus				–					–	Plus				–					–
Downstream PU concentration (DSPU)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–				–	–
Frame Relay SNA support (RFC 1490)	Plus										Plus									
Native Client Interface Architecture (NCIA) Server	Plus	–	–	–	–		–	–	–	–	Plus	–	–	–	–		–	–	–	–
NetView Native Service Point	Plus			–	–				–	–	Plus			–	–				–	–
QLLC[22]	Plus			–	–				–	–	Plus			–	–					
Response Time Reporter (RTR)	Plus	–	–	–	–		–	–	–	–	Plus	–	–	–	–		–	–	–	–
SDLC integration	Plus				–					–	Plus				–					
SDLC transport (STUN)	Plus				–					–	Plus				–					
SDLC-to-LAN conversion (SDLLC)	Plus				–					–	Plus				–					
SNA and NetBIOS WAN optimization via local acknowledgment	Plus										Plus									
SRB/RSRB[24, 25]	Plus									–	Plus									–
SRT	Plus				–					–	Plus				–					–
TG/COS	–	–	–	–	–	–	–	–	–	–	–	–	–		–					
TN3270	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
Protocol Translation																				
LAT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
Rlogin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
Remote Node[26]																				
ARAP 1.0/2.0[27]	–	–	–	–	–	–	–	–	–	–										
Asynchronous master interfaces				–	–				–	–				–	–				–	–

	Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Card Feature Sets																			
Features	**IP Routing**					**IP/IPX/ IBM/ APPN[1]**	**IP/IPX Routing[2]**				**Desktop (IP/IPX/Appletalk/DEC)**					**Enterprise[3]**				
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
ATCP[28]	–	–	–	–	–	–	–	–	–	–					–					–
CPPP																				
CSLIP																				
DHCP					–					–					–					–
IP pooling				–	–				–	–				–	–				–	–
IPX and ARAP on virtual asynch interfaces	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–				–	–
IPXCP[12]	–	–	–	–	–															
MacIP	–	–	–	–	–	–	–	–	–	–										
NASI[29]	–	–	–	–	–			–	–	–				–	–				–	–
NetBEUI over PPP				–	–			–	–	–				–	–				–	–
PPP																				
SLIP																				

	Cisco 2500 Series, Cisco 4000, Cisco 4500, Cisco 4700, and AccessPro PC Card Feature Sets																			
Features	**IP Routing**					**IP/IPX/ IBM/ APPN[1]**	**IP/IPX Routing[2]**				**Desktop (IP/IPX/Appletalk/DEC)**					**Enterprise[3]**				
Cisco IOS Release	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
Terminal Services[26]																				
LAT[30]	–	–	–			–	–	–	–	–	–	–	–	–	–					
Rlogin																				
Telnet																				
TN3270	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
X.25 PAD																				
Xremote	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					

1. IP/IPX/IBM/APPN is a new feature set in Cisco IOS Release 11.2. This feature set has no additional options. It offers a low-end APPN solution for this set of hardware platforms.
2. The IP/IPX feature set was discontinued in Cisco IOS Release 11.2. All features in this feature set prior to Cisco IOS Release 11.2 are now available in the Desktop/IBM feature set, including APPN.
3. Enterprise is available with APPN in a separate feature set. Use the product numbers that specify APPN. In Cisco IOS Release 11.2, APPN includes APPN Central Registration (CRR) and APPN over DLSw+.
4. AppleTalk load balancing is available in Cisco IOS Release 11.2.
5. IRB supports IP, IPX, and AppleTalk; it is supported for transparent bridging, but not for SRB; it is supported on all media-type interfaces except X.25 and ISDN bridged interfaces; and IRB and concurrent routing and bridging (CRB) cannot operate at the same time.
6. In Cisco IOS Release 11.2, the Novell IPX feature includes display SAP by name, IPX Access Control List violation logging, and plain-English IPX access lists.
7. See the feature category “IBM Support” for information about source-route bridging (SRB) in Cisco IOS Release 10.3 and later releases. In Cisco IOS Release 11.2, translational bridging is fast switched by default but can be disabled.
8. ATM LAN emulations for Banyan VINES is only supported in Enterprise.
9. ISDN support includes calling line identification (ANI), X.25 over the B channel, ISDN subaddressing, and applicable WAN optimization features.
10. PPP includes support for LAN protocols supported by the feature set, address negotiation, PAP and CHAP authentication, and PPP compression. Multilink PPP is available in Cisco IOS Release 11.0(4) and later releases.
11. X.25 includes X.25 switching.
12. IPX header compression (RFC 1553) is available in the feature sets that support IPX in Cisco IOS Release 11.1(1) and later releases.
13. X.25 payload compression is supported in Cisco IOS Release 10.2 and later releases. X.25 and Frame Relay payload compression are supported in Cisco IOS Release 11.0(4) and later releases.
14. BGP4 includes soft configuration, multipath support, and prefix filtering with inbound route maps.
15. NLSP is supported with the Desktop option in Cisco IOS Release 10.3(2) and later releases.
16. RED and RSVP are supported in IP/IPX/IBM/APPN for the Cisco 4000, 4500, and, 4700 only.
17. Automatic modem configuration is available for all features sets in Cisco IOS Release 11.1(2) and later releases. For the Enterprise feature set, automatic modem configuration is available in Cisco IOS 11.1(1) and later releases.
18. The RMON events and alarms groups are supported on all interfaces in Cisco IOS Release 11.1 and later releases. Separate enhanced RMON feature sets are also available with Cisco IOS Release 11.1. In Cisco IOS Release 11.2, RMON full is available with the plus feature sets
19. MAC security for hubs is applicable to the following Cisco 2500 series Ethernet hub models: Cisco 2505, Cisco 2507, Cisco 2516, and Cisco 2518.
20. For more details, see the description of the new data encryption options in the section “Cisco IOS Release 11.2 Feature Sets” earlier in this chapter,
21. With Cisco IOS Release 11.2, TACACS+ Single Connection and TACACS+ SENDAUTH enhancements are supported.
22. QLLC and Bisync are available in IP/IBM in Cisco IOS Release 11.0(3) and later releases, and in IP/IPX/IBM and Desktop/IBM base in Cisco IOS Release 11.0(2) and later releases.
23. Cisco IOS Release 11.2 introduces several DLSw+ enhancements available in the Plus, Plus 40, and Plus 56 feature sets. See the section “IBM Support” later in this chapter for more details.
24. In Cisco IOS Release 10.2, RSRB was supported in all feature sets. In Cisco IOS Release 10.3 and later releases, SRB/RSRB is supported in all feature sets.
25. With Cisco IOS Release 11.2, SRB/RSRB is fast switched. This enhancement is on by default, but can be disabled.
26. Supported on access severs (with limited support on router auxiliary ports).
27. The Cisco 4000, Cisco 4500, and Cisco 4700 products do not support ARAP 1.0/2.0.
28. ATCP and DHCP proxy client is supported in Cisco IOS Release 10.3(3) and later releases.
29. NASI is supported in Cisco IOS Release 11.1(2) and later releases.

30. Use of LAT requires terminal license (FR-L8-10.X= for an 8-user license or FR-L16-10.X= for a 16-user license).

Table 14 Cisco IOS Release 11.2, 11.1, 11.0, 10.3, and 10.2 Feature Sets—Platform-Specific Cisco 2500 Series and AS5100 Access Server

	Cisco 2500 Series and AS5100 Platform-Specific Feature Sets																			
Features	**ISDN**					**CFRAD[1]**					**LAN FRAD[2]**					**Remote Access Server**				
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
Platforms Supported																				
Cisco 2500 series routers: models 2501, 2502, 2505, 2507, 2509-2515, 2524	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cisco 2503I, Cisco 2504I						–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cisco 2501CF, Cisco 2502CF, Cisco 2520CF-2523CF	–	–	–	–	–						–	–	–	–	–	–	–	–	–	–
Cisco 2501LF, Cisco 2502LF, Cisco 2520LF-2523LF	–	–	–	–	–	–	–	–	–	–				–	–	–	–	–	–	–
Cisco 2509-2512, Cisco AS5100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
LAN Support																				
AppleTalk 1 and 2[3]		–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
DECNet IV	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
GRE						–	–	–	–	–				–	–					
Integrated routing and bridging (IRB)[4]		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
IP						–	–	–	–	–				–	–					
Multiring						–	–	–	–	–				–	–					
Novell IPX[5]						–	–	–	–	–				–	–					
Source-route bridging[6]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
Transparent bridging[6]	–	–	–	–	–	–	–	–	–	–				–	–	–	–	–	–	–
Transparent and translational bridging[6]						–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
WAN Services																				
Combinet Packet Protocol (CPP)		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Dialer profiles		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Frame Relay	–	–	–	–	–									–	–					
Frame Relay traffic shaping		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Half bridge/half router for CPP and PPP		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
HDLC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–					
IPXWAN 2.0	–	–	–	–	–	–	–	–	–	–				–	–					
ISDN[7]						–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

	Cisco 2500 Series and AS5100 Platform-Specific Feature Sets																			
Features	**ISDN**					**CFRAD[1]**					**LAN FRAD[2]**					**Remote Access Server**				
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
Multichassis Multilink PPP (MMP)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
PPP[8]														–	–					
SMDS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Switched 56	–	–	–	–	–	–	–	–	–	–	–	–		–	–					
Virtual Private Dial-up Network (VPDN)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
X.25[9]	–	–	–	–	–	–	–	–	–	–	–	–		–	–					
WAN Optimization																				
Bandwidth-on-demand[10]						–	–	–	–	–	–	–	–	–	–					
Custom and priority queuing														–	–					
Dial backup						–	–	–	–	–	–	–	–	–	–					
Dial-on-demand						–	–	–	–	–	–	–	–	–	–					
Header[11], link and payload compression[12]	–	–	–	–	–									–	–					
Header[12] and link compression						–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Snapshot routing						–	–	–	–	–	–	–	–	–	–					
Weighted fair queuing													–	–					–	–
IP Routing																				
BGP						–	–	–	–	–	–	–	–	–	–	–	–			
BGP4[13]		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–
EGP						–	–	–	–	–	–	–	–	–	–	–	–			
Enhanced IGRP																				
Enhanced IGRP Optimizations		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
IGRP														–	–					
NHRP						–	–	–	–	–	–	–	–	–	–	–	–			–
On Demand Routing (ODR)		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
OSPF							–	–	–	–	–	–	–	–	–	–	–			
OSPF Not-So-Stubby-Areas (NSSA)		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–
OSPF On Demand Circuit (RFC 1793)		–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–
PIM						–	–	–	–	–	–	–	–	–	–					
Policy-based routing						–	–	–	–	–	–	–	–	–	–				–	–

Features	Cisco 2500 Series and AS5100 Platform-Specific Feature Sets																			
	ISDN					CFRAD[1]					LAN FRAD[2]					Remote Access Server				
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**
RIP														–	–					
RIP Version 2			–	–	–			–	–	–			–	–	–			–	–	–
Other Routing																				
AURP						–	–	–	–	–	–	–	–	–	–					
IPX RIP						–	–	–	–	–				–	–					
NLSP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
RTMP						–	–	–	–	–	–	–	–	–	–					
Multimedia and Quality of Service																				
Generic traffic shaping		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
Random Early Detection (RED)		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Resource Reservation Protocol (RSVP)		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Management																				
AutoInstall	–	–	–	–	–									–	–					
Automatic modem configuration[14]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			–	–	–
HTTP Server		–	–	–	–		–	–	–	–		–	–	–	–		–	–	–	–
RMON events and alarms[15]			–	–	–	–	–	–	–	–	–	–	–	–	–			–	–	–
SNMP														–	–					
Telnet														–	–					
Security																				
Access lists														–	–					
Access security														–	–					
Extended access lists														–	–					
Lock and Key			–	–	–			–	–	–			–	–	–			–	–	–
MAC security for hubs[16]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MD5 routing authentication				–	–			–	–	–				–	–				–	–
RADIUS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			–	–	–
TACACS+[17]														–	–					
IBM Support (Optional)																				
BAN for SNA Frame Relay support	–	–	–	–	–		–	–				–	–	–	–	–	–	–	–	–
Bisync[18]	–	–	–	–	–				–	–				–	–	–	–	–	–	–

	Cisco 2500 Series and AS5100 Platform-Specific Feature Sets																	
Features	**ISDN**					**CFRAD[1]**					**LAN FRAD[2]**					**Remote Acces**		
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**
Caching and filtering	–	–	–	–	–									–	–	–	–	–
DLSw+[19]	–	–	–	–	–									–	–	–	–	–
Frame Relay SNA support (RFC 1490)	–	–	–	–	–									–	–	–	–	–
Native Client Interface Architecture (NCIA) Server	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
NetView Native Service Point	–	–	–	–	–				–	–				–	–	–	–	–
Polled asynch (ADT, ADPLEX)	–	–	–	–	–				–	–				–	–	–	–	–
QLLC[18]	–	–	–	–	–				–	–				–	–	–	–	–
RFC 1795	–	–	–	–	–				–	–				–	–	–	–	–
RSRB	–	–	–	–	–						–	–	–	–	–	–	–	–
SDLC integration	–	–	–	–	–									–	–	–	–	–
SDLC transport (STUN)	–	–	–	–	–									–	–	–	–	–
SDLC-to-LAN conversion (SDLLC)	–	–	–	–	–									–	–	–	–	–
SNA and NetBIOS WAN optimization via local acknowledgment	–	–	–	–	–									–	–	–	–	–
SRB/RSRB[20]	–	–	–	–	–	–	–	–	–	–				–	–	–	–	–
SRT	–	–	–	–	–	–	–	–	–	–				–	–	–	–	–
Protocol Translation																		
LAT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
PPP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Rlogin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Telnet	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
TN3270	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
X.25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Remote Node[21]																		
ARAP 1.0/2.0[22]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Asynchronous master interfaces	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
ATCP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
CPPP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
CSLIP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
DHCP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
IP pooling	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
IPX and ARAP on virtual asynch interfaces	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
IPXCP[23]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
MacIP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
PPP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			

	Cisco 2500 Series and AS5100 Platform-Specific Feature Sets																	
Features	**ISDN**					**CFRAD[1]**					**LAN FRAD[2]**					**Remote Acces**		
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**	**10.3**	**10.2**	**11.2**	**11.1**	**11.0**
SLIP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Terminal Services[21]																		
LAT[24]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Rlogin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Telnet	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
TN3270	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
X.25 PAD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Xremote	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			

