Pipeline
Your OSS/BSS Information Source.
www.pipelinepub.com Volume 8, Issue 5

IPv6 to the Rescue!

By Jesse Cryderman

It's hard to talk standards without covering a standard that touches every piece of IP-based traffic on the planet: Internet Protocol, or IP.

IP addressing is a little like phone numbering, in that it's subject to number exhaustion. Residents of densely populated cities like New York City are familiar with phone number exhaustion. As more and more people sign up for phone service, area codes run out of numbers, and new area codes are added.

Instead of 10 or 11 digits routing voice traffic to phones at the end of the line however, IP addresses route data packets to networked devices using a different numbering schema. And while there is a logical limit to how many people can inhabit a specific plot of land (in biology, it's called the carrying capacity), there is no limit to the number of networked devices that can exist.

Like phone numbers, addresses for IPv4 (IP version 4, the current IP addressing protocol) might look like an 11-digit number to a human—184.238.14.180, for instance. In reality, those digits are actually hexadecimal representation of 32-bit binary expressions; in other words, numbers that make sense to people vs. computers. Computers work in the cold world of binary code, and each IPv4 address is actually 32 ones and zeros in sequence. The number of variations in a 32-digit binary sequence then, is approximately 4 billion, which is a big number, representing a lot of IP addresses.

However, 4 billion is no match for the connected world of today, and as more and more devices—from televisions to automobiles—become networked, the number of IP addresses required to support this evolution must be able to scale beyond our wildest expectations.

Enter IPv6, the addressing standard to rule them all.

A Big Number

In order to keep pace with the explosion in connected devices, 32-bit addressing just won't cut it. The Internet Engineering Task Force (IETF) decided that 64-bit addressing is also too limiting, and instead settled on a 128-bit addressing scheme. That means each IP address would be comprised of a 128 digit sequence of ones and zeros. The number of variations, or addresses, enabled by IPv6 is massive;

340 trillion trillion trillion, or 34 x 1038 addresses. This is equal to every atom in the human body managing 8 billion unique IP addresses. Suffice it to say, IPv6 should have no problem keeping up with the connected universe.

Baked-In Security

Aside from providing an addressing scheme designed to (possibly) outlive the human race, IPv6 has the additional benefit of providing innate security to the data packets it shuttles around the globe. Internet Protocol Security (IPsec) encrypts and authenticates packets of data traveling on an IPv6 network. IPsec is another standard specified by the IETF. While IPv4 + IPsec solutions are in use currently, they are not the norm; with IPv6, all standards-compliant implementations must utilize IPsec. And unlike widespread security standards like SSL, IPsec is application and platform agnostic. If your network is running on IPv6, it is much more secure than in the past.

How Many Addresses are Left?

Today, the internet is out of addresses. Technically, in fact, the pool of unassigned IP addresses was exhausted in February of 2011. According to the Internet Society (ISOC), a non-profit organization that advances internet-related standards and education:

> This begins the final chapter in the history of IPv4, as each of the five regions of the world have now received their final blocks of addresses to distribute for use in new network developments. The regions will each run out of IPv4 addresses at different times, at which point the only new IP addresses available for Internet growth will be IPv6.

Technically, in fact, the pool of unassigned IP addresses was exhausted in February of 2011.

The Internet's Father Speaks Out

Vint Cerf, VP and Chief Internet Evangelist, Google, is widely recognized as the father of the internet (along with Bob Kahn, not Al Gore). Mr. Cerf drove the creation of TCP/IP, helped form ICANN, and created the first internet-connected email service. He is also a very vocal proponent for the transition to IPv6. He underlined this need at a recent IPv6 gala:

> The most important point I could make it is now imperative on a national and international level for all countries and all ISPs to implement IP version 6 [IPv6]. In the absence of the implementation of IPv6, in parallel with IPv4, we won't really be able to expand the internet. How can anyone possible imagine that the internet can continue to expand, given the fact that IPv4 address space has already officially run out at this point, there can't be any question in anyone's mind that the correct way forward, and the only responsible way forward, is to implement IPv6.

To further spur the adoption of IPv6, the ISOC coordinated World IPv6 day in June of 2011, and Vint Cerf, as well as Google, were very active at the event. But IPv6 is clearly not being adopted at a rate that matches the rate of IPv4 address exhaustion. Why not?

Network Readiness

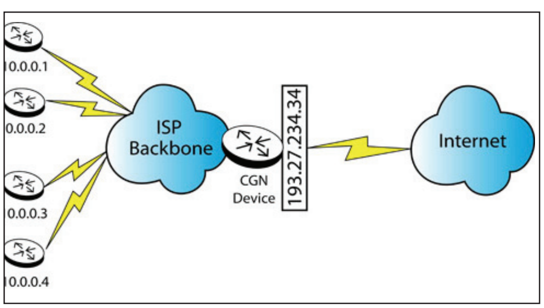
The Internet Engineer Task Force (IETF) succinctly answers this question of adoption rate: “The biggest weakness of IPv6 is its incompatibility with IPv4.”

Jumping from a network that operates on a 32-bit address architecture to a 128-bit architecture is not a simple task. To anyone familiar with personal computing, it’s akin to running Windows Vista 64 on a 32-bit processor: not going to happen natively. This affects both the networks who deliver the data, as well as the consumers, as devices on both ends need to be IPv6 standardized. And while numerous operators and websites have demonstrated IPv6 readiness, a large segment of the population would be unable to access the internet if their provider went all-IPv6 at the drop of a hat.

