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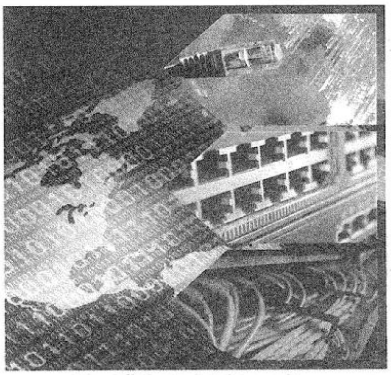
Last days of IPv4

The last IPv4 addresses have been allocated. Now it's just a matter of time before they run out. ***Prashant L. Rao*** reports on the ongoing transition to IPv6



With the last of the IPv4 address blocks being handed over, it is natural to be curious as to when IPv4 will be phased out for the more accommodating IPv6. Some things are clear though. It will be a gradual transition taking longer than a decade as this is not a trivial task. Largely, it is a chicken-and-egg situation. Unless there's demand, carriers will not offer IPv6 and unless they offer it, companies cannot avail of it. Technically, it's eminently feasible to run IPv4 and IPv6 in parallel to ease migration.

Talk to Sridhar Sarathy, VP, India Operations, Juniper Networks and he matter-of-factly grounds the hype around the end of IPv4. "I liken this to the Y2K hysteria when people feared the worst. It is not as serious as that and it is not as if once we run out of IPv4 addresses we would be in big trouble. As the supply dwindles, new Internet users will be issued IPv6 addresses and, at some point, Web sites will start mapping to IPv6 addresses," he said. The IANA have assigned the last IPv4 address blocks to regional Internet industries which will, in turn, allocate these to individuals and enterprises. "While the last of the allocation by the IANA happened last week we have technically not run out of Internet addresses. It might take a few months before we run out of IPv4 addresses," he added.

In part, it is because the exhaustion of IPv4 addresses was foretold so long ago, that there's no real panic. "The estimates of the time of complete IPv4 address exhaustion have varied widely from the early 2000s. As early as 2003, Paul Wilson (the then director of APNIC) stated that, based on rates of deployment at that time, the available space would last for one or two decades. In September 2005, another report suggested that the pool of available addresses would deplete in as little as four to five years. In the past couple of years, IPv4 allocations have accelerated, which means that the exhaustion dates would be earlier," commented Rajesh Kaul, Regional Director, India, Brocade Communications.

Pranesh Babu, Chief Technology Officer, Sify Technologies, said, "It has been estimated that the Internet Assigned Numbers Authority (IANA) will exhaust allocating all of its IPv4 addresses to Regional Internet Registries (RIR) by April 2011 and that the RIRs will, in turn, run out of addresses by July 2012. The last /8 allocation (16 mn IP addresses) to our RIR (APNIC) has already been done by IANA."

"As of January 1, 2011, the number of unused IPv4 addresses stands at 495.66 million as compared to 721.06 million, the number of available addresses last year. We collectively used 225.4 million addresses worldwide in 2010. Previous predictions pegged late 2011 as the anticipated date of IPv4 address exhaustion but there's still no definite answer to this one," said Manish Dalal, Vice President - Asia Pacific, Verisign.

Are we ready

As it happens, the usage of IPv6 is pretty low today. Estimates put it at 1-2%, which just goes to show how much remains to be done. Having said that, the protocol is supported by all recent versions of the popular operating systems and networking equipment.

"Networking companies have been ready for a long time producing boxes that are IPv6 compatible. As of today, it is difficult to say how much of this is being used. There was a study in 2008 and, at that time, penetration was less than 1%. Today IPv6 has been implemented on all major OSs," commented Sarathy. On June 8th, 2011, World IPv6 day will be observed in order to test drive the protocol and show that the networks are working. As of now, if you type *ipv6.google.com* it takes you to the site but the kind of traffic that it can handle is unknown.

"Right now, estimates show that roughly only about 2% of Web sites support IPv6," said Prashant Gupta, Head Solutions, Verizon Business.

"For a while, they will function in parallel and as all the Web access, e-commerce etc. will work better on IPv6 and people will gradually move to it," felt Sarathy.