1. Cisco IOS Release 10.3 and 10.2 CFRAD software is available on the Cisco 2501CF and 2502CF models only.
2. Cisco IOS Release 11.0(5) and LAN FRAD software is available with the following models: 2501LF, 2502LF, 2520LF, 2521LF2522LF, and 2523LF.
3. Appletalk load balancing is available in Cisco IOS Release 11.2.
4. IRB supports IP, IPX, and AppleTalk; it is supported for transparent bridging, but not for SRB; it is supported on all media-type interfaces except X.25 and ISDN bridged interface concurrent routing and bridging (CRB) cannot operate at the same time.
5. In Cisco IOS Release 11.2, the Novell IPX feature includes display SAP by name, IPX Access Control List violation logging, and plain-English IPX access lists.
6. See the category “IBM Support” for information about source-route bridging (SRB) in Cisco IOS Release 10.3 and later releases. In CIsco IOS Release 11.2, translational bridging i but this can be disabled.
7. ISDN support includes calling line identification (ANI), X.25 over the B channel, ISDN subaddressing, and applicable WAN optimization features.
8. PPP includes support for LAN protocols supported by the feature set, address negotiation, PAP and CHAP authentication, and PPP compression. Multilink PPP
9. X.25 Includes X.25 switching.
10. Bandwidth-on-demand means two B channel calls to the same destination.
11. IPX header compression (RFC 1553) is available in the feature sets that support IPX.
12. X.25 and Frame Relay payload compression.
13. BGP4 includes soft configuration, multipath support, and prefix filtering with inbound route maps.
14. Automatic router configuration is supported in all feature sets for Cisco IOS 11.1(2). Supported only in Enterprise for Cisco IOS 11.1(1).
15. RMON events and alarms is supported on all interfaces.
16. Applicable to the following Cisco 2500 series Ethernet hub models: Cisco 2505, Cisco 2507, Cisco 2516, and Cisco 2518.
17. With Cisco IOS Release 11.2, TACACS+ Single Connection and TACACS+ SENDAUTH enhancements are supported.
18. QLLC and Bisync are available in IP/IBM in Cisco IOS Release 11.0(3) and later releases, and in IP/IPX/IBM and Desktop/IBM base in Cisco IOS Release 11.0(2) and later rel
19. Cisco IOS Release 11.2 introduces several DLSw+ enhancements available in the Plus, Plus 40, and Plus 56 feature sets. See the section “IBM Support” later in this chapter for
20. With Cisco IOS Release 11.2, SRB/RSRB is fast switched. This enhancement is on by default, but can be disabled.
21. Remote node and terminal services supported on access servers (with limited support on router auxiliary ports).
22. The Cisco 4000 series products do not support ARAP 1.0/2.0.
23. IPX header compression (RFC 1553) is available in the feature sets that support IPX.
24. Use of LAT requires terminal license (FR-L8-10.X= or FR-L16-10.X=).

Table 15 Cisco IOS Release 11.2 and 11.1 Feature Sets—Cisco AS5200 Access Server

	Cisco AS5200 Access Server Feature Sets					
Features	**IP Routing**	**IP or IP/Modem**	**Desktop**	**Desktop or Desktop/ Modem**	**Enterprise[1]**	**Enterprise or Enterprise/ RMON/Modem**
Cisco IOS Release	**11.2**	**11.1**	**11.2**	**11.1**	**11.2**	**11.1**
LAN Support						
Apollo Domain	–	–	–	–		
AppleTalk 1 and 2[2]	–	–				
Banyan VINES	–	–	–	–		
Concurrent routing and bridging						
DECnet IV	–	–				
DECnet V	–	–	–	–		
GRE						
Integrated routing and bridging (IRB)[3]		–		–		–
IP						
LAN extension host						
Multiring						
Novell IPX[4]	–	–				
OSI	–	–	–	–		
Source-route bridging (SRB)	–	–	–	–		
Transparent and translational bridging[5]						
XNS	–	–	–	–		
WAN Services						
ATM LAN emulation: Rate queues for SVC per subinterface	–	–	–	–		–
Combinet Packet Protocol (CPP)		–		–		–
Dialer profiles		–		–		–
Frame Relay						
Frame Relay SVC Support (DTE)	–	–	–	–		–
Frame Relay traffic shaping		–		–		–
Half bridge/half router for CPP and PPP		–		–		–
HDLC						
IPXWAN 2.0	–	–				
ISDN[6]						
Multichassis Multilink PPP (MMP)	–	–	–	–		–
PPP[7]						
SMDS						
Switched 56						
Virtual Private Dial-up Network (VPDN)	–	–		–		–

	Cisco AS5200 Access Server Feature Sets					
Features	**IP Routing**	**IP or IP/Modem**	**Desktop**	**Desktop or Desktop/ Modem**	**Enterprise[1]**	**Enterprise or Enterprise/ RMON/Modem**
Cisco IOS Release	**11.2**	**11.1**	**11.2**	**11.1**	**11.2**	**11.1**
X.25[8]						
WAN Optimization						
Bandwidth-on-demand						
Custom and priority queuing						
Dial backup						
Dial-on-demand						
Header[9], link and payload compression[10]						
Snapshot routing						
Weighted fair queuing						
IP Routing						
BGP						
BGP4[11]		–		–		–
EGP						
Enhanced IGRP						
Enhanced IGRP Optimizations		–		–		–
ES-IS	–	–	–	–		
IGRP						
IS-IS	–	–	–	–		
Named IP Access Control List		–		–		–
Network Address Translation (NAT)	Plus	–	Plus	–	Plus	–
NHRP						
On Demand Routing (ODR)		–		–		–
OSPF						
OSPF Not-So-Stubby-Areas (NSSA)		–		–		–
OSPF On Demand Circuit (RFC 1793)		–		–		–
PIM						
Policy-based routing						
RIP						
RIP Version 2						
Other Routing						
AURP	–	–				
IPX RIP	–	–				
NLSP	–	–				
RTMP	–	–				

	Cisco AS5200 Access Server Feature Sets					
Features	**IP Routing**	**IP or IP/Modem**	**Desktop**	**Desktop or Desktop/ Modem**	**Enterprise[1]**	**Enterprise or Enterprise/ RMON/Modem**
Cisco IOS Release	**11.2**	**11.1**	**11.2**	**11.1**	**11.2**	**11.1**
SMRP	–	–				
SRTP	–	–	–	–		
Multimedia and Quality of Service						
Generic traffic shaping		–		–		–
Random Early Detection (RED)		–		–		–
Resource Reservation Protocol (RSVP)		–		–		–
Management						
AutoInstall						
Automatic modem configuration[12]						
HTTP Server		–		–		–
Modem Management	Plus		Plus		Plus	
RMON events and alarms[13]	Plus		Plus		Plus	
RMON full	Plus	–	Plus	–	Plus	–
SNMP						
Telnet						
Security						
Access lists						
Access security						
Extended access lists						
Kerberized login	–	–	–	–		
Kerberos V client support	–	–	–	–		–
Lock and key						
MAC security for hubs						
MD5 routing authentication						
RADIUS						
TACACS+[14]						
IBM Support (Optional)						
BAN for SNA Frame Relay support	Plus	–	Plus	–		
Bisync	Plus	–	Plus	–		
Caching and filtering	Plus	–	Plus	–		
DLSw+ [15]	Plus	–	Plus	–		
Downstream PU concentration (DSPU)	–	–	–	–		
Frame Relay SNA support (RFC 1490)	Plus	–	Plus	–		
Native Client Interface Architecture (NCIA) Server	Plus	–	Plus	–		–

	Cisco AS5200 Access Server Feature Sets					
Features	**IP Routing**	**IP or IP/Modem**	**Desktop**	**Desktop or Desktop/ Modem**	**Enterprise[1]**	**Enterprise or Enterprise/ RMON/Modem**
Cisco IOS Release	**11.2**	**11.1**	**11.2**	**11.1**	**11.2**	**11.1**
NetView Native Service Point	Plus	–	Plus	–		
QLLC	Plus	–	Plus	–		
Response Time Reporter (RTR)	Plus	–	Plus	–		–
SDLC integration	Plus	–	Plus	–		
RFC 1795	Plus	–	Plus	–		
SDLC transport (STUN)	Plus	–	Plus	–		
SDLC-to-LAN conversion (SDLLC)	Plus	–	Plus	–		
SNA and NetBIOS WAN optimization via local acknowledgment	Plus	–	Plus	–		
SRB/RSRB[16]	Plus	–	Plus	–		
SRT	Plus	–	Plus	–		
TG/COS	–	–	–	–		
TN3270	–	–	–	–		
Protocol Translation						
LAT	–	–	–	–		
Rlogin	–	–	–	–		
Remote Node[17]						
ARAP 1.0/2.0						
Asynchronous master interfaces						
ATCP	–	–				
CPPP						
CSLIP						
DHCP						
IP pooling						
IPX and ARAP on virtual asynch interfaces	–	–	–	–		
IPXCP[12]	–	–				
MacIP	–	–				
NASI[18]	–	–	–	–	–	–
NetBEUI over PPP	–	–	–	–	–	–
SLIP						

	Cisco AS5200 Access Server Feature Sets					
Features	**IP Routing**	**IP or IP/Modem**	**Desktop**	**Desktop or Desktop/ Modem**	**Enterprise[1]**	**Enterprise or Enterprise/ RMON/Modem**
Cisco IOS Release	**11.2**	**11.1**	**11.2**	**11.1**	**11.2**	**11.1**
Terminal Services[17]						
LAT[19]	–	–	–	–		
Rlogin						
Telnet						
TN3270	–	–	–	–		
X.25 PAD						
Xremote	–	–	–	–		

1. Enterprise is available with APPN in a separate feature set. Use the product numbers that specify APPN. In Cisco IOS Release 11.2, APPN includes APPN Central Registration (CRR) and APPN over DLSw+.
2. AppleTalk load balancing is available in Cisco IOS Release 11.2.
3. IRB supports IP, IPX, and AppleTalk; it is supported for transparent bridging, but not for SRB; it is supported on all media-type interfaces except X.25 and ISDN bridged interfaces; and IRB and concurrent routing and bridging (CRB) cannot operate at the same time.
4. In Cisco IOS Release 11.2, the Novell IPX feature includes display SAP by name, IPX Access Control List violation logging, and plain-English IPX access lists.
5. See the feature category "IBM Support" for information about source-route bridging (SRB) in Cisco IOS Release 10.3 and later releases.
6. ISDN support includes calling line identification (ANI), X.25 over the B channel, ISDN subaddressing, and applicable WAN optimization features.
7. PPP includes support for LAN protocols supported by the feature set, address negotiation, PAP and CHAP authentication, PPP compression, and Multilink PPP.
8. X.25 includes X.25 switching.
9. IPX header compression (RFC 1553) is available in the feature sets that support IPX in Cisco IOS Release 11.1(1) and later releases.
10. X.25 and Frame Relay payload compression are supported.
11. BGP4 includes soft configuration, multipath support, and prefix filtering with inbound route maps.
12. Automatic modem configuration is available for all features sets in Cisco IOS Release 11.1(2) and later releases. For the Enterprise feature set, automatic modem configuration is available in Cisco IOS 11.1(1) and later releases.
13. The RMON events and alarms groups are supported on all interfaces in Cisco IOS Release 11.1 and later releases. Enhanced RMON feature sets are also available in Cisco IOS Release 11.1. In Cisco IOS Release 11.2, RMON full is available with the plus feature sets.
14. With Cisco IOS Release 11.2, TACACS+ Single Connection and TACACS+ SENDAUTH enhancements are supported.
15. Cisco IOS Release 11.2 introduces several DLSw+ enhancements available in the Plus, Plus 40, and Plus 56 feature sets. See the section "IBM Support" later in this chapter for more details.
16. With Cisco IOS Release 11.2, SRB/RSRB is fast switched. This enhancement is on by default, but can be disabled.
17. Supported on access severs (with limited support on router auxiliary ports).
18. NASI is supported in Cisco IOS Release 11.1(2) and later releases.
19. Use of LAT requires terminal license (FR-L8-10.X= for an 8-user license or FR-L16-10.X= for a 16-user license).

Table 16 Cisco IOS Release 11.1—RMON Platform-Specific Feature Sets

	RMON Platform-Specific Feature Sets[1]		
Features	**IP/RMON Routing**	**P/IPX/RMON Routing**	**Enterprise/ RMON**
Cisco IOS Release	**11.1**	**11.1**	**11.1**
Platforms Supported			
Cisco 2500 series routers: Ethernet models 2501, 2503, 2505, 2507, 2509, 2511, 2513, 2514, 2516, 2518, 2520, 2522, 2524 AS5100 access servers			
AS5200 access server	–	–	
LAN Support			
Apollo Domain	–	–	
AppleTalk 1 and 2	–	–	
Banyan VINES	–	–	
Concurrent routing and bridging			
DECnet IV	–	–	
DECnet V	–	–	
GRE			
IP			
LAN extension host			
Multiring			
Novell IPX	–		
OSI	–	–	
Transparent and translational bridging[2]			
XNS	–	–	
WAN Services			
Frame Relay			
HDLC			
IPXWAN 2.0	–		
ISDN[3]			
PPP[4]			
SMDS			
Switched 56			
X.25[5]			
WAN Optimization			
Bandwidth-on-demand			
Custom and priority queuing			
Dial backup			
Dial-on-demand			

	RMON Platform-Specific Feature Sets[1]		
Features	**IP/RMON Routing**	**P/IPX/RMON Routing**	**Enterprise/ RMON**
Cisco IOS Release	**11.1**	**11.1**	**11.1**
Header[6], link and payload compression[7]			
Snapshot routing			
Weighted fair queuing			
IP Routing			
BGP			
EGP			
Enhanced IGRP			
ES-IS	–	–	
IGRP			
IS-IS	–	–	
NHRP			
OSPF			
PIM			
Policy-based routing			
RIP			
RIP Version 2			
Other Routing			
AURP	–	–	
IPX RIP	–		
NLSP	–		
RTMP	–	–	
SMRP	–	–	
SRTP	–	–	
Management			
AutoInstall			
Automatic modem configuration			
RMON nine-group Ethernet[8]			
SNMP			
Telnet			
Security			
Access lists			
Access security			
Extended access lists			
Kerberized login	–	–	
Lock and key			
MAC security for hubs[9]			

	RMON Platform-Specific Feature Sets[1]		
Features	**IP/RMON Routing**	**P/IPX/RMON Routing**	**Enterprise/ RMON**
Cisco IOS Release	**11.1**	**11.1**	**11.1**
MD5 routing authentication			
RADIUS			
TACACS+			
IBM Support (Optional)[10]			
BAN for SNA Frame Relay support			
Bisync			
Caching and filtering			
DLSw+			
Downstream PU concentration (DSPU)	–	–	
Frame Relay SNA support (RFC 1490)			
NetView Native Service Point			
QLLC			
SDLC integration			
SDLC transport (STUN)			
SDLC-to-LAN conversion (SDLLC)			
SNA and NetBIOS WAN optimization via local acknowledgment			
SRB/RSRB			
SRT			
TG/COS	–	–	
Protocol Translation			
LAT	–	–	
PPP	–	–	
Rlogin	–	–	
Telnet	–	–	
TN3270	–	–	
X.25	–	–	
Remote Node[11]			
Asynchronous master interfaces			
ATCP	–	–	
CPPP			
CSLIP			
DHCP			
IP pooling			
IPX on virtual asynch interfaces	–		

	RMON Platform-Specific Feature Sets[1]		
Features	**IP/RMON Routing**	**P/IPX/RMON Routing**	**Enterprise/ RMON**
Cisco IOS Release	**11.1**	**11.1**	**11.1**
IPXCP[6]	–		
MacIP	–	–	
NASI[12]	–		
NetBEUI over PPP			
PPP			
SLIP			
Terminal Services[11]			
LAT[13]	–	–	
Rlogin			
Telnet			
TN3270	–	–	
X.25 PAD			
Xremote	–	–	

1. In Cisco IOS Release 11.2, RMON is available in the Plus feature sets. It is listed as "RMON full" in the appropriate hardware platform tables. RMON is only available as a separate platform-specific feature set in Cisco IOS Release 11.1.
2. See the category "IBM Support" for information about source-route bridging (SRB).
3. ISDN support includes calling line identification (ANI), X.25 over the B channel, ISDN subaddressing, and applicable WAN optimization features.
4. PPP includes support for LAN protocols supported by the feature set, address negotiation, PAP and CHAP authentication, PPP compression, and Multilink PPP.
5. X.25 Includes X.25 switching.
6. IPX header compression (RFC 1553) is available in the feature sets that support IPX with Cisco IOS Release 11.1(1) and later releases.
7. X.25 and Frame Relay payload compression.
8. The RMON events and alarms groups are supported for all interfaces; however, the full nine groups are supported for Ethernet interfaces only. For security reasons, packet capture only captures packet headers, not data.
9. MAC security for hubs applies to the following Cisco 2500 series Ethernet hubs: 2505, 2507, 2516, and 2518.
10. IBM support is available as a separate Cisco IOS feature set with the IBM base option: IP/IBM base, IP/IPX//IBM base.
11. Remote node and terminal services are supported on access servers (with limited support on router auxiliary ports).
12. NASI is available on Cisco IOS Release 11.1(2) and later releases.
13. Use of LAT requires terminal license (FS-L8-10.X= for an 8-user license or FS-L16-10.X= for a 16-user license).

