IPv6 Routing

Preparing Your Network for the Future

White Paper
March, 2007

Abstract

Today's Internet is being gradually replaced by tomorrow's Internet. Internet Protocol Version 4 (IPv4) is slowly being supplemented by Internet Protocol Version 6 (IPv6), a newer, more robust suite of protocols and standards designed to dramatically increase the pool of global IP addresses, simplify network administration, resolve security and mobility issues, and improve Quality of Service (QoS). Services providers around the world are starting to examine new IPv6 equipment and explore the implications of the changes to come. This White Paper defines and describes IPv6, explores the advantages of the new protocol, and introduces D-Link's new IPv6 and IPv4 compliant solutions.

Building Networks for People

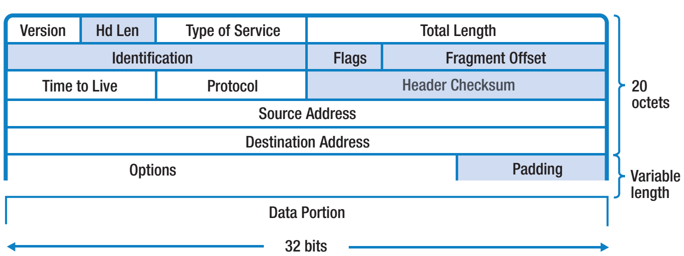
Defining IPv6

Most of the existing Internet is currently Internet Protocol Version 4 (IPv4), the 26-year-old protocol that has done a remarkably proficient job handling the Web boom. IPv4 has not been substantially changed since RFC 791 was published in 1981, and it has a finite number of addresses that are depleting at an increasing rate. New devices, applications and the growth of the Internet in the developing world are sucking up IP addresses.

The IETF designed Internet Protocol Version 6 (IPv6) to address the future shortage of IP addresses. As more devices and applications that require IP addresses emerge, more IP addresses are required. IPv6 - essentially a network layer protocol for packet-switched internetworks - quadruples the number of network address bits from 32 bits (in IPv4) to 128 bits. More bits mean more address combinations, and we solve the address depletion problem for decades to come. Switches and networking gear that can handle IPv6 headers are needed to accomplish this. IPv6 will eventually replace IPv4, but the two can co-exist for as long as necessary.

IPv6 provides numerous other enhancements that will be covered below, but this is a good working definition for starters. It should also be noted that IPv6 was designed with a minimum of additional new features in order to have minimal impact on upper and lower layer protocols.

IPv4 Packet Structure



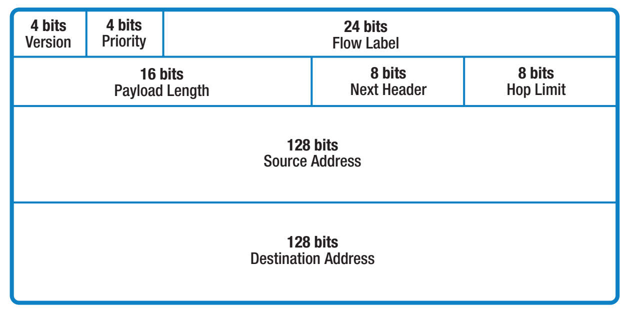
IPv4 32-bit packet

Additional Addresses and Beyond

The primary issue that IPv6 resolves is IPv4 address depletion. As more devices (like cell phones, mobile devices, and integrated IP appliances and utilities) come into existence, they require unique addresses in order to work optimally. IP-reliant applications also require addresses. IPv6 resolves the address depletion issue, enabling worldwide economic growth models and the rapid pace of network innovation to continue expanding. The booming populations and growing economies in Asia, for example, are depending upon IPv6 to enable rapid build-out of their Internet infrastructures. Countries with more stable populations and historically sufficient address space allocations - like the U.S., the European countries, and Australia - may not be as hard pressed for address growth as the Asian countries.

Addresses in IPv6 are 128 bits long versus 32 bits in IPv4. The existing IPv4 protocol supports roughly 4.3 billion addresses - enough to give almost every living person one address. In contrast, IPv6 supports approximately 5×1028 addresses for each of the 6.6 billion people on the planet today. The number is a bit abstract, but nevertheless, that's a lot of computers, cell phones, PDAs, IP cars, IP dish washers, IP lighting systems, and IP tracking devices per person... and room to grow.

IPv6 Packet Structure



IPv6 128-bit packet

As a result, IPv6 eliminates the need for Network Address Translation (NAT) and other intermediary fixes, like address reuse and temporary use allocations, that disrupt the end-to-end nature of Internet traffic. Those methods achieve the aim of address expansion, but they fail to meet the needs of always-on systems (cable modems, broadband and new generation wireless infrastructures) that are becoming more and more prevalent across the planet.

