IPv4 TO IPv6 TRANSITION – UPDATE 2011

An overview of the new Internet addressing protocol, its implications for business and government, and Telstra's approach to the transition.

WHITE PAPER

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EXECUTIVE SUMMARY

IPv4 is the dominant addressing protocol used on the Internet and most private networks today. With the current exponential growth in Internet users worldwide, combined with the limited address range of IPv4, the number of available public IPv4 addresses remaining is very limited. IPv6 is the next-generation Internet protocol that will replace IPv4, providing a vastly expanded address space. This white paper provides an update on the current industry status of IPv6, how the IPv4 to IPv6 transition will affect some organisations, and Telstra's perspective on the transition.

Internet Transition

IPv4, the dominant addressing protocol, is rapidly running out of capacity and will be replaced by IPv6

The protocol that governs communication on the Internet (and most intranets) today is called Internet Protocol version 4, or IPv4. The popularity of the Internet has caused a shortage of public IPv4 addresses and they are quickly running out, with the global registry of IPv4 addresses from the IANA (Internet Assigned Numbers Authority) exhausted in February 2011 and the Asia-Pacific regional registry in April 2011[I]. Other Regional Internet Registries (RIRs) are expected to be exhausted between 2012 and 2014[II]. Once this happens, no more IPv4 addresses will be allocated to Internet service providers (ISPs).

Individual ISP run-out will depend upon how well each ISP manages its address pools compared to the rate of each ISP's subscriber growth. The transition from IPv4 to IPv6 is a popular issue and one which the industry will spend more time managing in the coming years. The transition is complex and will require IPv6 support by an end-to-end industry ecosystem. The ecosystem includes customer premise equipment, modems/home gateways, network systems, management (OSS/BSS, tools), content and applications.

Telstra's Approach

Telstra's approach is based on the dual-stack solution, allowing both IPv4 and IPv6 addresses to co-exist

Telstra has been planning for the IPv6 transition for a number of years. We have a defined transition strategy and a well-advanced IPv6 implementation program. Our strategy for IPv6 introduction is based on the dual-stack solution, allowing both IPv4 and IPv6 addresses to co-exist until the transition to IPv6 is complete.

Telstra will ensure that customers can migrate to IPv6 at their own pace, with minimal impact to services

This approach will make sure that the transition occurs with minimal impact to customers. Customers will not be forced to move to IPv6 overnight - they can deploy and migrate to IPv6 as they become ready. Telstra is already testing dual-stack technology on a number of key networks and products to seamlessly introduce IPv6.

Similar to service providers, businesses face a challenge in undertaking the complex transition of their IPv4 internal ecosystems without impacting services. Just as Telstra has done, it is advised that every online or IT-based business should prepare an IPv4 to IPv6 transition strategy.

Telstra will provide timely information and updates on our own program of work to assist customers, suppliers and others in the industry to manage their transition.

WHAT IS IPv6?

IPv6 was designed during the mid-1990s, when the Internet Engineering Task Force (IETF) realised that IPv4 address size constraints would soon be a major impediment to the continued growth of the Internet. IPv6 was first known as the Next Generation Internet Protocol (IPng) during development within the IETF. Since 1998, it has officially been known as IPv6. In the transition to IPv6, both IPv6 and IPv4 will co-exist until IPv6 eventually replaces IPv4.

The most obvious difference between IPv6 and IPv4 is the vastly expanded IP address space available

The most obvious difference between IPv6 and IPv4 is the address size. IPv6 addresses comprise 128 bits, whereas IPv4 addresses comprise 32 bits. This difference results in a huge expansion in available IP address space:

- IPv4: 2^{32} addresses equals 4.3 billion addresses (less than the global human population of 4.7 billion)
- IPv6: 2^{128} addresses. Because the last 64 bits are used to allocate addresses within a subnet, that leaves 2^{64}, which equals 18 billion billion subnet addresses.

IPv6 is not backwardly compatible with IPv4

Whilst IPv6 performs the same address function as IPv4, IPv6 is not backwardly compatible with IPv4. Therefore, an IP data session must use either IPv4 or IPv6 end-to-end. IPv6 and IPv4 can be used together with translation mechanisms such as Application Layer Gateways when the applications are known and supported end-to end.

