Business Solutions

Cisco IOS Software and Multiprotocol Label Switching

Cisco Systems, Inc:

Cisco Systems, Inc. is the worldwide leader in networking for the Internet. Cisco hardware and software solutions are used to link computers and computer networks, so people have easy access to information regardless of differences in time, place, or type of computer system. Customers benefit from Cisco networking solutions through more efficient exchange of information, in turn leading to cost savings, process efficiencies, and closer relationships with their customers, prospects, business partners, suppliers, and employees. Cisco solutions provide the networking foundation for companies, universities, utilities, and government agencies worldwide.

The Company was founded in late 1984 by a small group of computer scientists from Stanford University seeking an easier way to connect different types of computer systems. Cisco Systems shipped its first product in 1986. Since then, Cisco has grown into a multinational corporation with over 14,500 employees in more than 200 offices in 55 countries.

Cisco IOS Software:

Overview:

The agility of a network is a measure of its ability to adapt to changing environments and seize opportunities in a nimble, opportunistic manner. Cisco IOS® software enables quick and reliable deployment of new Internet applications through its intelligent network services.

At the heart of the Internet sits Cisco IOS software. A great deal of the world's business communication and electronic commerce activities rely on Cisco IOS software intelligent packet forwarding, security, and network management capabilities. In fact, virtually all Internet traffic today passes over equipment from Cisco Systems.

Highlights

- End-to-end solutions on a common IP fabric
- Rich in advanced technology
- Standards: an open foundation for Cisco IOS software
- Cost-effective upgrades for network enhancement
- Rapid time to market
- Testing and quality assurance
- Distributed development: working hand-in-hand with customers
- Training for network professionals

Multiprotocol Label Switching: Technology Overview

The Challenge

The explosive growth of the Internet presents a serious challenge to service providers and equipment suppliers in terms of tremendous increases in traffic and the number of users. The demand for creating differentiated IP services and getting these new value-added services to market quickly is also increasing.

Other challenges include additional costs of mapping IP over Layer 2 networks as well as difficulties in identifying better network utilization and fault handling. There is also a constant need to adapt to individual services in order to generate increased revenue streams.

The Solution

Cisco IOS® Multiprotocol Label Switching (MPLS) fuses the intelligence of routing with the performance of switching and provides significant benefits to networks with a pure IP architecture as well as those with IP and ATM or a mix of other Layer 2 technologies. MPLS technology is key to scalable virtual private networks (VPNs) and end-to-end quality of service (QoS), enabling efficient utilization of existing networks to meet future growth and rapid fault correction of link and node failure. The technology also helps deliver highly scalable, differentiated end-to-end IP services with simpler configuration, management, and provisioning for both Internet providers and subscribers.

The MPLS standard, published by the Internet Engineering Task Force (IETF), evolved from the Cisco Tag Switching implementation. Cisco's leadership and experience in the Tag Switching and MPLS arena translates into a feature-rich implementation and a robust, proven platform for service-provider and business networks.

MPLS Technology

Based on Label Swapping, where a single forwarding mechanism provides opportunities for new control paradigms and applications, MPLS Label Forwarding is performed with a label lookup for an incoming label, which is then swapped with an outgoing label and finally sent to the next hop. Labels are imposed on the packets only once at the edge of the MPLS network and removed at the other end. These labels are assigned to packets based on groupings or forwarding equivalence classes (FECs). Packets belonging to the same FEC get the same treatment. The label is added between the Layer 2 and the Layer 3 header (in a packet environment) or in the virtual path identifier/virtual channel identifier (VPI/VCI) field (in ATM networks). The core network merely reads labels, applies appropriate services, and forwards packets based on the labels. This MPLS lookup and forwarding scheme offers the ability to explicitly control routing based on destination and source addresses, allowing easier introduction of new IP services.

Applications

Businesses rely on Cisco IOS software for delivery of the most complete MPLS feature set. The most common applications of Cisco IOS MPLS include:

Traffic Engineering—MPLS traffic-engineering enables an MPLS backbone to expand on the traffic-engineering capabilities of Layer 2 ATM and Frame Relay networks.

