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DEMYSTIFYING IPv6 TRANSITION - WHAT DOES IT MEAN FOR ORGANIZATIONS?

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Abstract

Internet Protocol Version 4 (IPv4) which was developed almost three decades ago is the prevalent protocol version in use today. However, with the unanticipated growth of internet and proliferation of interconnected devices, we could soon be facing a scenario where IPv4 addresses are exhausted. While IPv4 addressing allows for billions of addresses, IPv6, the next version of the protocol, has provisions for trillions of addresses which is potentially inexhaustible. Sooner rather than later, migration to IPv6 will be inevitable for all enterprises.

This whitepaper from Wipro goes over the challenges of IPv4, benefits of migrating to IPv6, and the approach that enterprises could take to counter the challenges and avoid the pitfalls that they would face during IPv6 migration. It also presents a typical customer roadmap that enterprises could follow before they plunge headlong into IPv6 migration and implementation.

Introduction

The Internet Protocol Version 4 (IPv4) is the first standardized version of the internet protocol. Although introduced in 1981, it is still relevant and is the dominant network protocol in use today. IPv4 uses 32-bit addressing system which translates to 4.3 billion addresses. There are 6 billion mobile phones in use in the world today and by 2016, there will be over 10 billion mobile connected devices. Although IPv4 has served its purpose well so far, the exponential growth of the internet, associated network security threats and the encryption needs were not anticipated.

The Internet Assigned Numbers Authority (IANA) was given the responsibility of allocating IPv4 addresses and it did so by distributing a subset of these to the Regional Internet Registries (RIR) in blocks of approximately 16.8 million addresses each.

Regional Internet Registries (RIRs) manage, distribute, and register internet number resources (IPv4 and IPv6 addresses and Autonomous System Numbers) within their respective regions.

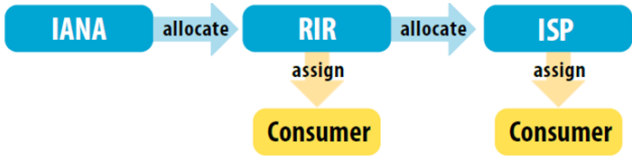


Figure 1 : IPv4 addresses allocation

There are five RIRs:

- AfriNIC
- APNIC
- ARIN
- LACNIC
- RIPE NCC

Figure 2 : Regional Internet Registries

IANA allocated its last five blocks of addresses in February 2011 signalling that the full capacity of IPv4 addresses has been reached. Also, in April 2011, the Asia Pacific Regional Internet Registry (APNIC RIR) entered the last stages of IPv4 allocation increasing the criteria for assignment. Thus, for the organizations in the region, it became much more difficult to obtain the IPv4 address space and it is set to affect the remaining regions in the near future.

IANA predicts that IPv4 addresses allocated to RIRs will run out this year. When that happens, many new applications and services will only support IPv6 and enterprises will be compelled to migrate from the universal IPv4 to IPv6. IPv6 is the successor to IPv4 and uses 128 bit addressing thereby increasing the number of available addresses to an amount large enough to support the addressing for the entire earth's growing Internet population.

Limitations of IPv4

The ubiquity of the internet and the increasing number of servers, workstations and devices are rapidly leading to a scarcity of available public IPv4 addresses. The value of IPv4 addresses is well illustrated by the fact that Microsoft bought 666,624 IP addresses from Nortel for USD 7.5 million in 2011.

With several other constraints such as lack of in-built network security and limited Quality of Service (QoS), the stage is set for a more accommodating IP platform that would serve the growing demands better.

The IPv4 routing table is huge with over 85,000 routes a normal happening. A simplified header and structured approach to addressing in IPv6 reduces the number of routes and improves efficiency by faster routing of data.