IPv6 also simplifies subnet address management complexities. It takes significant time and effort to change address space allocation in IPv4 subnets when location changes and growth create discontinuity between nodes. With IPv6 networks, increased address space (by a factor of 10^16) goes far beyond the number of physical nodes, thus alleviating the problem.

Additional IPv6 features include security and QoS enhancements, built-in multicasting, stateless autoconfiguration, mobility advantages, plus a number of other improvements covered below. Peer-to-peer advances and seamless mobile switching capabilities are some of the more exciting applications. In addition, IPv6 supports jumbogram packets over the IPv4 64 KB limit. This is a significant performance benefit for high-throughput networks.

Forces beyond these fundamental issues are driving IPv6 adoption, as well. The U.S. Government, for example, mandated that network backbones of all federal agencies must deploy IPv6 by 2008. And China is aggressively implementing IPv6 as part of their 5-year "China Next Generation Internet." They see IPv6 as a strategic technology differentiator.

All these factors are encouraging those in the network infrastructure business to examine new IPv6 equipment and explore the implications of the changes to come.

Stateless Autoconfiguration of Hosts

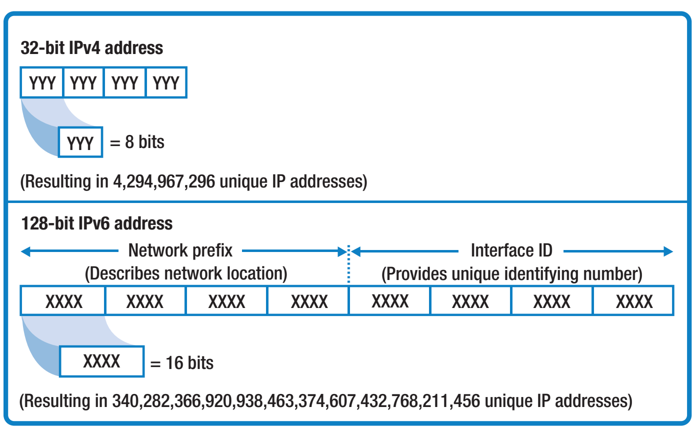
In addition to larger address space, one of the main advantages of Ipv6 concerns autoconfiguration. Existing IPv4 implementations usually have to be manually configured or configured via a stateful address configuration protocol like Dynamic Host Configuration Protocol (DHCP). As more computers and devices come online, automatic configuration that does not rely on DHCP is more crucial.

IPv6 avoids DHCP altogether. When connected to a routed IPv6 network, IPv6 hosts are automatically configured. Without a router present, IPv6 hosts on the same link can automatically configure themselves with link-local addresses.

Better Mobility

Since mobility is built into the IPv6 base standard, mobile nodes can now communicate location changes and enable optimal routing. IPv6 avoids IPv4's triangular routing approach, so a user can move from location to location without the need for message forwarding. IPv6 has a superior design in this respect, allowing for much smoother transitions and hand-offs. Ideally, users roam freely between fixed, wireless, mobile, terrestrial, satellite or any other IPv6 network.

Comparison of IPv6 and IPv4 Address Scheme



IPv6 allows for 50 octillion unique addresses for every one of the 6.5 billion people on earth.

Simplified Network Administration

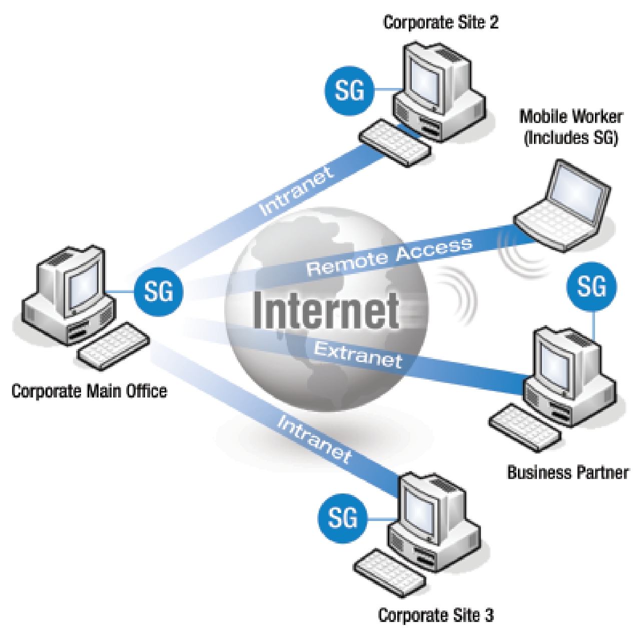
IPv6 simplifies network administration for a number of reasons. For starters, since options and other variables are removed from the base header, IPv6 headers compress better than IPv4 headers. Efficiency is gained even though IPv6 headers are larger than IPv4. This - along with the way the header itself is structured - improves header processing. Additional advantages include:

- Fixed subnet length
- More flexible network architecture (deeper hierarchy and policies for routing and route aggregation)
- Stateless autoconfiguration
- Mobile IP embedded support
- Enhanced multicast
- Mandatory IP Security (IPSec)

More discussion on security and multicasting follows.

