

Cisco IOS XE Software for Cisco ASR 900U Series Aggregation Services Routers

Cisco IOS[®] Software is always evolving to provide you with more features of higher quality. Cisco IOS XE Software releases provide a modular structure for Cisco[®] ASR 900U Series Aggregation Services Routers. Why is this modularity important? It allows the software to significantly enhance quality and performance by taking advantage of the separation of the data plane and the control plane.

Cisco IOS XE Software on the Cisco ASR 903U Router, ASR 902U Router, and ASR 920U Router includes licenses for Metro Aggregation Services. Feature sets can be activated as needed. In this way, customers pay only for what they require and use.

Figure 1. Cisco ASR 903U, 902U, and 920U Routers



Software Releases and Options

Cisco ASR 900U Series routers are supported in Cisco IOS XE Software. The Cisco IOS XE Software release is designed to provide modular packaging, feature velocity, and powerful resiliency. The Cisco ASR 900U Series Routers are supported as of Cisco IOS XE Software Release 16.6.1.

Consolidated Software Packages

Three consolidated software packages contain a superset of all features. The individual feature sets can be activated after the correct feature licenses are applied to the router. Table 1 describes the Cisco IOS XE universal consolidated packages supported on the Cisco ASR 900U Series Router and the functionality supported in each of these universal images. The functionality is made available through the appropriate technology package licenses.

Table 1. Universal Cisco IOS XE Software consolidated packages for Cisco ASR 900U Series Routers

| Cisco IOS XE Consolidated Package | Part Number | Description |
|--|-------------------|-----------------------------------|
| Cisco ASR 900 RSP2 IOS XE UNIVERSAL - NO | SASR900R2NPEK9166 | • Provides a consolidated package |

| Cisco IOS XE Consolidated Package | Part Number | Description |
|---|-------------------|---|
| PAYLOAD ENCRYPTION | | <ul style="list-style-type: none"> Offers complete Cisco IOS XE Software feature support |
| Cisco ASR 920 Series IOS XE - No Payload Encryption | SASR920P2NPEK9166 | <ul style="list-style-type: none"> Provides a consolidated package Offers basic feature support without a license, including Secure Shell (SSH) and SNMPv3 support |
| Cisco ASR920 Series IOS XE UNIVERSAL - PAYLOAD ENCRYPTION | SASR920P2K9166 | <ul style="list-style-type: none"> Provides a consolidated package Offers complete Cisco IOS XE Software feature support Offers Payload Encryption support |

Flexible Software Activation

ASR 900U Series routers support the Cisco IOS software activation feature. With this capability, Cisco IOS Software feature sets can be activated with software licenses, supporting a “pay as services grow” model. This model allows users to invest in software resources only when their businesses need it. All Cisco ASR 900U Series software licenses, except OC3/OC12 port licenses, are on a per-chassis basis. Cisco ASR 902U, 903U routers offer three Cisco IOS Software licenses:

- **Metro Services license:** Offers advanced Quality of Service (QoS), Carrier Ethernet Layer 2 features, Synchronous Ethernet (SyncE) and Ethernet Operations, Administration, and Maintenance (OAM) capabilities.
- **Metro IP Services license:** Offers all capabilities of the Metro Services license with the addition of IEEE 1588-2008 Ordinary Clock and Transparent Clock, Bidirectional Forwarding Detection (BFD), Layer 3 features for advanced IP routing protocols, multi-VPN routing, and Layer 3 Multicast and Forwarding Customer Edge (multi-VRF CE) capabilities.
- **Metro Aggregation Services license:** Adds the following capabilities to the Metro IP Services license: Multiprotocol Label Switching Transport Profile (MPLS-TP); MPLS, Ethernet over MPLS (EoMPLS), Circuit Emulation Service over Packet Switched Network (CESoPSN), and Structure Agnostic TDM over Packet (SAToP) pseudowires; Multirouter Automatic Protection Switching (MR-APS); Multichassis Link Aggregation and Control Protocol (mLACP); MPLS traffic engineering (MPLS TE); MPLS Fast Reroute (FRR); and MPLS VPN support.

Table 2 lists the main features in the Cisco IOS licenses for ASR 902U and 903U routers. Availability of features is dependent on software release and implementation schedule.

