IPv6 and 4-byte ASN Update

Philip Smith  <pfs@cisco.com>
PacNOG 8
Pohnpei, FSM
22nd-27th November 2010
IPv6 Update
2004 → Today

- Resurgence in demand for IPv4 address space
  - 5% address space still unallocated (10/2010)
  - Exhaustion predictions have ranged from wild to conservative
  - …but early 2011 seems realistic at current rates
  - …but what about the market for address space?

- Market for IPv4 addresses:
  - Creates barrier to entry
  - Condemns the less affluent to NATs

- IPv6 offers vast address space
  - The only compelling reason for IPv6
Current Situation

- General perception is that “IPv6 has not yet taken hold”
  IPv4 Address run-out has now made it into “headline news”
  More discussions and run-out plans proposed
  Private sector still demanding a business case to “migrate”
  No easy Return on Investment (RoI) computation

- But reality is very different from perception!
  Something needs to be done to sustain the Internet growth
  IPv6 or NAT or both or something else?
Status in Internet Operational Community

- Service Providers get an IPv6 prefix from their regional Internet Registries
  Very straightforward process when compared with IPv4
  APNIC members simply “tick a box”

- Much discussion amongst operators about transition:
  NOG experiments of 2008 – http://www.civil-tongue.net/6and4/
  What is really still missing from IPv6 –
  Many presentations on IPv6 deployment experiences
Service Provider Status

▪ Many transit ISPs have “quietly” made their backbones IPv6 capable as part of infrastructure upgrades
  Native is common (dual stack)
  Providers using MPLS use 6PE
  Tunnels still used (unfortunately)

▪ Examples:
  NTT/Verio has been long time IPv6 capable
  HE, OpenTransit/FT, TATA International, Telecom Italia, GlobalCrossing, Telefonica, C&W (EU),…
  OCCAID
    IPv6-only transit ISP effort (linking Asia, N-America, EU)
OS, Services, Applications, Content

- Operating Systems
  MacOS X, Linux, BSD Family, many SYS V
  Windows: XP SP2 (hidden away), Vista, 7
  All use IPv6 first if available

- Applications
  Browsers, E-mail clients, IM, bittorrent,…

- Services
  DNS, Apache WebServer, E-mail gateways,…

- Content Availability
  Needs to be on IPv4 and on IPv6
Why are we still waiting…?

- That killer application?
  - Internet Gaming or Peer to Peer applications?
  - Windows 7 (?), Apple iPad (?)

- Our competitors?
  - Any network deployed in last 3 years will be IPv6 capable
  - Even if not enabled!

- The end-user should not have to choose protocols
  - Remember “Turbo” button on early IBM PC clones?

- Content
  - Do the content providers know about IPv6?
The On-going Debate (1)

- IPv6 Multihoming
  Same toolset as IPv4 — long term non-scalable
  ‘Ultimate Multihoming Solution’ no nearer discovery
  LISP is making interesting progress though

- Early rigid IPv6 address allocation model
  “One size fits all” barrier to deployment:
  Only ISPs “should” get IPv6 space from RIRs
  Enterprises “should” get IPv6 space from ISPs only
  Routing table entries matter, not the nature of business
  What is an ISP?
The On-going Debate (2)

- Not every IPv4 device is IPv6 capable
  Do we really need to replicate all IPv4 capability in IPv6 prior to considering deployment?

- “We have enough IPv4”
  Those with plenty denying those with little/nothing

- Migration versus Co-existence
  Realistically IPv6 and IPv4 will co-exist for many years
  Dual-stack operating systems in network equipment makes this trivial
Why not use Network Address Translation?

- Private address space and Network address translation (NAT) could be used instead of IPv6
- But NAT has many serious issues:
  - Breaks the end-to-end model of IP
  - Breaks end-to-end network security
  - Serious consequences for Lawful Intercept
  - Non-NAT friendly applications means NAT has to be upgraded
  - Some applications don’t work through NATs
  - Layered NAT devices
  - Mandates that the network keeps the state of the connections
  - How to scale NAT performance for large networks?
  - Makes fast rerouting and multihoming difficult
  - How to offer content from behind a NAT?
Is IPv4 really running out?
Is IPv4 really running out?

