CISCO SYSTEMS

Cisco **7600** Series Internet Router

The Cisco 7600 Series Internet Router delivers high-performance wide- and metropolitan-area network (WAN and MAN) capabilities with high-touch IP services at the network edge. Now, service providers (SPs) and enterprises can "service enable" their networks at optical speeds, providing competitive advantage and service differentiation to the SP and high-speed connectivity and link usage efficiency to the enterprise. The Cisco 7600 Series helps SPs break through service and bandwidth barriers to increase new revenue and profits.

Cisco 7600 Series Internet Router Chassis

The Cisco 7600 Series provides customers the flexibility of three different form factors through 3-slot, 6-slot and 9-slot chassis. As one of the most scalable systems in the industry, each chassis offers the ability to bring DS0 to OC-48 WAN connectivity, and 10-Mbps Ethernet to 10-Gigabit Ethernet LAN connectivity to metropolitan aggregation, WAN edge aggregation, and enterprise networking applications (see Tables 1 and 2).

Table 1 Cisco 7600 System Characteristics

	Cisco 7603	**Cisco 7606**	**Cisco 7609**
Height	7 inches (4 RU)	12.25 inches (7 RU)	33.5 inches (20 RU)
Chassis/Rack	10	6	2
Slots	3 (horizontal)	6 (horizontal)	9 (vertical)
NEBS Compliant	Yes	Yes	Yes
Bandwidth	32 Gbps	160 Gbps	256 Gbps
Switching Performance	15 Mpps	30 Mpps	30 Mpps
Service Performance	6 Mpps per OSM	6 Mpps per OSM	6 Mpps per OSM

Figure 1

Cisco 7600 Series
Internet Router

Cisco 7603   Cisco 7606   Cisco 7609

Table 2 Features and Benefits of the Cisco 7600

Feature	Benefit
Scalable and modular bandwidth capacity	Backplane is scalable up to 256 Gbps via the crossbar switch fabric (WS-X6500-SFM2)
Chassis options	Three chassis options (Cisco 7603, 7606, and 7609) specifically designed to fit different space requirements and applications
WAN interfaces ranging from DS0 to OC-48/STM-16	Broad range of WAN interfaces allows scalability as bandwidth requirements grow
High-speed channelized optical connectivity (channelized OC-12 and channelized OC-48 to DS3)	Provides the industry's highest-density DS3, OC-3, and OC-12 connectivity to enable cost savings and easy deployment
LAN connectivity	Supports the full Catalyst® 6000 Series of high-density/high-speed Ethernet, Fast Ethernet, Gigabit Ethernet, and 10-Gigabit Ethernet LAN modules
FlexWAN module for evolution from the Cisco 7500 to the Cisco 7600	Provides both a distinct growth path and investment protection for Cisco 7200 and 7500 WAN interfaces
Parallel Express Forwarding (PXF)-enabled high-performance IP services	Field-upgradable application-specific integrated circuit (ASIC) provides the flexibility and time-to-market advantages of software upgrades with the processing speed of hardware-accelerated IP services
Wide range of IP services and quality of service (QoS)	IP services can be applied to queue, rate-limit, shape, and account for traffic flows, allowing for maximum revenue generation per connection
Multiprotocol Label Switching (MPLS) Provider Edge (PE) functionality • Label Imposition, Disposition and Swapping MPLS • MPLS class of service (CoS) • Ethernet over MPLS • MPLS virtual private network (VPN)	For service providers and high-end enterprise customers: • Highly scalable standards-based implementation • Efficient Layer 2 transport across Layer 3 MPLS core • End-to-end IP QoS support • Support for Layer 2 and Layer 3 MPLS VPNs • Basic MPLS switching support for ISP core

**Series**

Cisco 7600 Applications

The Cisco 7600 is ideally positioned for deployment at the network edge—both in service provider and enterprise environments.

Cisco 7600 Service Provider Solutions

Service providers require networking platforms that scale from DS0 to OC-48c and beyond. They must also support a consistent set of high-performance features across this broad range of speeds. The ability to deploy a wide set of revenue-generating services using a single standardized platform is an enormous benefit. Figure 2 shows typical SP deployment situations and the Cisco 7600 solutions that effectively meet these needs.

