Q&A

Internet Protocol Version 6

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Q. What is Internet Protocol Version 6 (IPv6)?

A. IPv6 is the next generation of the protocol that runs the Internet. IPv6 is currently a set of requests for comments (RFCs) and draft standards in the IETF. IPv6 is designed to improve upon IPv4's scalability and ease of configuration and to reintroduce the original TCP/IP benefits for global networking. These issues are central to the competitiveness and performance of all types of network-dependent businesses. Its use will also expand the capabilities of the Internet to enable a variety of valuable and exciting scenarios, including large-scale peer-to-peer and mobile applications.

Q. What does the Internet run on today?

A. Today, the Internet runs on IPv4, but after years of experimentation and interoperability events (6net.org, 6NET, Moonv6, and so on), IPv6 is ready and is being integrated into production Internet infrastructures of, for example, several service providers and National Research Experimentation Networks (NREN).

Q. Is there an IPv5?

A. IPv5 was once an experimental draft proposal in the IETF defining a real-time streaming protocol. It did not result in a standard deployed on production networks. It is actually called the Internet Streaming Protocol:

http://www.ietf.org/rfc/rfc1819.txt

1819 Internet Stream Protocol Version 2 (ST2) Protocol Specification—Version ST2+; L. Delgrossi and L. Berger, eds., August 1995 (format: TXT = 266,875 bytes) (obsoletes RFC1190, IEN 119) (status: experimental).

Q. What applications will IPv6 enable?

A. Any application that runs on top of IPv4 can be modified to run over IPv6. However, IPv6 enables—through its effectively infinite address space—simple mass-market deployment of peer-to-peer applications and use of nontraditional Internet-connected devices. These include consumer electronics devices such as DVD players, TVs, and digital cameras and residential IP telephony and videoconferencing equipment. Some of these devices are enabled today using IPv4, though at a small scale and with significant operational and development complexity. IPv6 restores innovative freedom to the application developer at the same time it enables cost-effective support and deployment for network operators.

Q. Which Cisco Systems® platforms support IPv6?

A. Cisco® IPv6 solutions are progressively developed across the overall Cisco portfolio. Cisco routers and Layer 3 switches running one of the following Cisco IOS® Software releases are IPv6-capable: Cisco IOS Software releases 12.2T, 12.3M, 12.3T, 12.4M, 12.4T, 12.2S (and derivatives), 12.0S (Cisco 12000 Series routers and Cisco 10720 Router only) and Cisco IOS-XR Software (Cisco Carrier Routing System—CRS-1, Cisco XR 12000 Series Router).

For details, please refer to the Cisco IPv6 solutions paper at http://www.cisco.com/en/US/products/ps6553/products_white_paper09186a00802219bc.shtml.

The Cisco IOS Software IPv6 feature set description per Cisco IOS Software Release is available from the Cisco IPv6 Start Here manual at http://www.cisco.com/en/US/products/sw/iosswrel/ps5187/products_configuration_guide_chapter09186a00801d65ed.html.

Q. How will IPv6 be deployed?

A. Service providers and enterprises will look to integrate IPv6 support and capabilities into their existing IPv4 infrastructures. Cisco has added IPv6 to its Cisco IOS Software. This means that current networks based on Cisco are IPv6-capable, enabling coexistence and parallel operation between IPv4 and IPv6, thereby allowing network managers to configure IPv6 when it is required.

Q. How will we manage IPv6?

A. We believe there will be several years of coexistence between IPv4 and IPv6 while the array of devices and applications evolves. Therefore management of IPv6 will be offered in phases over time. To enable network managers to control both environments, Cisco initially provided IPv6 instrumentation for management capabilities using an IPv4 transport. As network management stations and applications evolve, subsequent releases support IPv6 transport when appropriate. Cisco network management solutions such as LAN Management Solution (LMS) 2.5, NetFlow Collector 5.0, and Cisco Network Registrar 6.2 already provide IPv6 capabilities including as network layer for new environments.