IPv4 ADDRESS RUN OUT

The global top-level registration body, IANA (Internet Assigned Numbers Authority), exhausted its supply of available IPv4 addresses in February 2011. APNIC (Asia Pacific Network Information Centre) is the Regional Internet Registry which allocates IP addresses in the Asia-Pacific region. Unfortunately for Australia, APNIC effectively ran out of addresses in April 2011. The Asia-Pacific is also the highest growth region for IP address allocation. Telstra and any other ISP in the Asia-Pacific region are now only eligible for a total allocation of 1024 further addresses from APNIC.

There will be no further large allocations of IPv4 addresses for Asia-Pacific ISPs

Because no further large allocations of IPv4 addresses are available, the ability of Asia-Pacific ISPs to allocate IPv4 addresses for new customers depends on the number of addresses they already hold, the rate at which they are using them for new services, and the ISP's capability to adopt address translation technologies, which may reduce their rate of address demand. These factors will be different for each ISP, so it is likely that ISPs across the industry will run out of IPv4 addresses across a wide timeframe – some may run out within only a couple of years, others may be able to delay that exhaustion well into the future.

WHAT HAPPENS WHEN IPv4 ADDRESSES RUN OUT?

Internal enterprise networks using private IPv4 addresses will not be affected

Firstly, internal enterprise networks using private IPv4 addresses will not be impacted. Nor will the run-out impact existing IPv4 networks and IPv4 based services already allocated IPv4 addresses — they will continue to operate normally.

IPv4 and IPv6 will co-exist on the Internet for many years

Secondly, IPv4 and IPv6 will co-exist in the Internet for many years, quite likely for decades. Unlike Y2K, there is no cut-off date when IPv4 use will cease and the world will fully migrate to IPv6. The plan is for gradual transition: different regions and industry players will move to IPv6 at different rates. Consequently, end users will need the capability to access both IPv4 and IPv6 content and services on the Internet. This dual capability may be inherent in the end users' equipment, or may be provided transparently by their or the content publishers' ISPs.

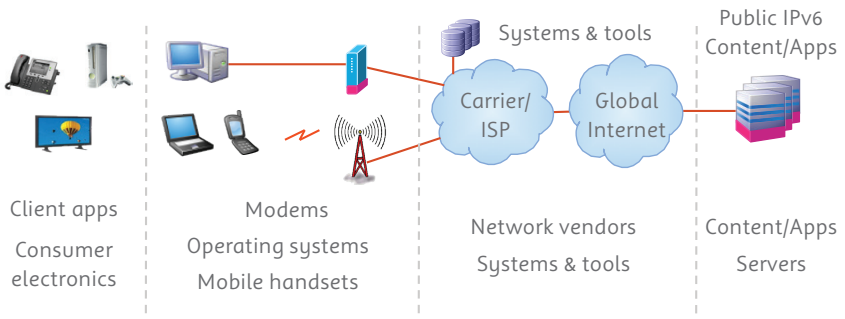
To enable this dual protocol access during the transition period, technology solutions were developed in conjunction with the development of the IPv6 protocol in the mid-1990s. Three categories of transition technologies exist:

- Tunnelling – encapsulates one protocol within another (e.g. IPv6 in IPv4, IPv4 in IPv6)
- Protocol Translation – translates packets between protocols (e.g. IPv6 to IPv4)
- Dual-stack – support both protocols in parallel within one network.

Telstra's dual-stack path enables both protocols to co-exist on our networks

Telstra has chosen the dual-stack path, enabling both protocols on its networks. The use of dual stack will ensure our customers have the current functionality of IPv4 always available to them even while they start deploying IPv6 in their systems. The transition from IPv4 to IPv6 is a known issue which the industry will have to manage over the coming years. The transition will take time as it will require IPv6 support by an industry end-to-end eco-system including CPE, modems/home gateways, networks, systems (OSS/BSS, tools), content and applications.

Figure 1: IPv6 Ecosystem



IPv6 is the accepted solution, however, moving the entire ecosystem to IPv6 will take many years

Source: Telstra

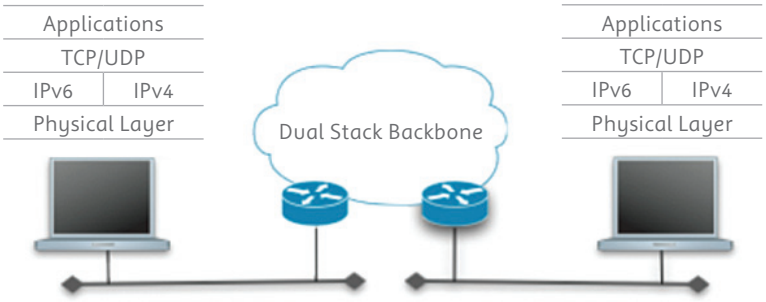
WHAT HAPPENS WHEN IPv4 ADDRESSES RUN OUT?

