

IPv6 Deployment Planning



ISP Workshops

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



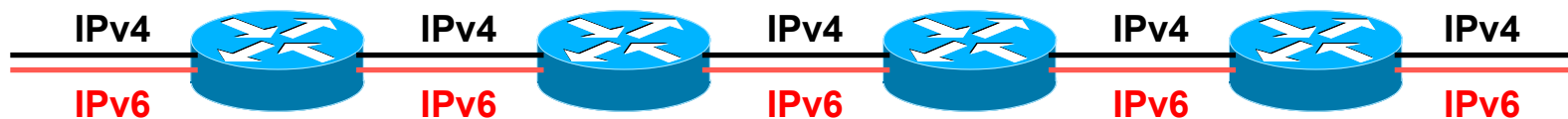
What do we want to achieve?

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

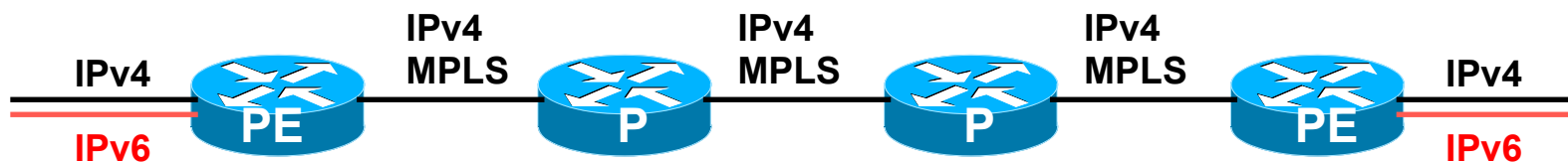
Native IP Backbone

- 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)
 - Non-Volatile Configuration 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, NVRAM, 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
 - Trying to multihome 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
 - /56 for a small 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:
 - /56 = 256 subnets
 - Reserve the whole /48
 - Enterprise/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

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