Traffic engineering is enabled through MPLS mechanisms that allow traffic to be directed through a specific path, which may not necessarily be the least-expensive path. Network managers can implement policies to ensure optimal traffic distribution and improve overall network utilization.

Key features of traffic engineering:

- Traffic engineering routes traffic flows across a network based on the resources the traffic flow requires and the resources available in the network.
- Traffic engineering employs "constraint-based routing," in which the path for a traffic flow is the shortest path that meets the resource requirements (constraints) of the traffic flow.

- Traffic engineering replaces the need to manually configure the network devices to set up explicit routes. Instead, you can rely on the MPLS traffic-engineering functionality to understand the backbone topology and the automated signaling process.
- Traffic engineering accounts for link bandwidth and for the size of the traffic flow when determining explicit routes across the backbone.

MPLS guaranteed bandwidth services is a value-added enhancement to traditional traffic-engineering mechanisms. It combines the IP QoS technology with MPLS to provide services such as point-to-point guarantees in an MPLS-enabled network. MPLS lets service providers deliver guaranteed pipes and bandwidth allocations. Guaranteed bandwidth allows distributed bookkeeping of QoS resources to traffic engineer both premium and best-effort traffic such as voice and data.

Fast reroute (FRR)—Traffic engineering is essential for telcos and Internet service provider backbones. Both backbones must support a high use of transmission capacity, and the networks must be very resilient so that they can withstand link or node failures. FRR allows extremely quick recovery if a node or link fails. Such fast recovery prevents end-user applications from timing out and also prevents loss of data.

MPLS VPNs greatly simplify service deployment compared to traditional IP VPNs. As the number of routes and customers increase, MPLS VPNs easily scale, while providing the same level of privacy as Layer 2 technologies. In addition, they can transport non-unique IP addresses across a public domain. Following are some of the benefits of MPLS in general and MPLS VPNs in particular:

– *Scalability*—Most VPNs deployed today entail building a point-to-point network within the carrier network at Layer 2 using Frame Relay or ATM permanent virtual circuits (PVCs). The need to establish and manage a full mesh of virtual circuits within the provider's WAN makes it difficult to add large volumes of new sites quickly.

MPLS VPNs support any-to-any (full mesh) communication among all the sites without the need to build a full-mesh Layer 2 PVC network.

– *Private address space*—MPLS VPNs provide a network-based solution to VPN connectivity, meaning there is no tunnel setup requirement from one site to another. The sites may use public or private IP address without the need of Network Address Translations (NATs) to connect via the provider's network, and this offer better security than otherwise possible.

– *IP + ATM integration*—When MPLS VPNs are set up using ATM label switch routers (LSRs) such as the BPX® 8650, the capabilities of scalable connectionless service of IP are combined with the performance and traffic management capabilities of ATM to provide a seamless integration of IP and ATM networks with lower complexity in management than an overlay network.

– *Security*—MPLS protocols ensure that traffic from individual VPNs are isolated from each other in a similar way that Frame Relay networks ensure the privacy of individual virtual circuits.

– *Centralized service*—Building VPNs in Layer 3 has the additional advantage of targeting other Layer 3 services to a group of users represented by the VPN.

A VPN must give service providers more than a mechanism for privately connecting users to intranet services. It must also provide a way to flexibly deliver value-added services to targeted customers. Scalability is critical, because customers want to use services privately in their intranets and extranets.

Furthermore, because MPLS VPNs are seen as private intranets, it's easy to take advantage of new IP services:

- Quality of service
- Telephony support within a VPN
- Centralized services such as content and Web hosting to a VPN

Now myriad combinations of specialized services can be customized for individual customers; for example, a service that combines IP multicast with a low-latency service class to enable video conferencing within an intranet can easily be created.

MPLS class of service (CoS)—This critical capability ensures that important traffic is given the appropriate priority over the network and that latency requirements are met. IP QoS mechanisms can be seamlessly implemented in an MPLS environment.