Table 17 Cisco IOS Release 11.2, 11.1, 11.0, and 10.3 Feature Sets—Cisco 1003, Cisco 1004, and Cisco 1005 Routers

	Cisco 1003, Cisco 1004, and Cisco 1005 Feature Sets[1]													
Features	**IP Routing[2]**				**IP/IPX Routing[2, 3]**			**IP/Appletalk Routing[2, 3]**			**IP/IPX/Appletalk Routing[4]**			
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**10.3**
LAN Support														
AppleTalk 1 and 2[5]	–	–	–	–	–	–	–							
GRE														
Integrated routing and bridging (IRB)[6]		–	–	–		–	–		–	–		–	–	–
IP														
Novell IPX[7]	–	–	–	–				–	–	–				
Transparent and translational bridging[8]														
WAN Services[9]														
Dialer profiles		–	–	–		–	–		–	–		–	–	–
Frame Relay (Cisco 1005 only)														
Frame Relay SVC Support (DTE) (Cisco 1005 only)	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
Frame Relay traffic shaping (Cisco 1005 only)		–	–	–		–	–		–	–		–	–	–
HDLC														
ISDN (Cisco 1003 and 1004) [10]														
PPP														
SMDS (Cisco 1005 only)														
Switched 56 (Cisco 1005 only)														
X.25														
SLIP (Cisco 1005 only)			–	–			–	–	–	–	–	–	–	–
WAN Optimization														
Bandwidth-on-demand (Cisco 1003 and 1004)														
Custom and priority queuing														
Dial backup														
Dial-on-demand[11]														
Header[12] and link compression[13]														–
Payload compression (Cisco 1005 only)[14]														
Snapshot routing[15]														
Weighted fair queuing				–										–

	Cisco 1003, Cisco 1004, and Cisco 1005 Feature Sets[1]													
Features	**IP Routing[2]**				**IP/IPX Routing[2, 3]**			**IP/Appletalk Routing[2, 3]**			**IP/IPX/Appletalk Routing[4]**			
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**10.3**
IP Routing														
Enhanced IGRP														
Enhanced IGRP Optimizations		–	–	–		–	–		–	–		–	–	–
IGRP														
Network Address Translation Table (NAT)	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
On Demand Routing (ODR)		–	–	–		–	–		–	–		–	–	–
OSPF	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
OSPF Not-So-Stubby-Areas (NSSA)	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
OSPF On Demand Circuit (RFC 1793)	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
PIM	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
RIP														
RIP Version 2			–	–			–			–			–	–
Other Routing														
AURP	–	–	–	–	–	–	–	Plus	–	–	Plus	–	–	–
IPX RIP	–	–	–	–				–	–	–				–
NLSP	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
SMRP	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
RTMP	–	–	–	–	–	–	–							
Multimedia and Quality of Service														
Random Early Detection (RED)	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
Resource Reservation Protocol (RSVP)	Plus	–	–	–	Plus	–	–	Plus	–	–	Plus	–	–	–
Management														
ClickStart			–	–			–			–			–	–
HTTP Server			–	–			–			–			–	–
SNMP														
Telnet														

	Cisco 1003, Cisco 1004, and Cisco 1005 Feature Sets[1]													
Features	**IP Routing[2]**				**IP/IPX Routing[2, 3]**			**IP/Appletalk Routing[2, 3]**			**IP/IPX/Appletalk Routing[4]**			
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**10.3**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.0**	**10.3**
Security														
Access lists														
Access security														
Extended access lists														
Lock and key			–	–			–			–			–	–
Network-layer encryption, (export controlled 40-bit and 56-bit DES)	Encrypt	–	–	–	Encrypt	–	–	Encrypt	–	–	Encrypt	–	–	–
Router authentication	Encrypt	–	–	–	Encrypt	–	–	Encrypt	–	–	Encrypt	–	–	–
TACACS+[16]		–	–	–		–	–		–	–		–	–	–

1. This table lists feature sets that are common to the Cisco 1003, Cisco 1004, and Cisco 1005. For Cisco 1005 platform-specific feature sets, see Table 18.
2. The IP, IP/IPX, and IP/Appletalk feature sets are not available with Plus, Plus 40, or Plus 56 feature set options in Cisco IOS Release 11.2.
3. The IP/IPX and IP/Appletalk feature sets are available with Cisco IOS Release 11.0(4) and later releases.
4. In Cisco IOS Release 10.3, for the Cisco 1005, the IP/IPX/Appletalk feature set offers three feature set options: Option 1 includes HDLC, PPP, SDMS, and Frame Relay, but not X.25, and is available on all feature sets; Option 2 includes X.25 only, and is available with the IP/IPX, IP/Appletalk, and IP/IPX/Appletalk feature sets; and Option 3 includes Asynch, PPP, and SLIP and is available with the IP, IP/IPX features sets. In Cisco Release 11.0, only Option 1 and Option 2 were available.
5. Appletalk load balancing is available in Cisco IOS Release 11.2.
6. IRB supports IP, IPX, and AppleTalk; it is supported for transparent bridging, but not for SRB; it is supported on all media-type interfaces except X.25 and ISDN bridged interfaces; and IRB and concurrent routing and bridging (CRB) cannot operate at the same time.
7. In Cisco IOS Release 11.2, the Novell IPX feature includes display SAP by name, IPX Access Control List violation logging, and plain-English IPX access lists.
8. With Cisco IOS Release 11.2, transparent and translational bridging is fast switched. This enhancement is on by default, but can be disabled.
9. In Cisco IOS Release 11.1 and later releases, Cisco 1005 “WAN Services” offers three feature set options: Option 1 includes HDLC, PPP, SDMS, and Frame Relay, but not X.25, and is available on all feature sets; Option 2 includes X.25 only, and is available with the IP/IPX, IP/Appletalk, and IP/IPX/Appletalk feature sets; and Option 3 includes Asynch, PPP, and SLIP and is available with the IP, IP/IPX features sets. In Cisco Release 11.0, only Option 1 and Option 2 were available. In Cisco IOS Release 10.3, see footnote 4 above.
10. ISDN support includes calling line identification (CLI/ANI), ISDN subaddressing, and applicable WAN optimization features.
11. Dial-on-demand is available for the Cisco 1005 with “WAN Services” Option only. See footnote 9 above.
12. IPX header compression (RFC 1553) is available in the feature sets that support IPX in Cisco IOS Release 11.1(1) and later releases.
13. X.25 and Frame Relay payload compression. Frame Relay payload compression is available in Cisco IOS Release 11.0(4) and later releases for the Cisco 1005.
14. The IP/Appletalk feature set in Cisco IOS Release 10.3 for the Cisco 1005 supports header and link compression, but not header, link and payload compression.
15. Snapshot routing is not included in Cisco IOS Release 11.1 and later releases for the Cisco 1005.
16. With Cisco IOS Release 11.2, TACACS+ Single Connection and TACACS+ SENDAUTH enhancements are supported.

Table 18 Cisco IOS Release 11.2, 11.1, and 11.0 Feature Sets— Platform-Specific Cisco 1005

	Cisco 1005 Platform-Specific Feature Sets						
Features	**IP/OSPF/PIM Routing[1]**			**IP/Asynch[1]**		**IP/IPX/Asynch[1]**	
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.2**	**11.1**
LAN Support							
AppleTalk 1 and 2	–	–	–	–	–	–	–
GRE							
Integrated routing and bridging (IRB)[2]		–	–		–		–
IP							
Novell IPX[3]	–	–	–	–	–		
Transparent and translational bridging[4]							
WAN Services[5]							
Asynch	–	–	–				
Dialer profiles		–	–		–		–
Frame Relay				–	–	–	–
Frame Relay traffic shaping		–	–	–	–	–	–
HDLC				–	–	–	–
PPP[6]							
SMDS				–	–	–	–
Switched 56				–	–	–	–
X.25[7]				–	–	–	–
SLIP	–	–	–				
WAN Optimization							
Custom and priority queuing							
Dial-on-demand[8]							
Header[9], link and payload compression [10]							
Snapshot routing[11]							
Weighted fair queuing							
IP Routing							
Enhanced IGRP							
Enhanced IGRP Optimizations	–	–	–				
IGRP							
On Demand Routing (ODR)		–	–		–		–
OSPF				–	–	–	–
OSPF Not-So-Stubby-Areas (NSSA)		–	–	–	–	–	–
OSPF On Demand Circuit (RFC 1793)		–	–	–	–	–	–
PIM				–	–	–	–
RIP							
RIP Version 2			–				

	Cisco 1005 Platform-Specific Feature Sets						
Features	**IP/OSPF/PIM Routing[1]**			**IP/Asynch[1]**		**IP/IPX/Asynch[1]**	
Cisco IOS Releases	**11.2**	**11.1**	**11.0**	**11.2**	**11.1**	**11.2**	**11.1**
Other Routing							
IPX RIP	–	–	–	–	–		
Management							
ClickStart		–	–		–		–
HTTP Server		–	–		–		–
SNMP							
Telnet							
Security							
Access lists							
Access security							
Extended access lists							
Kerberos V client support	–	–	–	–	–	–	–
Lock and key			–				
TACACS+[12]		–	–		–		–

1. These feature sets are not available with the Plus, Plus 40, or Plus 56 feature set options in Cisco IOS Release 11.2.
2. IRB supports IP, IPX, and AppleTalk; it is supported for transparent bridging, but not for SRB; it is supported on all media-type interfaces except X.25 and ISDN bridged interfaces; and IRB and concurrent routing and bridging (CRB) cannot operate at the same time.
3. In Cisco IOS Release 11.2, the Novell IPX feature includes display SAP by name, IPX Access Control List violation logging, and plain-English IPX access lists.
4. With Cisco IOS Release 11.2, transparent and translational bridging is fast switched. This enhancement is on by default, but can be disabled.
5. In Cisco IOS Release 11.1 and later releases, Cisco 1005 "WAN Services" offers three feature set options: Option 1 includes HDLC, PPP, SDMS, and Frame Relay, but not X.25, and is available on all feature sets; Option 2 includes X.25 only, and is available with the IP/IPX, IP/Appletalk, and IP/IPX/Appletalk feature sets; and Option 3 includes Asynch, PPP, and SLIP and is available with the IP, IP/IPX features sets. In Cisco Release 11.0, only Option 1 and Option 2 were available. In Cisco IOS Release 10.3, see footnote 2 above.
6. PPP includes support for LAN protocols supported by the feature set, address negotiation, PAP and CHAP authentication, and PPP compression. Multilink PPP is included with Cisco IOS Release 11.0(4) and later releases.
7. X.25 is available for the Cisco 1005 only and is available by itself in "WAN Services" Option 2 in Cisco IOS Release 11.0 and later releases for the following feature sets: IP/IPX, IP/Appletalk, and IP/IPX AppleTalk.
8. Dial-on-demand is available for the Cisco 1005 with "WAN Services" Option only.
9. IPX header compression (RFC 1553) is available in the feature sets that support IPX in Cisco IOS Release 11.1(1) and later releases.
10. X.25 and Frame Relay payload compression. Frame Relay payload compression is available in Cisco IOS Release 11.0(4) and later releases.
11. Snapshot routing is not included in Cisco IOS Release 11.1 and later releases for the Cisco 1005.
12. With Cisco IOS Release 11.2, TACACS+ Single Connection and TACACS+ SENDAUTH enhancements are supported.

Table 19 Cisco IOS Client Feature Sets—Cisco 1001 LAN Extenders

Category	LAN Extension
LAN support	LAN extension
WAN services	PPP
WAN optimization	Priority queuing, protocol filtering
Management	At central site on host router

Cisco IOS Software Features

Although there are two forms of Cisco IOS software packaging—traditional software packaging and software feature set packaging—the features are the same. Therefore, the descriptions in this section are applicable to both software packages.

Protocols

- TCP/IP (Transmission Control Protocol/Internet Protocol)

  Cisco provides the following TCP/IP features: Internet Protocol (IP) access lists, IP Security Option (IPSO), IP accounting, SNMP, Serial Line Internet Protocol (SLIP), Address Resolution Protocol (ARP), Domain Name System (DNS) support, ICMP support, and Internet Group Management Protocol (IGMP). Cisco supports both TCP and User Datagram Protocol (UDP) at the transport layer for maximum flexibility in services.

  IP supports such common applications as mail, terminal emulation, and file transfer, including File Transfer Protocol (FTP), and Telnet. It also supports the ARP and Reverse Address Resolution Protocols (RARP).

  Cisco IOS Releases 10.0 and later support Department of Defense Intelligence Information System Network Security for Information Exchange (DNSIX) extended IPSO processing enhancements and the two kinds of extended IPSO fields defined by the DNSIX 2.1 specification. Cisco IOS Release10.0 also introduced Hot Standby Router Protocol (HSRP), which detects when the designated active router fails. At this point, a selected standby router assumes control of the HSRP group's Media Access Control (MAC) and IP address.

