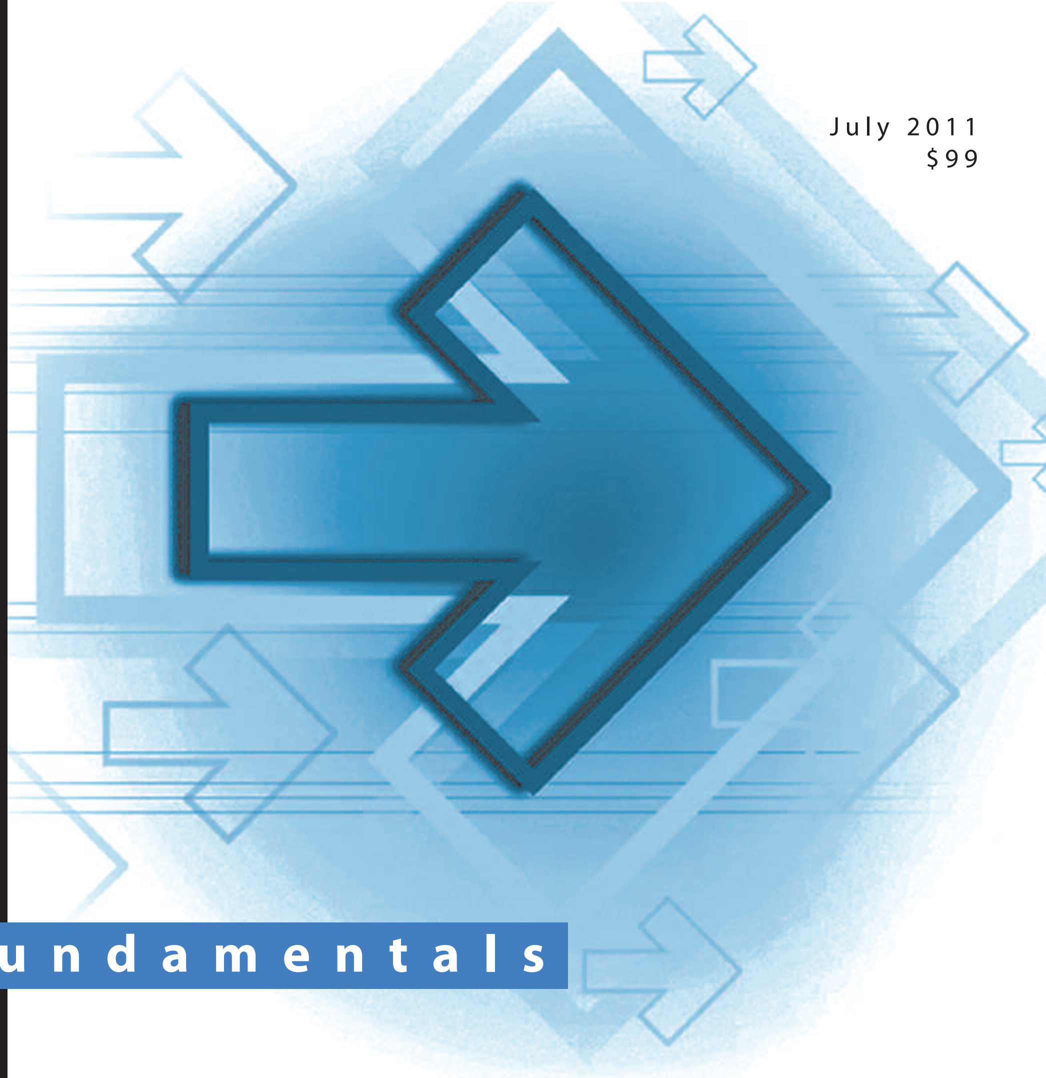
InformationWeek
analytics

Analytics.InformationWeek.com

July 2011
$99



Fundamentals

The Switch to IPv6: How to Make a Smooth Transition

IPv4 address space is being gobbled up by the vast number of devices connecting to the Internet, and it's expected to be depleted in the next year. So the question is not whether to make the move to IPv6 but when. *InformationWeek Analytics* offers recommendations for ensuring that your data center is fully ready.