Scarcity of available public IPv4 addresses

Network Address Translation(NAT) is a short term measure

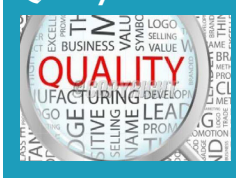
- Does not support network layer security standards and the correct mapping of all upper layer protocols
- Creates network problems when two organizations that use the same private IPv4 address ranges communicate

Lack of inbuilt security mechanism

Internet Protocol Security (IPSec) provides network security

- Not built-in and is optional for IPv4
- Implementations are proprietary and therefore come at an additional cost

Quality of Service is limited



IPv4 based networks cannot differentiate time sensitive data payloads from non-time sensitive data payloads

Figure 3 : IPv4 Limitations

Why and when an enterprise should consider IPv6

By 2015, there will be more than 7.1 billion mobile connected devices globally. Smart phones, home and industrial appliances, transportation, integrated telephony, sensor networks, distributed computing, gaming, online business and all other spheres are being driven by the internet increasingly. The phenomenal growth in the number of objects connecting to the network and the interactions between them brings an increased focus on the rate of depletion of IPv4 addresses, network security and QoS making the transition to IPv6 inevitable. Not adopting IPv6 will not only limit the growth of the internet but also the business potential of enterprises. As more and more users start adopting IPv6-only devices, enterprises with IPv4 websites will surely be left behind if they do not provide for this shift.

Realizing the urgency, governments across the world are mandating a transition to IPv6. The US government has mandated its federal agencies to ensure that all 10,000 of its websites support IPv6 by September 2012 and internal applications that communicate with public internet servers migrate to IPv6 by 2014.

In India, the Telecommunication Engineering Center under the Department of Telecommunications has been given the mandate to facilitate a smooth transition from IPv4 to IPv6. All financial institutions in India have been directed to make the entire ecosystem, including websites and payment gateways, IPv6 compliant by December 2012. Similarly, governments in Japan, South Korea, China, and the European Commission have multi-million dollar projects in place to accelerate IPv6 deployment.

Benefits galore

IPv6 offers various advantages over its predecessor. The expanded addressing capacity of IPv6 will provide about 340 trillion, trillion, trillion unique addresses in contrast to the addressing capability of IPv4 which is limited to 4 billion. The apparent inexhaustibility of the number of IPv6 addresses can be inferred from the quote by Steven Leibson – "we could assign an IPV6 address to EVERY ATOM ON THE SURFACE OF THE EARTH, and still have enough addresses left to do another 100+ earths."[1] IPv6 will eliminate the need for Network Address Translation (NAT) devices and thereby the capital and operating costs associated with its deployment and maintenance. In addition to addressing capacity, the auto-configuration feature in IPv6 improves manageability and reduces network administration costs.

IPv6 also delivers much needed benefits on the security front. The IP Security protocol suite has been built into the IPv6 architecture making way for an intrinsic security mechanism with IPv6 implementation. Identical security mechanisms in all applications within an enterprise simplifies security management. A more secure network protocol additionally paves the way for deployment of applications that require secure transactions.

The extensible structure of the IPv6 header allows provisioning for new features. IPv6 gives better QoS than IPv4 as the IPv6 header contains a field which allows packets that start from a particular host and head to a particular destination, to be identified and handled quickly and efficiently by the routers.

IPv6 adoption will benefit various sectors, namely, government, defense, telecommunications, power, transportation and logistics, gaming, real estate, health care and education.