  Cisco IOS Release 10.3 introduced support for the following features: MultiGroup Hot Standby Router Protocol, NHRP, Type of Service (TOS) Queuing, Cisco Discovery Protocol (CDP), and BGP Communities. MultiGroup Hot Standby Protocol allows multiple routers on a LAN to provide fast backup for each other, providing increased redundancy and enhanced fault tolerance. NHRP allows routers to dynamically discover data link addresses for other routers on a WAN cloud. TOS Queuing allows an application to specify the quality of service each packet should receive, allowing one to maintain control over the quality of service for different types of traffic. CDP is a network-layer, protocol-independent feature that allows two devices that do not share a common network-layer protocol to dynamically discover each other. Support for BGP Communities allows destinations in BGP to be grouped into communities and allows routing decisions to be based on these communities. This results in increased network scalability.

Cisco IOS Release 11.0 introduced support for the following features: Route Authentication with MD5, Policy-Based Routing, IP ACL (Access Control List) Violation Logging, and Weighted Fair Queuing. The Routing Authentication feature provides a method of authenticating routing updates using the Message Digest 5 (MD5) encryption algorithm. This public-domain algorithm is defined in RFC 1321. Policy-Based Routing provides the ability to route packets differently based on the characteristics of the traffic. With this feature, customers are able to implement routing policies based on source and/or destination IP addresses, TCP port numbers, and/or packet lengths. With IP ACL Violation Logging, routers can use existing router logging facilities to log IP ACL violations whenever a packet matches a particular access list entry, providing more proactive network security. Weighted Fair Queuing is a sophisticated traffic priority management algorithm that identifies conversations (traffic streams) and then breaks up the trains of packets belonging to each conversation to ensure that the capacity is shared fairly between individual conversations. The algorithm automatically sorts among conversations without the need for the user to define access lists. Weighted Fair Queuing provides an automated way to stabilize network behavior during congestion and results in increased performance and reduced retransmission.

Cisco IOS Release 11.1 introduced support for the following features: NHRP on IPX, Fast Install for Static Routes, Fast-Switched GRE, and RIPv2. With support for NHRP on IPX, customers can dynamically resolve IPX addresses in large scale WAN environments in addition to resolving IP addresses. Fast Install for Static Routes ensures that a floating static route is installed as soon as either the routing protocol or interface reports a loss of connectivity. This fast floating static route installation provides faster convergence when utilizing dial-on-demand circuits to back up, for example, a leased-line or frame relay service. While RIPv2 shares the same basic algorithms as RIPv1, it supports several new features including subnet masks, authentication, multicasting, and external route tags. With RIPv2, customers choosing to implement RIP may now make much more efficient use of their allocated address space by implementing Variable Length Subnet Masks (VLSM) within their networks.

Cisco IOS Release 11.2 introduces support for the following features: On Demand Routing (ODR), OSPF On Demand Circuit (RFC1793), OSPF Not-So-Stubby-Areas (NSSA), BGP4 soft configuration, BGP4 multipath support, BGP4 prefix filtering with inbound route maps, Network Address Translation (NAT), Named IP access control list (ACL), and integrated routing and bridging (IRB).

- ODR provides minimum-overhead IP routing for stub sites. Stub routers (usually low end routers with limited memory and CPUs that have low-speed connections) commonly have a WAN connection to the hub router and a small number of LAN network segments (stub networks) that are connected directly to the stub router. ODR minimizes the configuration and bandwidth overhead required to provide full routing connectivity. Moreover, it eliminates the need to configure an IP routing protocol at the stub routers.
- OSPF On-Demand Circuit (RFC1793) is an enhancement to the OSPF protocol, as described in RFC 1793, that allows efficient operation over demand circuits such as ISDN, X.25 SVCs, and dial-up lines. OSPF On-Demand Circuit is ideally suited to network infrastructures with an OSPF backbone and peripheral sites connecting to the central backbone network. The feature allows the consolidation on a single routing protocol and the benefits of the OSPF routing protocol across the entire network, without incurring excess connection costs.

- NSSA allows stub areas to import external OSPF routes in a limited fashion, so that OSPF can be extended across the stub to the backbone connection and logically become part of the same network. As with regular stub areas, this can be deployed in conjunction with multiple area border routers (ABRs), and NSSA ABRs can inject a default route into the NSSA.
- BGP4 soft configuration allows BGP4 policies to be configured and activated without clearing the BGP session, hence without invalidating the forwarding cache. This enables policy reconfiguration without causing short-term interruptions to traffic being forwarded in the network. This prevents periods of instability within an autonomous system (AS) when administrators need to modify their policies.
- BGP4 multipath support provides BGP load balancing between multiple exterior BGP (EBGP) sessions. If there are multiple EBGP sessions between the local AS and the neighboring AS, multipath support allows BGP to load balance among these sessions. Depending on the switching mode, per packet or per destination load balancing is performed.
- BGP4 prefix filtering with inbound route maps allows the network administrator to specify the level of summarization or aggregation that will be accepted in an advertised network prefix from a neighboring AS. This allows prefix-based matching support to the inbound neighbor route map. With this addition, an inbound route map can be used to enforce prefix-based policies.
- Network Address Translation (NAT) provides a mechanism for a privately addressed network to access registered networks, such as the Internet, without requiring a registered subnet address. This eliminates the need for host renumbering and allows the same IP address range to be used in multiple intranets. Translations can be static or dynamic in nature.
- The named IP ACL feature gives network managers the option of using names for their access control lists. Named IP ACLs function similarly to their numbered counterparts, except that they use names instead of numbers. This feature eliminates some of the confusion associated with maintaining long access control lists and removes the limit of 100 extended and 99 standard access control lists, so that additional IP access control lists can be configured.
- Integrated routing and bridging (IRB) delivers the functionality to extend VLANs and Layer 2 bridged domains across the groups of interfaces on Cisco IOS software-based routers and interconnect them to the routed domains within the same router. This represents another integral component of the Cisco Fusion architecture for scalable and efficient integration of Layer 2 and Layer 3 environments in multiprotocol networks.

  Currently, IRB supports three protocols: IP, IPX, and AppleTalk, in both fast switching and process switching modes. Current considerations include the following: IRB is not supported on Cbus platforms (the AGS+ and Cisco 7000 series); IRB is supported for transparent bridging, but not for source route bridging; IRB is supported on all media-type interfaces except X.25 and ISDN bridged interfaces; IRB and concurrent routing and bridging (CRB) cannot operate at the same time.

- ISO CLNS (International Organization for Standardization Connectionless Network Service)

  Cisco supports packet forwarding and routing for the ISO CLNS protocol, which is a standard for the network layer of the Open Systems Interconnection (OSI) model.

  Cisco supports the following standards: ISO 9542 (End System-to-Intermediate System [ES-IS] protocol routing), ISO 8473 (Connectionless Network Protocol [CLNP]), ISO 8348/Ad2 (network service access points [NSAP]), and ISO 10589 (Intermediate System-to-Intermediate System [IS-IS] protocol routing).

  Cisco IOS Release 10.3 introduced support for OSI/CLNS dial-on-demand routing (DDR).

- CMNS (Connection-Mode Network Service)

  Cisco's support of CMNS allows local X.25 switching to be extended to different media (Ethernet, Token Ring, and FDDI) with the use of OSI-based NSAP addresses. Cisco's implementation of CMNS runs X.25 (packet level) over Logical Link Control, type 2 (LLC2) (frame level) and supports ISO 8208 (packet level) and 8802-2 (frame level) standards.

- DECnet Phase IV and Phase V

  DECnet support on Cisco routers includes local- and wide-area DECnet Phase IV and V routing over Ethernet, Token Ring, FDDI, and serial lines. Cisco IOS Releases 10.0 and later also support Phase IV Prime.

  Cisco IOS Release 10.3 introduced support for the following features: DECnet dial-on-demand routing (DDR), Dynamic DECnet Route Advertisements, and DECnet Host Name to Address Mapping. DECnet DDR supports static routing of the DECnet IV protocol. Support for Dynamic DECnet Route Advertising provides routing within networks that are migrating from DECnet Phase IV to DECnet/Phase V). Name to Address Mapping allows one to assign mnemonic host names to DECnet host addresses.

  Cisco IOS Release 11.1 introduced support for Target Address Resolution Protocol (TARP). TARP provides networking support for applications (typically used by telephone companies) running on SONET devices.

- Novell IPX

  Cisco's implementation of Novell's Internetwork Packet Exchange (IPX) protocol has been certified as providing full IPX functionality (Cisco IOS Releases 10.0 and later). A Cisco router connects Ethernet, Token Ring, and FDDI networks, either directly or through high-speed serial lines (56 kbps to T1 speeds), X.25, or Frame Relay. Cisco IOS Releases 10.0 and later support Enhanced IGRP.

  Cisco IOS Release 10.3 introduced support for NLSP, IPXWAN 2.0, and IPX Floating Static Routes. NLSP, designed and specified by Novell, is more efficient and scalable than IPX RIP routing and can be used to replace the existing SAP protocol as a more efficient way of conveying Service Advertisement information. IPXWAN provides Novell interoperability over T1, Frame Relay, X.25, and ISDN circuits. Floating Static Routes make it possible to design and build very flexible and robust routing topologies.

Cisco IOS Release 11.0 introduced support for SPX Spoofing. With this feature, Novell clients and servers create their own "watchdog keepalive" packets at a user-defined rate. SPX Spoofing receives, recognizes, and successfully acknowledges these packets at both the client and server ends of a wide-area link. Requests for the transmission of legitimate information triggers the dial-up connection, resulting in decreased WAN costs.

Cisco IOS Release 11.1 introduced support for the following features: Enhanced IGRP to NLSP Route Redistribution, Input Access Lists, Per-Host Load Balancing, NLSP Route Aggregation, Raw FDDI IPX Encapsulation, and IPX Header Compression. Enhanced IGRP to NLSP Route Redistribution is the method by which routing information is passed between Enhanced IGRP and NLSP routing domains in IPX networks. Through the use of Enhanced IGRP to NLSP Route Redistribution, users may now select the routing protocol, or combination of routing protocols, which meets their needs. For example, an IPX network can now be built that uses a combination of RIP and NLSP on the NetWare servers and uses Enhanced IGRP as the single backbone protocol. IPX Input Access Lists provide added flexibility in building secure IPX networks. They can be used to validate user information at the borders of networks and build more sophisticated firewalls. Per-Host Load Sharing is a load sharing process that transmits successive packets (or a traffic stream) for a given destination host over the same path when multiple equal-cost paths are present. Since Per-Host Load Sharing sends all packets destined for an end host over the same media interface, the likelihood of packets being received out of order is greatly reduced, thus minimizing retransmissions and network overhead.

NLSP Route Aggregation provides the ability to divide IPX networks into multiple NLSP areas and allows routing information in properly designed hierarchically addressed networks to be shared between areas in a much more efficient manner. Cisco IOS Release 11.1 introduced router support for an additional IPX encapsulation on FDDI media. This encapsulation, FDDI_RAW, is most often encountered when bridges or switches are used to connect Ethernet-based Novell networks using the 802.3_Ethernet encapsulation to FDDI based networks. By implementing FDDI_RAW encapsulation, Cisco makes it possible to recognize and route these packets, either to other LAN or WAN media, or back onto FDDI in one of the Novell approved FDDI formats. Routing support for FDDI_RAW can eliminate the requirement of changing Ethernet encapsulation on servers and clients when deploying switched internetworks. IPX Header Compression, described in RFC 1553, permits the compression of IPX packet headers over various WAN media. This can reduce header information from 30 bytes down to as little as 1 byte in size, resulting in saved bandwidth and reduced costs associated with IPX routing over WAN links.

Cisco IOS Release 11.2 introduces several new Novell IPX features including Display SAP by Name, IPX Access Control List (ACL) violation logging, and Plain-English IPX Access Lists.

— Display SAP by Name

  Display SAP by Name allows network managers to display SAP entries that match a particular server name or other specific value. The current command that displays IPX servers has been extended to allow the use of any regular expression (including supported special characters) for matching against the router's SAP table. By providing network managers with the ability to more effectively display SAP table entries, network diagnostic and maintenance costs can be reduced.

— IPX Access Control List Violation Logging

IPX Access Control List violation logging allow routers to use existing router logging facilities to log IPX ACL violations whenever a packet matches a particular access-list entry. The first packet to match an entry is logged immediately; updates are sent at approximately five-minute intervals.

This feature allows logging of source and destination addresses, source and destination socket numbers, protocol (or packet) type (for example, IPX, SPX, or NCP), and action taken (permit/deny).

Along with the responsibility for controlling the flow and accessibility of information in today's networks, network managers are increasingly challenged with detecting and correcting breaches of network security. IPX ACL violation logging provides a method of establishing a centralized reporting system in order to provide early notification of attempted unauthorized access.

— Plain-English IPX Access Lists

With Plain-English IPX Access Lists, the most common protocol and socket numbers used in IPX extended ACLs can be specified by either name or number (as opposed to just the cryptic numbers required in the past.)

Protocol types supported include RIP, SAP, NCP, and NetBIOS. Supported socket types include Novell Diagnostics Packet Enhanced IGRP and NLSP.

Plain-English IPX Access Lists greatly reduce the complexity and readability of IPX extended access control lists, reducing network management expense by making it easier to build and analyze the access control mechanisms used in IPX networks. By reducing the complexity of the commands, it is easier than ever to control the security and accessibility of IPX network resources.

- AppleTalk Phase 1 and Phase 2

Cisco routers support AppleTalk Phase 1 and AppleTalk Phase 2. For AppleTalk Phase 2, Cisco routers support both extended and nonextended networks. Cisco's implementation of AppleTalk can route packets over Ethernet, Token Ring, and FDDI LANs and over X.25, High-Level Data Link Control (HDLC), Frame Relay, and SMDS WANs.

Cisco also offers enhancements to AppleTalk, including support for MacIP, IPTalk, and SNMP over AppleTalk.

Cisco's implementation of AppleTalk supports the following routing protocols:

— Routing Table Maintenance Protocol (RTMP)

— AppleTalk Update-Based Routing Protocol (AURP) (Cisco IOS Releases 10.2 and later)

The AURP is a standard Apple Computer routing protocol that provides enhancements to the AppleTalk routing protocols that are compatible with AppleTalk Phase 2. The primary function of AURP is to connect two or more noncontiguous AppleTalk internets that are separated by a non-AppleTalk network, such as IP. In these configurations, you would want to use AURP instead of RTMP, because AURP broadcasts fewer data packets than RTMP.

— Enhanced IGRP (Cisco IOS Releases 10.0 and later)

Cisco IOS Release 10.3 introduced support for AppleTalk Inter-Enterprise Routing. This feature allows for autonomous address administration among internetworks/domains in an enterprise network and provides reduced hop counts when traversing the network.