But providers have to do something because, “the drop-dead deadline for external Web sites to support IPv6 is January 1, 2012,” cautions John Curran, President and CEO of the American Registry for Internet Numbers. “When we get to the end of 2011, we’re going to have a lot of people connecting over IPv6 and that doesn’t bode well for the content providers who don’t support IPv6.”

Instead, networks have looked at various methods for processing or translating IPv6 packets and delivering them over IPv4 networks. These solutions fall into three technology categories: dual stacks, tunnels, and address translations. On a broad level, one such strategy is Carrier Grade NAT (CGN), which is used by most of the major providers in the United States.

For example Chris Mayer, VP systems integration and testing at Verizon, told Pipeline about his company’s plan for transition to IPv6. “A lot of the devices that communicate IP in the home are not IPv6 now, and not only are the end devices an issue, but the entire industry is exhausting IPv4,” said Mayer. “Technology solutions we intend to use include carrier-grade NAT.”



However, all of the “solutions” are stop-gaps that have potential downsides. NAT, for example, breaks end-to-end connectivity, and “stateful NAT cannot be deployed on the core layer because the core layer has multi-pathing and multi-homing requirements,” said Huawei in a recent whitepaper.

Technically, in fact, the pool of unassigned IP addresses was exhausted in February of 2011.

Additionally, there is an issue of timing. As Huawei pointed out, “If a provider begins IPv6 deployment too early, the provider must assume the costs for interworking with the surrounding networks. If a provider begins IPv6 deployment too late, the total costs on network swap increase.”

The likely scenario then, is a slow transition to IPv6. Estimates range from eight to 12 years total, before we move to a fully IPv6 world, and in the meantime, both versions of IP addressing will need to be managed and supported by networks and the devices they service.

Consumer Compatibility

According to Microsoft, another active participant in World IPv6 Day, “IPv6 support in home routers will ultimately provide a better user experience in voice and video communications, peer-to-peer games, and other technologies that require end-to-end connectivity.”

For the consumer and operator who rent routing hardware, the problem is, again, compatibility. As we reported earlier this year, most home routers don’t support IPv6, including popular LinkSys routers from Cisco. There are workarounds, however, and routers with enough firmware memory which may be able to be upgrades. Even if an ISP doesn’t provide native IPv6 support, there are transition technologies that support v6 traffic over a v4 network. Microsoft published these workarounds to accommodate various ISP scenarios

ISP Scenario	Router requirements
Private IPv4 Connectivity (Teredo for IPv6)	• Adhere to Teredo-compatible behavior. For example, allow inbound and outbound traffic from UDP port 3544, and do not perform symmetric translation.
Public IPv4 Connectivity (6to4 for IPv6)	• Implement DHCv6 server stateless. • Implement 6to4 gateway functionality. • Support IPv6 host autoconfiguration and Neighbor Discovery.
Native IPv6 Connectivity	• Provide with DHCPv6 server and stateful client functionality. • Support the ISP’s client-to-ISP authentication and encapsulation protocol. • Support the IPv6 host autoconfiguration and Neighbor Discovery.
Native IPv6 Connectivity with Tunneled IPv4	• Provide both DHCPv6 server and stateful client functionality. • Support the ISP’s IPv4-over-IPv6 tunneling protocol. • Provide both IPv6 native LAN functionality and IPv4 native LAN functionality simultaneously, without one interfering with the other.
All ISP Scenarios	• Support mDNS (LLMNR) • Provide UPnP enabled stateful packet filtering capabilities.

Advice for Vendors

As the world transitions to IPv6, there will be significant business opportunities for vendors who support one of the many translation protocols and enable IPv6 communication along the many touchpoints in a network. Again, Vint Cerf provides some words of wisdom:

> Those of you who might be making equipment for the internet (software and hardware) should keep in mind the idea that anything that might be mobile needs to be outfitted with both v4 and v6 capability, because you may be in a place where only v6 is working, you may be in a place where only v4 is working, or you may be in a place where both of them are working and you need to get to both IPv4 and IPv6 destinations at the same time.

What's Next?

The world is clearly prepping for a transition to IPv6, and it's now a question of when, not if, IP traffic will be shuttled via 128-bit addresses. This was nowhere more evident than at World IPv6 day, which saw more than 225 businesses converge to take part in a global test flight of IPv6. The participants included everyone from Facebook and Skype, to Akami, Limelight Networks, Telekom Indonesia, Comcast, Verizon, AT&T, and Sprint.

The Internet Society hosted the event, and said that, "by acting together, ISPs, web site operators, OS manufacturers, and equipment vendors will be able to address problems, such as IPv6 brokenness in home networks and incomplete IPv6 interconnection. Also, on the day itself, any global scalability problems can be found in a controlled fashion and resolved cooperatively."

By all accounts, the day was a success, and some of testing tools developed for World IPv6 day are available to the public—to test the readiness of your network and learn its limitations, click here: http://test-ipv6.com/

When we imagine a world with myraid connected devices—from coffee makers to alarm clocks—and all of the automation and efficiency such a world can offer, we must also imagine a "phonebook" with numbers for each of these devices, and IPv6 will provide the address pool to support these dreams for at least the next century.