- Yes
  IANA IPv4 free pool runs out in June 2011
  RIR IPv4 free pool runs out within 2-3 months after
  http://www.potaroo.net/tools/ipv4/

- Small industry producing gadgets and widgets predicting IPv4 run-out
  http://inetcore.com/project/ipv4ec/index_en.html
  http://ipv6.he.net/statistics/
IPv4 run-out

- RIR Policy Development process in each RIR region is now handling many proposals relating to IPv4 run-out
  - The Last /8
    - All RIRs will receive one /8 from the IANA free pool
  - IPv4 address transfer
    - Permits LIRs to transfer address space to each other rather than returning to their RIR
  - Soft landing
    - Reduce the allocation sizes for an LIR as IPv4 pool is depleted
  - IPv4 distribution for IPv6 transition
    - Reserving a range of IPv4 address to assist with IPv6 transition (for Large Scale NATs etc)
4-byte ASN Update
Autonomous System Number (ASN)

- Two ranges
  - 0-65535 (original 16-bit range)
  - 65536-4294967295 (32-bit range - RFC4893)

- Usage:
  - 0 and 65535 (reserved)
  - 1-64495 (public Internet)
  - 64496-64511 (documentation - RFC5398)
  - 64512-65534 (private use only)
  - 23456 (represent 32-bit range in 16-bit world)
  - 65536-65551 (documentation - RFC5398)
  - 65552-4294967295 (public Internet)

- 32-bit range representation specified in RFC5396
  Defines “asplain” (traditional format) as standard notation
Autonomous System Number (ASN)

- ASNs are distributed by the Regional Internet Registries
  - They are also available from upstream ISPs who are members of one of the RIRs

- Current 16-bit ASN allocations up to 56319 have been made to the RIRs
  - Around 35000 are visible on the Internet

- The RIRs also have received 1024 32-bit ASNs each
  - Out of 825 assignments, around 500 are visible on the Internet

- See [www.iana.org/assignments/as-numbers](http://www.iana.org/assignments/as-numbers)
32-bit ASNs

- Standards documents

- 16-bit ASNs
  - Refers to the range 0 to 65535

- 32-bit ASNs
  - Refers to the range 65536 to 4294967295
    (or the extended range)

- 32-bit ASN pool
  - Refers to the range 0 to 4294967295
Getting a 32-bit ASN

- Sample RIR policy
  www.apnic.net/docs/policy/asn-policy.html

- From 1st January 2007
  32-bit ASNs were available on request

- From 1st January 2009
  32-bit ASNs were assigned by default
  16-bit ASNs were only available on request

- From 1st January 2010
  No distinction – ASNs assigned from the 32-bit pool
Representation

- Representation of 0-4294967295 ASN range
  - Most operators favour traditional format (asplain)
  - A few prefer dot notation (X.Y):
    - asdot for 65536-4294967295, e.g. 2.4
    - asdot+ for 0-4294967295, e.g. 0.64513

  **But regular expressions will have to be completely rewritten for asdot and asdot+ !!!**

- For example:
  - `^[0-9]+$` matches any ASN (16-bit and asplain)
    - This and equivalents extensively used in BGP multihoming configurations for traffic engineering
  - Equivalent regexp for asdot is: `^([0-9]+)|([0-9]+\.[0-9]+)$`
  - Equivalent regexp for asdot+ is: `^[0-9]+\.[0-9]+$`
Changes

- 32-bit ASNs are backward compatible with 16-bit ASNs
- **There is no flag day**
- You do NOT need to:
  - Throw out your old routers
  - Replace your 16-bit ASN with a 32-bit ASN
- You do need to be aware that:
  - Your customers will come with 32-bit ASNs
  - ASN 23456 is not a bogon!
  - You will need a router supporting 32-bit ASNs to use a 32-bit ASN locally
- If you have a proper BGP implementation, 32-bit ASNs will be transported silently across your network
How does it work?