"The equipment is IPv6 ready. IPv6 has been designed to work concurrently with IPv4. Older or relatively recent equipment can be used at the edge of the network and new devices can do IPv4- IPv6 translation. In this way, older equipment can still be used," said Subhashini Prabhakar, Chief Technology Manager, Dax Networks.

"There has been a mixed response from the industry. Some players have set up a special-purpose IPv6-only Web site and are experimenting with techniques for supporting IPv6 on their main Web site in 2011, while others have said that they would support IPv6 traffic later in September 2012, the date that Web sites operated by US federal agencies are required to support IPv6. Brocade Networks began supporting IPv6 on its main Web site *www.brocade.com* from last August. It took us only six weeks to deploy the new standard and we used ADX load balancers to handle the translation services between IPv4 and IPv6 network traffic. We have IPv6-enabled our Web site, DNS services and mail server," said Kaul.

Babu said, "The core equipment manufacturers on the carrier or service provider side are already shipping IPv6 ready equipment. There is a lot to be done with regard to the readiness of customer premise equipment. The IPv6 forum has already set up four 'IPv6 ready label' testing laboratories which can certify the equipment to be IPv6 ready. Enabling IPv6 on the mobile would be another key factor considering the explosion in sales of smartphones. However, most operating systems including Linux, Windows (XP and above) and Mac OS are already IPv6 enabled. Recycling older hardware, which isn't IPv6 capable would be a requirement for the adoption of IPv6 by end users and it would require a great deal of resolve on part of the government and enterprises to consciously adopt a strategy to recycle equipment that is incompatible with IPv6. The Government of India has made a good beginning in asking all government departments to have a nodal officer to champion IPv6 adoption under the India IPv6 Task force."

"On the surface, it may appear that simply upgrading software or enabling a feature will solve the issue. However, the challenge is infinitely more complex. There are many legacy and home-grown devices in the Internet today that cannot be upgraded easily to support IPv6. Much of the IPv6 software code that has been released has not been tested extensively, particularly in a large-scale environment. Releasing unstable code into a large production environment could wreak havoc on the existing Internet ecosystem. There are also fears surrounding security in an IPv6 environment. What new vulnerabilities are waiting to be exploited? What old vulnerabilities are able to get a new lease on life? For these reasons, many large Internet-backbone operators are hesitant to jump headfirst into the world of IPv6," said Gupta. Most major suppliers of Internet backbone equipment already support IPv6 in their hardware and software. The fact that most networks are hybrids, consisting of equipment from multiple vendors, as well as both old and new equipment, further complicates matters. Older equipment may not support IPv6, creating a need for a technology refresh—one that may not be financially justifiable. Perhaps just as frightening are all of the ancillary services that are provided by backbone operators. The most notorious one that's often overlooked is that of Domain Name Services (DNS). With the introduction of IPv6, the DNS infrastructure will need to evolve to operate on the IPv6 Internet, as well as be able to resolve IPv6

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addresses. Other services that need to be addressed are mail servers and gateways, caching servers, news servers and various network monitoring and reporting systems.

Dalal felt, "Equipment readiness for the transition depends on a case-to-case basis. For example, low-level equipment including network adapters and network switches may not be affected by the change, since they transmit link layer frames without inspecting the contents. Networking devices that obtain IP addresses or perform routing based on IP address do need IPv6 support. Most equipment would be IPv6 capable with a software or firmware update if the device has sufficient storage and memory space for the new IPv6 stack. In some cases, non-compliant equipment needs to be replaced because the manufacturer no longer exists or software updates are impossible, for example, because the network stack is implemented in permanent read-only memory. Other equipment that is typically not IPv6-ready ranges from Voice over Internet Protocol devices to laboratory equipment and printers."

The corporate challenge

The transition would be a gradual one. Sarathy felt that companies would prefer to get new equipment and do the IPv6 transition as part of their next upgrade.

Prabhakar said, "IPv6 has been designed to work concurrently with IPv4. IPv6 packets can be tunneled through existing IPv4 networks and this sets the stage for a relatively smooth, gradual transition to IPv6. This is possible without much change in hardware. Most networking players today support IPv6 functionality in most of their products."

There are a number of transition mechanisms involved which includes dual stack, tunneling, automatic tunneling, configured tunneling, proxying and translation.