Table 2. Feature sets in Cisco ASR 902U, 903U Routers licenses

| Metro Services | Metro IP Services | Metro Aggregation Services |
|---|---|--|
| Baseline | All features in Metro Services plus: | All features in Metro IP Services plus: |
| QoS, with deep buffers and Hierarchical QoS (HQoS) | IP routing (Routing Information Protocol [RIP], Open Shortest Path First [OSPF], Enhanced Interior Gateway Routing Protocol [EIGRP], Border Gateway Protocol [BGP], Intermediate System-to-Intermediate System [IS-IS]) | MPLS (Label Distribution Protocol), MPLS VPN (MultiProtocol BGP) and Segment Routing |
| Layer 2: 802.1d and 802.1q | Protocol-Independent Multicast (PIM) (Sparse Mode [SM], dense mode [DM], source-specific multicast [SSM]), and SSM mapping | MPLS TE and FRR |
| Ethernet Virtual Circuit (EVC) | BFD | MPLS OAM |
| Ethernet OAM (802.1ag, 802.3ah) | Multi-VRF CE (VRF lite) with service awareness (ARP, ping, Simple Network Management Protocol [SNMP], syslog, trace-route, File Transfer Protocol [FTP], and Trivial File Transfer Protocol [TFTP]) | MPLS-TP, FlexLSP |
| Multiple Spanning Tree (MST) and Resilient Ethernet Protocol (REP) | IEEE 1588-2008 Ordinary Clock and Transparent Clock | Pseudowire emulation (EoMPLS, CESoPSN, and SAToP) |
| Synchronous Ethernet | | Virtual Private LAN Service (VPLS) and Hierarchical VPLS (HVPLS) |

| Metro Services | Metro IP Services | Metro Aggregation Services |
|---------------------------------|-------------------|---|
| IPv4 and IPv6 host connectivity | | Pseudowire redundancy MR-APS and mLACP |

The Cisco ASR 920U router supports the Cisco IOS Software activation feature. With this capability, Cisco IOS Software feature sets can be activated with software licenses, supporting a “pay as you grow” model. This model allows service providers to invest in software resources only when their businesses need them. All software licenses for Cisco ASR 920U routers are available on a per-chassis basis. The ASR 920U router offers three Cisco IOS Software licenses:

- **Metro Access license:** Offers advanced Quality of Service (QoS), Carrier Ethernet Layer 2 features, Synchronous Ethernet (SyncE), and Ethernet Operations, Administration, and Maintenance (OAM) capabilities.
- **Metro IP Access license:** Offers all capabilities of the Metro Access license with the addition of IEEE 1588-2008 Ordinary Clock and Transparent Clock, Bidirectional Forwarding Detection (BFD), Layer 3 features for advanced IP routing protocols, multi-VPN routing, and Layer 3 Multicast and Forwarding Customer Edge (multi-VRF CE) capabilities.
- **Advanced Metro IP Access license:** Adds the following capabilities to the Metro IP Services license: Multiprotocol Label Switching Transport Profile (MPLS-TP); MPLS, Ethernet over MPLS (EoMPLS), Circuit Emulation Service over Packet Switched Network (CESoPSN), and Structure Agnostic TDM over Packet (SAToP) pseudowires; Multirouter Automatic Protection Switching (MR-APS); Multichassis Link Aggregation and Control Protocol (mLACP); MPLS traffic engineering (MPLS TE); MPLS Fast Reroute (MPLS FRR); and MPLS VPN support.

Table 3 lists the main features in the Cisco IOS licenses for ASR 920U router. Availability of features is dependent on software release and implementation schedule.

