Internet Protocol version 6 (IPv6) Peering

Why You Need It Now

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Executive Summary

Internet Protocol version 6 (IPv6) is a network layer standard developed in the early 1990s to solve one critical issue: The projected exhaustion of IPv4 addresses. Industry experts agree that IP address shortages will become increasing prevalent during the next 10 to 15 years, first in Asia, where IPv4 addresses are least abundant. Eventually, enterprises, service providers, and organizations will run out of IPv4 addresses, prompting a worldwide shift to IPv6-based networks.

More than an answer to the problem of address depletion, IPv6 offers numerous business advantages over IPv4 that service providers can leverage to improve services and build revenues. Yet many businesses in the United States wonder why they should implement IPv6 sooner rather than later. This white paper explains the reasons. It provides an overview of the technology, description of benefits, and summary of the technologies. In addition, this white paper explains the Switch and Data Management Company IPv6 solution and provides examples of high-profile Switch and Data IPv6 peering customers.

Market Overview

In large parts of the world today, adoption of IPv6 peering is well underway. This is especially the case in Asia, where countries such as China, Japan, South Korea, and India cite scarcity of IPv4 addresses as motivation for migration to IPv6. Asian enterprises, service providers, and governments embraced the Internet relatively late compared to their U.S. counterparts and as a result received fewer addresses. By contrast, Stanford University, with its combined student/faculty population of approximately 20,000, has more IPv4 address space than the entire nation of China. Countries such as South Korea and China received 23 and 38 million addresses respectively, while the U.S. received 3 billion.

In the U.S., IPv6 peering currently accounts for a small fraction of traffic on the Internet, which is still dominated by IPv4-based communications. The slow adoption is partly due to the perception that there is ample supply of IPv4 addresses. Some experts believe that Network Address Translation (NAT)[1], a method by which IP addresses are mapped from one group to another, has solved the problem of address depletion and hence there is no need for the new protocol. But NAT is only a temporary fix at best. Experts generally agree that it is only a matter of time before IPv4 addresses run out in the U.S., sometime by 2020. Thus, those who wait too long before implementation could lose valuable revenue sources and the ability to meet customer demand for emerging services. Conversely, early adopters stand to reap substantial benefits as supplies diminish. One might compare the situation to that of the auto industry, which faces an uncertain future with its continued reliance on the fossil fuel burning engine. However, automakers that are among the first to adopt hybrid or other advanced auto engine technology will be ahead of the game when oil supplies are no longer capable of supporting the world's demand for oil.

In the case of the telecommunications industry, the early adopters of IPv6 are global providers with IPv6 customers based outside of the U.S. Because there are fewer of them compared to the number of IPv4 providers, the interconnection points where they provide IPv6 services in the U.S. have become, in effect, pockets of IPv6 connectivity. In all likelihood these pockets will grow larger within the next few years due to new U.S. government and defense department requirements and continued support for IPv6 within academic and research communities. And because such interconnection sites have historically been at the vanguard of technological change, where use of an effective new technology can spread very rapidly, reluctant providers will likely rethink their IPv6 participation as the number of IPv6 providers grows exponentially around them.

[1] Internet Engineering Task Force, *RFC3022 – Traditional IP Network Address Translator (Traditional NAT)*, (Network Working Group, 2001).

The Case for Accelerated Adoption

A number of convincing arguments can be made for accelerated IPv6 implementation. Proponents believe that service providers should migrate to IPv6 immediately, especially if they need to:

- **Adopt IPv6 peering to maintain business relationships with Asian firms and organizations** – IPv6 connectivity is critical for U.S. firms conducting international business, acquiring or merging with foreign companies, and working with foreign governments. Soon certain Web sites in Asia will be unreachable without IPv6.

- **Comply with U.S. Office of Management and Budget (OMB) and Department of Defense (DoD) mandates** – Due to IPv6's stronger security mechanisms, the U.S. DoD has mandated all U.S. military and defense contractor networks connected to the DoD backbone to be IPv6 compliant by 2008; a mandate issued by the U.S. Office of Management and Budget (OMB) in 2005 requires IPv6 compliance by all federal agencies and government contractors by June 2008. The bottom line: Any government or defense contractor that wishes to continue working for the U.S. government or military must be IPv6 capable by 2008. As the transition to IPv6 begins, service providers and hardware and software vendors serving government and external organizations will also need to update their networks. Additionally, the mandates may spur much broader adoption, presenting compelling new revenue opportunities for IPv6 ready providers. Historically, after the U.S. government ordered that a specific technology be used by its agencies, the commercial world followed suit. For example, following a U.S. General Services Administration (GSA) mandate requiring that all data be submitted in the Microsoft DOS format, businesses across the U.S. began standardizing on Microsoft applications. If the same pattern emerges, service providers without IPv6 capability will miss the chance to quickly capitalize on the market for IPv6-based services.