Telstra continually monitors industry developments with regard to the other transition technologies and we may choose to apply other methods where appropriate.

Co-existence of IPv4 and IPv6

Dual-stack (IPv6/IPv4) remains the accepted industry direction for the introduction of IPv6. Tunnelling has sometimes been used by early IPv6 adopters where native IPv6 has not been available end-to-end. IPv4 to IPv6 protocol translation mechanisms may also be applied in the future in certain circumstances.

Figure 2: Dual-stack supports both protocols in parallel within one network



GOVERNMENT MANDATES

Some Governments have set mandates to ensure a well-managed transition from IPv4 to IPv6 before IPv4 addresses run out

Initially targeted at enterprises, institutions and government related Internet services, IPv6 mandates are now being issued for consumer broadband services

The importance of continued Internet growth has been recognised by many governments due to its critical role for areas such as e-commerce, healthcare services and public information dissemination. This has led some governments to set IPv6 technology mandates to ensure a well-managed transition from IPv4 to IPv6 prior to the run-out of IPv4 addresses. The smooth and ordered adoption of these technologies will ensure continued Internet connectivity for all of their citizens.

The technology mandates have been primarily targeted at enterprises, institutions and departments that provide governments with their Internet connectivity services. Only recently IPv6 mandates for consumer broadband services have been issued.

North America

In August 2005, the US OMB (Office of Management and Budgets) issued Memorandum M 05 22: Transition Planning for Internet Protocol Version 6 (IPv6). This sets the US Federal Agencies a hard deadline for compliance to IPv6 on their core IP networks.

This mandate led many major US Service Providers (e.g. AT&T, Sprint, Verizon, QWest, NTT America) to develop government and enterprise solutions to allow agencies to buy IPv6 products and services to meet their core connectivity requirements. In practice, all of the agencies met the mandate because they were able to demonstrate that their backbone networks were capable of carrying IPv6 packets by the agreed deadline. However, there was no need to actually implement IPv6-based services. A draft roadmap for IPv6 adoption by the US Government has recently been prepared.

Europe

The European Commission communicated an IPv6 action plan in May 2008. The target was to have 25% of European customers accessing the Internet using IPv6 by 2010, which challenges all players (ISPs, content providers, customer premise equipment vendors, governments and organisations) to work towards this target.

Asia

Many Asian countries, including China, Japan and Korea have been early adopters of IPv6 due to government mandates. For example:

- Chinese Government Strategy: China Next Generation Internet (CNGI) sets out a five year plan (2006-2010) for the adoption of IPv6
- Korean Government Strategy: The Korean Government has the strategic IPv6 Promotion Plan II, which sets a vision of deploying IPv6 for the public sector.

GOVERNMENT MANDATES

Australia

The AGIMO (Australian Government Information Management Office) has set the following timeframes for IPv6 adoption within the Australian Government and its departments:

- Preparation Jan 2008 - December 2009
- Transition Jan 2010 - December 2011
- Implementation Jan 2012 - December 2012.

The Australian Department of Defence has also mandated a move to IPv6.

INDUSTRY READINESS FOR IPv6

Industry has been slow to adopt IPv6 since few commercial drivers exist

Across the globe, the industry has been slow to adopt IPv6, since very few commercial drivers for migration have existed at present. By its very nature, the Internet involves a huge number of disparate groups and thus a coordinated approach is difficult to achieve. The lack of a commercial imperative is due to a 'chicken and egg' situation: why support IPv6 in the equipment if there are no IPv6 services, and why create an IPv6 service if nobody can use it?