Q. Who is going to deploy IPv6 first?

A. Business opportunities are promoting the deployment of IPv6. We are seeing an increase of IPv6 activities for the following markets:

- Worldwide national research networks (NRNs) and downstream sites (universities, research labs) now integrate IPv6 on their production networks.
- Service providers around the world—particularly in Japan for broadband infrastructures—are promoting adoption, including open commercial IPv6 services and trials.
- Mobile service providers in the United States and other regions who consider the benefits of IPv6 address space to support their business model and customer adoption rates.
- Government and federal agencies that plan for their infrastructure evolution through longer than average budget lead times are looking at long-term interoperation and have started requiring products that support IPv6 (reference the mandate by U.S. Office Management and Budget in its memo of August 2, 2005).
- In the U.S. federal space, the Department of Defense envisions IP addresses for each piece of equipment on personnel and is looking to manage IP address space through correlation to geographic regions.
- It is expected that the general availability of IPv6 on Microsoft Windows Vista in the second half of 2006 will encourage IPv6 adoption in the enterprise environment as well as the consumer market through its embedded suite of applications.

  For additional details, please refer to http://www.cisco.com/en/US/prod/collateral/iosswrel/ps6537/ps6553/prod_white_paper0900aecd8032b2ad.shtml.

Q. How many addresses will IPv6 accommodate? How does that compare to IPv4?

A. IPv6 supports addresses that have four times the number of bits as those of IPv4 addresses (128 instead of 32). IPv6 is expected to accommodate, theoretically, an almost infinite number of IP addresses (3.4340,282,366,920,938,463,463,374,607,431,768,211,456). This is four billion times four billion times four billion (2^^96) times the size of the IPv4 address space (2^^32).

In a theoretical sense this is approximately 665,570,793,348,866,943,898,599 addresses per square meter of the surface of planet Earth (assuming Earth's surface is 511,263,971,197,990 square meters).

In the long run, though, the focus on IPv6 is about much more than the number of individual addresses. The IPv6 address space is set up to enable many more edge networks (called subnets). To simplify configuration and plug-and-play operation models, the actual number of addresses in use will be substantially less than the theoretical maximum. Utilization of a noticeable percentage of the available subnet space is projected to take well over 100 years.

Q. Why is there an IP address shortage? When will we feel the effect?

A. The IETF and the industry are anticipating that IPv4 will not be able to accommodate the need for an ever-increasing amount of IP addresses in the next few years. Expanded IP addresses are needed to accommodate (1) the proliferation of Internet devices such as personal computers, personal digital assistants (PDAs), wireless devices, and new Internet appliances; (2) the expansion of the Internet through the world; (3) the increasing the use of "always on" Internet access; and (4) the requirements of emerging Internet applications. IPv6 is a solution to enable a mass market and sustain the growth of the human population and the increased adoption of the Internet.

Various exhaustion models have been applied to the consumption data over the last 15 years with a wide array of projections. For additional details, please refer to the *Internet Protocol Journal*, September 2005 issue on http://www.cisco.com/ipj.

Q. What will be the effect on end users?

A. End users probably will not see much difference if their Internet service providers run IPv6; all Internet applications should run transparently on both IPv4 and IPv6. However, as new applications and devices running IPv6 become available, end users will be able to expand the amount of applications and devices they use over the Internet. At some point, with IPv6, consumers will receive an "official" IP address block—much like a home phone number or street address—with full Internet connectivity, thus eliminating the current process of securing a temporary Internet address and/or translating from a private address each time the user wants to access the Internet. A persistent IP address block is expected to more easily support consumer applications such as distributed gaming and Internet telephony as well as open up a variety of new applications and markets, including mobile environments such as transportation. For example, with permanent IP addresses, users with mobile phones and PDAs will be able to stay connected without disrupting the application, as required in IPv4 reattachment exercises.

Q. Given that Cisco supports IPv6 deployment, is Cisco saying that IPv4 products will soon be obsolete?

A. No. Cisco has been discussing its "integration and coexistence strategy" as it relates to IPv6 with customers since it began working on defining IPv6 standards. IPv4 will remain in use as long as businesses require it. Cisco offers "dual stack" support on its solutions for businesses to operate hybrid IPv4 and IPv6 networks. This integrated approach allows each application to move independently, thereby lowering operational costs and allowing the network manager to plan an orderly evolution.

Q. What is the roadmap for IPv4?

A. As previously stated, we do not expect IPv4 to go away for several years. The Cisco objective is to provide best-in-class feature sets and products for both IPv4 and IPv6 protocols for the foreseeable future.