"The IPv6 Ready Logo program, sponsored by the IPv6 Forum, is aimed at promoting IPv6 as the next generation Internet technology as well as stimulating the creation of standards-based interoperable implementations throughout the industry," said Kaul.

"The starting point in implementing a transition to IPv6 is to establish an overall company-wide strategy for IPv6 adoption. Many large enterprises with segmented organizational structures tend to pursue business unit transformation strategies within each business unit. With IPv6, this approach is likely to prove inefficient because organizational assets, know-how and competencies cannot be leveraged and reused effectively. Another important consideration is to include IPv6 requirements in planned product lifecycle replacement expenditures and to mandate IPv6 compliance for the procurement of new hardware and software. Staff training and IPv6 competency development should be taken into account and this will impose additional costs," commented Gupta.

Once the transition strategy is defined, the enterprise should launch gap assessments to gauge the level of IPv6 readiness of its network and IT resources. The outcome of the gap analysis should be a characterization of internal deficiencies pertaining to IPv6 deployment and estimated costs and time frames to redress the issues. A subtle aspect that can easily be overlooked is the dependency on IP addressing structure that may exist in enterprise business logic back-office systems. If IP addresses are stored in databases as 32 bit numeric fields, adjustments would be needed to accommodate IPv6 (128 bit numeric field) addresses.

"IPv6 addresses have to be acquired. Generally, these should be obtained from the upstream Internet service provider. However, if the enterprise is extremely large and multi-homed to more than one carrier, it may be possible to obtain direct Provider Independent IPv6 address allocation from its Regional Internet Registry (RIR—e.g., ARIN in North America). However, Provider Independent IPv6 address blocks are not guaranteed to be routable within the global Internet, especially those smaller than /32. Consequently, the enterprise should check with its service provider to ensure that an IPv6 net block obtained directly from an RIR is routable," he added.

In terms of actual project implementation, many transition methods can be employed to execute an IPv6 initiative. Broadly speaking, a transition scheme will involve successive stages of increasing IPv6 enablement. Examples include: (1) IPv6 endpoints interconnected by IPv6-over-IPv4 tunnels across an IPv4 backbone, (2) dual-stack IPv4/IPv6 embodiments and (3) IPv4 endpoints interconnected by IPv4-over-IPv6 tunnels across an IPv6 backbone. These and other methods are described in numerous public domain publications from standards bodies and other sources. The enterprise should conduct adequate due diligence to determine which transition method is appropriate for its environment. Throughout the transition process, the enterprise should be mindful of potential security issues that could arise as a result of deficiencies that may exist in some vendor's IPv6 offerings.

Babu said, "Both of these protocols are going to co-exist for some time in the future. The good news is that there is an option of dual stack wherein end point equipment can communicate in either IPv4 or IPv6 based on the other side's client or server capability. It is quite an effort to transition an existing IPv4 IT infrastructure to IPv6 but it is necessary to start at the earliest considering the situation on the IPv4 address space front. The recommended IPv6 adoption method is to first look at the network and make it dual stack IPv4 / IPv6 enabled and then look at migrating a part of the applications (typically Web front ends) to dual stack IPv6. We then need to start migrating users to the dual stack IPv4 / IPv6 environment, team by team, depending on the readiness of user end points."

Gupta felt, "The evolution to IPv6 will not be an easy one. Even though some degree of progress has been made at the operating system and backbone router levels, much work is still required for application support and at the network's edge. Perhaps the biggest burden will fall on the shoulders of ISPs to embrace IPv6 and undertake the necessary integration to make it a reality. However, given the complexity of such an evolution and the time required to make the transition, IPv6 needs to be taken seriously today."

The catalyst that spurs the adoption of IPv6 may be applications that have yet to evolve. These most likely will be applications that take advantage of key features of IPv6 or are perhaps available only on the IPv6 Internet. That will necessitate a move to the IPv6 platform and motivate end-users of those applications to make a move to the IPv6 world.

The biggest challenges to this transition theory come from the ubiquity of IPv4 in today's world, as well as the enhancements that have been made to IPv4 to overcome the issues that IPv6 is intended to solve. In the end, mandates from influential organizations such as the U.S. Department of Defense may be what will drive the adoption of IPv6 worldwide.