The CoS feature for MPLS enables network administrators to provide differentiated types of service across an MPLS network. Differentiated service allows the providers to offer a range of services by simply marking packets with a DiffServ code point (DSCP) and treating packets appropriately. In supplying differentiated service, MPLS CoS offers packet classification, congestion avoidance, and congestion management.

All IP QoS mechanisms can be transparently taken advantage of in an MPLS environment. The service provider can thus offer end-to-end QoS guarantees in an IP environment.

Any Transport over MPLS (AToM)

Because the core of the MPLS network uses a label-swapping mechanism, this feature can be exploited to transport any protocol such as Frame Relay, ATM, or just Ethernet in a point-to-point fashion from site A to site B across the service provider's cloud. This feature allows service providers to offer traditional data services such as Frame Relay or ATM to their customers with a MPLS-based network.

Services such as Ethernet over MPLS can be a key to capturing the metropolitan market for service providers where the providers can offer transparent LAN service and provide support for the LAN protocols, without compromising security.

Summary

Cisco IOS MPLS introduces a new architectural paradigm. In MPLS environments, the control plane and the forwarding plane are separated, thus enabling several benefits that were previously impractical within IP environments.

The above paradigm can be easily applied to time-division multiplexing (TDM) switches or optical switches where TDM cross connects or optical wavelengths can be set up using MPLS control plane. The TDM channel or the optical wavelength now indicates the label switching path. Using this paradigm, a seamless network can be built with routers, ATM switches, TDM cross connects, and optical cross connects. The entire network now uses a single mechanism to set up and tear down LSPs, allowing extensions of MPLS-based services such as VPN, traffic engineering, FRR, and any transport over MPLS (AtoM).

Cisco IOS MPLS: Key Features and Benefits

Features	Benefits
Industry Standard	• Supports open, heterogeneous installations • Facilitates interoperability
New IP + ATM Network Model	• Reduces complexity as compared to IP over ATM • Increases IP scalability
Separated Control and Forwarding Planes	• Single forwarding mechanism provides opportunites for new control paradigms and applications
Explicit Data Forwarding—Terminal Equipment (TE), Guaranteed Bandwidth (GB), Frame Relay	• Offers ability to better control traffic and re-route packets • Enables explicit path forwarding of packets and bandwidth allocations for latency-sensitive applications • Offers fast fault-recovery time
Scalable VPN Services	• Provides a “build-once, sell many times” model • Provides highly scalable routing and optimal use of network resources
Developed from Cisco Tag Switching	• Offers most complete MPLS feature set • Features prove Cisco leadership and experience in MPLS

Protocol Support

Link Layer: Ethernet, ATM, Packet over SONET (POS), Dynamic Packet Transport (DPT), and point-to-point links.

Platform Support

All Cisco IOS Release 12.1 versions and later include MPLS features.

For Additional Information

Additional information about the Cisco IOS MPLS technology can be found at http://www.cisco.com/go/mpls/ or by contacting your local Cisco representative.

Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

European Headquarters
Cisco Systems Europe
11, Rue Camille Desmoulins
92782 Issy Les Moulineaux
Cedex 9
France
http://www-europe.cisco.com
Tel: 33 1 58 04 60 00
Fax: 33 1 58 04 61 00

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-7660
Fax: 408 527-0883

Asia Headquarters
Nihon Cisco Systems K.K.
Fuji Building, 9th Floor
3-2-3 Marunouchi
Chiyoda-ku, Tokyo 100
Japan
http://www.cisco.com
Tel: 81 3 5219 6250
Fax: 81 3 5219 6001

Cisco Systems has more than 200 offices in the following countries. Addresses, phone numbers, and fax numbers are listed on the Cisco Connection Online Web site at http://www.cisco.com/go/offices.

Argentina · Australia · Austria · Belgium · Brazil · Canada · Chile · China · Colombia · Costa Rica · Croatia · Czech Republic · Denmark · Dubai, UAE
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