Q. Will there be any learning curve issues for customers of IPv6 products?

A. As with any new technology, IPv6 requires a learning curve for network managers and operations personnel. For end users, the protocol is transparent, and there should be no learning curve unless their application requires typing in explicit addresses. To assist customers in becoming comfortable with IPv6, Cisco Systems has developed an IPv6 education program that includes:

- Cisco IOS Software IPv6 instructor-led training
- Cisco IOS Software IPv6 e-learning class available from Cisco.com
- IPv6 book available from Cisco Press
- Emerging technologies such as RFID and Zigbee will accelerate the use of "sensor networks" and create the demand for global addresses.

Q. How much will upgrading to IPv6 cost customers? What are the hardware and software effects of upgrading to IPv6?

A. Cost to enable IPv6 on a network depends on the number of products and applications deployed and the strategy of deployment. The integration of IPv6 includes fixed costs such as training and human resources associated with the project and variable costs dependent on the network devices and applications that require IPv6 support. For example, networks built with Cisco 7200 Series routers only need to upgrade their software to one of the Cisco IOS Software releases that supports IPv6. Another example could be older infrastructure of more than five years, which would likely require a hardware upgrade to gain IPv6 support (for example, Cisco 2500 or 4000 series routers). New Cisco products such as Cisco CRS-1 or Cisco MDS 9000 Advanced Services Module are IPv6-capable from the beginning. If older hardware needs to be replaced, looking ahead to use a "normal lifecycle" replacement strategy will minimize the explicit cost to deploy IPv6 by acquiring the capability before it is needed.

Q. Given that IPv6 is an industry standard, what competitive differentiators do Cisco products offer customers?

A. Having a long history of supporting multiprotocol networks, we have added IPv6 to Cisco IOS Software, keeping in mind our customers' deployment scenarios. This enables our customers to deploy innovative implementations such as IPv6 over Multiprotocol Label Switching (MPLS) (also known as 6PE), customer premises equipment (CPE) autoconfiguration through Dynamic Host Configuration Protocol (DHCP) IPv6 prefix delegation, both currently IETF draft proposals that Cisco primary differentiators are to offer strong IPv6 performance as well as a superior set of control plane features across platforms and environments from core to edge networks and inclusive of broadband access infrastructures.

Q. When will IPv6 be integrated into commercial and enterprise networks?

A. Although adoption has already begun, the movement to IPv6 depends on a number of factors, including the geographical region and market segment. However, we do know that in the Asia-Pacific region IP addresses are perceived to be in short supply. Therefore Japan has a strong motivation to move to IPv6, and the Japanese government has taken a strong interest in supporting the technology. There have been announcements in China and other parts of Asia Pacific as well as Europe supporting the notion that deployments in these regions will occur within the next two to five years. The U.S. federal government has also expressed interest in IPv6 and is one of the major proponents for adoption in North America. Several large enterprises and cable network operators have also recently expressed interest as they strain to grow in the dwindling IPv4 space. Full adoption by commercial and enterprise networks also depends on IT IPv6-capable applications. It is expected that IPv6 being on by default on Microsoft Windows Vista will accelerate the adoption.

Q. What is the difference between hardware and software IPv6 acceleration?

A. IPv6 is a full set of protocols that the latest releases of Cisco IOS Software support across a wide range of Cisco platforms. As on IPv4, high-end routers and Layer 3 switches may require—dependent of their design—hardware acceleration to achieve line rate performances on their entire set of interfaces, not only for raw traffic but also including services such as packet filtering, quality of service (QoS), and others. Following the same considerations as for IPv4, the Cisco portfolio includes software forwarding as well as hardware-assisted forwarding routers and Layer 3 switches for IPv6.

Forwarding an IPv6 packet requires more processing than forwarding an IPv4 packet, because IPv6 lookups are performed on 128-bit addresses instead of 32-bit addresses as for IPv4. In addition, packet filtering might have to deal with more bits to parse Layer 4 information when IPv6 option headers are present—for example, mobile IP traffic, whereas the typical IPv4 scenario simply bypasses the hardware whenever the variable-length IPv4 options are present.

IPv6 hardware-assisted forwarding is available on Cisco hardware such as the Cisco CRS-1; Cisco 7600 and 12000 series routers; Cisco 10720 Router; and Cisco Catalyst 3560, 3750, and 6500 series switches.

Q. In the light of Network Address Translation (NAT) working well and correctly, what is the business case for service providers to upgrade their networks to support IPv6?