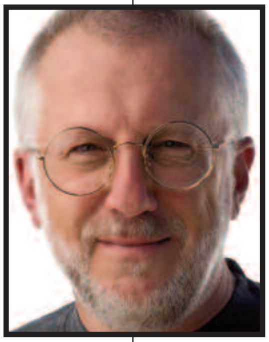
By Martin Levy

Report ID: S3170711

TABLE OF CONTENTS

ABOUT US | ***InformationWeek Analytics'*** experienced analysts arm business technology decision-makers with real-world perspective based on a combination of qualitative and quantitative research, business and technology assessment and planning tools, and technology adoption gleaned from experience.

If you'd like to contact us, write to managing director **Art Wittmann** at *awittmann@techweb.com,* executive editor **Lorna Garey** at *lgarey@techweb.com* and research managing editor **Heather Vallis** at *hvallis@techweb.com*. Find all of our reports at *www.analytics.informationweek.com.*



Martin Levy
Hurricane Electric

Martin Levy coordinates global IPv6 backbone services for Hurricane Electric, a leading Internet backbone and colocation provider.

Originally from the United Kingdom, Martin has been in the United States for more than 27 years and lives close to the Bay Area.

Executive Summary

The benefits of IPv6 are many, including 128-bit address space, more efficient routing, simplified network configuration, support for new services and improved security. The Commerce Department estimates that IPv6 adoption will provide an ongoing benefit to the global economy of $10 billion.

The transition from IPv4 to IPv6 will require a comprehensive inventory of hardware and software (including possible product upgrades), as well as accommodations for IPv6 in all procurement plans. The move will take time and effort, so don't wait until the last minute to get started.

InformationWeek Analytics shows you how to make sure your data center is fully ready for the switch.