Table 3. Feature sets in Cisco ASR 920U Router license

| Features | Metro Access license | Metro IP Access license | Advanced Metro IP Access license |
|---|----------------------|-------------------------|----------------------------------|
| QoS, with deep buffers and hierarchical QoS (HQoS) | ✓ | ✓ | ✓ |
| Layer 2: 802.1d and 802.1q | ✓ | ✓ | ✓ |
| EVC | ✓ | ✓ | ✓ |
| Ethernet OAM (802.1ag and 802.3ah) | ✓ | ✓ | ✓ |
| Multiple Spanning Tree (MST) and Resilient Ethernet Protocol (REP) | ✓ | ✓ | ✓ |
| Synchronous Ethernet | ✓ | ✓ | ✓ |
| IPv4 and IPv6 host connectivity | ✓ | ✓ | ✓ |
| IP routing (Routing Information Protocol [RIP], Open Shortest Path First [OSPF], Enhanced Interior Gateway Routing Protocol [EIGRP], Border Gateway Protocol [BGP], and Intermediate System-to-Intermediate System [IS-IS]) | | ✓ | ✓ |
| Protocol-Independent Multicast (PIM) (Sparse Mode [SM], Dense Mode [DM], Source-Specific Multicast [SSM]), SSM mapping | | ✓ | ✓ |
| BFD | | ✓ | ✓ |
| Multi-VRF CE (VRF lite) with service awareness (Address Resolution Protocol [ARP], ping, Simple Network Management Protocol [SNMP], syslog, trace-route, File Transfer Protocol [FTP], and Trivial File Transfer Protocol [TFTP]) | | ✓ | ✓ |
| IEEE 1588-2008 Ordinary Clock and Transparent Clock | | ✓ | ✓ |
| MPLS (Label Distribution Protocol [LDP] and VPN) | | | ✓ |
| MPLS TE and Fast Reroute (FRR) | | | ✓ |
| MPLS OAM | | | ✓ |
| MPLS-TP | | | ✓ |
| Pseudowire emulation (EoMPLS, CESoPSN, and SAToP) | | | ✓ |
| Virtual Private LAN Service (VPLS) and Hierarchical VPLS (HVPLS) | | | ✓ |
| Pseudowire redundancy | | | ✓ |

Additional Feature Licenses

The following three Cisco IOS feature-set licenses are used to activate new software functionality for ASR 900U Series routers in addition to the feature-set capabilities.

- **ATM license:** Allows service providers to activate ATM functionality on Time-Division Multiplexing (TDM) interfaces when required. One license is required for each ASR 902U and 903U router that needs ATM functionality to be activated in the system. This includes support for ATM pseudowires over MPLS (ATMoMPLS), ATM local switching, ATM interworking, and local ATM termination. This license requires the system to have at least one T1/E1, OC-3/STM-1, or OC-12/STM-4 card installed.
- **OC3 port license:** Allows service providers to activate OC3 ports on the Cisco ASR 920U router. One license is required for each OC3 port. The A900-IMA4OS IM supports four OC3 ports.
- **IEEE 1588-2008 BC/MC license:** Allows service providers to activate IEEE 1588-2008 Boundary Clock (BC) or Master Clock (MC), or both, when required. One license is required for each chassis that needs IEEE 1588-2008 BC or MC functionality to be activated in the system.
- **IPsec license:** The IPsec license allows enterprises to provide security for the transmission of sensitive information over unprotected networks such as the Internet. IPsec acts at the network layer, protecting and authenticating IP packets between participating IPsec devices ("peers").

One IPsec license is required and installed in the router for IPsec functionality to work. When you enable or disable the IPsec license, a reboot is mandatory for the system to function properly.

Regular Cisco IOS XE Universal Software packages do not support data plane (payload) encryption. However, control plane encryption is supported with these images, with processing done in software.

A separate Cisco IOS XE Software package is available to include payload encryption. This software package is available for ASR-920U-12SZ-IM only.

Cisco IOS XE Software Release Schedule

The Cisco IOS XE Software delivery schedule allows customers to qualify releases more quickly and have a definitive release schedule for new software images. This schedule is summarized in the following highlights.

- **Time-based releases:** Releases are planned for delivery three times a year (every four months). New software features and hardware are introduced in each release. Releases have fewer incremental features included when compared with traditional Cisco IOS Software releases, reducing customer qualification time.
- **Two release support durations:** Each Cisco IOS XE Software release is classified as either a Standard Support or Extended Support release. A Standard Support release has a total engineering support lifetime of one year or 18 months, with two or three scheduled rebuilds. The Extended Support release provides a total engineering support lifetime of two or four years, with four or up to 10 scheduled rebuilds. For more information about the Cisco IOS XE Software end-of-life policy and associated support milestones for specific Cisco IOS XE Software releases, visit <https://www.cisco.com>.
- **Rebuilds scheduled at regular intervals:** Rebuilds are created only for bug fixes, and no new features are included in a rebuild image. For a release rebuild schedule, visit the [Cisco IOS XE Software support timeline](#) for details.

Part Numbers for License Options and Activation Keys

Table 4 lists part numbers for Cisco ASR 920U and ASR 903U software feature options.