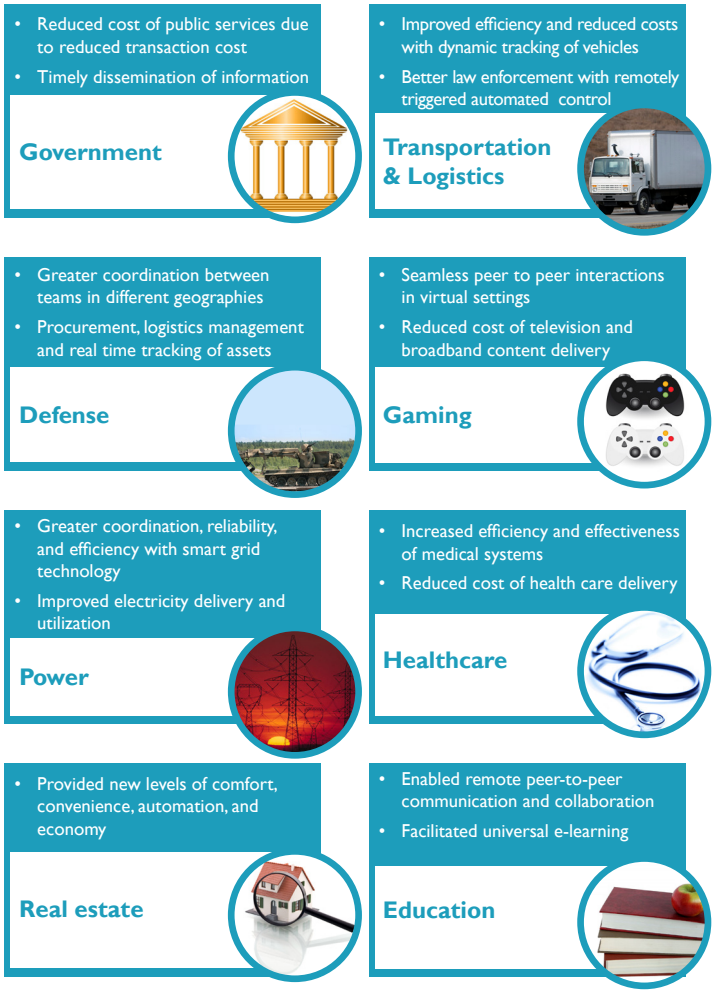


Figure 4 : IPv6 Benefits for various industry sectors

IPv4 to IPv6 Transition – Challenges and Solution

For any enterprise, transitioning from IPv4 to IPv6 will not be a simple activity. The migration would require a change in not only the network infrastructure but the complete ecosystem, hardware as well as software, from applications, firewalls and modems to servers and data centers. There will also be challenges associated with new technology adoption which would include issues related to interoperability, scalability, performance, integration and security. The fact that IPv6 is not backward compatible with IPv4 compounds the problem.

This implies that enterprises will have to adopt a phased approach and IPv4 and IPv6 will co-exist till the entire ecosystem has been successfully transitioned and tested. An integrated and coherent strategy will have to be planned for dual protocol access and to ensure continuity of business critical services. Further, there will be technology, operational and cost overheads that the organizations would need to provision for.

Typical Customer Roadmap for IPv6 transition

A typical customer roadmap would involve the following steps prior to implementation:

Figure 5 : Steps prior to IPv6 transition implementation

Defining the transition approach

There are many possible combinations of transition strategies such as core to edge, edge to core, routing protocol area and subnet. In core to edge, IPv6 is first added to core devices and then migrated toward the edge whereas in edge to core, it is added to the edge devices first. The migration objective would drive the selection of the best suited transition approach.

Assessing the enterprise readiness

An enterprise needs to understand the technical and business drivers of IPv6 transition. The existing infrastructure, i.e., network components, software applications and interfaces needs to be verified for its compatibility with IPv6. Business logic systems, security management, compliance management and risk management need to be reviewed.

Developing the implementation plan

This would include deciding on the combination of transition mechanisms and implementation technologies. Various transition mechanisms such as dual stack, tunneling and translation have been developed to allow dual protocol existence. Dual stack allows IPv4 and IPv6 to coexist in the same devices and networks and is ideally suited for core and inflection points in the network. Tunneling allows IPv6 packets to be transmitted over an IPv4 infrastructure and vice versa and is ideally suited for cores that are not IPv6-ready. Translation enables IPv4 devices to communicate with IPv6-only devices and is well suited for the edges.

Defining the dependencies and milestones

Like any other technology project management, various phases of the transition, key dependencies and milestones associated with the completion of each phase need to be identified and documented.

Defining the testing strategy and pilot plan

Among other aspects, the testing strategy would include the encapsulation and de-capsulation of IPv6, and compatibility and interoperability for IPv4 as well as IPv6. IPv6 transition should be implemented and tested in pilot mode before scaling it enterprise-wide to identify issues that could potentially impact critical services if deployed on the production network. Testing and piloting will provide the enterprise an opportunity for course correction in technology as well as schedule, if required.

Identifying the training needs

IPv6 is significantly different from IPv4 and therefore IT personnel will require training in the protocol suite and its implementation. The level of training could vary depending upon the functions the individuals perform i.e., development, deployment or maintenance of IPv6 transition.

Evaluating cost of transition

An economic assessment by RTI International for the National Institute of Standards and Technology estimates that approximately $25 billion will be incurred over a 25-year period for the United States to transition to IPv6. The total cost of transition for an enterprise would include cost of hardware and software procurement, reconfiguration of existing servers, routers, firewalls and operating systems, training and operations. The costs related to transition can be dispersed incrementally through planned maintenance and upgrades of existing infrastructure.