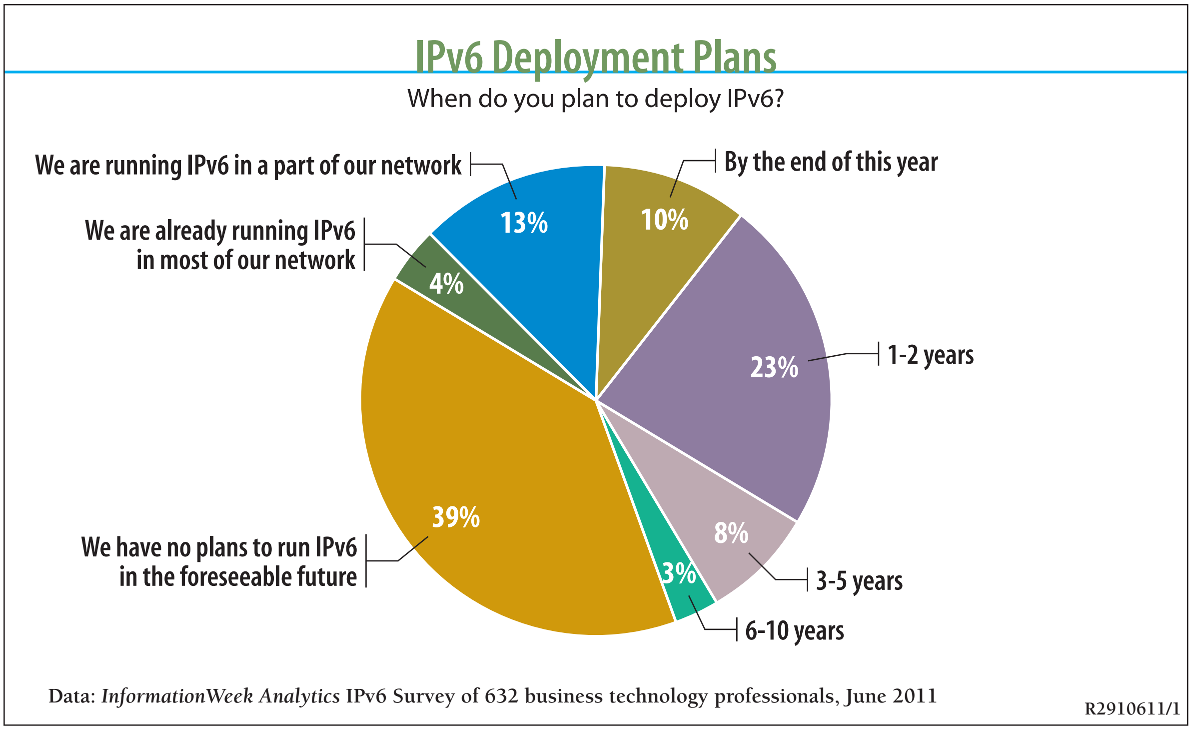
How to Make a Smooth Transition to IPv6

With IPv4 address space rapidly dwindling, and expected to be used up in the near future, the time is now to add support for IPv6. A smooth transition will require a comprehensive inventory of hardware and software, as well as accommodations for IPv6 in all procurement plans. Your organization's network is a strategic asset that should not be neglected. The transition to IPv6 takes time and effort, and a carefully managed transition is better than one done in a panic.

With the growing number of Internet-connected devices in use today, it is expected that the supply of IPv4 addresses will be depleted in the next year or so. IPv4 addresses are distributed by the Internet Assigned Numbers Authority to five Regional Internet Registries. The RIRs distribute the addresses to ISPs, which in turn distribute the addresses to individual users and hosts. In early February, the IANA distributed the last five blocks of IPv4 addresses to the RIRs.

Once an ISP's supply of IPv4 addresses is exhausted, it likely will not hesitate to reclaim IPv4

Figure 1



addresses from residential users for more profitable endeavors, hastening end user adoption of IPv6. Indeed, AT&T, Verizon and others have announced that they will cease offering IPv4 addresses to smartphones sometime around the end of this year. In addition, T-Mobile (soon to merge with AT&T) is now supporting IPv6 in customer trials.

The presence of large numbers of IPv6 endpoints by the end of 2011 will force companies that provide computational services (for example, e-commerce organizations and electronic bankers) to ensure that their infrastructure is IPv6-compliant.

Bear in mind that in your transition to IPv6, you are not alone. Content delivery networks such as Limelight and Akamai plan to become fully IPv6-compliant before the end of the year. Officials at the American Registry for Internet Numbers recommend that all website operators enable IPv6 by Jan. 1. All U.S. government public-facing servers are slated to be IPv6-compatible by September 2012, and internal federal systems must use compatible by 2014. (Translation: If you want to sell IT products to the federal government, then you had better be IPv6-compliant.)

IPv6 Benefits

IPv6 will provide many benefits, not the least of which is 128-bit address space. IPv6's address space allows for an almost unimaginably large number of unique addresses (340 undecillion, or a 1 followed by 36 zeroes) and thus a virtually permanent solution.

Other IPv6 benefits include more efficient routing, more efficient packet processing, directed data flows, simplified network configuration, support for new services and improved security. Indeed, the U.S. Commerce Department has estimated an ongoing benefit to the global economy of $10 billion per year from IPv6 adoption.

Then there are the drawbacks of *not* transitioning, including endpoint incompatibility and reduced service availability and performance, not to mention any loss of business incurred because of inevitable network problems.

Developing a Transition Plan

Today's global challenge is transitioning each and every connected device from IPv4 to IPv6 while maintaining connectivity during the period of transition.

To provide backward compatibility for IPv4 while supporting IPv6, the global Internet and nearly every IT shop must embrace a dual-stack IP world. All stops on the communication pathway—from endpoint devices to ISPs to backbone providers—must operate with IPv6 alongside IPv4. Although the dual-stack requirement seems daunting, a transition to dual-stack support need not be difficult.

The process of choosing a service provider, hosting company, hardware vendor or application software provider must now include the question, "Do you support IPv6?"

Service providers, hosting companies and telcos should specify whether each connection can

IPv6 Helping Hands

Several technologies can help organizations effectively support both IPv4 and IPv6. These technologies, among others, can be leveraged to gently phase in adoption of IPv6 across your enterprise.

