IPv6 Deployment Planning

ITU/APNIC IPv6 Infrastructure Workshop

21st – 23rd June

Phnom Penh

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Introduction

- Presentation introduces the high level planning considerations which any network operator needs to be aware of prior to deploying IPv6
- Content applicable for:
  - Business decision makers
  - Network managers
  - Network engineers
    - Will also require implementation detail

Agenda

- Goals
- Network Assessment
- Network Optimisation
- Procuring IPv6 Address Space
- IPv6 Address plan
- Deployment
- Seeking IPv6 Transit
- Customers

Goals

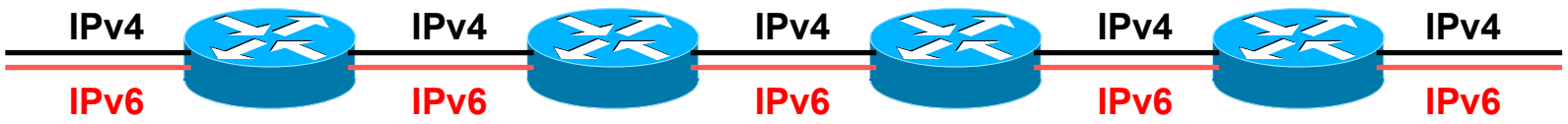
What do we want to achieve?

Goals

- Ultimate aim is to provide IPv6 to our customers:
  - Customers = end users
  - Customers = content providers
- Strategy depends on network transport:
  - Native IP backbone
    - Dual Stack is the solution
  - MPLS backbone (tunnels)
    - 6PE or 6VPE is the solution
    - The core infrastructure will remain IPv4 only

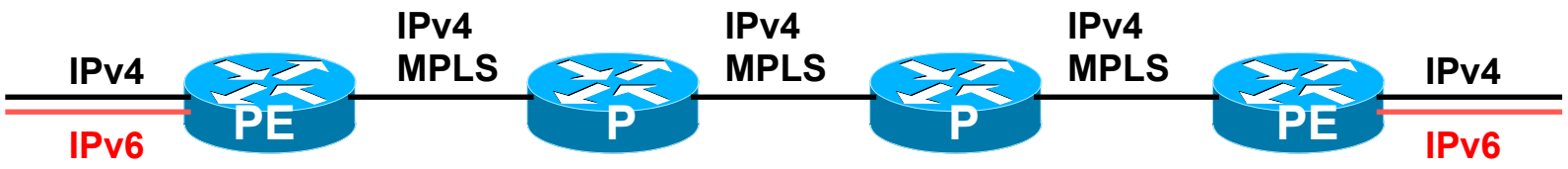
Native IP Backbone

- Routers are the infrastructure
  - Customer connections connect to the native backbone
  - VPN services provided using GRE, IPSEC, IPinIP etc
  - Providing IPv6 for customers means upgrading the native infrastructure to dual-stack



MPLS Backbone

- Routers are the infrastructure
  - Public and Private network access provided within the MPLS cloud
  - The core network does NOT need to be IPv6 aware
  - IPv6 access provided by 6PE or 6VPE
  - Provider Edge routers need dual stack capability



Network Assessment

What can run IPv6 today, and what needs to be upgraded?

Audit

- First step in any deployment:
  - Review existing network infrastructure
- Primarily routers across backbone
  - Perhaps also critical servers and services (but not essential as initial focus is on routing infrastructure)

Process

- Analyse each location/PoP
- Document
  - Router or any other L3 device
  - RAM (installed and used)
  - FLASH memory
  - Software release versions
  - Most network operators already keep track of this info
    - If not, RANCID (www.shrubbery.net/rancid/) makes this very easy
- Sanity check
  - Check existing connectivity
  - Remove unused configuration
  - Shutdown and clean up unused interfaces

Software Issues (1)

- Does the existing software have IPv6 support?
  - Yes: deployment is straightforward
  - No: investigate cost of upgrade
- Is a software upgrade available?
  - Yes: is hardware suitably specified?
  - No: hardware replacement
- Implement software upgrade
  - Budget, purchase & schedule installation

Software Issues (2)