This situation is now changing with the occurrence of the global IPv4 exhaustion. Nevertheless, while many parts of the industry are now supporting IPv6, others are lagging behind. The following is a brief analysis of the readiness of key industry sectors:

Network Equipment

Generally, network equipment vendors already provide IPv6 dual-stack support

In the main, network equipment vendors already provide IPv6 support (dual-stack) for the core and edge of networks. Key vendors have been hardware and software-ready for several years, with equipment deployed in small-scale trials. Even though IPv6 capability has existed in most network routing equipment for some time, it has often not been enabled for use. Network control path functions like DNS, DHCP and RADIUS, however, are not yet uniformly supported for IPv4/IPv6 dual-stack across all vendors. These remain among the 'work in progress' issues for the industry.

Internet Infrastructure

Global IPv6 Backbones

Global IPv6 interconnectivity is now growing rapidly

As IPv4 and IPv6 do not interwork, it is essential there is global IPv6 interconnectivity similar to the IPv4 Internet today. The global network of IPv6 interconnectivity is now growing rapidly. We expect there will be a substantial interconnected Australian IPv6 backbone between many, if not most, ISPs by the end of 2011.

Domain Name Servers

IPv6 devices will resolve Internet domain names into IP addresses using IPv6 entirely

A critical step along the path to IPv6 was implemented on 4 February 2008, when ICANN (Internet Corporation for Assigned Names and Numbers) assigned IPv6 addresses and provided IPv6 connectivity to six of the Internet's root domain name servers (DNS). Similar enhancements are being made to other top-level DNS (e.g. for .com and .org). The APNIC servers for the .au domain also have IPv6 connectivity. These enhancements to DNS will allow IPv6 devices to resolve Internet domain names into IP addresses entirely using IPv6.

Service Providers

To connect to the global IPv6 Internet, customers will need to use a service provider that supports IPv6 and provides the required connectivity through to the global IPv6 backbones.

INDUSTRY READINESS FOR IPv6

Enterprise Virtual Private Networks (VPN)

Service providers in the US have begun offering dual-stack VPN services largely to support federal agencies in response to US Government mandates. Telstra's dual-stack IPv6 VPN product capabilities are in an advanced stage of development.

Broadband

There are still few consumer broadband IPv6 offerings from ISPs, but it is expected there will be an increasing number in the Australian market during 2011-12.

Customer Environment

In general, few modem gateways and other consumer on-premise equipment currently support IPv6

Consumer Modems and IP Devices

In general, very few modem gateways and other CPE appliances in use by consumers currently support IPv6. The main exception includes some high-end PDA mobile phones running Windows Mobile, and some CPE made for specific markets such as Japan. In the vast majority of cases, these IPv4-only devices will not be economically upgradeable to support IPv6. This is because the device is not upgradeable in any way, or because additional resources (e.g. flash memory or RAM) are required to support IPv6. IPv6 capability from many consumer gateway vendors is only starting to be released during 2011.

The long lifespan of broadband modem gateways means that many consumers will not have IPv6 connectivity capability for several years unless they opt to replace their modem with a dual-stack capable gateway.

Mobile Handsets

Dual-stack IPv4/IPV6 capability is expected to become available on selected new mobile handsets during 2011/12. Carriers will need to support IPv6 in their networks for handset use of IPv6 to be possible.

Operating Systems

Most, if not all, mainstream consumer and business operating systems available now have IPv6/IPv4 dual stack capability. However, legacy systems with either no or limited IPv6 capability (such as Windows XP) are expected to be in widespread use for several years yet.

INDUSTRY READINESS FOR IPv6

Applications and Content

Applications

Many applications will work when used with IPv6. Others will need to be checked and modified

Applications have to be specifically written to take advantage of IPv4/IPv6 dual stack capabilities in the underlying operating system. In many cases, applications will work correctly when used over an IPv6 network. Others will need to be checked and modified to meet the dual-stack requirements and take advantage of IPv4/IPv6 dual-stack capabilities built in to most recent underlying operating systems.

Applications can be divided into the following major categories:

- Server applications: Servers typically include web servers, database servers and mail servers, but can also include others such as those used for multiplayer online gaming. The applications running on these servers respond to requests from client applications which are carried across IP networks
- Client applications: End users run client applications which initiate requests to server applications across IP networks (the web browser being the most common example)
- Peer-to-peer applications: In this case the end user application acts as both a client and a server and can communicate directly with other users across IP networks.

Most applications interface at the IP socket layer and won't be affected whether the transport is IPv4 or IPv6. However, some applications may have been originally written in a way that ties them to IPv4, and these will have to be modified. Some examples include:

- Use of hard coded IPv4 addresses
- IP address data structures that only cater for IPv4 size addresses
- User interfaces that display an IP address, or allow an IP address to be entered only in IPv4 format.