- **Tunnel Brokers (6in4):** The 6in4 protocol allows IPv6 traffic to be tunneled inside IPv4 packets whose IP headers have the IP protocol number set to 41. This allows sending IPv6 traffic over the IPv4 Internet.

- **6to4:** This protocol provides IPv6 connectivity over an IPv4 network by mapping IPv4 addresses into IPv6 addresses using the special 2002::/16 prefix. A 6to4 relay router at the network edge is required to encapsulate and decapsulate IPv6 traffic sent to and from site nodes. 6to4 is often derided as a temporary measure, but it serves a purpose during the transition to full IPv6 support.

- **Teredo:** This tunneling protocol provides IPv6 connectivity to nodes located behind IPv6-unaware NAT devices. Like 6to4, Teredo embeds an IPv4 address inside an IPv6 address, although unlike 6to4, Teredo encapsulates IPv6 packets within IPv4 UDP packets that can be routed through NAT devices. Teredo traffic can be identified by its 2001:0::/32 prefix. Like 6to4, Teredo is loved by few and is considered a temporary solution for IPv6 connectivity.

- **6rd:** This facilitates rapid IPv6 deployment at ISPs. Although derived from 6to4, it uses an ISP-specific network prefix and operates only within a single ISP.

- **NAT64:** This provides connectivity between IPv6 hosts and IPv4 servers.

be provided as a dual-stack connection and is fully dual-stack to the rest of the world. In the end, service providers and vendors must offer feature parity between IPv4 and IPv6 for at least the features and services on which your organization relies. The technologies and features that are most critical will vary from organization to organization, of course, but there are a few that are essential for general Internet connectivity:

- DNS
  - >> IPv6 AAAA and PTR records supported in any DNS services used.
  - >> IPv6 glue records supported.
  - >> Ability to deploy IPv6 name servers and/or name servers used are available on IPv6.
- Routing
  - >> Native dual-stack network.
  - >> Good upstream IPv6 transit and/or good and diverse IPv6 peering.
  - >> Delegated IPv6 prefixes meet needs without heroic measures.
- Staff
  - >> Provider must have a staff that is trained and knowledgeable in IPv6.
  - >> Provider must offer IPv6 services on the same terms, SLAs and reliability as IPv4.
  - >> IPv6 must not be treated as an optional add-on feature; it must be a core part of providers' services.

