Planning the transition to IPv6

An Allstream White Paper
# Table of contents

Why transition now? ........................................................................................................... 1

Transition mechanisms ...................................................................................................... 2

Transition phases ............................................................................................................. 2

IPv6 transition challenges ............................................................................................... 3

Taking advantage of IPv6 benefits .................................................................................. 4

Putting together the transition project ........................................................................... 5

Conclusion ....................................................................................................................... 5
Planning the transition to IPv6

By now most businesses, specifically their IT departments, have become aware of the ongoing, albeit slow, transition of the Internet world to the IPv6 protocol. They have learned about the imminent depletion of available IPv4 addresses, how new IPv6 addresses are 128 bits instead of 32 bits, and how this creates a great abundance of new addresses – a development which will lead to a new wave of improved business models and innovative applications.

Another well-known fact in the IT community is the basic incompatibility between the two versions of Internet protocols – leading to the realization that the transition will not be effortless or transparent. They will need to develop sensible strategies and project plans in order to make their conversion to IPv6 a success.

Without getting into the details of specific strategies and plans, this document examines a few of the essential steps that ought to be taken by a business transitioning to IPv6 and highlights the inherent challenges that such an undertaking may undoubtedly bring.

Why transition now?

While everybody is pleased with the idea of an enlarged IP address space and understands the need for business continuity, still too many businesses regard adding IPv6 to their existing IPv4 network as a secondary priority, for which classic business case formulas and approaches are difficult to apply. However, a closer look reveals some compelling reasons as to why a business should move to IPv6 now rather than later.

Depletion deadline is getting closer

In 2011, the Asia Pacific Network Information Centre (APNIC) was the first IP registrar to allocate their final /8 IPv4 address block. The European IP authority, Réseaux IP Européens (RIPE) made a similar announcement in September 2012 and the American Registry of Internet Numbers (ARIN) is expected to exhaust their allocation of IPv4 addresses sometime in the second half of 2013. This means that service providers in those regions are tightly managing their remaining IPv4 allocations and will soon actively deploy IPv6 addresses for their Internet clients. Clearly, the number of IPv6 networks on the Internet will rapidly grow and the inability to directly communicate with IPv6 hosts will become a serious liability to any business.

Maintain business continuity

One day you may notice that many of your potential customers use only IPv6 addresses or that some of your most important customers or suppliers have fully enabled IPv6. At that point, to be able to communicate with them and keep your business operating at the desired capacity, you will have to transition your business to IPv6. Large enterprises, because of their size, have many more interaction channels and hence, more exposure to a change in Internet communication protocols. As a result, they need to act sooner than others, but as a rule, nobody can afford to fall behind their partners as the technology moves forward.

Protecting share of global markets

To operate on a global scale, a business needs to maintain relationships and tap into business opportunities in areas of the globe where IPv6 will soon be the only protocol “spoken” by the local networks. Also, in the near future, IPv6 compatibility will become a mandatory requirement when submitting bids for government and other prominent organizations or enterprises. Delaying the implementation of IPv6 may prevent you from pursuing opportunities that can help grow your business.

Prevent cost increases

Waiting until the last minute, and trying to implement ad-hoc solutions through deployment of workarounds or additional equipment, will in the end prove to be more costly than a timely, carefully planned transition. Adequate planning can ensure an optimal solution that saves deployment costs now and prevents maintenance issues and repair costs in the future.
Provide the best customer experience to all your customers

With the spread of IPv6 addresses among businesses and households, businesses that are still operating in the IPv4 world will be more difficult to reach. Customer requests will have to traverse translating gateways to reach the desired website or application servers, and this fact alone will introduce delays and complications. Certain applications, such as Internet banking or e-commerce, have little tolerance for such hurdles and the additional security risks that they impose. Businesses that fail to upgrade may lose clients who expect the same level of experience in every interaction.