- If existing software supports IPv6:
  - Are deployed software versions consistent across infrastructure?
    - Recommend maximum of two variations (easier troubleshooting, bug tolerance, etc)
- If existing software does not support IPv6:
  - Cost of upgrade to a version which does?
  - Testing for existing feature compatibility:
    - A software image with IPv6 may have “lost” features required for the existing operational network

Hardware Issues

- Can hardware specification be upgraded (eg RAM, FLASH etc)?
  - Yes: budget, purchase, installation
  - No: hardware replacement
- Hardware replacement:
  - Assess suitable replacement product
  - Analyse impact on operating network, existing services and customer

Result

- Once the previous steps are completed, entire network is running IPv6 capable software
- Deployment of IPv6 can now begin

Network Optimisation

Is the IPv4 network the best it can be?

Optimisation

- IPv4 networks have been deployed and operational for many years
  - Your network may fall into this category
- Optimisation means:
  - Does the interior routing protocol make sense?
  - Do all routing protocols have the latest best practices implemented?
  - Are the IGP metrics set so that primary and backup paths operate as expected?

Motivation for Optimisation

- IPv6 deployment (apart from MPLS cores) will be dual stack
  - Which means sitting alongside existing IPv4 configurations
- Aim is to avoid replicating IPv4 “shortcuts” or “mistakes” when deploying IPv6
  - IPv6 configuration will **replicate** existing IPv4 configuration
- Improvements in routing protocol BCPs should be deployed and tested for IPv4
  - Take the opportunity to “modernise” the network

Procuring IPv6 address space

Now we need addresses…

Getting IPv6 address space (1)

- From your Regional Internet Registry
  - Become a member of your Regional Internet Registry and get your own allocation
    - Membership usually open to all network operators
    - RIR specific details for IPv6 allocations are listed on the individual RIR website
  - Open to all organisations who are operating a network
  - Receive a /32 (or larger if you will have more than 65k /48 assignments)

Getting IPv6 address space (2)

- From your upstream ISP
  - Receive a /48 from upstream ISP's IPv6 address block
  - Receive more than one /48 if you have more than 65k subnets
- If you need to multihome:
  - Apply for a /48 assignment from your RIR
  - Multihoming with provider's /48 will be operationally challenging
    - Provider policies, filters, etc

Address Planning

- IPv6 address space available to each network operator is large compared with IPv4
  - Design a scalable plan
  - Be aware of industry current practices
  - Separation of infrastructure and customer addressing
  - Distribution of address space according to function

Addressing Plans – Infrastructure

- Network Operators should procure a /32 from their RIR
- Address block for infrastructure
  - /48 allows 65k subnets in the backbone
- Address block for router loop-back interfaces
  - Number all loopbacks out of one infrastructure /64
  - /128 per loopback
- Point-to-point links
  - /64 reserved for each, address as a /127
- LANs
  - /64 for each LAN

Addressing Plans – Customer

- Customers get one /48
  - Unless they have more than 65k subnets in which case they get a second /48 (and so on)
- Industry standard for customer assignments today:
  - /64 for just one LAN
  - /60 for a small network
  - /56 for a medium network
  - /48 for a large network

Deploying IPv6

Now we put it onto the network

IPv6 Deployment

- Number all the infrastructure interfaces according to the established addressing plan
  - No customers yet
- Secure routers and L3 devices for IPv6 access
- Enable IPv6 internal routing protocols
  - First IGP – care needed not to break IPv4 connectivity
  - iBGP – should replicate IPv4 iBGP
- Check that operation compares with IPv4 operation
  - Fix any problems – in a dual stack network the protocols must function the same way

Seeking IPv6 Transit

Hello World, I'd like to talk to you…

Seeking Transit

- Most transit ISPs now offer native IPv6 transit
- Next step is to decide:
  - To give transit business to those who will accept a dual stack connection

    or
  - To stay with existing IPv4 provider and seek a tunnelled IPv6 transit from an IPv6 provider

Dual Stack Transit Provider

- Fall into two categories:
  A. Those who sell you a pipe over which you send packets
  B. Those who sell you an IPv4 connection and charge extra to carry IPv6
- ISPs in category A are much preferred to those in category B
- Charging extra for native IPv6 is absurd, given that this can be easily bypassed by tunnelling IPv6
  - IPv6 is simply protocol 41 in the range of IP protocol numbers