Enlisting an Expert partner

As discussed so far, IPv4 to IPv6 transition is beset with a multitude of technical and operational decisions and challenges. For an enterprise to embark on this on its own without the required expertise would have huge impact on cost and resources, infrastructure and personnel. Bringing in an expert partner would therefore help it avoid the common pitfalls and effect a smooth transition. The partner can be involved with one or all the phases of the IPv6 implementation/ migration.

Expert partners such as Wipro have been actively engaged in reclaim,

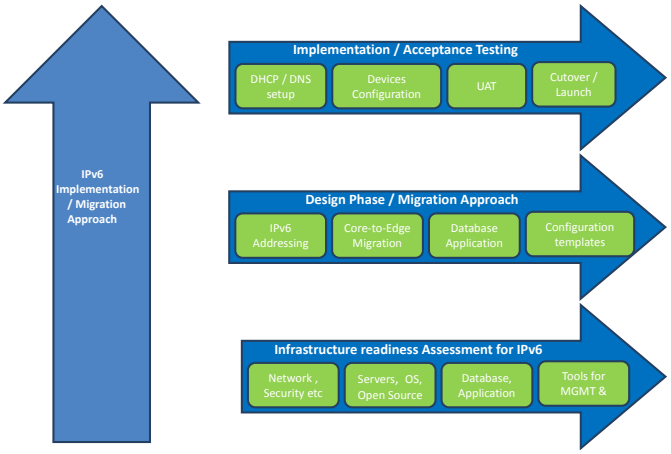


Figure 6 : IPv6 Implementation / Migration Approach

re-use, and optimization of IPv4 blocks in enterprises and ISP environments. With successful implementations on Carrier Grade Network Address Translation (CGNAT) which extends the lifetime of IPv4 address utilization, it provides enterprises sufficient headroom to evaluate and eventually move to IPv6. As technology evangelists and system integrators, expert partners such as Wipro have formulated best practices that ensure that design and build do not become prohibitively expensive and IPv6 migration is achieved with minimal impact. They are fully equipped to facilitate the smooth migration from IPv4 to IPv6 for banks, financial institutions, ISPs and telecom vendors alike.

A leading Indian web portal recently undertook IPv6 migration and successfully went through the phased approach. It assessed its existing infrastructure and inventory for IPv6 compatibility and identified the gaps for an upgrade. It planned the IPv6 address mechanism for all its data centers and offices taking into account scalability, summarization and easy administration. Dual stack migration approach was taken for all data centers. IPv4 and IPv6 reachability and IPv6 ready applications were tested. The portal is now in the stage of readiness of IPv6 supported application.

Conclusion

IPv6 migration is accepted and supported by organizations globally. Although the initial costs seem high, organizations understand the long term benefits of such a transition. The costs related to transition can be distributed incrementally through planned maintenance and upgrades of existing infrastructure. The network maintenance and upkeep costs of IPv6 network will likely be less than its IPv4 counterpart, with the removal of NAT and the enabling of end-to-end communications with the need for intermediary equipment.

Migration from IPv4 to IPv6 is a gradual phased process that must include careful planning and the transition capability to deliver mechanisms to enable the same with best ROI. IPv6 ensures enhanced end to end service delivery along with highly scalable and future ready infrastructure. It will enable service providers to support current and next generation applications for many more users worldwide.

The savings associated with the Internet's use over long distance communication can be applied to IPv6 where devices with IPv6 addresses in different geographies can communicate with each other. IPv6 could also simplify the activation, configuration, and operation of certain networks and services, particularly mobile networks. These factors contribute to reduced costs, easier deployment and enhanced features and emphatically make the case for IPv6 migration.

References

1. Link http://blog.asmallorange.com/ipv6

About the Author

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Varun Malhotra is the National Practice Manager – Integrated Communications Network in the System Integration & Maintenance Services Business Unit and has over 10 years of experience in the industry. He has extensive experience in Consulting, Design and Implementation of multiple Enterprise Networking technologies for various business transformations. He currently leads all solution specific requirements and act as a lead for addressing end-to-end solution requirements for all key customers across Wipro Infotech. Varun holds a Master of Science Degree in Computer Science and an Advanced Diploma in Software Applications.

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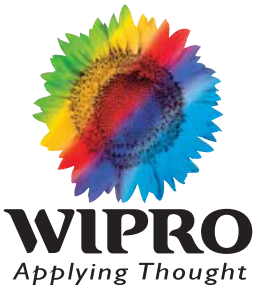

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