Competition

It is quite likely that many of your competitors are already working to position themselves at the forefront of the transition to IPv6. They plan to take full advantage of the increasing number of service providers that now support IPv6 to benefit from aligning themselves with major businesses and websites (Google, Facebook, etc.) that have enabled the new protocol for their products and services. To maintain a competitive edge it is necessary to start the transition process as soon as possible.

Transition mechanisms

The essential incompatibility between the two protocols requires that businesses use appropriate translation and interfacing mechanisms during the transition period. This ensures that when they deploy IPv6 internally, they have backwards compatibility or a translation gateway to provide ongoing access to IPv4 content on the Internet. There are a variety of techniques to achieve this and the detailed descriptions are outside the scope of this document. Many of these methods rely on tunneling or translation proxies placed in the communication path. However, the most popular and practical approach has proven to be the “dual stack”, which involves equipping the network devices with both IPv6 and IPv4 address functionality at the network layer of the TCP/IP stack. It allows Internet nodes, such as routers or hosts, to operate as required on IPv4 or IPv6, depending on the protocol used by incoming Internet packets. As IPv4 address space becomes harder to get, businesses will also need to rely on IPv6 to IPv4 gateways to provide backwards connectivity to IPv4 content.

Transition phases

As you consider enabling IPv6 connectivity for your business, it is important to realize that not all elements of your IT infrastructure need to be upgraded at once. Careful planning and prioritization can make initial deployments less expensive while also allowing for an immediate impact on your business’ IP connectivity.

The first step before any upgrade is to conduct a full audit of your network infrastructure elements and generate a complete inventory in accordance with the accepted standards in your organization. This inventory will be used as a reference document when establishing needs, IPv6 compatibility, device lifecycle and monitoring progress.

The next step is to obtain IPv6 address space from your Internet service provider. Many providers have already invested in their own IPv6 transition and are quite able to satisfy this requirement.

Subsequent phases of the transition are determined by the priority of the IT infrastructure elements being upgraded to IPv6. Most experts agree on the following order of priorities:

1. Systems, applications and content that are accessible through the Internet

The focus of this stage is to make sure that customers, partners, and the public at large, can use IPv6 to interact with your organization over the Internet. Most of those interactions will be with devices and applications located in the DMZ area of your network. At a minimum, your web servers, DNS servers, and email systems need to be able to handle the new protocol.

There are a number of approaches to enable web server accessibility through IPv6:
Planning the transition to IPv6

- Upgrade existing servers to operate with IPv6, while maintaining IPv4 capabilities. Currently many major web server vendors offer the necessary software updates.
- Deploy a parallel set of servers that will handle only IPv6 requests. In some cases, this approach may be simpler and has the advantage of reducing the impact on other elements of the network.
- Deploy Address Family Translation (AFT) functionality (also known as NAT64) in other network components like web server proxies, load balancers, routers, etc. The AFT primarily enables IPv6 hosts to access IPv4 content.

As in the case of web servers, vendors of Mail Transfer Agents (MTAs), have released IPv6 enabled versions that can be immediately installed in a network to deliver IPv6 email capabilities. One fact to remember is that new IPv6 compatible anti-spam software may not be as feature rich as the current IPv4 versions.

DNS (Domain Name System) servers are essential to the proper operation of any IP network. When introducing IPv6 into your network it is important to publish the IPv6 addresses of all Internet-visible servers using the new AAAA record type, in the same way you have published your IPv4 addresses today in an A record. For your DNS to respond to domain name lookups by both IPv4 and IPv6 addresses, the best strategy is to enable dual stack functionality on your DNS server.

2. Systems and applications used by corporate workers to access Internet resources

Upgrading these systems has a lower priority than ensuring an IPv6 Internet presence. However, it still needs to be done at some point and the most popular alternatives, as listed below, are very similar with the ones recommended for Internet accessible applications:
- Provide internal users with dual-stack enabled hosts and devices
- Equip internal users with IPv6 enabled hosts and network devices. IPv6 packets to and from internal users will need to be tunneled through the areas of the corporate network still using only IPv4. To avoid tunneling, deploy NAT64 gateways in the network to translate IPv6 packets into IPv4.