Many applications, including web browsers, already support dual-stack function. Others are subject to the planned timing of upgrades by the application developer. Ideally, applications should be agnostic to the use of IPv4 or IPv6. An application that supports dual-stack will usually give preference to IPv6 if it is available, otherwise it will fall back to using IPv4.

Content Providers

Most major Internet content providers have yet to move to a dual-stack architecture

Most major Internet content providers are yet to make the move to a dual-stack architecture. Some have established specific IPv6-only versions of their site to enable IPv6 access to users who have IPv6 connectivity, and who deliberately choose to use IPv6 (e.g. ipv6.google.com and www.v6.facebook.com). Many Internet content providers are beginning to plan for a dual-stack architecture. This was exhibited when many content providers participated in World IPv6 Day (held on 8 June 2011) to trial IPv6 at a global level.

WHAT DOES THE TRANSITION MEAN FOR BUSINESS?

Multinational enterprises and those that deal with government departments are most likely to be impacted by government mandates. This will drive the need to support IPv6 (e.g. Australian Government departments implementing IPv6 in 2012).

The IPv4 public address run-out will mostly affect businesses in their external connections

Public IPv4 address shortages will have minimal impact on Enterprise VPNs due to the prevailing use of private IPv4 addressing. The IPv4 public address run-out will mostly affect businesses in their external connections to consumers and the broader Internet. Each business needs to consider whether to deliver IPv6 based services to consumers who prefer to use IPv6.

Businesses must ensure an IPv6 communication path from the enterprise edge to where IPv6 supported applications are hosted

Consumers will move to dual-stack CPE configured with an IPv6 address as well as an IPv4 address (either public or private) in order to access both IPv4 and IPv6 content. Businesses that host applications accessible via the Internet will need to cater for consumers with IPv4 or IPv6 public addresses. Since each protocol needs to work end-to-end, for businesses the transition does not end with deployment of dual-stack devices at the enterprise edge. It also requires enterprise network design changes to make the communication path IPv6-capable from the enterprise edge to where IPv6 supported applications are hosted.

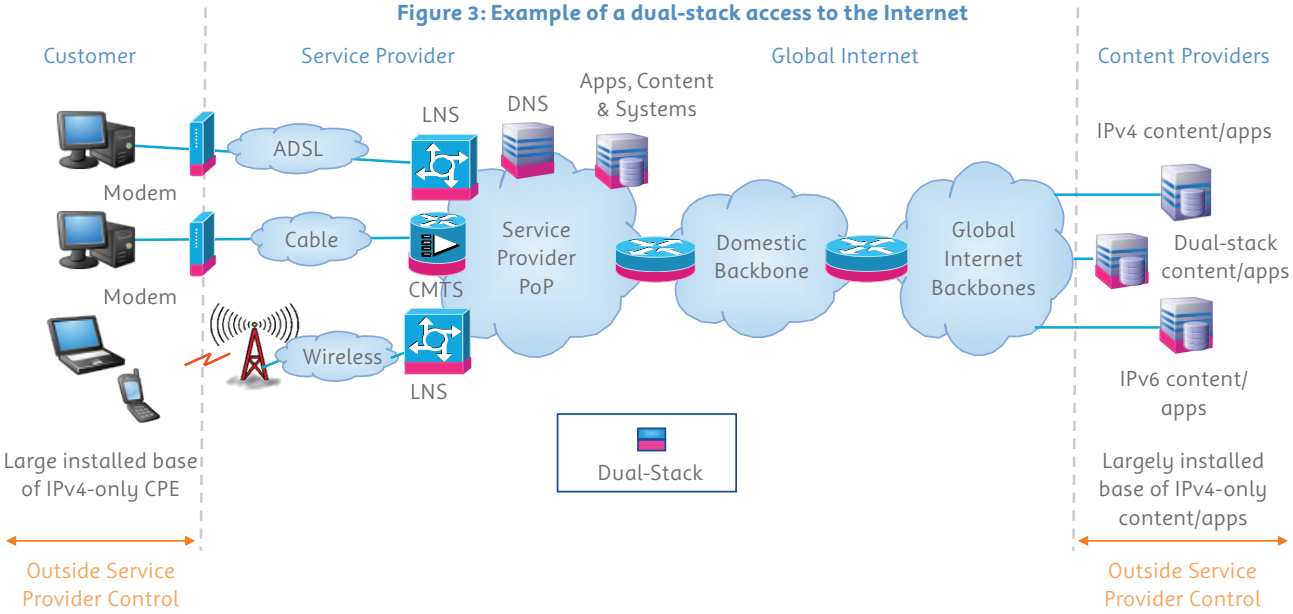
Businesses face a similar challenge to service providers, such as Telstra, in making the IP addressing transition. Transitioning to IPv6 requires the full ecosystem to move (i.e. network equipment, modems, consumer devices, operating systems, applications, content servers, IT systems, etc). Therefore, the transition from IPv4 to IPv6 will be a large and complex task that will require significant coordination across the full spectrum of players involved in end-to-end IP services.