Dalal advised, "If you are surfing content over IPv4, you want to be sure that you can surf content over IPv6 as well. Therefore, you should look at incrementally introducing IPv6 into the service delivery part of your network. Also, if you have implemented IPv4 in your network, you won't have to work too hard to understand IPv6 and be able to implement this protocol in your network. If you have a regular technology refresh cycle, the transition will not be too difficult."

Service Providers and IPv6

"IP service providers will play a key role in this transition, supporting their customers with IPv6-enabled services. As IPv6 migration requires careful planning to adapt, integrate and co-exist with the current IPv4 network environment, it is better that it is a planned process initiated now, rather than become a fire fighting action when

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addresses run out," said Babu.

"Since ISPs are the ones that bring everything together—end-user devices and software, communicating via edge-services, over large IP backbones—perhaps they will shoulder the greatest burden in driving the adoption of IPv6. The technology is becoming available, and the fears are recognized. The applications haven't evolved yet, but, for many ISPs, there is great concern that they will not be able to react quickly enough when the applications do arrive. Many ISPs may find themselves making early nominal investments in IPv6, not only to limit their financial risk, but also to provide them with the opportunity to attain expertise," commented Gupta.

Kaul said, "Many ISPs will help accelerate the cut over to IPv6 via a designated date, June 8 2011, now known as the World IPv6 Day, which will involve an intensive 24-hour testing period designed to demonstrate the protocol's mettle and viability. That's important, as IPv6 still only accounts for 0.2% of the world's Internet traffic, a number that will undoubtedly accelerate quickly in the upcoming months and years. World IPv6 Day is intended to convince the Internet service and content providers that IPv6 is ready for prime time and that they should make the transition now. The earliest IPv6 adopters that we have seen are content delivery networks such as Limelight Networks, which announced IPv6 support last year for its technology to distribute customers' data across the global Internet. Those CDN companies could become more important since they can provide an easy way for companies that lack IPv6 support on their Web sites to get it. Essentially, it would become the CDN company's problem."

"Service providers are the ones that hand out IP addresses and the address scarcity is faced in the public domain only. IPv6 is largely an untested technology for both techs and non-techs. There are few ISPs who can or want to provide IPv6 connectivity," commented Prabhakar.

"Service providers don't need to undertake major hardware/infrastructure change. The challenge is with respect to set top boxes etc. ISPs will have to set up the network or the enterprise won't work. Most of the backbones already have a native IPv6 or some kind of tunnel that supports this. Most enterprises have plans for supporting IPv6. The limiting factor is that it doesn't bring in more revenue and in the short term you may have to manage two networks," said Sarathy.

A gradual transition

"It will happen gradually, led by ISPs as they have to reconfigure the network for IPv6. Enterprises will need to hand out addresses to smartphones etc. and so they will start issuing IPv6 addresses and set up the infrastructure at which point they would have to go to the service provider and ask for IPv6," said Sarathy.

Prabhakar said, "Coupled with worldwide Internet growth and increased mobility of people round the world, it appears now to be more imperative than ever to deploy IPv6 so as to overcome the address limitations imposed by, as well as lack of user mobility of, IPv4. IPv4 and IPv6 would co-exist for at least twenty years before IPv4 becomes obsolete. There are a few good ways to safely and cleanly transition onto IPv6, the cleanest of all being dual stack where none of the protocols rely on each other. The problem is that, for it to be trouble-free on the client-side, it has to have enough IPv4 addresses available so that the transition is smooth for v6 to take power before v4 gets gradually phased out due to an address shortage."

Babu said, "As we near IPv4 address depletion, content providers will start building IPv6 capabilities to their content along with IPv4. There will be no migration or switchover at a single point in time but rather a process of migration over time. Both IPv4 and IPv6 will co-exist for the foreseeable future (5 to 10 years). As their clients and users migrate out of IPv4 to IPv6, the application and content providers will see an increase in the usage of their IPv6 systems with the use of IPv4 reducing."

We have known that this day would come for over a decade. Despite that, IPv6 usage is still abysmally low. This indicates that the transition would take a while, perhaps within this decade or even into the next one. However, it will happen as there is no other way.

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