3. Systems and applications for internal use

Currently most business networks are using Network Address Translation (NAT) to create private IPv4 address space for internal network devices, hence upgrading these systems to IPv6 is not an immediate requirement. This is true as long as your key network systems are still using IPv4 addresses and do not require access to IPv6 only content. However, some internal elements of the network may still need public addresses and if that particular area of the network experiences significant growth, the lack of new IPv4 addresses may create problems. Clearly, internal hosts and application servers still need to be enabled to IPv6 at some point. By reviewing the lifecycle of each device, the future IPv6 address assignment can be predetermined and integrated in the appropriate phase of your IPv6 upgrade strategy.

IPv6 transition challenges

The transition to IPv6 cannot be done overnight and without overcoming some significant challenges. Understanding the nature of these challenges and devising effective strategies is essential for a successful transition. Deciding on a minimum level of acceptable performance is also important as this will serve as reference for assessing the impact of the IPv6 upgrade. Below are a number of aspects that your IPv6 transition project needs to consider.

1. Cost

Enabling your network for IPv6 involves a number of expenses that good planning should provide for. The areas most likely to require additional funds include:
- Network infrastructure (new equipment and/or upgrades)
- Configuring, testing and managing the new IPv6 enabled elements of the network
- Staff training
- Upgrade of any customized software

IPv6 upgrade budget plans should assess the size and priority of each and allocate funds accordingly.
2. Complexity of managing two protocols at the same time

During the transition, the incompatibility of the two protocols creates the necessity to simultaneously manage two overlaying virtual networks on the same physical network. Most businesses today upgrade their network using dual stack architecture. As the transition begins, not all areas of the network will be upgraded at the same time; in some cases the IPv6 enabled elements will initially form IPv6 “islands”. To bridge IPv6 communication through the dominant IPv4 network, these islands may need to be connected through IPv6 over IPv4 “tunnels”. These tunnels will need to be carefully managed until the transition is complete.

3. Security

The complexity of the transition can be a security challenge in itself. It could be more difficult, in this interim period while the two protocols coexist, to maintain the integrity of the network operations. In addition, malicious attackers may use the addressing space available to their advantage by designing schemes that will elude classic blocking software. To prevent such effects, the transition project needs to provide for deep packet inspection mechanisms, alerts and good configuration change control for your network. These measures will be able to effectively detect and neutralize all incoming threats. Also, remember that due to the separation of your IPv4 and IPv6 networks, both need to be independently secured.

4. Standards and vendor readiness

Selecting the right equipment to implement the transition plan ought to be another essential project goal. Many vendors claim to be “IPv6 ready” but not all of them mean the same thing while making that claim. Lack of clear definition for the term “IPv6 ready”, and its rather loose correlation with IPv6 industry standards, puts the onus on each IT manager to check, in detail, the functionality and the specifications of any device or application to be installed in the network. This information needs to be assessed from the perspective of the organization’s particular requirements.

Testing of the new IPv6 functionality should be done using test programs recommended by trustworthy agencies such as the IPv6 forum. The US National Institute of Standards and Technology is also working on a certification program that will clearly evaluate the IPv6 readiness of devices and applications on the market.

Until these standards and procedures mature, some vendors may wait for market pressure before offering an IPv6 upgrade for a certain feature. If that feature happens to have a prominent role in your transition, you will need to adjust your upgrading and purchasing plans accordingly. In fact, it is a good idea to establish purchasing practices that will ensure IPv6 compatibility for any future equipment or application to be introduced in your network.

A test lab environment may be the best investment for your team as they prepare to deploy IPv6 in your network.

5. Latency

As your internal transition to IPv6 progresses, the outside world is also gradually adopting IPv6. While this is happening, expect IPv6 communications to have a somewhat higher latency than the IPv4 packets. In the short term, lack of IPv6 peering agreements between some service providers, as they enable their networks, means IPv6 packets may need to use longer routes to reach their destination. In addition, IPv6 packets may be routed through a number of translation devices and tunnels. These factors will likely increase latency and temporarily slow communication. Direct IPv6 to IPv6 communication will provide the minimum latency and the best performance.