WHAT IS TELSTRA'S APPROACH TO THE TRANSITION?

Telstra has prepared for the transition through a clear strategy and implementation program

Telstra has been planning for this transition for a number of years. We have a defined transition strategy and a well-advanced IPv6 implementation program. Our strategy for IPv6 introduction is based on the dual-stack approach, allowing both IPv4 and IPv6 addresses to co-exist until the transition to IPv6 is complete. This approach will make sure that the transition occurs with minimal impact on customers - they are not forced to move to IPv6 overnight and can deploy and migrate to IPv6 as they become ready. Telstra is already testing a number of key networks and products to seamlessly introduce IPv6 across our services. Timing for implementation in each product will depend on business drivers and equipment availability (e.g. CPE). It covers services across Telstra Internet Direct (TID), Enterprise networks, Consumer Broadband, Mobiles and Telstra's global networks.

Figure 3: Example of a dual-stack access to the Internet



Dual-Stack enables a smooth transition, supporting both IPv6 and IPv4

Source: Telstra

TID and IP-VPN Services

The benefits of dual-stack technology for TID and IP-VPN customers are as follows:

- Continued service availability even as IPv4 addresses run out
- Smooth transition to IPv6 at own pace
- Native IPv6 connectivity which provides better performance than IPv6 tunnels
- Essentially unlimited Internet addressing
- Leverages the Telstra Next IP® network.

WHAT IS TELSTRA'S APPROACH TO THE TRANSITION?

BigPond Broadband

Most consumer broadband customers will be more interested in the content and applications they use, rather than which IP addressing protocol is being used. Nevertheless:

- For many, the transition to IPv6 will occur smoothly and transparently as each of the components of the end-to-end service moves to dual-stack (e.g. modems, PCs, content)
- The industry is expecting that Internet content and applications will be dual-stack or IPv4-only for a long time to come
- It is unlikely that any significant content on the Internet will be available through IPv6-only for many years yet.

Mobiles including Telstra Mobile Broadband

- Initial availability of IPv6-capable mobile devices is not expected until 2011/12
- In the future there may be developments in self-contained mobile solutions, which will also drive IPv6 use (e.g. Telemetry and machine-to-machine solutions).

Applications and Content

Telstra applications and content will transition to be offered over IPv6 (to achieve end-to-end IPv6) as well as IPv4.

Telstra's Global Networks

Telstra's global networks operated by Telstra International Group adopted the same business approach as Telstra's guideline for the IPv4 to IPv6 transition. Key features include:

- Dual-stack approach to seamlessly support the co-existence of IPv4 and IPv6 IP routing on global IP networks, including the MPLS-VPN platform and Global Internet / IP Transit platform
- No hard cut-over for customers and continuing support for customer IPv4 address-based IP routing on Telstra global networks in the coming years
- Continue IPv4 and IPv6 support for IP network's auxiliary services such as DNS services on global Internet platform, looking glass on online port etc
- From FY 2011/12, Telstra International Group will start leasing IPv6 addresses to customers needing to connect to Telstra's global IP networks, with limited IPv4 Address also available
- Native IPv6 Address IP routing on core network is on the road map
- Telstra is committed to work with global network partners for native IPv6 traffic peering and/or interconnection for both private and public IP networks.

WHAT SHOULD BUSINESSES DO NOW?

Businesses can begin to prepare for their own IP addressing transition through the following steps:

1. Conduct an IPv6 readiness assessment

- Network hardware
- Servers, PCs (e.g. operating systems)
- Network management and security
- Applications
- IT systems
- Organisational capability (IPv6 skills)
- Understand coexistence implications (performance, resources).