Table 4. Cisco ASR 902U and ASR 903U software options

| Part Number | Product Name |
|-----------------------------|--------------|
| Feature set license options | |

| Part Number | Product Name |
|--|--|
| SLASR902-M | Cisco ASR 902 Metro Services |
| SLASR902-I | Cisco ASR 902 Metro IP Services |
| SLASR902U-A | Cisco ASR 902 Metro Aggregation Services |
| SLASR903-M | Cisco ASR 903 Metro Services |
| SLASR903-I | Cisco ASR 903 Metro IP Services |
| SLASR903U-A | Cisco ASR 903 Metro Aggregation Services |
| Feature set product activation keys | |
| SLASR902-M= | Cisco ASR 902 Metro Services Paper PAK |
| L-SLASR902-M= | Cisco ASR 902 Metro Services E-Delivery PAK |
| SLASR902-I= | Cisco ASR 902 Metro IP Services Paper PAK |
| L-SLASR902-I= | Cisco ASR 902 Metro IP Services E-Delivery PAK |
| SLASR902U-A= | Cisco ASR 902 Metro Aggregation Services Paper PAK |
| L-SLASR902-A= | Cisco ASR 902 Metro Aggregation Services E-Delivery PAK |
| SLASR903-M= | Cisco ASR 903 Metro Services Paper PAK |
| L-SLASR903-M= | Cisco ASR 903 Metro Services E-Delivery PAK |
| SLASR903-I= | Cisco ASR 903 Metro IP Services Paper PAK |
| L-SLASR903-I= | Cisco ASR 903 Metro IP Services E-Delivery PAK |
| SLASR903U-A= | Cisco ASR 903 Metro Aggregation Services Paper PAK |
| L-SLASR903-A= | Cisco ASR 903 Metro Aggregation Services E-Delivery PAK |
| Feature set upgrade product activation keys | |
| SLASR902-M-I= | Cisco ASR 902 Metro to Metro IP Paper PAK |
| SLASR902-M-A= | Cisco ASR 902 Metro to Metro Aggregation Paper PAK |
| SLASR902-I-A= | Cisco ASR 902 Metro IP to Metro Aggregation Paper PAK |
| L-SLASR902-M-I= | Cisco ASR 902 Metro to Metro IP E-Delivery PAK |
| L-SLASR902-M-A= | Cisco ASR 902 Metro to Metro Aggregation E-Delivery PAK |
| L-SLASR902-I-A= | Cisco ASR 902 Metro IP to Metro Aggregation E-Delivery PAK |
| SLASR903-M-I= | Cisco ASR 903 Metro to Metro IP Paper PAK |
| SLASR903-M-A= | Cisco ASR 903 Metro to Metro Aggregation Paper PAK |
| SLASR903-I-A= | Cisco ASR 903 Metro IP to Metro Aggregation Paper PAK |
| L-SLASR903-M-I= | Cisco ASR 903 Metro to Metro IP E-Delivery PAK |
| L-SLASR903-M-A= | Cisco ASR 903 Metro to Metro Aggregation E-Delivery PAK |
| L-SLASR903-I-A= | Cisco ASR 903 Metro IP to Metro Aggregation E-Delivery PAK |
| Feature licenses | |
| FLSASR902-ATM | Cisco ASR 902 ATM License |
| FLSASR902-1588 | Cisco ASR 902 IEEE 1588-2008 BC/MC License |
| FLSASR903-ATM | Cisco ASR 903 ATM License |
| FLSASR903-1588 | Cisco ASR 903 IEEE 1588-2008 BC/MC License |
| Feature licenses product activation keys | |
| FLSASR902-ATM= | Cisco ASR 902 ATM License Paper PAK |
| L-FLSASR902-ATM= | Cisco ASR 902 ATM License E-Delivery PAK |
| FLSASR902-1588= | Cisco ASR 902 IEEE 1588-2008 BC/MC License Paper PAK |
| L-FLSASR902-1588= | Cisco ASR 902 IEEE 1588-2008 BC/MC License E-Delivery PAK |
| FLSASR903-ATM= | Cisco ASR 903 ATM License Paper PAK |
| L-FLSASR903-ATM= | Cisco ASR 903 ATM License E-Delivery PAK |
| FLSASR903-1588= | Cisco ASR 903 IEEE 1588-2008 BC/MC License Paper PAK |
| L-FLSASR903-1588= | Cisco ASR 903 IEEE 1588-2008 BC/MC License E-Delivery PAK |

Table 5 lists the part numbers of software feature options for the Cisco ASR 920U-12SZ-IM router.