Cisco IOS Release 11.0 introduced support for the following features: AppleTalk Name Binding Protocol (NBP) Filtering, AppleTalk Floating Static Routes, and SMRP. AppleTalk NBP Filtering allows network administrators to use Cisco routers to build firewalls, dial-on-demand triggers, and queuing options based on any designed NBP type or object. A "floating static route" is a statically configured route that can be overridden by dynamically learned routing information. Thus, a floating static route can be used to create a "path of last resort" that is used only when no dynamic information is available. Floating static routes make it possible to design and build very flexible and robust routing topologies. The Simple Multicast Routing Protocol (SMRP) provides multicast routing functions for AppleTalk traffic. Applications produced by Apple Corporation, such as QuickTime Conferencing (QTC), will require support for SMRP. As a result, Cisco and Apple have partnered, and Cisco has become the first internetworking vendor to license the SMRP technology. In the future, Apple will support QTC on IP networks using IP Multicast. Network administrators will be able to use SMRP for QTC over AppleTalk and IP Multicast for QTC over IP.

Cisco IOS Release 11.2 introduces the AppleTalk load balancing feature. This feature allows AppleTalk data traffic to be distributed more evenly across redundant links in a network. AppleTalk load balancing can reduce network costs by allowing more efficient use of network resources. Network reliability is improved because the chance that network paths between nodes will become overloaded is reduced. For convenience, load balancing is provided for networks using native AppleTalk routing protocols such as Routing Table Maintenance Protocol (RTMP) and Enhanced IGRP. AppleTalk load balancing operates with both process and fast switching.

Cisco IOS Release 11.1 introduced support for SMRP fast switching.

- Banyan VINES

  Cisco's implementation of Banyan's Virtual Integrated Network Service (VINES) provides routing of VINES packets on all media types. Although the software automatically determines a metric value that it uses for routing updates based on the delay set for the interface, this software implementation allows you to customize the metric. Cisco's implementation also offers address resolution to respond to address requests and broadcast address propagation. MAC-level echo support is also available for Ethernet, IEEE 802.2, Token Ring, and FDDI media. Name-to-address mapping for VINES host names is also supported, as are access lists to filter packets to or from a specific network.

  Cisco's implementation of VINES supports Routing Table Protocol (RTP) and Sequenced Routing Update Protocol (SRTP).

  Cisco IOS Release 10.3 introduced support for Banyan VINES DDR.

  Cisco IOS Release 11.0 provides support for Floating Static Routes. A "floating static route" is a statically configured route that can be overridden by dynamically learned routing information. Thus, a floating static route can be used to create a "path of last resort" that is used only when no dynamic information is available. Floating static routes make it possible to design and build very flexible and robust routing topologies. One important application of floating static routes is to provide backup routes in topologies where dial-on-demand routing is used.

- XNS

  Cisco provides a subset of the XNS protocol stack to support XNS routing. XNS traffic can be routed over Ethernet, FDDI, and Token Ring LANs, as well as over point-to-point serial lines running HDLC, Link Access Procedure, Balanced (LAPB), X.25, Frame Relay, or SMDS.

- Apollo Domain

  The Apollo Domain routing protocol is the native-mode networking protocol for Apollo workstations. The Cisco routing software implementation supports packet forwarding and routing for the Apollo Domain network protocols on Ethernet, FDDI, and serial interfaces using HDLC or X.25 encapsulation.

- HP Probe

  Cisco supports HP Probe Proxy. HP Probe is a unique set of protocols that perform resolution of machine names down to physical IEEE 802.3 addresses. Support of HP Probe Proxy eliminates the need for an HP Probe/Proxy server on every IEEE 802.3 segment containing HP hardware. Thus a Cisco internetwork server can act as an HP Probe/Proxy server for every IEEE 802.3 segment it is attached to, saving valuable machine resources and allowing for easier configuration.

- Multiring

  Multiring protocol allows SRB to be used as a framing mechanism. It allows any Layer 3 protocol packet (IP, IPX, AT, VINES, and so forth) to be framed as SRB packets. Specifically, multiring enables an interface to use the routing information field (RIF) for routing between SRB and routed networks. Multiring is commonly used for Token Ring IPX networks.

Network Management

Cisco IOS Release 11.2 introduces two new network management features:

- HTTP Server

  HTTP Server is an HTML management tool that allows you to navigate through the command-line interface (CLI) via Web-like hot links. You can monitor your routers through an HTML interface to the command-line interface. You can also modify your Web page to add frequently used hot links or to add your company logo.

  HTTP Server on a Cisco 7200 series router provides a logical view of the hardware configuration. You can point and click on interfaces to check their status or to modify the configuration.

- ClickStart

  ClickStart is a powerful new Web-based software solution that enables users to install a Cisco router in minutes. ClickStart enables Cisco 1000 series ISDN access routers to be accessed by any Web browser on any desktop platform including Microsoft Windows, Windows 95, Windows NT, UNIX and, MacOS. The easy-to-use Web-based interface guides you through the router installation process. By completing an initial setup form, you can easily configure the router and bring up the ISDN network connection. The router is then manageable from a central location, so that fine-tuning and upgrades can be performed remotely. ClickStart is only available on Cisco access products.

Multimedia and Quality of Service

Cisco IOS Release 11.2 introduces a new category of software features that support multimedia applications and the increased service quality needed to run these applications. The features include the following:

- Resource Reservation Protocol (RSVP)

  RSVP enables applications to dynamically reserve necessary network resources from end-to-end for different classes of service. RSVP enables applications with real-time traffic needs, such as multimedia applications, to coexist with bursty applications on the same network. RSVP works with both unicast and multicast applications. Multimedia applications can coexist with bursty applications on the same network. Parallel networks are not required to support different applications; new multimedia applications can be supported while continuing to support legacy applications.

- Random Early Detection (RED)

  RED helps eliminate network congestion during peak traffic loads. RED uses the characteristics of robust transport protocols (such as TCP) to reduce transmission volume at the source when traffic volume threatens to overload a router's buffer resources. RED works with RSVP to maintain end-to-end quality of service during peak traffic loads. Congestion is avoided by selectively dropping traffic during peak load periods. This is performed in a manner designed to damp out waves of sessions going through TCP slow start.

- Generic Traffic Shaping

  Generic Traffic Shaping (also called Interface Independent Traffic Shaping) helps reduce the flow of outbound traffic from a router interface into a backbone transport network when congestion is detected in the downstream portions of the backbone transport network or in a downstream router. Generic Traffic Shaping works on interfaces to a variety of Layer 2 data link technologies (including Frame Relay, SMDS, Ethernet, and so forth.). Generic Traffic Shaping helps eliminate bottleneck situations by throttling back traffic volume at the source end of the network.

Secure Data Transmission

Cisco IOS Release 11.2 introduces two new data transmission security features, router authentication and network-layer encryption. With these new features, you can now run high assurance, confidential connections over public or untrusted IP networks. These features can be used to build multiprotocol virtual private networks (VPNs), using encrypted generic routing encapsulation (GRE) tunnels. Router authentication and network-layer encryption can also be used to deploy secure telecommuting services, intranet privacy, and virtual collaborative or community-of-interest networks.

- Router Authentication

  Router authentication enables two routers to perform a one-time, two-way authentication by exchanging Digital Signature Standard (DSS) public keys prior to passing encrypted traffic. The hash signatures of these keys are compared to authenticate the routers and allow the data to pass.

- Network-Layer Encryption

  With network-layer encryption, routers use Diffie-Hellman key exchange to securely generate a Data Encryption Standard (DES) 40- or 56-bit session key. New session keys are generated on a configurable basis. Encryption policy is set by "crypto-maps" that use extended IP access lists to define which network, subnet, host, or protocol pairs are to be encrypted between routers.

  Network-layer encryption and router authentication are packaged in the Encryption 40 and Plus 40 (40-bit encryption) or Encryption 56 and Plus 56 (56-bit encryption) feature sets in Cisco IOS Release 11.2.

IBM Support

- SRB (source-route bridging)

  Source-route bridging is used primarily in IBM environments. The Cisco router acts simultaneously as a level 3 router and a level 2 source-route bridge. This allows protocols such as IPX and XNS to be routed on Token Rings. For Token Ring support in non-IBM environments, multiring provides an alternative (see "Protocols" above).

- TLB (source-route translational bridging)

  Bridges packets between a source-route bridging domain and a transparent bridging domain. A software "bridge" is created between a specified virtual ring group and a transparent bridge group.

  In Cisco IOS Release 11.2, TLB is fast switched. No queuing is done, and resource utilization is low. This enhancement is on by default, but can be disabled. It is supported across all router platforms.

  Fast switched SR/TLB improves performance on all platforms by a factor of at least 2, and for the Cisco 4500 and Cisco 4700, by a factor of 3. It is ideal for IBM environments (for example, where low-cost Ethernet adapters are being installed on campus, but Token Ring connectivity to a FEP is still required), and for campus environments with a mix of Token Ring and Ethernet LANs and/or switches that rely on the Cisco IOS software for translational bridging.

- SRT (source-route transparent bridging)

  SRT is the concurrent operation of source-route bridging and transparent bridging on the same interface.

- IBM RSRB (remote source-route bridging)

  Cisco's support of RSRB supports SNA traffic in a LAN environment. RSRB provides encapsulation of SNA, with features that allow routing around link failure, overcome hop count problems, reduce broadcast messages, eliminate time-outs, and offer a broad selection of media alternatives.

- IBM SDLC (Synchronous Data Link Control) integration

  Cisco supports SDLC by either serial tunneling (STUN) of SNA traffic, or SDLLC, which converts SDLC to the LLC2 protocol (including Ethernet, Token Ring, and FDDI) and allows RSRB to be used for transport. SDLC integration provides availability and scalability enhancements similar to RSRB.

- IBM DLSw+ (Data Link Switching Plus) (Cisco IOS Release 10.3(2) and later)

  Cisco supports standardized Data Link Switching for interoperability with other vendors, but has added features on top of the standard to improve availability, scalability, and performance. DLSw+ encapsulates SNA in TCP/IP, allowing SNA traffic to participate in multiprotocol networks. DLSw+ allows alternate methods of encapsulation and provides features such as Border Peer, which reduces TCP/IP connections, and therefore network traffic.

  Cisco IOS Release 11.2 introduces several enhancements and new features to DLSw+:

  — LAN Network Manager (LNM) over DLSw+

    LNM over DLSw+ allows DLSw+ to be used in Token Ring networks that are managed via IBM's LNM software. Using this feature, LNM can be used to manage Token Ring LANs, Control Access Units (CAUs), and Token Ring attached devices over a DLSw+ network. All management functions continue to operate as they would in an RSRB network or source route bridged network.

  — Native Service Point (NSP) over DLSw+

    NSP over DLSw+ allows Cisco's NSP feature to be used in conjunction with DLSw+ in the same router. Using this feature, NSP can be configured in remote routers, and DLSw+ can provide the path for the remote service point PU to communicate with NetView. This allows full management visibility of resources from a NetView 390 console, while concurrently offering the value-added features of DLSw+ in an SNA network.

  — Down Stream Physical Unit (DSPU) over DLSw+

    DSPU over DLSw+ allows Cisco's DSPU feature to operate in conjunction with DLSw+ in the same router. DLSw+ can be used either upstream (toward the mainframe) or downstream (away from the mainframe) of DSPU.

    DSPU concentration consolidates the appearance of up to 255 physical units into a single PU appearance to virtual telecommunications access method (VTAM), minimizing memory and cycles in central site resources (VTAM, NCP, and routers) and speeding network startup. Used in conjunction with DLSw+, network availability and scalability can be maximized.

  — Advanced Peer-to-Peer Networking (APPN) over DLSw+

    APPN over DLSw+ allows Cisco's APPN feature to be used in conjunction with DLSw+ in the same router. With this feature, DLSw+ can be used as a low-cost way to access an APPN backbone or APPN in the data center. In addition, DLSw+ can be used as a transport for APPN, providing nondisruptive recovery from failures and high speed intermediate routing. In this case, the DLSw+ network appears as a connection network to the APPN network nodes.

  — Source Route Bridging (SRB) over FDDI to DLSw+

    SRB over FDDI to DLSw+ allows access to DLSw+ over source route bridged FDDI LANs. In the past, the supported local DLCs were only Token Ring, Ethernet, or SDLC. With this extension, Token Ring-attached devices can access a DLSw+ router using source route bridging over an FDDI backbone. At the remote site, the device can be attached over Token Ring, Ethernet, SDLC, or FDDI. This is useful either in environments with Token Ring switches that use FDDI as a campus backbone or environments with Cisco 7000 series and Cisco 7500 series routers providing SRB over an FDDI backbone.

- WAN optimization

  By caching NetBIOS names and routing information fields, discovery traffic is reduced across the WAN.

- SNA session availability

  SNA session availability is improved by providing the capability to route around network failures. Additionally, by providing local acknowledgment, fewer sessions are lost due to congestion.

- IBM Frame Relay (RFC 1490) (Cisco IOS Release 10.3(1) and later)

  Enhancing its Frame Relay RFC 1490 support, Cisco adds multiprotocol encapsulation for SNA. This allows direct attachment to IBM FEPs, as well as utilization of Frame Relay networks between routers, with minimal encapsulation overhead.

- DSPU (Downstream Physical Unit Concentration) (Cisco IOS Release 10.3(1) and later)

  DSPU support allows a Cisco router to act as a DSPU concentrator in SNA networks, eliminating the need for an SNA gateway to provide physical unit concentration. This support reduces the number of PU definitions required in the mainframe, which conserves mainframe resources, simplifies administration, and reduces polling overhead.

- IBM QLLC (Qualified Logical Link Control) (Cisco IOS Release 10.2(2) and later)

  QLLC allows SNA data to be transported over an X.25 network without requiring special X.25 software or hardware in the SNA devices. Cisco's support provides conversion to/from X.25 to LAN or SDLC protocols. This feature improves performance on X.25 backbones, reduces costs by eliminating FEP costs, and simplifies consolidation of traditional SNA networks with newer LAN internetworks.

- IBM mainframe channel attachment

  Cisco IOS Releases 10.2 and later support IBM's channel attachment technologies for attaching networks to mainframe channels. A mainframe channel is an intelligent processor that manages the protocol on the communications media and controls the transfer of data to and from main CPU storage. With Software Release 10.2, TCP/IP is supported over the channel.

  With Cisco IOS Release 11.0, subarea SNA and Advanced Peer-to-Peer Networking (APPN) are supported along with the capability to download TCP/IP to the CIP to reduce mainframe TCP/IP resources.

- Advanced Peer-to-Peer Networking (APPN) network node support

  Cisco IOS Releases 11.0 and later support IBM's APPN protocols. APPN provides native SNA routing between intelligent processors, without requiring a mainframe in the network. It provides dynamic directory services and topology updates, so that any APPN Network Node can locate resources and select the best path through the network based on SNA class of service (COS), which provides prioritization at an application level. APPN from Cisco provides support for legacy 3270 traffic across the APPN network through the Dependent LU Requestor (DLUR) support.

  Cisco IOS Release 11.1 introduced the following APPN data-link layer enhancements: APPN over ATM using RFC 1483, APPN over PPP using RFC 1661, APPN over SMDS using a Cisco-proprietary encapsulation, and APPN over ISDN using PPP and RFC 1661. These enhancements provide additional ways to transport APPN on a wide area network.