A. The NAT model works well in an Internet that is mostly client/server based with the server on the public side, but the growth of devices or applications such as videoconferencing or distributing gaming that can do peer-to-peer or server-to-client promote the need for global addressing that is at the origin of the IP success. In the past, older protocols—for example, AppleTalk, DECnet, IPX, and SNA—required application-layered gateways to enable communications between applications and hosts. This is what NAT does today. The real business case for service providers is the reduction in complexity and cost by removing the NAT device that creates support calls every time it breaks an application.

Q. Will Cisco support the intracampus IPv6 technology promoted by Microsoft and used in Windows XP, .NET server, 2003 server, and future Vista releases? If so, when?

A. Cisco IOS Software routers and Layer 3 switches already deliver the protocol set that enables IPv6 to be run in a Microsoft Windows environment. Cisco IOS Software enables either native IPv6 deployment or tunneling mechanisms such as 6to4 and Intrasite Automatic Tunnel Addressing Protocol (ISATAP) such as those implemented on Microsoft Windows. Cisco IOS Software also implements the router side of IETF default router selection to work with the client side implemented on Windows.

Q. What is the Cisco strategy for IPv6 as it relates to mobility?

A. As with other components, the Cisco strategy is to integrate mobile IPv6 on platforms that already support mobile IPv4 to allow customers to focus on their business needs and not on a particular version of IP. As the IETF mobile IPv6 standard has stabilized, Cisco IOS Software has integrated mobile IPv6 Home Agent beginning with Cisco IOS Software Release 12.3(14)T, then releases 12.4M and 12.4T. With the support for host mobility in place, Cisco continues working in the IETF on network mobility because the two approaches to mobility solve different kinds of real-world problems.

Q. When will Cisco ship IPv6 firewall capabilities to customers? What platforms will it support?

A. Cisco added IPv6 firewall capabilities to its portfolio in 2004. The Cisco IOS Software firewall feature set from Release 12.3(7)T and above as well as Cisco PIX® Firewall Software Version 7.0, including Cisco ASA 5500 Series adaptive security appliances, do support IPv6. Future releases of the Firewall Service Module (FWSM) on Cisco Catalyst 6500 Series switches will get IPv6 support in early 2006.

Q. When will Cisco integrate IPv6 capabilities in data centers? What platforms will it support?

A. Introducing IPv6 in data centers must be determined by business and application needs. To complement IPv6 support on its routers and Layer 3 switches portfolio, Cisco is introducing IPv6 support on release 3.0 of Cisco MDS 9000 Series multilayer switches in October 2005.

Q. What does Cisco offer in the way of planning and implementation services to help navigate the transition to an IPv6 environment?

A. Cisco provides a trusted IPv6 solution backed by years of development and operational experience covering the world's largest IPv6-enabled installed base.

Cisco Systems offers IPv6 Assessment and Migration Consulting Services to ensure customer success in the preparation and planning of complex elements in migrating from IPv4 to IPv6 are fully considered. Cisco will assess your current network environment and provide you with a clear and complete plan for the transition. Through diagnostic tools and reporting, Cisco will work with you to meet the complex demands of the transition.

The Cisco Lifecycle Services approach helps companies succeed with advanced technologies through a broad portfolio of targeted end-to-end services that are aligned with Cisco technology solutions. Cisco Lifecycle Services help customers achieve network-related business goals throughout the lifecycle of the network. The network lifecycle has six distinct phases: prepare, plan, design, implement, operate, and optimize. A lifecycle approach orchestrates the alignment of business and technical requirements at every phase.

Preparation Services provide technology and business vision for the future. Consulting for network planning as a part of Business Planning Services provides assessment and testing of the current performance of the network and architecture, planning for the future, and skill assessments.

Q. Is IPv6 more secure than IPv4?

A. Because it restores the original end-to-end model of TCP/IP and has IP Security (IPSec) embedded in the core IPv6 specifications, IPv6 is often presented as being more secure than IPv4. Unfortunately, Internet security is far more complex than just IPSec support.

Cisco addresses security in an IPv6 environment in its IPv6 security portfolio, which is documented in the Cisco IPv6 solution paper at http://www.cisco.com/en/US/products/ps6553/products_white_paper09186a00802219bc.shtml.

ADDITIONAL REFERENCE

http://www.join.uni-muenster.de/Dokumente/FAQs/Facts_and_Fiction.php?lang=en

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