Figure 2

Cisco 7600 Service Provider Applications
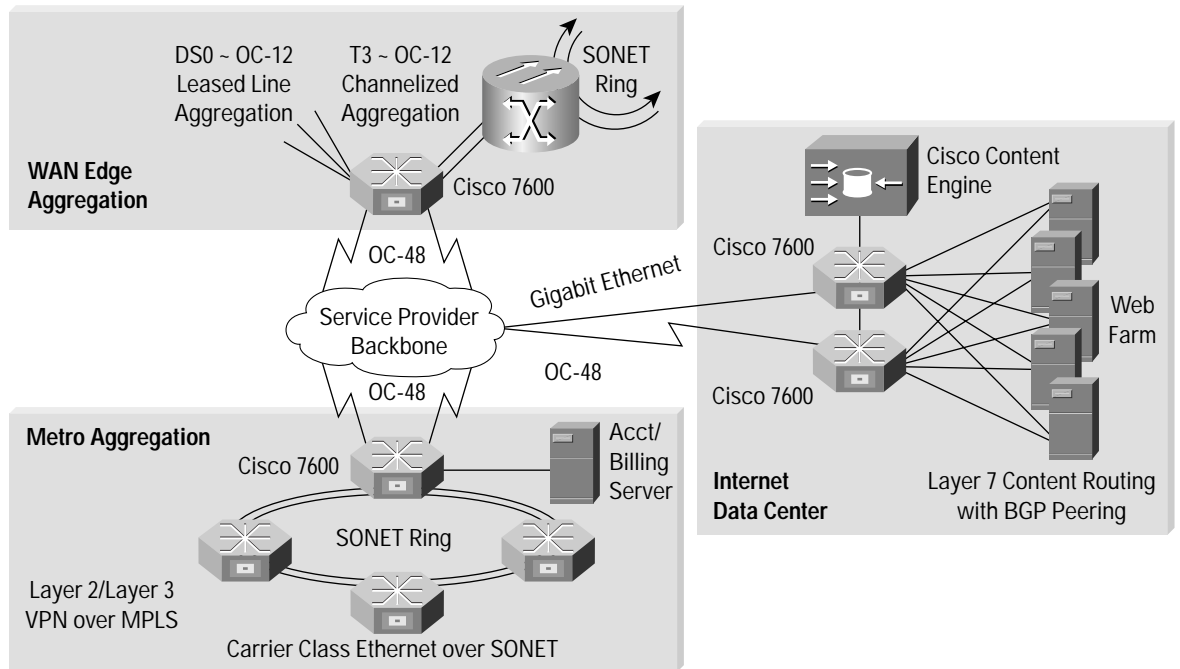
WAN Edge aggregation—The Cisco 7600 is an ideal platform for integrating all aspects of a point of presence (POP): customer aggregation, Web-hosting services, and high-speed access to the backbone in a single platform. For customer aggregation needs, the Cisco 7600, configured with the Channelized OC-12 or OC-48 optical services modules (OSMs), or the FlexWAN with Cisco 7200 and 7500 port adapters, provides connectivity from DS0 to OC-48. The eight-port Channelized OC-12 and two-port Channelized OC-48 OSMs provide the industry's highest-density DS3, OC-3, and OC-12 aggregation. Optical customer termination and backbone connectivity are achieved through the high-speed PXF-enabled OC-3c/STM-1, OC-12c/STM-4, and OC-48c/STM-16 interfaces.

Metropolitan aggregation—The Cisco 7600 with the PXF IP service-enabled Gigabit Ethernet WAN OSM is ideally suited for metropolitan aggregation. The Gigabit Ethernet WAN OSM supports virtual LAN (VLAN) trunking so that multiple customers in an office building or metropolitan area can share the same Gigabit Ethernet access switch fiber but use separate VLANs to access the service provider's POP. The Gigabit Ethernet WAN OSM is equipped with Cisco's patented PXF technology to support high-touch, high-performance packet services. PXF-based traffic shaping can be used to offer sub-rate Gigabit Ethernet connections when customers do not have enough current traffic to justify a full Gigabit Ethernet, but may in the future. The Cisco 7600 also offers a range of choices for either Layer 2 or 3 metropolitan services based on either MPLS or traditional Ethernet forwarding schemes.

Cisco 7600 Enterprise Solutions

Enterprises now require networking platforms that can aggregate remote users, branch offices, and business partners with speeds from DS0 to OC-12/STM-4 while maintaining the ability to connect to their service providers at OC-12/STM-4 and beyond.