Taking advantage of IPv6 benefits

While visibility from the Internet remains the highest priority, a successful IPv6 upgrade should aim to leverage many, if not all, of the inherent benefits of the IPv6 protocol. Some steps towards that goal are relatively straightforward to implement:

- Ensure that you receive at least a /48 size block of IPv6 addresses from your service provider. This will allow your business to assign and manage 65,536 /64 networks. Each /64 network contains $2^{32}$ IP public addresses to assign to individual hosts, providing greater flexibility in setting up various sub-netting arrangements.
• Routing tables will become less complex and two way applications such as VoIP or video will deliver better performance while being much easier to deploy. With IPv6 end points will no longer need to use NAT traversal techniques and will be able to directly communicate with each other.

• The abundance of IPv6 address space can be used to make provisioning and troubleshooting the new network less complex and difficult. To achieve this, it is recommended to follow the best practices for subnetting IPv6, like those from IP Best Current Operational Practices (IPBCOP). By defining network segments, reserving a /64 for network management and loopback addresses, reserving certain groups of subnets for specific locations, departments or functions, and implementing subnets based on hexadecimal digit or nibble boundary will improve the readability of your configuration and make your network more manageable.

• Make the most of the Stateless Address Auto Configuration (SLAAC) feature of IPv6. This feature allows you to program the hosts on your network to dynamically acquire their address at start by listening to the traffic on the subnet and looking at their internal MAC address. This approach does not require a DHCP server for assigning addresses, considerably reducing the difficulty of the provisioning process. It is recommended that key network elements, hosts and devices like routers, mail servers, etc. – which may have a large number of IP specific network security policies – be assigned static IP addresses, since it is more likely that their network card, and therefore MAC address, could be changed due to repairs or other reasons. If this is not properly recorded, it will create a conflict with other entries in the DNS tables or have other network impacts.

Putting together the transition project

Creating an effective project plan for enabling your network to IPv6 requires approaches and methodologies that are generally applicable to all IT projects. The main elements of project planning include:

• Determining the scope of project
• Determining which IPv6 benefits you will leverage
• Identifying and involving all stakeholders
• Performing risk analysis
• Establishing resources, budget, timelines and responsibilities

It is important that from initiation the plan is one that considers the entire organization. Unlike other cases, breaking up the upgrade into smaller projects involving different business units or areas of the network, might be counterproductive because it will introduce new internal transition requirements, obscure interdependencies, and potentially miss opportunities for optimization.

Conclusion

Although the development of the IPv6 has been initiated mainly as a solution for the problem of IPv4 address space depletion, it has in fact, achieved much more than that. It has produced a modern protocol that includes built in features that were implemented only as after thoughts in the old protocols (see QoS and IPSec provisions). IPv6 has the potential to enable new applications or business models that will transform the business IT environment in many meaningful ways. A successful transition will bring all these benefits to your business and will get you ready to do business through the Internet of the future. The time to start planning is now.
About Allstream

Allstream is the only national communications provider working exclusively with business customers. Our focus is helping you simplify IT operations to improve productivity, maximize performance and manage costs. Our IP solutions are delivered on a fully managed, fully secure national network and backed by our industry-leading commitment to customer service: The Allstream Service Guarantee. Driven by the expertise of our 2,500 employees across Canada, we operate a 30,000 km fibre-optic network combining advanced IP connectivity, digital switching, Ethernet-featured services, and the latest security technologies. Our portfolio includes the highest-capacity voice, data and Internet connections, unified communications, and managed services, all flexibly designed for the needs of large, mid-market and small businesses. We can help you compete more profitably by converging voice and data over a single, reliable, end-to-end infrastructure that delivers exceptional quality of service between metropolitan centres.