- **Support Internet enabled devices and services that require unique IP addresses** – As more and more subscribers embrace Voice over IP (VoIP), mobility, and broadband-enabled home entertainment services, the numbers of Internet enabled devices such as personal digital assistants (PDAs) and mobile and VoIP phones will increase dramatically. Unfortunately, IPv4 cannot supply enough private addresses to support exponential growth in devices and users. IPv6 quadruples the number of network address bits from 32 bits in IPv4 to 128 bits, providing more than enough unique IP addresses for every network device and user throughout the world. The use of unique IPv6 addresses improves the ability to reach individual customers and helps enable end-to-end security for networked devices, a crucial capability for emerging applications that leverage such Internet-enabled devices. In fact, many early IPv6 adopters

believe that IPv6 positions them to capitalize on the growing market for new services. According to Mike Leber, president of Switch and Data customer Hurricane Electric, “IPv6 enables us to get a major edge on a potentially significant future customer demand.”

- **Take advantage of open peering arrangements** – Today’s **s**ervice providers can benefit from a relatively open frontier for IPv6 peering. Most Tier 1 carriers have a virtual “open door” policy for IPv6 peering; they welcome peering partners without requiring them to meet stringent peering conditions. This represents an enormous opportunity for service providers that wish to implement IPv6 peering. Service providers that partner with their larger counterparts will lead the IPv6 revolution and thus become major players in the IPv6 industry. This will provide them with brand identification in the marketplace that slower adopters may have trouble attaining. Additionally, this will provide numerous advantages, including the ability to pick and choose peering partners and charge higher prices, enabling providers to remain increasingly competitive and profitable.

Benefits of IPv6 Peering

Service providers that adopt IPv6 peering gain numerous competitive advantages, plus advanced features that help them improve services for customers. Benefits include:

- **Enhanced QoS** – IPv6 allows service providers to improve traffic prioritization and bandwidth allocation for different applications such as VoIP, enabling them to advertise a superior class of service than competitors. And by adjusting the IPv6 header, network managers can add powerful, flow-based resource reservation schemes and DiffServ enhancements that improve QoS even more.
- **Increased Security** – IPv6 includes integrated IP Security (IPSec), providing better security control and data protection for all users, unlike the much more susceptible IPv4. With IPv6, service providers do not have to integrate security mechanisms in each application or maintain multiple security systems, reducing operations and capital costs. And, because IPv6 does not impose restrictions on end-to-end security, deployment of personalized services that require secure transactions is far less complicated and time consuming.
- **Improved Performance** – IPv6 eliminates the need to use NAT and thus also rids the network of performance degradation caused by NAT processing. In addition, IPv6 leverages multicasting, which decreases the number of packets carried across the network. This improves bandwidth efficiency and reduces resource demands by network nodes.
- **Streamlined Administration** – Numerous IPv6 features make the network administrator’s task far simpler. For example, auto address and

Domain Name Server (DNS) configuration help reduce the number of Dynamic Host Configuration Protocol (DHCP) servers, resulting in lower time and costs for maintaining the servers. Auto network renumbering, which cannot be achieved with IPv4 networks, facilitates easy renumbering without manual reconfiguration of each router or host.

- **Enhanced Mobile Performance** – The Mobile IPv6 (MIPv6) protocol includes a number of advantages over MIPv4, including route optimization, which improves mobile network performance. Moreover, due to the massive address supply provided by IPv6, additional mobility management functions such as the use of a Foreign Agent are no longer required, further reducing capital and operations costs.

Preparations for IPv6 Peering

Switch and Data recommends that service providers begin using IPv6 as soon as possible to avoid IP address depletion, support new services, and satisfy the potentially large customer demand. The transition to IPv6 can be accomplished without major hardware upgrades and without impacting current IPv4 services. All major router/switch vendors – including Cisco Systems, Juniper Networks, Nortel, Extreme Networks, and Foundry Networks – support IPv6 in their operating systems, eliminating much of the need for hardware upgrades.

IPv6 was designed to work concurrently with IPv4 (unless a node is configured as IPv6 only). The protocol enables IPv6 packets to be tunneled through existing IPv4 networks and also sets the stage for a relatively smooth, gradual transition to IPv6.

Service providers deploying IPv6 technology can use one of four strategies to ensure reliable communications between IPv6 and IPv4 networks. In addition, service providers must request IPv6 space from the American Registry of Internet Numbers (ARIN), www.arin.net. Each of the following methods enables network upgrades and incremental IPv6 deployment with little or no disruption in IPv4 services:

- **Tunneling** – IPv6 over IPv4 tunnels encapsulate IPv6 traffic within IPv4 packets, enabling communication between isolated IPv6 sites or connection to remote IPv6 networks over an IPv4 backbone. Tunnels can be implemented easily at a relatively low cost.
- **Dedicated data links** –This method enables IPv6 domains to communicate using the same Layer 2 infrastructure used for IPv4, however separate links are configured for IPv6 and IPv6 traffic. This method provides end-to-end routes for IPv6 traffic with no impact on IPv4-based communications and revenue.
- **IPv6 over Multiprotocol Label Switched (MPLS) networks** – This allows isolated IPv6 domains to communicate with each other over an MPLS IPv4 backbone. IPv6 over MPLS can be implemented easily over

existing MPLS networks without the need for hardware or software upgrades.