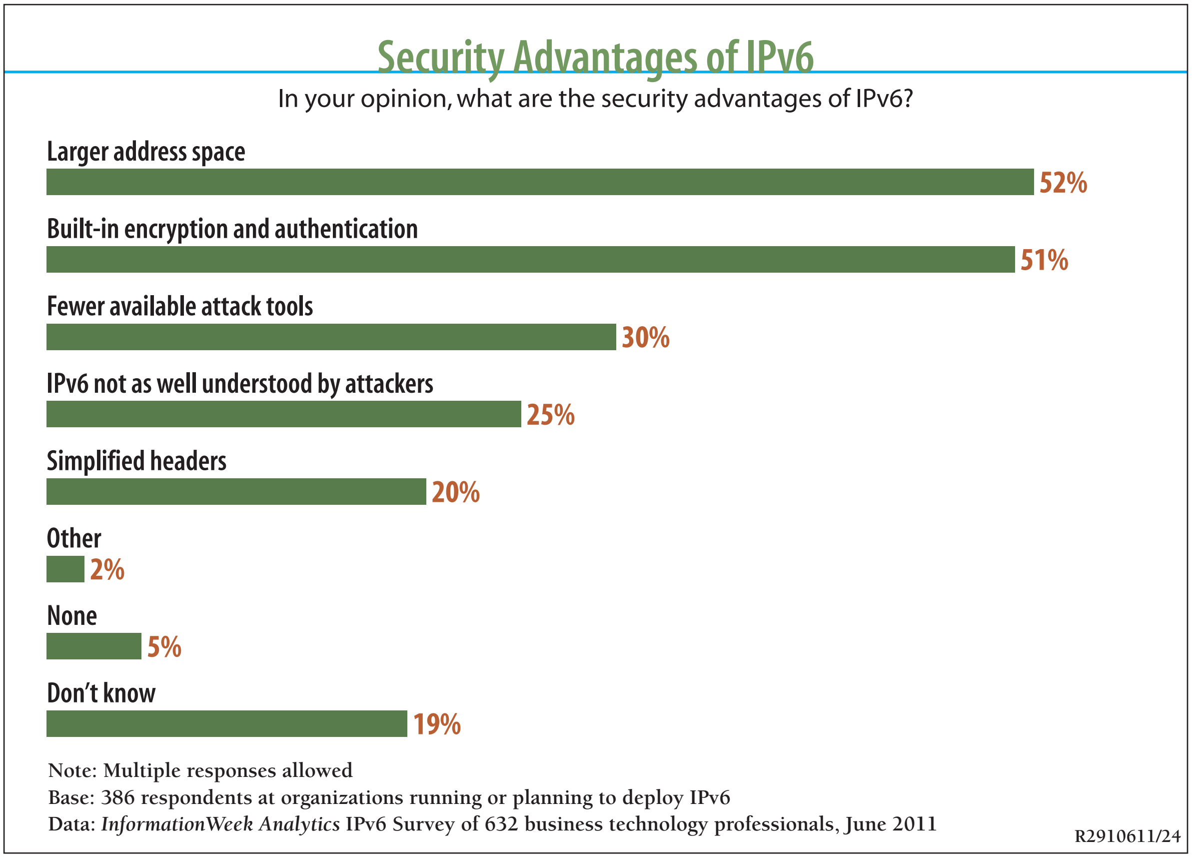
In addition, the percentage of core backbones that run IPv6 increases daily. It is reasonable to ask whether interconnects between one backbone and another are native IPv6, as this affects whether IPv6 traffic can be moved at line rate in and out of the network.

Taking Stock of Your Systems

One of the most important steps data center managers must take in the transition to IPv6 is to enumerate existing systems and their level of IPv6 support. For organizational reasons, a database that denotes which systems passed and failed should be kept. The database should list the vendor, model number and version of each system in the network. Note that the type of database used here is not important—it could be a simple spreadsheet.

Although there are gradations of levels of IPv6 support, in the end there is just one criterion that matters: If you can turn off IPv4 on your network and still run a device with the same services and applications enabled and the same throughput and performance characteristics, then the system can be considered fully IPv6-compliant. If you cannot, then it is not fully IPv6-compliant.