Table 5. Cisco software options for ASR 920U-12SZ-IM Router

| Part Number | Product Name |
|--|--|
| Feature set license options | |
| ASR920-S-M | Cisco ASR 920 Series - Metro Access |
| ASR920-S-I | Cisco ASR 920 Series - Metro IP Access |
| ASR920U-S-A | Cisco ASR 920 Series - Advanced Metro IP Access |
| Feature set product activation keys | |
| ASR920-S-M= | Cisco ASR 920 Metro Access Services Paper Product Activation Key (PAK) |
| L-ASR920-S-M= | Cisco ASR 920 Metro Access Services E-Delivery PAK |
| ASR920-S-I= | Cisco ASR 920 Metro IP Access Services Paper PAK |
| L-ASR920-S-I= | Cisco ASR 920 Metro IP Access Services E-Delivery PAK |
| ASR920U-S-A= | Cisco ASR 920 Advanced Metro IP Access Services Paper PAK |
| L-ASR920-S-A= | Cisco ASR 920 Advanced Metro IP Access Services E-Delivery PAK |
| Feature set upgrade product activation keys | |
| ASR920-S-M-I= | Cisco ASR 920 Metro Access to Metro IP Access Paper PAK |
| ASR920-S-M-A= | Cisco ASR 920 Metro Access to Advanced Metro IP Access Paper PAK |
| ASR920-S-I-A= | Cisco ASR 920 Metro IP to Advanced Metro IP Access Paper PAK |
| L-ASR920-S-M-I= | Cisco ASR 920 Metro Access to Metro IP Access E-Delivery PAK |
| L-ASR920-S-M-A= | Cisco ASR 920 Metro Access to Adv Metro IP Access E-Delivery PAK |
| L-ASR920-S-I-A= | Cisco ASR 920 Metro IP to Advanced Metro IP Access E-Delivery PAK |
| Feature licenses | |
| ASR920-GNSS | ASR 920 GNSS License |
| ASR920-1588 | Cisco ASR 920 IEEE 1588-2008 BC/MC License |
| ASR920-IPSEC | ASR 920 IPsec License |
| Port licenses | |
| ASR920-1G-6 | Cisco ASR920 Series - 6 ports GE license |
| ASR920-10G-2 | Cisco ASR920 Series - 12 ports GE license |
| ASR920-12G-4-10G | Cisco ASR 920 Series - 12 ports GE and 4 ports 10G license |
| FLSASR900-1OC3 | ASR 900 1 Port OC3/STM-1 License |
| Port licenses product activation keys | |
| ASR920-1G-6= | Cisco ASR 920 Series - 6 ports GE license Paper PAK |
| L-ASR920-1G-6= | Cisco ASR 920 Series - 6 ports GE license E-Delivery PAK |
| ASR920-10G-2= | Cisco ASR 920 Series - 12 ports GE license Paper PAK |
| L-ASR920-10G-2= | Cisco ASR 920 Series - 12 ports GE license E-Delivery PAK |
| FLSASR900-1OC3= | ASR 900 1 Port OC3/STM-1 License Paper PAK |
| L-FLSASR900-1OC3= | ASR 900 1 Port OC3/STM-1 License E-Delivery PAK |

| Part Number | Product Name |
|---|---|
| Feature licenses product activation keys | |
| ASR920-1588= | Cisco ASR 920 IEEE 1588-2008 BC/MC License Paper PAK |
| L-ASR920-1588= | Cisco ASR 920 IEEE 1588-2008 BC/MC License E-Delivery PAK |

Major Features

Table 6 lists the features supported by Cisco IOS XE in Cisco ASR 900U Series routers. Availability of features is dependent on software release, Route Switch Processor (RSP) version, and implementation schedule. Check release notes for additional details.