Dual Stack Transit Provider

- Advantages:
  - Can align BGP policies for IPv4 and IPv6 – perhaps making them more manageable
  - Saves money – they charge you for bits on the wire, not their colour
- Disadvantages:
  - Not aware of any

Separate IPv4 and IPv6 transit

- Retain transit from resolute IPv4-only provider
  - You pay for your pipe at whatever $ per Mbps
- Buy transit from an IPv6 provider
  - You pay for your pipe at whatever $ per Mbps
- Luck may uncover an IPv6 provider who provides transit for free
  - Getting more and more rare as more ISPs adopt IPv6

Separate IPv4 and IPv6 transit

- Advantages:
  - Not aware of any
  - But perhaps situation is unavoidable as long as main IPv4 transit provider can't provide IPv6
  - And could be a tool to leverage IPv4 transit provider to deploy IPv6 – or lose business
- Disadvantages:
  - Do the $$ numbers add up for this option?
  - Separate policies for IPv4 and IPv6 – more to manage

Customer Connections

Network is done, now let's connect paying customers…

Customer Connections

- Giving connectivity to customers is the biggest challenge facing all ISPs
- Needs special care and attention, even updating of infrastructure and equipment
  - Cable/ADSL
  - Dial
  - Leased lines
  - Wireless Broadband

IPv6 to Broadband Customers

- Method 1: Use existing technology and CPE
  - This is the simplest option – it looks and feels like existing IPv4 service
  - PPPoE v6 + DHCPv6 PD
  - Used by ISPs such as Internode (AU) and XS4ALL (NL)
- Issues:
  - IPv6 CPE are generally more expensive (not the "throwaway" consumer devices yet)
  - Cheaper CPE have no IPv6 yet – need to be replaced/ upgraded

IPv6 to Broadband Customers

- Method 2: use 6rd
  - This is for when Broadband infrastructure cannot be upgraded to support IPv6
  - Used by ISPs such as FREE (FR)
  - Example:
    - 2001:db8:6000::/48 assigned to 6rd
    - Customer gets 192.168.4.5/32 by DHCP for IPv4 link
    - IPv6 addr is 2001:db8:6000:0405::/64 for their LAN (taking last 16 bits of IPv4 address)
    - DHCPv6 PD can be used here too (eg to give /56s to customers)
- Issues:
  - All CPE needs to be replaced/upgraded to support 6rd

IPv6 to Dialup Customers

- Use existing technology:
  - Most dialup access routers are easily upgradable to support IPv6
  - Service looks and feels like the IPv4 service
  - PPPv6 with DHCPv6 PD (perhaps)
  - CPE is usually PC or laptop (and most OSes have supported IPv6 for many years)
  - Service already offered for several years by many ISPs

IPv6 to Fixed Link Customers

- Use existing technology:
  - Most access routers (PE) and Customer routers (CPE) are easily upgradeable or replaceable to include IPv6 support
  - Service looks and feels like existing IPv4 service
- Configuration options:
  - IPv6 unnumbered on point to point links (or address them)
  - Static routes, subnet size according to business size
  - Or use BGP with private or public (multihomed) ASN
  - Whatever is done for IPv4 should be repeated for IPv6
- Fixed link Customers are probably the easiest to roll IPv6 out to
  - Customer deploying IPv6 within their own networks is a separate discussion (rerun of this presentation!)

IPv6 to Customers

- What about addressing? Here is a typical strategy:
  - Mobile Device:
    - /64 = 1 subnet
  - Home/Small Organisation:
    - /60 = 16 subnets
    - Reserve the whole /56
    - Reserve a /48 for small orgs = 256 small orgs per /48
  - Medium Organisation:
    - /56 = 256 subnets
    - Reserve the whole /48
  - Large Organisation:
    - /48 = 65536 subnets

Customer Connections

- What about customer end systems?
  - Is IPv6 available on all their computers and other network connected devices?
  - How to migrate those which aren't?
  - How to educate customer operations staff
  - What about their CPE?
  - What about the link between your edge device and their CPE?
  - What about security?

Conclusion

We are done…!

Conclusion

- When deploying IPv6 for the first time, a strategy and planning are of paramount importance
- Presentation has highlighted the steps in the planning and presentation process
  - Variations on the theme are quite likely – there is no single correct way of proceeding

IPv6 Deployment Planning