Figure 2

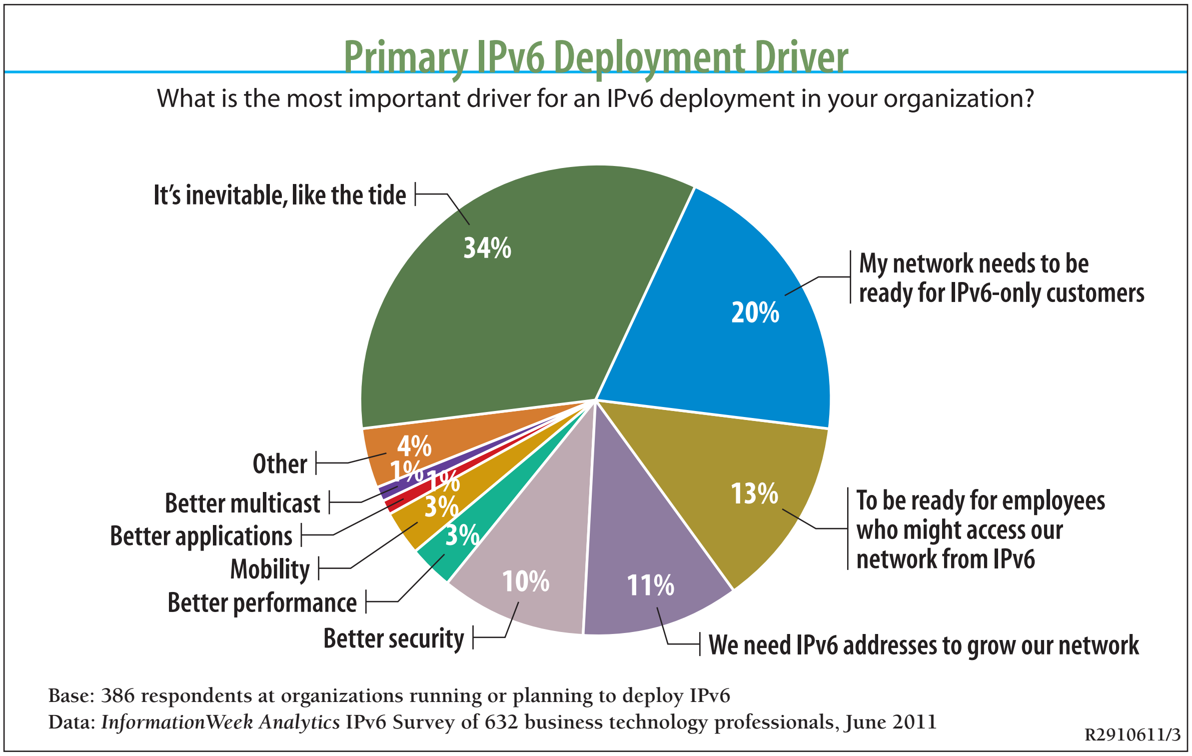


For systems that fail the test, research must be done to determine whether there are newer product versions that provide full IPv6 support. Your database will likely have multiple entries for a single system, as you may have to diagnose and categorize at which level a failure occurred (NIC driver, host operating system, software application and so on). For example, it may be that your VPN system is capable of transporting IPv6 packets within the VPN's encrypted tunnel, but a remote VPN client may be unable to reach the VPN head end across an IPv6-only backbone.

In many cases, the level at which the failure occurred may not be clear, and there will be no recourse but to contact the vendor's tech support line for guidance.

There will also be systems that have general IPv6 connectivity but whose overall feature set is not fully functional when IPv6 is enabled. Your hardware and software vendors should state whether there are any known caveats or limitations in their products' IPv6 support.

Figure 3



Infrastructure that implements filtering or security based on IP addresses (for example, a firewall) must support IPv6 addressing schemes. Also, hardware upgrades may be necessary. For example, memory increases may be needed in dual-stacked network hardware to maintain two sets of routing tables.

When upgrading network infrastructure, updating software will usually suffice to make a device IPv6-compliant, although this can be as disruptive as upgrading hardware. Also, note that sometimes software upgrades necessitate hardware upgrades. For example, flash memory requirements can increase for certain head end OS upgrades.

Nearly all major desktop and smartphone operating systems in use today fully support IPv6. Windows, Mac OS X, Linux, Android, iOS and others have supported IPv6 for years, although early versions had IPv6-related bugs. When connected to IPv4-only networks, devices running these operating systems could not make use of the IPv6 capabilities. Enabling IPv6 within network elements (including routers, switches, access points, authentication servers, firewalls and intrusion-prevention systems) will awaken the new capabilities, but existing security and auditing systems may need upgrades to handle the new IPv6 address allocations.

Updating Applications

Although upon first glance it would appear that updating operating systems and data center hardware would be the primary task in an IPv6 transition, it is important not to underestimate the importance of updating the applications that run in the data center.

Custom networking applications—often written by contractors who are now long gone—are likely to be IPv4-centric; user interfaces with IP address fields that support only dotted-quad notation, log parsers and field validators must all be rewritten; and, in many cases, there will be no way to outsource this work to the vendor that originally created the software, as the source code may not be available.

Networking applications must be IP version-agnostic, and calls to networking APIs such as getaddrinfo() and getnameinfo() may need to handle the return of multiple IPv4 and IPv6 values. Internal data structures must change to support the 128-bit IPv6 address, and network monitoring tools and intrusion-detection software must be upgraded to support IPv6.