- If local router and remote router supports configuration of 32-bit ASNs
  
  BGP peering is configured as normal using the 32-bit ASN

- If local router and remote router does not support configuration of 32-bit ASNs
  
  BGP peering can only use a 16-bit ASN

- If local router only supports 16-bit ASN and remote router/network has a 32-bit ASN
  
  Compatibility mode is initiated…
Compatibility Mode:

- Local router only supports 16-bit ASN and remote router uses 32-bit ASN

- BGP peering initiated:
  Remote asks local if 32-bit supported (BGP capability negotiation)
  When local says “no”, remote then presents AS23456
  Local needs to be configured to peer with remote using AS23456

- BGP peering initiated (cont):
  BGP session established using AS23456
  32-bit ASN included in a new BGP attribute called AS4_PATH
  (as opposed to AS_PATH for 16-bit ASNs)

- Result:
  16-bit ASN world sees 16-bit ASNs and 23456 standing in for 32-bit ASNs
  32-bit ASN world sees 16 and 32-bit ASNs
Example:

- Internet with 32-bit and 16-bit ASNs
- AS-PATH length maintained
What do they look like?

- IPv4 prefix originated by AS196613
  
  ```
  as4-7200#sh ip bgp 145.125.0.0/20
  BGP routing table entry for 145.125.0.0/20, version 58734
  Paths: (1 available, best #1, table default)
  131072 12654 196613
  204.69.200.25 from 204.69.200.25 (204.69.200.25)
  Origin IGP, localpref 100, valid, internal, best
  ```

- IPv4 prefix originated by AS3.5
  
  ```
  as4-7200#sh ip bgp 145.125.0.0/20
  BGP routing table entry for 145.125.0.0/20, version 58734
  Paths: (1 available, best #1, table default)
  2.0 12654 3.5
  204.69.200.25 from 204.69.200.25 (204.69.200.25)
  Origin IGP, localpref 100, valid, internal, best
  ```
What do they look like?

- IPv4 prefix originated by AS196613

  But 16-bit AS world view:

  ```
  BGP-view1>sh ip bgp 145.125.0.0/20
  BGP routing table entry for 145.125.0.0/20, version 113382
  Paths: (1 available, best #1, table Default-IP-Routing-Table)
  23456  12654  23456
  204.69.200.25 from 204.69.200.25 (204.69.200.25)
  Origin IGP, localpref 100, valid, external, best
  ```
If 32-bit ASN not supported:

- Inability to distinguish between peer ASes using 32-bit ASNs
  They will all be represented by AS23456
  Could be problematic for transit provider’s policy

- Inability to distinguish prefix’s origin AS
  How to tell whether origin is real or fake?
  The real and fake both represented by AS23456
  *(There should be a better solution here!)*

- Incorrect NetFlow summaries:
  Prefixes from 32-bit ASNs will all be summarised under AS23456
  Traffic statistics need to be measured per prefix and aggregated
  Makes it hard to determine peerability of a neighbouring network
Implementations (Jan 2010)

- Cisco IOS-XR 3.4 onwards
- Cisco IOS-XE 2.3 onwards
- Cisco IOS 12.0(32)S12, 12.4(24)T, 12.2SRE, 12.2(33)SXI1 onwards
- Cisco NX-OS 4.0(1) onwards
- Quagga 0.99.10 (patches for 0.99.6)
- OpenBGPD 4.2 (patches for 3.9 & 4.0)
- Juniper JunOS 4.1.0 & JunOS 9.1 onwards
- Redback SEOS
- Force10 FTOS 7.7.1 onwards

http://as4.cluepon.net/index.php/Software_Support for a complete list
IPv6 and 4-byte ASN Update

Philip Smith  <pfs@cisco.com>
PacNOG 8
Pohnpei, FSM
22nd-27th November 2010