2. Prepare an IP addressing strategy

- Develop a high-level view of transition approach for the business.

3. Develop an end-to-end program view

- Network, IT, devices, applications, etc
- Processes to minimise impacts
- Communication of the IPv6 strategy within the business
- Maintain network security through the transition to IPv6
- Work with vendors, system integrators and service providers to define detail and align timings (e.g. link hardware upgrades to lifecycle processes to minimise costs)
- Analyse transition costs and develop a transition budget.

4. Formulate an Implementation Plan

- Identify dependencies and major milestones
- Use phased approach based on priorities and timings.

5. Progress Implementation

- Work in close coordination and consultation with network provider
- Telstra commits to providing timely information and updates on its program of work to assist customers, suppliers and others in the industry to manage their transition.

WHAT SHOULD BUSINESSES DO NOW?

Leverage our Experience and Best Practice

Telstra can assist and support customers in their transition to IPv6 through our Professional Services and Consulting Services. The services we provide include:

- Consulting:
  - Planning consultation, including business level investigation and analysis
  - Conduct a Communications Strategy plan update
  - Readiness assessments and check lists
  - Total ecosystem roadmap development (Not necessarily Telstra specific)
  - Vendor management and CPE
  - VoIP / other providers / web sites, etc
- Design and Architecture:
  - Network design
  - CPE programming remote or onsite (future)
- Project Management:
  - Transition planning
  - Seamless transition
  - Staged transition planning process, achieved via:
    - Workshops
    - Customised design
    - Implementation planning
  - Telstra can provide overall project management to guide a customer through the transition process.

CONCLUSION

The transition from IPv4 to IPv6 is a known issue which the industry will have to manage over the coming years. The transition will take time as it will require IPv6 to be supported by an end-to-end industry ecosystem including CPE, modems/home gateways, networks, systems (OSS/BSS, tools), content and applications.

Telstra has been planning for this transition for a number of years. We have a defined transition strategy and a well-advanced IPv6 implementation program. Our strategy for IPv6 introduction is based on the dual-stack approach, allowing both IPv4 and IPv6 addresses to co-exist until the transition to IPv6 is complete. This approach will make sure that the transition occurs with minimal impact on customers - customers are not forced to move to IPv6 overnight and can deploy and migrate to IPv6 as they become ready. Telstra is already testing a number of key networks and products to seamlessly introduce IPv6.

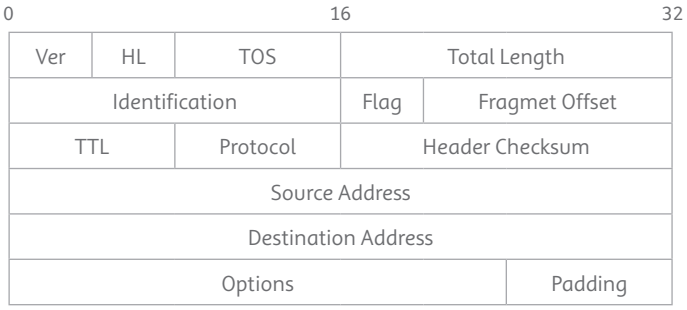
Businesses face a similar challenge to service providers in undertaking a complex transition of their IP ecosystem without impacting services. It is advisable that businesses start preparing their IPv4 to IPv6 transition strategies.

Telstra will provide timely information and updates on our program of work to assist customers, suppliers and others in the industry to manage their transition.