In this aggregation scenario, high-performance services are critical. The Cisco 7600 provides services such as traffic shaping, security, and Class-Based Weighted Fair Queuing (CBWFQ) with Low Latency Queuing (LLQ). In addition, the Cisco 7600 offers the ability to connect database and application servers with Gigabit and Fast Ethernet all in the same chassis as well as offering a migration path for current Cisco 7200 and 7500 customers via the FlexWAN module. Utilizing a single, standardized platform, enterprises can benefit from the simplicity of network design and operational cost savings. Figure 3 shows how an enterprise can use the Cisco 7600 to effectively meet their needs.

Figure 3
Cisco 7600 Enterprise Applications
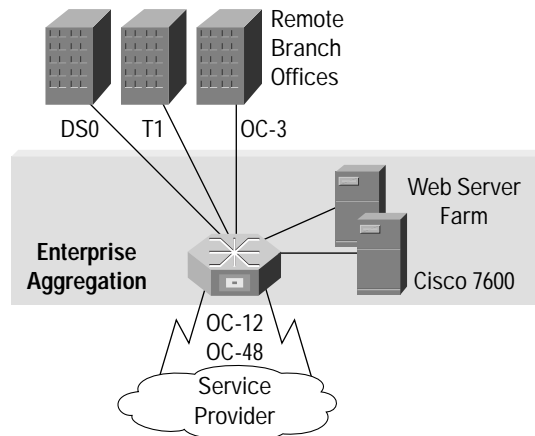
Sophisticated System Architecture

The Cisco 7600 Series Internet Router takes advantage of the Catalyst® 6500 Series infrastructure with an NEBS-3 compliant chassis, 256-Gbps crossbar switch fabric, and 30-Mpps switching performance. High availability is provided through logical and physical redundancy as well as Cisco IOS® Software capabilities. In addition, the Cisco 7600 offers a broad range of high-touch IP network services at optical speed through various Optical Services Modules (OSMs), enabled by Cisco patented PXF technology.

Figure 4

Cisco 7600 Internet Router System Architecture
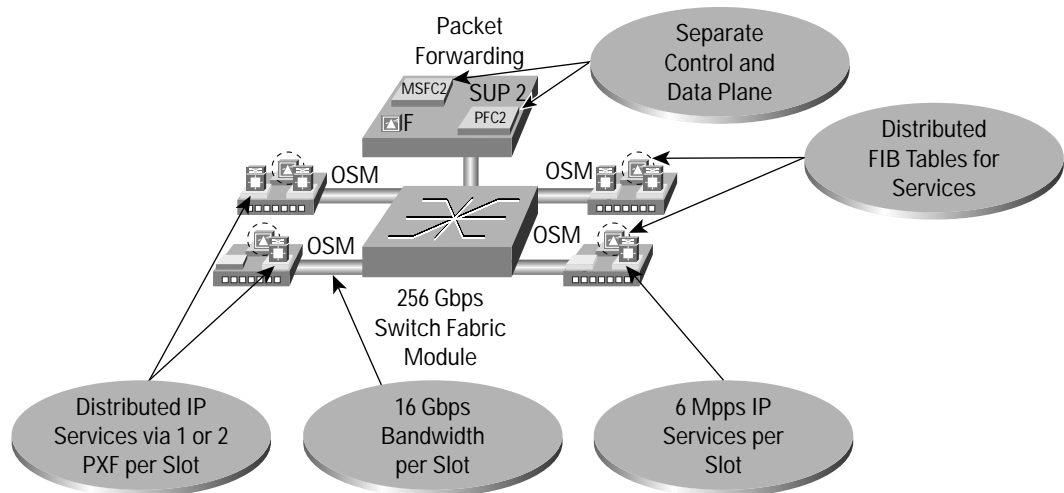
The Cisco 7600 incorporates a centralized switching and distributed IP service application architecture. The Supervisor 2 module with the policy feature card (PFC 2) and the multilayer switch feature card (MSFC2) provides centralized packet switching. This switching complex can simultaneously apply security access control lists (ACLs), apply QoS ACLs for traffic policing and marking, make policy decisions, and determine where to switch the packet, all at line rate regardless of packet size and flow length. Distributed IP network services are implemented in distributed OSMs, where each OSM has 32-Gbps bandwidth provided by a switch fabric module (SFM) and contains up to two PXF IP service processors to enable IP services at 6 Mpps.