Cisco IOS Release 11.2 introduces two new APPN features and enhancements:

— APPN CRR (Central Resource Registration)

APPN CRR support allows a Cisco IOS software-based router acting as a network node to register the resources of end nodes to the Central Directory Service (CDS) on Advanced Communication Facility/Virtual Telecommunication Access Method (ACF/VTAM). A Cisco IOS network node will now register resource names with a VTAM CDS as soon as it establishes connectivity with it. Prior to this enhancement, the router acting as a network node could not register end node resources. ACF/VTAM could, however, query the router to find these resources.

— APPN Dependent Logical Unit Requester (DLUR) MIB

The existing APPN MIB does not contain information about Dependent Logical Units (DLUs) accessing the APPN network through the DLU Requester (DLUR) function in the Cisco IOS network node. A standard MIB for DLUR has been defined by the APPN Implementers Workshop (AIW), the standards body for APPN, and is implemented in this release of the Cisco IOS software.

- BSC (Binary Synchronous Protocol Tunneling)

With Cisco IOS Release 11.0, Bisync tunneling is provided on the Cisco 2500 series and Cisco 4000 series serial interfaces. With this feature, Bisync traffic can be consolidated with SNA and other protocol traffic by encapsulating Bisync in TCP/IP. In addition to consolidating traffic to provide reduced equipment and line costs, Bisync tunneling will enhance availability by providing the capability to automatically reroute around network failures and locally acknowledging messages to reduce timeouts.

- TN3270 Server

Cisco IOS Release 11.2 introduces TN3270 server. The TN3270 server is a new feature of the Channel Interface Processor (CIP) of the Cisco 7000 family of routers. The TN3270 server allows TN3270 clients access to IBM and IBM-compatible mainframes without the limitations of existing alternatives. It off-loads 100 percent of the TCP/IP and TN3270 cycles from the mainframe, and offers a robust, scalable, and dynamic implementation that meets the stringent requirements of the data center.

The TN3270 server on the CIP is an extremely scalable solution when compared to other alternatives on the market. It supports up to 8000 concurrent sessions, while most external gateway solutions can only support up to 1000-2000 sessions.

- Native Client Interface Architecture (NCIA) architecture

Cisco IOS Release 11.2 introduces NCIA, which provides access of IBM SNA applications over routed internetworks and has been enhanced to be more flexible and scalable. The NCIA client, implemented in the client workstation, encapsulates the full SNA stack inside TCP/IP packets. These packets are sent to the NCIA server implemented in Cisco IOS software. The NCIA server de-encapsulates the TCP/IP packet and sends the LLC data to the host processor via RSRB or DLSw+.

The NCIA server supports SNA and NetBIOS sessions over a variety of LAN and WAN connections, including dial-up connections. The NCIA architecture supports clients with full SNA stacks to provide all advanced SNA capabilities, unlike some split-stack solutions. The new NCIA server enhancements provide the following additional benefits:

- Client configuration is simplified. It is no longer necessary to predefine ring numbers, and the NCIA server supports optional dynamic assignment of MAC addresses. There is no Logical Link Control, type 2 (LLC2), at the client. The client is configured as an end station not a router peer.
- The solution is more scalable. The limit is based on the number of LLC connections in the central site router rather than RSRB peer connections.
- The protocol used between client and server is efficient.

- Response Time Reporter (RTR)

  Cisco IOS Release 11.2 introduces RTR, which allows you to monitor network performance, network resources, and applications by measuring response times and availability. RTR statistics can be used to perform troubleshooting, problem notifications, and pre-problem analysis. RTR offers enhanced functionality over a similar IBM product, NetView Performance Monitor.

  RTR enables the following functions to be performed:

  - Troubleshoot problems by checking the time delays between devices (such as a router and a Multiple Virtual Systems [MVS] host) and the time delays on the path from the source device to the destination device at the protocol level.
  - Send SNMP traps and/or SNA alerts/resolutions when one of the following has occurred: a user-configured threshold is exceeded, a connection is lost and reestablished, or a timeout occurs and clears. Thresholds can also be used to trigger additional collection of time delay statistics.
  - Perform pre-problem analysis by scheduling the RTR and collecting the results as history and accumulated statistics. The statistics can be used to model and predict future network topologies

IP Routing Protocols

- IGRP (Interior Gateway Routing Protocol)

  Designed by Cisco for TCP/IP and ISO CLNS, IGRP monitors the network to determine the status of each route and selects the best route for each data packet. Cisco IOS Releases 10.0 and later support Enhanced IGRP.

- Enhanced IGRP

  Enhanced IGRP, an enhanced version of the IGRP developed by Cisco Systems, Inc., is supported by Cisco IOS Releases 10.0 and later. Enhanced IGRP uses the same distance vector algorithm and distance information as IGRP. However, the convergence properties and the operating efficiency of Enhanced IGRP have improved significantly over IGRP.

  The convergence technology is based on research conducted at SRI International and uses an algorithm referred to as the Diffusing Update Algorithm (DUAL). Note that Enhanced IGRP is supported on IP, AppleTalk, and IPX.

- Enhanced IGRP Optimization

  Cisco IOS Release 11.2 introduces enhanced IGRP optimization. With the wide-scale deployment of Enhanced IGRP in increasingly large and complex customer networks, Cisco has been able to continuously monitor and refine Enhanced IGRP operation,

integrating several key optimizations. Optimizations have been made in the allocation of bandwidth, use of processor and memory resources, and mechanisms for maintaining information about peer routers. These include the following:

- Intelligent bandwidth control. In network congestion scenarios, packet loss, especially the dropping of routing protocol messages, adversely affects convergence time and overall stability. To prevent this problem, Enhanced IGRP now takes into consideration the available bandwidth (at a granularity of per subinterface/virtual circuit if appropriate) when determining the rate at which it will transmit updates.
- Improved processor and memory utilization. Enhanced IGRP derives the distributed routing tables from topology databases that are exchanged between peer routers. This CPU computation has now been made significantly more efficient as has the protocol's queuing algorithm, resulting in improved memory utilization.
- Implicit protocol acknowledgments. Enhanced IGRP running within a router maintains state and reachability information about other neighboring routers. This mechanism has been modified so that it no longer requires explicit notifications to be exchanged but rather will accept any traffic originating from a peer as a valid indication that the router is operational. This provides greater resilience under extreme load.
- IPX service advertisement interleaving. Large IPX environments are typically characterized by many service advertisements that can saturate lower speed links at the expense of routing protocol messages. Enhanced IGRP now employs an interleaving technique to ensure that both traffic types receive sufficient bandwidth in large IPX networks.

- OSPF (Open Shortest Path First)

  This link-state-based interior gateway protocol is defined by RFC 1247.

- RIP (Routing Information Protocol)

  This interior routing protocol is used by the routing process on Berkeley-derived UNIX systems.

- EGP (Exterior Gateway Protocol)

  This routing protocol is used by all routers attached to the Defense Data Network (DDN).

- BGP (Border Gateway Protocol)

  BGP is a replacement protocol for EGP. BGP is defined by RFC 1163. Cisco IOS Releases 10.0 and later feature BGP4, which supports classless interdomain routing, enabling you to reduce the size of routing tables by creating aggregate routes.

- PIM (Protocol Independent Multicast)

  PIM is used between routers so they can track which multicast packets to forward to each other and to their directly connected LANs. PIM is supported by Cisco IOS Releases 10.2 and later.

- IS-IS (Intermediate System-to-Intermediate System)

  IS-IS is an ISO dynamic routing specification. Cisco's implementation of IS-IS lets you configure IS-IS as an IP routing protocol.

- NHRP (Next Hop Routing Protocol)

  NHRP allows routers to dynamically discover the data link address for other routers on a WAN cloud. This is particularly important in ATM, Frame Relay, SMDS, and X.25 environments. Today, it is necessary to configure the network layer and datalink layer address for all neighbors on a WAN cloud. NHRP enables the router to discover these addresses dynamically.

  NHRP is a critical requirement for building large scale WAN clouds using the emerging switching technologies. Cisco edited the NHRP standard and is the first router vendor to support the protocol.

  Initially NHRP will work across an arbitrary IP cloud by using GRE tunneling. Future releases will support NHRP across X.25, ATM, Frame Relay, and SMDS.

Bridging

Bridging software allows a router to function simultaneously as a bridge. The basic function of a bridge is to accept frames of data passing through a network and, based on information contained in the frame, to decide whether to forward each frame.

Cisco supports transparent and translational bridging. (See a previous section “IBM Support” for source-route bridging.)

Transparent bridging supports the following features:

- IEEE 802.1(d) Spanning-Tree Protocol
- IEEE 802.10 virtual LANs
- DEC spanning tree
- Bridging over X.25 and Frame Relay networks
- Remote bridging over synchronous serial lines
- Transit bridging of Ethernet frames across both FDDI media and UltraNet media (Software Release 9.14 and earlier only)

With the CSC-C2FCIT and CX-FIP cards, FDDI encapsulation methods allow transparent and translational bridging over FDDI interfaces.

Cisco IOS Release 10.3 introduced support for transparently bridged virtual LANs (VLAN), allowing a transparently bridged network to be logically subdivided by identifying traffic as belonging to a particular group. This feature allows customers to impose logical topologies upon their transparently bridged networks.

Cisco IOS Release 11.0 introduced support for Concurrent Routing and Bridging. This feature allows a given routable protocol to be routed on some interfaces and bridged on other interfaces within the same router.

Cisco IOS Release 11.1 introduced support for VLAN Routing. This set of features supports IP and IPX routing and transparent 802.1d bridging between IEEE 802.10 or Cisco ISL encapsulated switched virtual LANs. This enables communications between logically defined VLAN groups, while maintaining the integrity of VLAN firewalls (security, traffic isolation, and common logical addressing), provides a wide range of

VLAN configuration options with concurrent routing and VLAN forwarding where both Layer 2 and Layer 3 applications reside within the network, and provides VLAN communications within workgroups, across the campus, and across WANs.

Protocol Translation Support

Protocol translation software provides a gateway between LAT, X.25, and Telnet environments. The protocol translation option requires the purchase of the bridging and packet-switching features.

The protocol translation software allows bidirectional translation between the following protocols:

- X.25 and TCP
- X.25 and LAT
- LAT and TCP
- LAT and TN3270
- X.25 and XRemote

Packet Switching

Cisco supports packet-switching software for connection to different packet-switching services:

- LAPB

  Cisco IOS Release 10.3 introduced support for priority queuing with LAPB and compression.

  Cisco IOS Release 11.0 introduced support for Transparent Bridging over Multiprotocol LAPB. This feature provides encapsulation of transparent bridging packets over a multiprotocol LAPB connection.

- Frame Relay

  Cisco's Frame Relay implementation currently supports the following protocols: IP, DECnet, AppleTalk, Xerox Network Service, Novell IPX, ISO CLNS, Banyan VINES, transparent bridging, and source-route bridging.

These protocols are supported with a number of user-configurable software features and options to create stable, scalable, high-performance Frame Relay networks. The major features and options include the following:

- Virtual interface
- TCP/IP header compression
- Broadcast queue
- Frame Relay switching
- RFC 1490—multiprotocol encapsulation
- RFC 1293—Frame Relay Inverse ARP for IP, IPX, AppleTalk, and DECnet
- DE bit support
- LMI ("Gang of 4"), ANSI Annex D, and CCITT Annex A support
- Dial backup
- Frame Relay over ISDN

Cisco IOS Release 10.3 introduced support for the following features:

- Autoinstall over Frame Relay

  This feature allows for simple router installation at remote sites from a centralized management location, reducing the need for specialized router installation training for remote users. This results in considerable time and cost savings.

- RFC1490 - Transparent Bridging

  Transparent Bridging with RFC 1490 encapsulation allows interoperability with other vendor's routers and bridges through a Frame Relay network.

- Frame Relay Dial Backup per DLCI

  This feature allows individual Frame Relay Data Link Connection Identifiers (DLCIs) on a given physical interface to be backed up by another physical interface, enhancing the fault tolerance of DLCIs.

Cisco IOS Release 11.0 introduced support for the following features:

- Fast Switched Frame Relay Bridging
- DLCI Prioritization

  This feature allows up to four DLCIs to be created between any two sites so that each DLCI has a different priority level. These DLCIs can be used to create different priority queues for different types of traffic such as File Transfer Protocol (FTP), Telnet, or Systems Network Architecture (SNA). The mapping between priorities and DLCIs is done with currently available priority list definitions.

Cisco IOS Release 11.2 introduces support for the following features:

- Frame Relay Switched Virtual Circuits (SVC) support

  SVCs allow access through a Frame Relay network by setting up a path to the destination endpoints only when the need arises. This is similar to X.25 SVCs, which allow connections to be set up and torn down based on data traffic requirements.

Although SVCs entail link set up and tear down overhead, the benefit is that the VC is only established when data must be transferred. Frame Relay SVCs offer the following benefits:

- Cost savings via usage-based pricing instead of fixed pricing for a PVC connection. This is similar to the billing system used for standard telephone service.
- Dynamic modification of network topologies with any-to-any connectivity.
- Dynamic network bandwidth allocation or bandwidth-on-demand for large data transfers such as FTP traffic.
- Backup for PVC backbones.
- Conservation of resources in private networks. Connections and router CPU are allocated only when the connection is required to transfer data.

- Traffic shaping over Frame Relay

  Traffic shaping over Frame Relay improves the scalability and performance of a Frame Relay network by increasing the density of VCs and improving response time. The Frame Relay traffic shaping feature applies to Frame Relay PVCs and SVCs. It provides the following three capabilities:

  - Rate enforcement on a per VC basis**.** A peak rate can be configured to limit outbound traffic to either the committed information rate (CIR) or some other defined value such as the excess information rate (EIR).
  - Generalized backward explicit congestion notification (BECN) support on a per VC basis. The router can monitor BECNs and throttle traffic based on BECN marked packet feedback from the Frame Relay network.
  - Priority/custom/weighted-fair queuing (PQ/CQ/WFQ) support at the VC level**.** This allows for finer granularity in the prioritization and queuing of traffic, providing more control over the traffic flow on an individual VC.

- SMDS

  Including support for the following:

  - 15-digit addressing
  - Virtual interfaces
  - SMDS over ATM

  Cisco IOS Release 10.3 introduced support for the following features:

  - SMDSTalk

    SMDSTalk allows a Cisco router to be connected to a third party router or to a Macintosh running SMDSTalk software.

  - DECnet and OSI Dynamic Mapping over SMDS

    DECnet and OSI Dynamic Mapping over SMDS significantly reduce the amount of configuration required for a router by providing dynamic mapping of network-level addresses to E.164 addresses.

  Cisco IOS Release 11.1 introduced support for the following features:

  - Fast-Switched Transparent Bridging over SMDS

- Fast-Switched IPX over SMDS

- CMNS support to extend X.25 switching over LAN interfaces

- X.25
  - Virtual interfaces
  - X.25 payload compression
  - IPXWAN over X.25
- DDN X.25

  The DDN X.25 software option allows routers to connect to the Defense Data Network. This option also is included in the features of the packet switching option.