Table 6. Cisco ASR 900U Series Router software features

| Features |
|---|
| Ethernet Services |
| <ul style="list-style-type: none"> • Ethernet Flow Point (EFP) with support for: <ul style="list-style-type: none"> ◦ 802.1q ◦ 802.1ad ◦ Selective QinQ ◦ Inner and Outer VLAN classification ◦ VLAN local significance ◦ One VLAN tag ingress push ◦ Pop one VLAN tag ◦ Pop two VLAN tags ◦ Trunk-EFP construct for configuration simplification • Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) using Local Connect • IEEE 802.1s Multiple Spanning Tree (MST) • Per VLAN Spanning Tree Plus (PVST+) • Rapid Per VLAN Spanning Tree Plus (RPVST+) • Unidirectional Link Detection (UDLD) • Link Layer Discovery Protocol (LLDP) • Cisco Discovery Protocol (CDP) • Resilient Ethernet Protocol (REP) • ITU G.8032 • 802.3ad/802.1ax Link Aggregation Control Protocol (LACP) • Multichassis Link Aggregation Control Protocol (mLACP) • Layer 2 Protocol Tunneling (L2PT) • VPLS, HVPLS, Virtual Private Wire Service (VPWS), and EoMPLS • Routed Pseudowire and Routed VPLS • Static Multicast MAC addresses • IGMP snooping on Ethernet Flow Point • Link Pass Through • Pseudowire redundancy • Hot Standby Pseudowire • Multisegment Pseudowire • Flow Aware Transport Pseudowire (FAT PW) - RFC 6391 • Multichassis Link Aggregation Group (MC-LAG) • Ethernet loopback on EFP and Trunk EFP • Multicast Label Distribution Protocol v4 (mLDPv4) • Multicast Label Distribution Protocol v6 (mLDPv6) • MAC Security • VPLS over port-channel and bridge domain interface • Segment Routing |
| TDM, SONET/SDH, OTN, and ATM services |
| <ul style="list-style-type: none"> • Clear Channel and Channelized T1 and E1 ports • Clear Channel and Channelized (cbit, unframed) T3 and E3 ports • Channelized OC3/12/48/192 and STM-1/-4/-16/-64 ports |

Features

- High Order (HO) and Low Order (LO) SONET/SDH Switching
- Automatic Switching Protection (APS)
- Single Router Automated Protection switching (SR-APS)
- Multirouter Automated Protection switching (MR-APS)
- Access Circuit Redundancy (ACR)
- Multiplex Section Protection (MSP)
- Unidirectional Path Switched Ring (UPSR)
- Sub Network Connection Protection (SNCP)
- SONET Data Communications Channel (SDCC)
- Line Data Communications Channel (LDCC)
- Synchronization Status Messaging (SSM)
- Optical Transport Network (OTN) (G.709)
- Pseudowire setup and maintenance using the Label Distribution Protocol (LDP) - RFC 4447
- Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP) - RFC 4553
- Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH) Circuit Emulation over Packet (CEP) – RFC 4842
- Single Router Automated Protection switching (SR-APS)
- Multirouter Automated Protection switching (MR-APS)
- Access Circuit Redundancy (ACR)
- TDM Loopbacks
- Integrated BERT Testing
- Pseudowire redundancy
- Hot Standby Pseudowire
- Multisegment Pseudowire
- IETF ATM PWE₃ over MPLS
- ATM N:1 (N = 1) virtual channel connection (VCC) cell mode and ATM N:1 (N = 1) virtual path (VP) Cell Relay Mode
- ATM cell packing
- ATM IMA v1.0, 1.1 on the 16 port T₁/E₁ and on the 4 port OC-3/STM-1 interface module
- ATM AALo (for AAL₂ voice and data) and AAL₅
- ATM Class of Service (CoS) features Constant Bit Rate (CBR) and Unspecified Bit Rate (UBR) and per virtual circuit queuing
- Egress Quality of Service (QoS) on ML-PPP, PPP, PoS, and HDLC interfaces

Layer 3 and MPLS Services

- Hot Standby Router Protocol (HSRP)
- Virtual Router Redundancy Protocol (VRRP)
- Layer 3 routing on Routed interfaces and Bridge Domain Interfaces (BDI)
- Cisco Express Forwarding (CEF) load sharing of Equal Cost Paths (ECMP)
- Open Shortest Path First (OSPF) Version 2, RFC 2328
- Open Shortest Path First (OSPF) Version 3, RFC 5340
- Border Gateway Protocol (BGP) Version 4, RFC 4271
- BGP 4-byte Autonomous System number (ASN)
- BGP TCP Path MTU Discovery
- BGP Prefix-Independent Convergence (PIC) Edge and Core for IPv₄ and MPLS VPN
- Intermediate System to Intermediate System (IS-IS) – RFC 7142
- BFD for OSPF, IS-IS, BGP, Multicast, and static routes
- BFD over Ethernet, Routed port, HDLC and PPP interfaces
- BFD for HSRP group client
- Multihop BFD
- Multiprotocol Label Switching (MPLS)
- MPLS FlexLSP
- MPLS FlexLSP with Shared Risk Link Group (SRLG) Protection
- MPLS FlexLSP with nonrevertive, sticky mode
- Ethernet VPN (EVPN) VPWS single homed
- LDP with Label Edge Router (LER) and Label Switch Router (LSR)
- MPLS L₃VPN
- MPLS Transport Profile (MPLS-TP) for Ethernet, and TDM Pseudo Wires
- MPLS Traffic Engineering Fast Re-Route (TE-FRR)
- Dynamic Resource Reservation Protocol – Traffic Engineering (RSVP-TE) label allocation
- MPLS Point-to-Multipoint Traffic Engineering