End-to-End Security and IPsec

Since IPv6 reintroduces end-to-end connectivity by eliminating NAT schemes, security improves at the IP level. In terms of encryption, IPv4 employs optional IPsec, while the IPv6 protocol includes mandatory IPsec for all IPv6 devices.



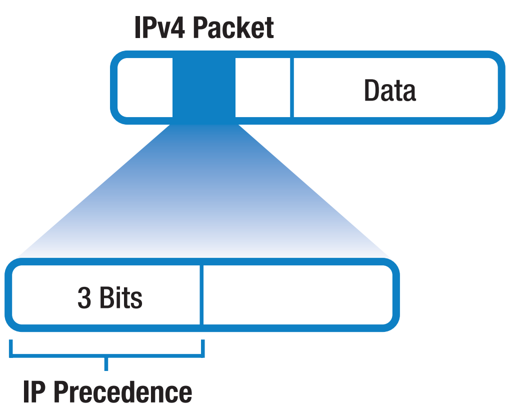
IPsec ensures secure data transmission when using the public Internet as a VPN backbone.

Built-In Multicast

Like IPsec, multicasting is optional with IPv4, but IPv6 includes multicast as part of the base protocol. Multicasting enables the simultaneous delivery of data to a group of destinations using the most efficient linking strategy available.

Higher Quality QoS

IPv6 enables Quality of Service that is not consistently available in NAT-based IPv4 networks. The IPv6 header contains traffic handling and identification fields that enable routers to identify and handle packets that belong to a "flow." Since this flow field is identified in the header, prioritized delivery is possible even when packets are IPsec encrypted.



xStack 3200 Series Centralized Management of Wired and Wireless Functionality

IPv4, by contrast, relies on Type of Service (TOS) fields that use UDP or TCP ports with limited functionality. Encrypted payloads, for example, cannot be identified via this methodology.

D-Link Solution - Future Proofing and a Seamless Migration Path to IPv6

D-Link is well positioned for smooth IPv6 migration and integration. As the IPv6 infrastructure evolves, existing solutions are available today, and several products in development promise to extend our reach into this "next generation" Internet.

Our D-Link xStack DGS-3612G switch supports IPv4/IPv6 static and dynamic routing, and includes a wide range of advanced security and QoS features for the emerging IP landscape. This is a fully managed Layer 3 switch that provides 12 SFP ports and 4 Combo 1000BASE-T Gigabit Ethernet ports. The DGS-3612G also provides virtual stacking functionality via D-Link SIM technology allowing up to 32 units to be managed via single IP address. It's the perfect solution for future proofing networks and seamlessly migrating to IPv6.

Applications and Adoption Drivers

D-Link IPv6 solutions address a number of scenarios that demand next generation IP, including:

- U.S. Government and Education installations that mandate IPv6 capability by 2008
- Aggressive IPv6 expansion in Asia
- Worldwide broadband adoption increases
- Increased prevalence of IP/cell phones
- Automobile navigation systems
- Emerging applications such as:
  - New Internet-enabled wireless devices
  - Home and industrial appliances
  - Smart IP energy and lighting systems
  - Distributed computing and gaming architectures
  - Internet-connected transportation systems
  - Integrated telephony services like VoIP and presence-aware communication
  - Sensor networks such as RFID and ZigBee
- Increased installation of "always-on" home networking via DSL or cable
- Neighborhood and community Wi-Fi and WiMax installations
- Expansion of home networking technologies (appliances, media systems, DVR/PVR)

Moving Forward with D-Link

IPv6 enables the end-to-end addressing required by all these new applications and Internet frontiers. In addition to a vastly expanded address space, the protocol offers a wide range of improvements, including:

- Stateless autoconfiguration
- Security enhancements
- Superior mobility
- Enhanced subnet address management
- Simplified network administration
- Built-in multicasting
- New QoS features

New D-Link switching solutions take full advantage IPv6 benefits. We offer customers leading-edge equipment, comprehensive support and a clear path to the next generation Internet.

For more information about IPv6 and D-Link's flexible network migration strategies, please call 1-800-326-1688 or visit www.dlink.com.