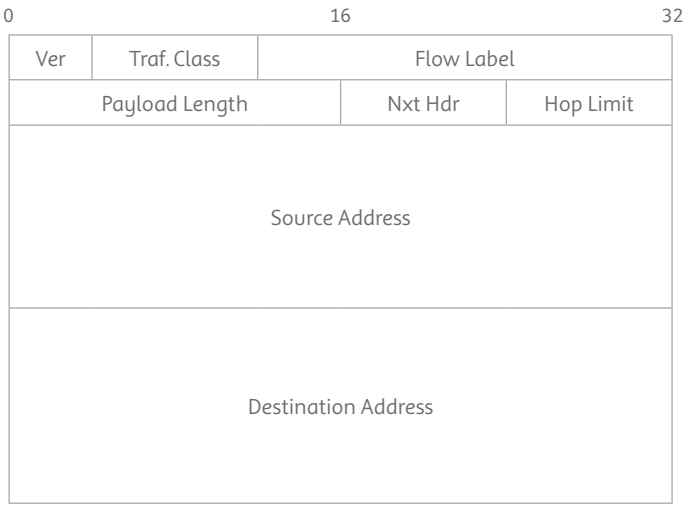
APPENDIX 1 – IP ADDRESSING

IP Address Header Formats

Table1



IPv4 Header



IPv6 Header

Address Ranges

Both IPv6 and IPv4 address ranges are often referred to in CIDR (Classless Inter-Domain Routing) notation, indicating how many of the bits in the range are used to identify the network prefix while the remaining bits identify subnets and hosts. For example, in 62.0.0.0/8 or (62/8), the '/8' indicates that the first 8 bits in the range are used for the common prefix and the remaining 24 bits are used for the host address within that network.

APPENDIX 1 – IP ADDRESSING

Individual Addresses and Notation

Table2

Address Family	Written as	Example
IPv4	Dotted Decimal Notation (four decimal ranges written to represent each byte of address space)	144.135.19.10
IPv6	Hexadecimal notation (eight hexadecimal ranges written to represent two bytes, separated by colons)	2001:0db8:85a3:0000:0000:8a2e:0370:7334
IPv6 (short-hand)	Hexadecimal notation (eight hexadecimal ranges with zeros removed)	2001:0db8:85a3::8a2e:0370:7334

Private Addressing

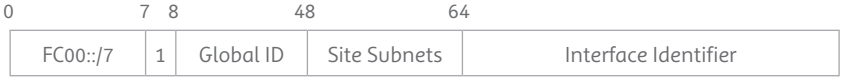
In IPv4, four specific address ranges were allocated for use in private networks (e.g. within an enterprise or home). The ranges are:

- 10.0.0.0/8 -- quite often used by large enterprise networks or internally by ISPs
- 172.16.0.0/12 -- often used to number enterprise or ISP backbone networks
- 192.168.0.0/16 -- often used in small office/home office (SOHO) applications
- 169.254.0.0/24 -- used for link-local applications.

These private addresses have no meaning on the public Internet. If external connectivity is required by nodes addressed privately, Network Address Translation (NAT) is used to translate the first three of these address ranges into public addresses when accessing the broader Internet.

IPv6 also has a range of addresses identified for local use known as the Unique Local Address range FC00::/7 (defined by RFC4193). In IPv4, when an interface is assigned a link-local address, we assume that the device is only connected to a local network. However, the practice of assigning multiple identifiers to interfaces is expected in IPv6 and therefore, all interfaces maintain a link-local address and additional IPv6 addresses.

Table 3: Unique Local Address Range



With regard to NAT, industry IPv6 addressing practices are still developing. Although there is a hope that significant use of IPv6 to IPv6 network address translation will be avoided, it is not yet clear as to whether enterprises will use public IPv6 space (derived from a registry), provider IPv6 space (granted from an ISP), or a local addressing scheme together with IPv6 NAT.

REFERENCES

I	The remaining allocations by the Asia-Pacific Network Information Centre are now rationed to a maximum of 1024 addresses per member under their latest policies – see "Policies for IPv4 address space management in the Asia Pacific region", http://www.apnic.net/policy/add-manage-policy.
II	"IPv4 Address Report" http://ipv4.potaroo.net has the latest exhaustion estimates of the other regional registries
1	Global IPv6 Strategies - From Business Analysis to Operational Planning by Patrick Grossetete, Ciprian Popoviclu, Fred Wettling, Cisco Press, June 2008
2	Deploying IPv6 Networks by Ciprian Popoviclu, Patrick Grossetete, Eric Levi-Abegnoli, Cisco Press, February 2006

Why Telstra?

Telstra provides network services and solutions to more than 200 of the world's top 500 companies. They rely on us to do business across 240 countries and territories and to enable greater productivity, efficiency and growth.

Telstra solutions offer the best of all worlds – skilled people and a rich portfolio of services delivered on our world-class Telstra Next IP® network and Next G® network. To ensure reliable performance, they're monitored and maintained from our dedicated centres using advanced management and operational systems. And they're backed by Telstra Enterprise-grade Customer Service® and one of Australia's largest and most qualified field and technical workforce.

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