IPv4 vs. IPv6

The first step in designing a transition plan involves getting to know IPv6 and how it differs from IPv4. A full description of IPv6 is beyond the scope of this article, but it's worth highlighting a few topics that transition team members must fully grasp before constructing an IPv6 transition plan.

- **IPv6 addressing:** Whereas an IPv4 address is represented in the familiar "dotted quad" notation, an IPv6 address is expressed as eight sets of four hexadecimal digits separated by colons. The first 64 bits are the network prefix, and the last 64 bits are the host identifier. A number of conventions are employed to make addresses less cumbersome, including omitting leading zeros and replacing contiguous "0000" sequences with the "::" sequence. Admittedly, this address syntax takes some getting used to.

- **Multiple addresses per network interface:** IPv4 devices usually have just one IP address per network interface, but IPv6 features multiple addresses per interface. These addresses include, but are not limited to, a link-local address, a solicited-node multicast address and an "all hosts" multicast address.

- **Address auto-configuration:** In IPv4, the Dynamic Host Control Protocol (DHCP) is used to dynamically assign an IP address. Multiple systems are available in IPv6 for auto-configuration, including DHCPv6 and ICMPv6 Router Advertisements.

- **Link-layer address discovery:** IPv4 hosts use the Address Resolution Protocol to translate IP addresses into link-layer addresses. With IPv6, in contrast, a number of ICMPv6 packet types are used to implement the Neighbor Discovery. These include Neighbor Solicitation, which is the equivalent of an ARP Request, and Neighbor Advertisement, which is the equivalent of an ARP Reply.

- **Multiple default gateways:** Whereas IPv4 usually has just one default gateway, IPv6 promotes multiple default gateways that advertise themselves with Router Advertisement messages (ICMPv6-ND). IPv6 endpoints may also send a Router Solicitation messages explicitly.

- **Duplicate address detection:** In IPv4, duplicate address detection is optional, whereas in IPv6 it is mandatory.

- **Multicast and broadcast:** Multicast is optional with IPv4, and 255.255.255.255 is the broadcast address. With IPv6, multicast is mandatory (at minimum, the "all hosts" and "solicited node" multicast addresses must be recognized), and there's no broadcast.

- **Fragmentation**: In IPv4, fragmentation is performed by routers, whereas in IPv6 it is performed by the traffic originator.

- **DNS resource records:** IPv6's "AAAA" DNS record is analogous to IPv4's "A" DNS record.

Want More Like This?

Making the right technology choices is a challenge for IT teams everywhere. Whether it's sorting through vendor claims, justifying new projects or implementing new systems, there's no substitute for experience. And that's what ***InformationWeek Analytics*** provides—analysis and advice from IT professionals. Our subscription-based site houses more than 900 reports and briefs, and more than 100 new reports are slated for release in 2011. ***InformationWeek Analytics*** members have access to:

Research: Bending the 80/20 Barrier: Automation Is Just the Start: In this report, we'll analyze the state of IT automation: where it's most frequently applied, implementation barriers and the benefits it brings to the enterprise.

Research: Wireless Nation 2011: It's been a year since our first Wireless Nation report, and one thing we can say with certainty is that the industry is buzzing with activity. Here's our take on what the coming months hold for IT teams charged with mobilizing, and improving the wireless user experience for employees and guests.

Informed CIO: 5 Pitfalls of Branch Office Consolidation: In this report, we'll outline what we see as the five most common big-picture problems CIOs are likely to face and outline promising solutions for each.

Best Practices: Deploying IPv6: Gateway to the Next-Gen Internet: Every company that depends on the Internet should have an IPv6 migration plan in place based on industry best practices.

Strategy Session: IPv6 Security: Problem Child or Opportunity to Improve?: In this Strategy report, we look into the new security reality as enterprises phase out IPv4.

PLUS: Signature reports, such as the *InformationWeek* Salary Survey, *InformationWeek* 500 and the annual State of Security report; full issues; and much more.

For more information on our subscription plans, please CLICK HERE.