The Cisco 7609 has the option to use a 256-Gbps SFM or a 32-Gbps bus that provides centralized switching performance of 30 or 15 Mpps, respectively. When the SFM is used, the Cisco 7609 can also support distributed switching with performance up to 168 Mpps by using the Catalyst 6500 16-port Gigabit Ethernet LAN card, which is powered by the Distributed Forwarding Card (DFC) and the SFM.

The Cisco 7606 has the option to use a 160-Gbps SFM or a 32-Gbps bus that provides centralized switching performance of 30 or 15 Mpps, respectively. When the SFM is used, the Cisco 7606 can also support distributed switching with performance up to 96 Mpps by using the Catalyst 6500 16-port Gigabit Ethernet LAN card, which is powered by the DFC and the SFM.

The Cisco 7603 has only the 32-Gbps bus option and provides 15-Mpps centralized switching performance. Distributed switching is not supported on the Cisco 7603.

Advanced PXF Technology

PXF is a Cisco patented "adaptive network processing" technology, which enables hardware-accelerated, parallelized, programmable IP network services to be delivered in a short time to market. As shown in Figure 5, the PXF IP services processor contains 16 networking-optimized CPUs, which are arranged in a 4 x 4 array. The four columns can be visualized as four pipelines where data packets flow through from ingress interface to egress interface. The four rows can be visualized as four IP service stages, where at each stage a different high-touch IP network service

can be microcode programmed in CPUs and applied to the packets passing through at line rate. Therefore, at any point of time, 16 data packets can be processed in parallel, yielding incredible improvement in features and performance compared to those with traditional designs based on general-purpose microprocessors or ASICs.

Figure 5
PXF Processor Architecture
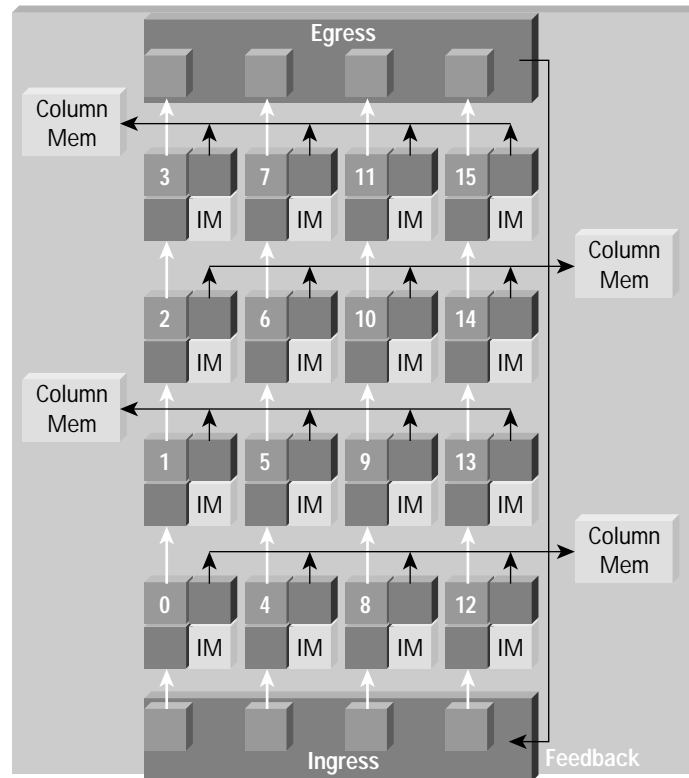
High-Speed Optical Connectivity

Cisco offers a wide range of OSMs for the Cisco 7600 Series to meet various interface scalability requirements and allow for high-performance IP service applications. These OSMs provide Internet connectivity at optical speed from OC-3 all the way to OC-48. Each OSM has two PXF processors on board and provides up to 6-Mpps IP services performance. The following OSMs are supported:

Packet over Sonet (POS)

- 4- or 8- or 16-port OC-3c/STM-1c with 4 ports of Gigabit Ethernet
- 2- or 4-port OC-12c/STM-4c with 4 ports of Gigabit Ethernet
- 1-port OC-48c/STM-16c with 4 ports of Gigabit Ethernet

ATM

- 2-port OC-12c/STM-4c with 4 ports of Gigabit Ethernet

Gigabit Ethernet

- 4-port Gigabit Ethernet WAN

Channelized

- 1-port OC-12c/STM-4c (DS3) with 4 ports of Gigabit Ethernet
- 1-port OC-48c/STM-16c (DS3) with 4 ports of Gigabit Ethernet

Dynamic Packet Transport

- 2-port OC48/STM-16 POS/DPT with 4 ports of Gigabit Ethernet

As shown above, each of the POS, ATM, and Channelized OSMs provides an additional four ports of Gigabit Ethernet to complement the WAN ports on each line card. These Gigabit Ethernet ports are not PXF enabled, so they do not have the advantage of the high-touch IP network services provided by PXF. They do, however, provide basic packet buffering and QoS mechanisms, as well as Cisco Gigabit EtherChannel® technology. On the other end, the four ports on the Gigabit Ethernet WAN OSM are all PXF enabled and they are used to provide Layer 3 connectivity and services in the WAN and MAN areas.