NetFlow Switching

Cisco IOS Release 11.2 introduces NetFlow Switching (NFS), a new software switching mechanism that allows Cisco routers to combine high-performance, network-layer switching with the application of network services.

To achieve this high performance, NetFlow Switching identifies traffic flows between internetwork endpoints and then, on a connection-oriented basis, switches packets in these streams at the same time that it applies relevant services. By identifying flows using both network-layer and transport-layer information, NetFlow Switching allows Cisco IOS services to be applied on a per-user, per-application basis.

With NetFlow Switching, network users can extend their use of existing Cisco IOS services, such as security access lists or the collection of traffic statistics, without paying the performance penalty usually associated with such processing-intensive functions. This increase in performance allows these services to be used in more places within the network and on a larger scale. Extending network security is increasingly important as networks need to support access from remote users and across public Internet services. Detailed information on traffic flows helps network managers to grow their networks in the most cost-effective way. With NetFlow Switching, network administrators finally have “call detail recording” information for their data networks.

NetFlow Switching provides increased performance for the application of existing Cisco IOS services such as security access lists and accounting. Previously, system performance could be affected by as much as 30 percent for each service invoked. With NetFlow Switching, system switching performance can be maintained within 10 to 15 percent of optimum levels—for all supported services. As with any connection-oriented technique, the performance of NetFlow Switching is affected by the total number of active flows.

NetFlow Switching is supported on the Cisco 7500 series and Cisco 7000 series routers with a Route Switch Processor (RSP). On these routers, NetFlow Switching can operate on the master RSP or on a distributed basis on individual Versatile Interface Processors (VIPs).

ATM

Cisco IOS Releases 10.0 and later support ATM interfaces. ATM is a cell-switching and multiplexing technology designed to combine the benefits of circuit switching (constant transmission delay and guaranteed capacity) with those of packet switching (flexibility and efficiency for intermittent traffic).

Cisco IOS Release 10.3 introduced support for transparent bridging over ATM and AppleTalk /CLNS fast switching over ATM.

Cisco IOS Release 11.0 introduced support for the following ATM features:

- ATM Point-to-Multipoint Signaling
- ATM Interim Local Management Interface (ILMI)
- RFC 1577 - Classical IP and ARP over ATM
- SVC Idle Disconnect

Cisco IOS Release 11.1 introduced support for the following ATM features:

- Bridged ELANs
- LANE MIBs

Cisco IOS Release 11.2 introduces the following new ATM LAN emulation features:

- Simple Server Redundancy Protocol (SSRP) for LAN Emulation

  SSRP provides stand-by redundancy for the following services used by clients in an ATM LAN emulation (LANE) network: LAN Emulation Configuration Server (LECS), LAN Emulation Server (LES), and Broadcast and Unknown Server (BUS). LAN emulation uses one LES/BUS per emulated LAN and one LECS per multiple emulated LANs. These service components represent single points of failure for each emulated LAN. SSRP removes these single points of failure, providing network managers the redundancy they need for campus ATM backbones with LAN emulation without adding administrative overhead. A completely redundant, dual-homed ATM backbone can be built without any failure points when SSRP is combined with Hot Standby Router Protocol (HSRP), the dual-PHY LANE card for the Catalyst 5000, and support for spanning tree on a per VLAN-basis.

- HSRP for LAN Emulation

  If there is more than one router connected to an emulated LAN, HSRP allows one of those routers to monitor the status of the other and take over the functions of that router should it fail or become unavailable.

  HSRP provides inter-ELAN (or inter-VLAN) routing redundancy. HSRP over LANE is transparent to hosts expecting always to be able to reach their default gateway (router). Without HSRP, IP hosts would need to be configured with RIP to recover from a failure of its default gateway.

- DECnet Routing support for LAN Emulation

  This feature adds the ability to route DECnet from a subinterface on an ATM router port running LAN Emulation to any other subinterface on an ATM router port or any other router port. This feature joins the current capability to route IP, IPX, and AppleTalk over LAN Emulation subinterfaces.

- UNI 3.1 signaling

  The ATM Forum submitted the UNI 3.0 signaling specification to the International Telecommunications Union (ITU), which subsequently made changes to the SSCOP encapsulation used to make signaling reliable. UNI 3.1 was published later by the ATM Forum to align with the ITU, otherwise there is no difference in functionality between UNI 3.0, currently supported on all Cisco ATM platforms, and UNI 3.1. The full breadth of UNI signaling protocol support is available.

- Rate Queues for SVCs per subinterface

  Currently, only PVCs can be assigned to a particular rate queue (which defines traffic shaping parameters), whereas SVCs always fall into the default rate queue. Now, all SVCs in a subinterface (such as a subinterface configured to run RFC 1577 classical IP over ATM) are put into the rate queue assigned to that subinterface. All connections (not just PVCs) in a subinterface can be traffic shaped identically to match a service contract, for example, with a service provider.

- AToM MIB

  Support for AToM MIB, described in IETF RFC 1695, provides definition of configuration information as well as error and cell-level counters. Cisco IOS software Release 11.2 provides a standard AToM MIB instrumentation for many of the counters already provided in a router's ATM interfaces. AToM MIB instrumentation is used by network management applications, such as Cisco's AtmDirector, to perform topology auto-discovery and status checking.

This catalog features the following products that support ATM:

- StrataCom BPX Service Node broadband ATM switch
- StrataCom AXIS Interface Shelf
- StrataCom IGX scalable ATM switch
- StrataCom Intelligent Network Server (INS)
- Inverse Multiplexing for ATM Trunk module (IMATM)
- LightStream 2020 ATM switch
- Catalyst 5000 LAN switch equipped with an ATM LAN emulation module
- Cisco 7000 series routers with the ATM Interface Processor (AIP)
- Cisco 4000 series routers (models 4500, 4500-M, and 4700-M) with an ATM Network Processor module

Dial-on-Demand Routing Support

Cisco's dial-on-demand routing (DDR) software provides support for connection to a range of circuit-switched services:

- POTS via an external modem
- SW56 via an external CSU
- ISDN (BRI and PRI) via integrated ISDN interfaces or external TAs

  ISDN signaling is provided for connection to a range of ISDN switch types across the world.

Dial-on-demand routing also provides a number of software options designed to enable specific applications and provide enhanced WAN optimization:

- Dial backup
- Supplementary bandwidth
- Bandwidth-on-demand
- Snapshot routing

Cisco IOS Release 10.2 and later provide support for multiprotocol routing over circuit switched services. This support is specifically enhanced for IP, IPX, and AppleTalk routing. In Cisco IOS Release 10.3, support is provided for DECnet, VINES, OSI, and XNS. Support is also provided for transparent bridging.

Cisco IOS Release 11.0 introduced support for ISDN Fast Switching.

Cisco IOS Release 11.1 introduced support for Asynchronous ISDN Access (V.120 support). This feature allows an ISDN Terminal Adapter (TA) connected to the serial port of a PC to call into an ISDN BRI or PRI hub router and be treated as if it were connected to a Cisco Access Server, allowing Cisco customers to migrate to asynchronous digital dial-up with Access Server functionality and to combine this with synchronous dial-up to a single or rotary grouped ISDN interface.

Access Server Features

In addition to the dial-on-demand features (which are also applicable to asynchronous ports), Cisco access servers support the following features:

- Terminal services

  Permits connection of asynchronous devices to a LAN or WAN through network and terminal-emulation software including X.25 packet assembler/disassembler (PAD), TN3270, Telnet, and rlogin.

- Remote node

  Permits connection to devices over a telephone network using Point-to-Point Protocol (PPP, IPCP, and IPXCP), XRemote, SLIP, and compressed SLIP (CSLIP). Appletalk Remote Access (ARA) protocol versions 1 and 2 and MACIP are supported.

- Multichassis Multilink PPP (MMP)

  Cisco IOS 11.2 introduces Multichassis Multilink PPP (MMP). This new feature extends Multilink PPP (MP) by providing a mechanism to aggregate B-channels transparently across multiple routers or access servers. MMP defines the methodology for sharing individual links in a MP bundle across multiple, independent platforms.

  The primary application for MMP is the ISDN dial-up pool; however, it can also be used in a mixed technology environment. Multichassis Multilink PPP provides a number of significant benefits over existing dial-up pool solutions. These include the following:

  — Organizations can scale their core network as needed. With MMP, new devices can be added to the dial-up pool at any time.

  — MMP is less CPU intensive than MP. The load for reassembly and resequencing can be shared across all devices in the stackgroup. This allows for the use of less expensive platforms in large dial-up pools.

  — MMP provides an interoperable multivendor solution because it does not require any special software capabilities at the remote sites. The only remote requirement is support for industry standard MP (RFC 1717).

- Asynchronous routing

  Provides full-featured IP, IPX, and AppleTalk routing. Routing can be implemented on asynchronous lines or between Ethernet or Token Ring and asynchronous lines.

Cisco IOS Release 10.3 introduced support for the following features:

- TN3270 enhancements
- PPP/SLIP on protocol translator virtual terminals
- TACACS+

  TACACS+ is an enhanced version of the Terminal Access Control Access Control System (TACACS). It provides enhanced security, more accurate accounting information, and improved remote access functionality.

  Cisco IOS Release 11.2 introduces the following new TACACS+ features:

  — TACACS+ Single Connection

    TACACS+ Single Connection is an enhancement to the Network Access Server (NAS) that increases the number of transactions per second supported. Prior to this enhancement, separate TCP connections would be opened and closed for each of the TACACS+ services: authentication, authorization, and accounting. This became a bottleneck for improving throughput on authentication services for large networks. With this enhancement, the connection is maintained in an open state for as long as possible, instead of being opened and closed each time a session is negotiated.

  — TACACS+ SENDAUTH Function

    SENDAUTH is a TACACS+ protocol change to increase security. SENDAUTH supersedes SENDPASS. The NAS can support both SENDAUTH and SENDPASS simultaneously. It detects if the daemon is able to support

SENDAUTH and, if not, will use SENDPASS instead. This negotiation is virtually transparent to the user, with the exception that the down-rev daemon may log the initial SENDAUTH packet as unrecognized.

- ATCP for PPP

  This feature allows multiprotocol AppleTalk connections into a network.

- Asynchronous mobility

  This feature allows mobile users connecting with modems to connect to their private networks via a public network.

Cisco IOS Release 11.0 introduced support for the following features:

- Asynchronous Callback

  This feature permits a Cisco router to establish a connection on a supported interface, recognize that a callback is desired, terminate the current connection, and initiate a connection callback to the caller.

- Asynchronous Master Interfaces

  This feature reduces configuration complexity on Cisco access servers by creating a pseudo-interface that contains all configuration information for one or more real asynchronous interfaces.

- ARAP and IPX on Virtual Asynchronous Interfaces

- Local IP Pooling

  This feature maintains a pool of IP addresses available to an arbitrary number of asynchronous interfaces, reducing the number of IP addresses required to support IP dial-in on multiple interfaces.

Cisco IOS Release 11.1 introduced support for the following features:

- Remote Node NetBEUI

  Microsoft has produced an internet draft that defines a protocol for passing NetBEUI over PPP. Application of the RFC allows remote PCs with remote access client software to dial into network access servers connecting into NetBEUI networks. The protocol used in these connections is a Point-to-Point Protocol (PPP) Network Control Protocol (NCP) called NetBIOS Frames Control Protocol (NBFCP).

- Modem Auto-Configuring

  This feature adds the ability for Cisco access servers to discover and identify an attached modem and then configure it with the appropriate modem command strings.

- Novell Asynchronous Services Interface (NASI)

  Novell Connection Services (NCS) Server uses NASI to provide out-going serial line access for PCs with NASI client drivers. This functionality is generally used to provide dial-out modem services to PCs on SPX/IPS networks. Cisco access servers can then function as CCS servers providing dial-out over IPX for PCs.

- Ident

  Ident is specified by RFC 1413. It is an insecure protocol for reporting the identity of a TCP connection initiator to the connection receiving host.

- RADIUS

  Remote Authentication Dial-In User Service (RADIUS) is an access server authentication, authorization, and accounting protocol developed by Livingston, Inc. It is a system of distributed security that secures remote access to networks and network services against unauthorized access. In many ways it is similar to XTACACS.

Cisco IOS Release 11.2 introduces Virtual Private Dial-up Network (VPDN), Dialer Profiles, Combinet Packet Protocol (CPP) support, and half bridge/half router for CPP and PPP.

- VPDN

  VPDN functionality is based on the Layer 2 Forwarding (L2F) specification that Cisco has proposed as an industry standard to the Internet Engineering Task Force (IETF). VPDN allows users from multiple disparate domains to gain secure access to their corporate home gateways via public networks or the Internet. Service providers who want to offer private dial-up network services can use VPDN to provide a single telephone number for all their client organizations. A customer can use dial-up access to a local point-of presence where the access server identifies the customer by PPP user name. The PPP user name is also used to establish a home gateway destination. Once the home gateway is identified, the access server builds a secure tunnel across the service provider's backbone to the customer's home gateway. The PPP session is also transported to this home gateway, where local security measures can ensure the person is allowed access to the network behind the home gateway.

  Of special interest to service providers is VPDN's independence of WAN technology. Because L2F is TCP/IP-based, it can be used over any type of service provider backbone network.

- Dialer Profiles is a new dialer feature that allows you to separate the "logical" portion of the configuration (network layer, encapsulation, dialer parameters) from that of the interface used to place or receive calls. Dialer Profile extends the flexibility of current dial-up configurations. For example, on a single ISDN PRI or PRI rotary group it is now possible to allocate separate profiles for different classes of user. These profiles may define normal DDR usage or backup usage.

- CPP

  CPP is a proprietary encapsulation used by legacy Combinet products for data transport. CPP also defines a methodology for performing compression and load sharing across ISDN links. The Cisco IOS software implementation of CPP supports both compression and load sharing using this proprietary encapsulation. CPP large installed base of early Combinet product users cannot upgrade to later software releases that support interoperability standards such as PPP. With CPP support, these users can integrate their existing product base into new Cisco IOS-based internetworks.

- Half bridge/half router for CPP and PPP

  Half bridge/half router allows low-end, simply configured bridge devices to bridge either PPP or CPP encapsulated data to a Cisco IOS core router. Half bridge/half router is designed for networks that have a small remote Ethernet segment with a single PPP- or CPP-compatible bridging device connected to a core network.

LAN Extension

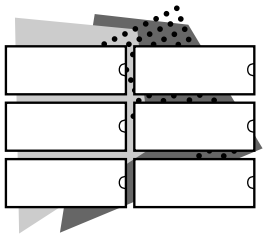
LAN extension expands Cisco's CiscoFusion architecture to include remote sites. CiscoFusion combines the ease-of-use of layer two switching (bridging) with the stability and security of layer three switching (routing). In a LAN extension system, a Cisco host router at a central site connects via wide-area links to Cisco LAN extender multilayer switches at remote sites in a "hub-and spoke" configuration. A LAN extender provides a transparent connection between the central and remote sites, logically extending the central site's network to include the remote LANs.