Features

- RSVP-TE Extensions for Associated Bidirectional Label Switched Paths (LSPs) – RFC 7551
- RSVP-TE Extensions to RSVP for LSP Tunnels – RFC 3209
- IP Loop Free Alternate Fast Re-Route (LFA FRR)
- Remote Loop Free Alternate Fast Re-Route (R-LFA FRR)
- Internet Group Management Protocol (IGMP) version 1 – RFC 1112
- IPv4 and IPv6 multicast
- PIM-SM, PIM Source Specific Multicast (PIM SSM), PIM SSM mapping
- IGMPv2 – RFC 2236
- IGMPv3 – RFC 3376
- IGMP group limiting
- Multicast Listener Discovery (MLD)
- Multicast VPN (MVPN) based on IETF Rosen Draft
- Multicast VPN (MVPN) based on Label Distribution Protocol (mLDP)
- Multicast VPN with GRE over Bridge Domain Interface (BDI)
- Segment Routing (SR)

IPv6

- Hardware based IPv6 data forwarding
- Addressing and discovery
- Manual IPv6 interface addressing
- ICMPv6 (RFC 4443)
- IPv4 and IPv6 dual stack
- IPv6 static routing
- OSPF for IPv6 (RFC 5340)
- DHCPv6 with relay function
- DHCPv6 server and client
- BFD for OSPF, IS-IS, BGP, and IPv6 static routes
- BFD on IP unnumbered interface
- IPv6 Provider Edge (6PE)
- IPv6 VPN Provider Edge (6VPE)
- IPv6 QoS

QoS

- Modular QoS CLI (MQC)
- Hierarchical QoS (HQoS)
- Port shaper and Low Latency Queuing (LLQ) in the presence of an EFP
- IEEE 802.1p Class of Service (COS) based QoS
- Classification based on inner and outer CoS
- IP Precedence Type of Service (ToS) based QoS
- Differentiated Services Code Point (DSCP) based QoS
- Differentiated Services MPLS-TE per Requirements for Support of Differentiated Services-aware MPLS Traffic Engineering – RFC 3564
- Egress marking of COS, ToS, DSCP, and MPLS EXP QoS fields
- Classification using Access Control List (ACL)
- 2-rate 3-color (2R3C) ingress Policing
- Differentiated Services Code Point (DSCP) traffic shaping
- Class-Based Weighted Fair Queuing (CBWFQ)
- Priority Queuing with up to 2 priority queues
- Weighted Random Early Detect (WRED)
- Egress shaping per queue
- Egress policing per queue
- Resource Reservation Protocol (RSVP) Call Admission Protocol (CAC)

Timing

- IEEE 1588-2008 Ordinary Clock over Ethernet, IP, and MPLS
- IEEE 1588-2008 end-to-end Transparent Clock over Ethernet, IP, and MPLS
- IEEE 1588-2008 Boundary Clock over Ethernet, IP, and MPLS
- IEEE 1588-2008 precision time protocol (PTP) telecom profile for frequency synchronization – ITU-T G.8265.1/Y.1365.1
- Hybrid clocking
- T1/E1 line timing

Features

- OCn/STM-n Line Timing
- Adaptive Clock Recovery (ACR)
- Differential Clock Recovery (DCR)
- Global navigation satellite system (GNSS) ports; Time of Day (ToD), 10MHz, 1 Pulse Per Second (1PPS)
- Building Integrated Timing Supply (BITS)
- ITU-T G.781 and GR-1244-CORE/GR-253-CORE based Clock Selection
- ITU-T SyncE with Ethernet Synchronization Messaging Channel (ESMC) (G.8261, G.8262, G.8264)
- ITU-T G.8275.2 Telecom Profile
- Synchronization Status Messages (SSM) (G.781, G.707, G.704)
- SyncO Ready (under Discussion by ITU-T ST15)
- Explicit Pointer Adjustment Relay (EPAR)
- Hop-by-Hop PTP Redundancy