Investment Protection

In addition to OSMs, the Cisco 7600 incorporates the FlexWAN module. The FlexWAN module enables the Cisco 7600 to use most of the port adapters shared with the Cisco 7200 and 7500, thus providing great investment protection in Cisco interfaces. FlexWAN allows the Cisco 7600 to aggregate low-speed traffic from n x DS0 to OC-3, thus complementing the high-speed interfaces offered by OSMs.

In addition, the Cisco 7600 supports the traditional LAN cards of the Catalyst 6500, including 8- and 16-port Gigabit Ethernet, 48-port 10/100BASE-TX, 24-port 100BASE-FX, 24-port 10BASE-FL cards and 1 port 10 Gigabit Ethernet.

Intelligent IP Services

Cisco 7600 IP services can be classified into four categories as follows:

- PFC2-Based IP Services
- PXF-Based Services
- BGP Policy Accounting System
- Multi protocol Label Switching

PFC2-Based IP Services

Several services are centralized in the PFC2; they run at 30 Mpps, including ACL, classification, and marking based on differentiated services code point (DSCP), type of service (ToS) and interface (physical or logical), and policy-based routing (PBR).

PXF-Based Services

The PXF processing complex provides high-performance QoS features on the OSMs. PXF was developed to provide efficient queue-scheduling that integrates traffic shaping with hierarchical link sharing while supporting a large number of queues while sustaining high performance.

PXF implements a separate queue for each DSCP value or interface (either logical or physical). This queuing mechanism offers OSMs the ability to provide very granular hierarchical traffic shaping and link sharing for up to 16000 (8000 per PXF) simultaneous queues per OSM and 66 queues per logical interface.

Each queue can have traffic shaping for both inbound and outbound traffic shaping on queues classified by DSCP, ToS, or interfaces. Figure 6 shows DSCP-based traffic shaping.

Figure 6
DSCP-Based Traffic Shaping

Policy:
Normal – 20 Mbps   Priority – 80 Mbps   Critical – 120 Mbps
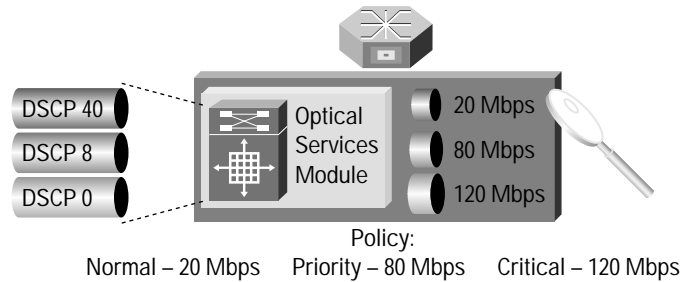
BGP Policy Accounting Services

BGP policy accounting services uses the Border Gateway Protocol (BGP) policy accounting traffic index as the classification criterion to perform services such as destination-sensitive billing/accounting based on the ultimate destination of a packet.

BGP policy accounting billing enables service providers to offer their customers differentiated billing options. For example, all traffic destined for a particular set of autonomous systems for each customer could be accounted for at one rate and traffic going to other destinations could be billed at a second rate. This feature is valuable because you may have a local peering agreement with another service provider who bills at $5.00 per 100 MB and the other service provider bills at $7.00 per 100 MB. So now you can accurately bill back to customers the amount of traffic they are sending to the different destinations.

Multiprotocol Label Switching (MPLS)

MPLS is fast becoming more critical in service-provider networks because of its scalability and traffic-engineering (TE) capabilities. The Cisco 7600 supports the major MPLS functions compliant with standards, such as:

- Label imposition/disposition
- Label swapping
- Label Distribution Protocol (LDP)
- Ethernet over MPLS (EoMPLS)
- MPLS CoS
- MPLS/VPN
- MPLS TE (available mid-2003)

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