LAN extenders support all standard network protocols valid for the connected LAN type, such as IP, IPX, AppleTalk, DECnet, VINES, and XNS. These multilayer switches support MAC address filtering (layer two), as well as protocol filtering and priority queuing (layer three), to control WAN traffic and to help reduce WAN costs.

The LAN extension architecture supports filtering both at the host router and at the LAN extender to enhance security and to reduce WAN costs, often the highest cost of operating a wide-area network. Like all Cisco routers, the host router's access lists can be configured to filter by protocol, service, and source or destination MAC address for both inbound and outbound traffic. LAN Extenders can be configured to filter local traffic bound for the host router based on source and destination MAC address and protocol type.

Like Cisco routers, LAN extenders support priority queuing. This feature allows network traffic to be directed, by protocol type, into four priority queues, allowing important or time-sensitive traffic to receive the required priority.

The host router (Cisco 2500 series, Cisco 4000 series, Cisco 7000 series, or AGS+) at the central site is where all the LAN extension configuration is done. Configuration options precisely control network access and traffic flow between the central and remote sites. In addition to providing access security, the host router reduces WAN costs by filtering out broadcasts, multicasts, and other undesired traffic from the central site and from other remote sites.



Software Distribution

To upgrade Cisco IOS software in the field, customers should order spare software (that is, a product number designated with an equal sign). Spare software is distributed in two ways—hard media and electronic downloading:

- Hard-media-based software

  Examples of hard-media software include a Flash memory card, diskette, or EPROM that must be physically installed. Software format media for Cisco IOS Releases 10.3 and later follow:

  — Cisco AccessPro PC card: DOS diskette for system software (which can be used on a UNIX-based system)

  — Cisco 1001: DOS diskette (which can be used on a UNIX-based system) for LAN Extender software

  — Cisco 1003, Cisco 1004, and Cisco 1005: Flash memory card or diskette

  — Cisco 1020: DOS diskette

  — Cisco AS5100 and AS5200 access servers: DOS diskettes (which can be used on a UNIX-based system) for system software

  — Cisco 2500 series: DOS diskette (which can be used on a UNIX-based system) for system software

  — Cisco 4000 series: DOS diskette (which can be used on a UNIX-based system) for system software

  — Cisco 7000 series: DOS diskette (which can be used on a UNIX-based system) or EPROM for system software and microcode

  — Cisco 7200 series: DOS diskette (which can be used on a UNIX-based system) or EPROM for system software and microcode

  — Cisco 7500 series: DOS diskette (which can be used on a UNIX-based system) for system software and microcode

  — AGS+: EPROM for system software and microcode, which is also available on diskette.

- Electronic downloading

  For Cisco products with Flash memory, you can download software onto your network (TFTP) server, and then load the software into Flash memory on your router. Systems must be running Software Releases 9.1, 9.14, or 9.17 or Cisco IOS Release 10.0 or later. The exception is the AGS+, which can be running Software Release 9.0 or later.

  Some systems, such as the Cisco 2500 series, the Cisco 4000 series, and the Cisco 7000 family, include Flash memory capability as standard equipment. Other systems can include the optional CSC-MC+ memory card with Flash memory and can, therefore, be updated to a new software maintenance release using electronic downloading.

  If you have a SMARTnet maintenance contract and Flash memory, you can download software from Cisco Connection Online (CCO).

Software Ordering Examples

This section describes Cisco's software ordering schemes by providing examples of what product numbers should be ordered in a variety of situations.

The prefix and suffix of the product number provide information as follows:

- SF prefix and no equal sign (=) as a suffix—software for a new system loaded at the factory into Flash memory, which can be either a PCMCIA Flash memory card (as is the case for Cisco 7500 series routers or Cisco 1003–1005 routers) or Flash memory SIMMS (as in case of Cisco 2500 series routers).
- SF prefix and an equal sign (=) as a suffix—software for a previously installed Cisco 1003–1005 router that is loaded into a PCMCIA Flash memory card.
- SW prefix and no equal sign (=) as a suffix—software loaded into a new system at the factory, for example, software loaded into EPROM in Cisco 7000 series and AGS+ routers or onto Flash memory cards or diskettes for some Cisco 1000 series routers.

Note Although Cisco 7000 series and AGS+ routers use software loaded into EPROM, Flash memory is available for these systems to enable software updates over a network.

- SW prefix and an equal sign (=) as a suffix—software for a previously installed system loaded on ROMs or diskette (as appropriate). This software is only orderable for a previously installed system and is primarily used for software updates and feature set upgrades. This type of product number can also be used to order software on diskette for netbooting.
- FR prefix—feature licenses, which authorize a customer to use the software feature.
- SWR prefix and an equal sign (=) as a suffix—spare software shipped on ROM for Cisco 7000 series routers.
- SWF prefix with an equal sign (=) as a suffix—spare software shipped on diskette for AGS+ routers.

Cisco 2500 Series Examples

Table 20 provides software ordering examples for a customer who initially purchased a Cisco 2500 series router running the Cisco IOS Release 11.0 Desktop feature set and updates to Release 11.1 Desktop or upgrades to Release 11.1 Enterprise. Table 21 provides software ordering examples for a customer who initially purchased a Cisco 2500 series router running the Cisco IOS Release 11.1 IP/IPX feature set and updates to Release 11.2. Table 22 provides software ordering examples for a customer who initially purchased a Cisco 2500 series router running the Cisco IOS Release 11.1 IP feature set and upgrades to Release 11.2 IP Plus. In the tables, note that the term *update* refers to moving to a higher Cisco IOS Release, and the term *upgrade* refers to moving to a higher feature set.

Table 20 Cisco 2500 Series Software Ordering Example—Cisco IOS Release 11.0 to Release 11.1

Scenario	Product Number	Product Number Description
Customer places initial software order for Desktop feature set, Cisco IOS Release 11.0 for a new Cisco 2500 series router	SF25B-11.0.9	2500 Cisco IOS Release 11.0 Desktop software loaded into Flash memory at the factory
Customer with SMARTnet contract updates to Cisco IOS Release 11.1, but stays with initial feature set[1]	N/A (update included with SMARTnet contract)	–
Customer without SMARTnet contract updates to Cisco IOS Release 11.1, but stays with initial feature set[1]	SW25B-11.1.3= (charged item)	Spare 2500 Cisco IOS Release 11.1 Desktop software on diskette
Customer with SMARTnet upgrades to the Enterprise feature set, but stays with initial software release (Cisco IOS Release 11.0)[1]	FR25-BA= (charged item)	Desktop-to-Enterprise upgrade license Customer downloads Cisco IOS Release 11.0 Enterprise image for the Cisco 2500 from CCO (no charge)
Customer without SMARTnet upgrades to the Enterprise feature set, but stays with initial software release (Cisco IOS Release 11.0)[1]	SW25A-11.0.9= (charged item)	Spare 2500 Cisco IOS Release 11.0 Enterprise software on diskette (which contains Cisco IOS 11.0 and the Enterprise feature set)
	FR25-BA= (charged item)	Desktop-to-Enterprise upgrade license
Customer with SMARTnet with Desktop feature set and Cisco IOS Release 11.0 upgrades to the Enterprise feature set and Cisco IOS Release 11.1[1]	FR25-BA= (charged item)	Desktop-to-Enterprise upgrade license Customer downloads Cisco IOS Release 11.1 Enterprise image for the Cisco 2500 from CCO (no charge)
Customer without SMARTnet with Desktop feature set and Cisco IOS Release 11.0 upgrades to the Enterprise feature set and Cisco IOS Release 11.1	SW25A-11.1.3= (charged item)	Spare 2500 Cisco IOS Release 11.1 Enterprise software on diskette (which contains Cisco IOS 11.1 and the Enterprise feature set)
	FR25-BA= (charged item)	Desktop-to-Enterprise upgrade license

1. Upgrades to another feature set or updates to another software release often require additional memory, which must be separately ordered. Each of the Access product chapters in this catalog lists the minimum recommended memory for each feature set by release level.

Table 21 Cisco 2500 Series Software Ordering Example—Cisco IOS Release 11.1 IP/IPX to Release 11.2 Desktop (IP/IPX/Appletalk/DEC)

Scenario	Product Number	Product Number Description
Customer places initial software order for IP/IPX feature set, Cisco IOS Release 11.1 for a new Cisco 2500 series router	SF25D-11.1.3	2500 Cisco IOS Release 11.1 IP/IPX software loaded into Flash memory at the factory
Customer without SMARTnet contract with IP/IPX feature set and Cisco IOS Release 11.2 upgrades to Desktop (IP/IPX/Appletalk/DEC) feature set Cisco IOS Release 11.2	SW25B-11.2.1=	Spare 2500 Cisco IOS Release 11.1 Desktop (IP/IPX/Appletalk/DEC) software on diskette (which contains Cisco IOS 11.2 and the feature set)
	FL25-DB=	IPX-to-Desktop (IP/IPX/Appletalk/DEC) upgrade license is ordered free of charge

Table 22 Cisco 2500 Series Software Ordering Example—Cisco IOS Release 11.1 IP to Release 11.2 IP Plus

Scenario	Product Number	Product Number Description
Customer places initial software order for IP feature set, Cisco IOS Release 11.1 for a new Cisco 2500 series router	SF25C-11.1.3	2500 Cisco IOS Release 11.1 IP software loaded into Flash memory at the factory
Customer with SMARTnet contract updates to Cisco IOS Release 11.2, but upgrades to the IP Plus feature set[1]	FL25-P= (charged item)	2500 base (IP) to IP Plus upgrade license
		Customer downloads Cisco IOS Release 11.2 IP Plus image for the Cisco 2500 from CCO (no charge)
Customer without SMARTnet contract updates to Cisco IOS Release 11.2, but upgrades to the IP Plus feature set	SW25CP-11.2.1 (charged item)	Spare 2500 Cisco IOS Release 11.2 IP Plus software on diskette (which contains Cisco IOS 11.2 and the IP Plus feature set)
	FL25-DB (charged item)	2500 base (IP) to IP Plus upgrade license

1. Upgrades to another feature set or updates to another software release often require additional memory, which must be separately ordered. Each of the Access product chapters in this catalog lists the minimum recommended memory for each feature set by release level.

Cisco 7500 Series Examples

This section assumes a customer purchases a new Cisco 7500 series router. Table 23 provides ordering examples for a customer who initially purchased a Cisco 7500 series router with the Cisco IOS Release 11.0 Desktop/IBM feature set and updates to Release 11.1 Desktop/IBM or upgrades to release 11.1 Enterprise. Table 24 provides ordering examples for a customer who initially purchased a Cisco 7500 series router with the Cisco IOS Release 11.1 Desktop/IBM feature set and upgrades to Release 11.2 Enterprise with the 56-bit encryption feature set. In the tables, note that the term *update* refers to moving to a higher Cisco IOS Release, and the term *upgrade* refers to moving to a higher feature set.

Table 23 Cisco 7500 Series Software Ordering Example—Cisco IOS Release 11.0 to Release 11.1

Scenario	Product Number	Product Number Description
Customer places initial software order for Cisco IOS Release 11.0 with Desktop/IBM feature set on a new Cisco 7500	SF-G75BS-11.0.9	Cisco 7500 Desktop/IBM Cisco IOS Release 11.0 software loaded into the router's PCMCIA Flash memory card at the factory
Customer with or without SMARTnet contract already has Cisco IOS Release 11.0 with Desktop/IBM feature set, and wants to order a spare copy on diskette	SW-G75BS-11.0.9=	Spare Cisco 7500 Desktop/IBM software on diskette
Customer with SMARTnet contract and Enterprise feature set updates to Cisco IOS Release 11.1	N/A (update included with SMARTnet contract)	Customer downloads Cisco IOS Release 11.1 Enterprise image for the Cisco 7500 from CCO
Customer without a SMARTnet contract, but with Enterprise feature set, updates to Cisco IOS Release 11.1	SW-G75A-11.1.3= (charged item)	Spare 7500 series Enterprise feature set, Cisco IOS Release 11.1 on diskette
Customer with SMARTnet contract and Desktop/IBM feature set, Cisco IOS Release 11.0, upgrades to Enterprise feature set and updates to Cisco IOS Release 11.1	FR75-BSA= (charged item)	Cisco 7500 series Desktop/IBM-to-Enterprise upgrade license Customer downloads Cisco IOS Release 11.1 Enterprise image for the Cisco 7500 from CCO
Customer without SMARTnet contract and with Desktop/IBM feature set, Cisco IOS Release 11.0, upgrades to Enterprise feature set and updates to Cisco IOS Release 11.1	FR75-BSA= (charged item) SW-G75A-11.1.3= (charged item)	Desktop/IBM-to-Enterprise upgrade license Spare 7500 series Enterprise feature set, Cisco IOS Release 11.1 on diskette
Customer upgrades to the Enterprise feature set, same Cisco IOS Release	FR75-BSA= (charged item)	Desktop/IBM-to-Enterprise upgrade

Table 24 Cisco 7500 Series Software Ordering Example—Cisco IOS Release 11.1 Desktop/IBM to Release 11.2 Enterprise with 56-bit Encryption

Scenario	Product Number	Product Number Description
Customer places initial software order for Cisco IOS Release 11.1 with Desktop/IBM feature set on a new Cisco 7500	SF-G75BS-11.1.3	Cisco 7500 Desktop/IBM Cisco IOS Release 11.1 software loaded into the router's PCMCIA Flash memory card at the factory
Customer with SMARTnet contract and Desktop/IBM feature set, Cisco IOS Release 11.1, upgrades to Enterprise feature set with 56-bit encryption feature set and updates to Cisco IOS Release 11.2	FR75-BSAT= (charged item)	Cisco 7500 series Desktop/IBM-to-Enterprise upgrade license
	FR75-56= (charged item)	Cisco 7500 series Encryption 56 upgrade license
		Customer downloads Cisco IOS Release 11.2 Enterprise with Encryption 56 image for the Cisco 7500 from CCO (no charge)
Customer without SMARTnet contract and Desktop/IBM feature set, Cisco IOS Release 11.1, upgrades to Enterprise feature set with 56-bit encryption feature set and updates to Cisco IOS Release 11.2	FR75-BSAT= (charged item)	Cisco 7500 series Desktop/IBM-to-Enterprise upgrade license
	FR75-56= (charged item)	Cisco 7500 series Encryption 56 upgrade license
	SW75AT-11.2.1= (charged item)	Spare Cisco 7500 series Enterprise with Encryption 56 image, Cisco IOS Release 11.2 on diskette

Note When upgrading a Cisco 7000 series router to the Enterprise feature set with Cisco IOS Release 11.0, you also need an 8- or 16-MB PCMCIA Flash memory card to accommodate memory requirements.

Software for the AGS+ router and older software releases for the Cisco 7000 series router do not use a feature set model. To update this type of software, you must order a SW= product number for the software and an FR= product number for the feature license.