OAM

- IEEE 802.1ag Connectivity Fault Management (CFM) over EFP
- IEEE 802.3ah Link OAM
- MPLS Fault Management Operations, Administration, and Maintenance – RFC 6427
- MPLS Generic Associated Channel (G-Ach) – RFC 5586
- BFD Connectivity Verification per OAM Framework for MPLS-Based Transport Networks – RFC 6371
- On-demand CV/Route Tracing per Mechanism for Performing Label Switched Path Ping (LSP Ping) over MPLS Tunnels – RFC 6424
- ITU-T Y.1731 Fault Management (FM) over EFP
- ITU-T Y.1731 Performance Management (PM) over EFP for Delay Measurement (DM) and Synthetic Loss Measurement (SLM)
- ITU-T Y.1564 Ethernet Service Activation Test methodology (SAT)
- Ethernet Local Management Interface (E-LMI), as a Provider Edge (PE) device
- CFM extensions for microwave Adaptive Code Modulation (ACM) actual air bandwidth exchange
- Two-Way Active Measurement Protocol (TWAMP) with VRF support – RFC 5357

Security

- Authentication, Authorization, and Accounting (AAA) with TACACS+ and RADIUS
- SSH Protocol v2
- MAC limiting per Bridge Domain (BD)
- Storm control for Port Mode
- Layer 3 Access Control Lists (ACL) for IPv4 and IPv6
- IPv4 unicast Reverse Path Forwarding (uRPF) strict mode
- MAC security
- Dynamic Arp Inspection (DAI)
- DHCP Snooping with option 82 insertion
- DHCP Option 82 Configurable Circuit ID and Remote ID
- Security Architecture for the Internet Protocol (IPsec)
- Advanced Encryption Standard (AES) CCM Mode with IPsec Encapsulating Security Payload (ESP)
- IPsec Internet Key Exchange (IKE), IKEv1 and IKEv2 Transform sets
- IPsec Virtual Tunnel Interfaces
- IPsec Encrypted Preshared Key
- IPsec Dead Peer Detection (IKE)
- IPsec Anti-Replay Window
- IPsec RSA keys, Certificate Revocation List (CRL) support and certificate enrollment for PKI
- IPsec Extended Sequence Number (ESN) support
- IPsec feature to negotiate traffic type/port for a session
- Facilitation of generating CSR File for Certificates
- Support for X.509 certificates
- Online Certificate Status Protocol (OCSP) – RFC 6960
- Storm Control

Manageability

- SNMP
- MIBs
- Dying Gasp message
- Embedded Event Manager (EEM)
- Cisco Discovery Protocol (CDP)

Features

- 802.1ab Link Layer Discovery Protocol (LLDP)
- Port Level Local SPAN (SPAN)
- Port Level Remote SPAN (RSPAN)
- Cisco IOS Command Line Interface (CLI)
- Cisco Prime™ Network: fault, provisioning, and performance management

Warranty Information

Find warranty information on Cisco.com at the [Product Warranties](#) page.

Service and Support

Cisco offers a wide range of services programs to accelerate customer success. These innovative services programs are delivered through a unique combination of people, processes, tools, and partners, promoting high levels of customer satisfaction. Cisco Services help you protect your network investment, optimize network operations, and prepare your network for new applications to extend network intelligence and the power of your business. For more information about Cisco Services, refer to Cisco Technical Support Services or Cisco Advanced Services.

Cisco is committed to reducing your total cost of ownership. Cisco offers a portfolio of technical support services to help ensure that Cisco products operate efficiently, remain highly available, and benefit from the most up-to-date system software. The services and support programs described in Table 7 are available as part of the Cisco Carrier Ethernet Switching Service and Support solution and are available directly from Cisco and through resellers.

Table 7. Service and Support

| Advanced Services | Features | Benefits |
|---|--|---|
| <p>Cisco Total Implementation Solutions (TIS), available directly from Cisco</p> <p>Cisco Packaged TIS, available through resellers</p> | <ul style="list-style-type: none"> • Project management • Site survey, configuration, and deployment • Installation, test, and cutover • Training • Major moves, adds, and changes • Design review and product staging | <ul style="list-style-type: none"> • Supplement existing staff • Help ensure functions meet needs • Mitigate risk |
| <p>Cisco SP Base Support and Service Provider-Based Onsite Support, available directly from Cisco</p> <p>Cisco Packaged Service Provider-Based Support, available through resellers</p> | <ul style="list-style-type: none"> • 24-hour access to software updates • Web access to technical repositories • Telephone support through the Cisco Technical Assistance Center (TAC) • Advance Replacement of hardware parts | <ul style="list-style-type: none"> • Facilitate proactive or expedited problem resolution • Lower total cost of ownership by taking advantage of Cisco expertise and knowledge • Reduce network downtime |

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