- **Dual-stack backbones** – These enable IPv4 and IPv6 applications to travel across a dual IP layer routing backbone. This method is easy to implement, plus it provides support for IPv4 and IPv6 applications.

In addition, service providers also require protocol translation technology such as a NAT-PT device or dual-stack servers to facilitate communications between IPv4-based and IPv6-based applications. Once service providers have upgraded their own infrastructure, they can leverage IPv6 peering at a peering exchange.

IPv6 Peering at Switch and Data

As the leader in Internet exchange point technology, Switch and Data has taken a big leap toward enabling global exchange of IPv6-based traffic. Switch and Data began developing its IPv6 peering capabilities even before the protocol was first ratified by the Internet Engineering Task Force (IETF) in 1998. A year earlier, Switch and Data's Palo Alto Internet Exchange (PAIX) facility established a native IPv6 peering test bed for participants seeking to deploy, test, audit, and easily transition to IPv6 peering. Since then, Switch and Data has incorporated IPv6 services into Layer 2 peering switches at all sites.

Customers that wish to implement IPv6 peering can do so at any Switch and Data facility easily and cost effectively. Customers can implement IPv4, IPv6, or dual IPv4/IPv6 peering using a single Switch and Data port; there is no extra charge, and there is no usage or setup fee required for IPv6 peering at any Switch and Data site.

Customer Involvement

Numerous Switch and Data customers embraced IPv6 development early on by involving themselves in standard bodies, summits, and organizations, and by implementing IPv6 peering. The following companies are just a few of Switch and Data's early adopter IPv6 customers:

NTT Communications – Tokyo-based NTT provides three IPv6 gateway services: native service providing a dedicated IPv6 connection, IPv6 tunneling service using an existing IPv4 connection, and IPv6 dual stack services delivering a balance of both native and tunneling services. NTT reports demand for IPv6 services from downstream Internet service providers, universities, research institutions, next generation application providers and organizations that focus on wireless technologies.

Global Crossing – Headquartered in Bermuda, Global Crossing provides IPv6 as a standard service component of its global Internet access services. The company's global MPLS-based IP VPN infrastructure became fully IPv6 enabled

in 2005. In 2003, the company signed a precedent-setting network security agreement with the U.S. Department of Homeland Security, DoD, U.S. Department of Justice, and the Federal Bureau of Investigation to support law enforcement and national security objectives.

Nokia Corporation – Finland-based Nokia has been a leader and active participant in the development of IPv6 specifications through the IPv6 working group in the Internet Engineering Task Force (IETF). Nokia IP security platforms and Nokia IPSO operating system software support IPv6 routing, and Nokia IP security appliances also support multicasting for efficient routing. In 2003 Nokia introduced the industry's first IPv4/IPv6 dual stack CDMA mobile phone. Nokia security appliances support dual stack IPv4/IPv6 firewalls and IPv6 to IPv4 tunneling, enabling customers to deploy IPv6 networks in conjunction with existing IPv4 infrastructure.

Conclusion

Because Switch and Data has supported IPv6 since its inception, the company fully understands the technology and the direction the market is headed. In evaluating this environment, Switch and Data has come to the conclusion that this technology is not only here to stay, but is helping to usher in a new era of telecommunications. In the coming years, IPv6 will help drive a renaissance of new applications and services that will improve the lives of everyone and contribute to the success of those that serve them. To help service providers take advantage of this opportunity, Switch and Data pledges strong support for its IPv6 customers as well as a continuing commitment to the future of IPv6.

About Switch and Data

Based in Tampa, Florida, Switch and Data Management Company is a leading provider of Internet exchange and collocation services. Switch and Data operates the largest footprint of neutral Internet exchange and collocation facilities in North America with 34 data centers in 23 markets serving more than 800 customers. Switch and Data's PAIX facility is recognized worldwide as the premier name in peering and Internet exchange services and is home to one of the largest commercial exchange points in North America. For more information, please visit http://www.switchanddata.com/.

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"What is the matter with IP Version 4?," Aug. 26, 2002, www.itdirector. com/article.php?id=3145

For More Information

The following sites provide useful information on IPv6:

- IPv6 Forum: www.ipv6forum.com
- IPv6 Information Page: www.ipv6.org/
- Internet Engineering Task Force (IETF): www.ietf.org/
- Nokia: www.nokia.com/ipv6
- KAME Project: www.kame.net
- WIDE Project: www.wide.ad.jp/wg/active/14_ipv6.html
- List of IPv6 Internet Exchanges: www.v6nap.net/
- Cisco IPv6 white papers: www.cisco.com/en/US/products/ps6553/prod_white_papers_list.html
- Wikipedia: IPv6 technical discussion, en.wikipedia.org/wiki/IPv6