32-bit ASNs

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NANOG45
ASN Terminology Soup – What???

- 2-octet, 2-byte, 16-bit, ASN16, and OLD all mean
  - AS 0 – 65,535
- 4-octet, 4-byte, 32-bit, ASN32, NEW, and AS4 all mean
  - AS 0 – 4,294,967,295
- ARIN terminology
  - "16-bit only AS numbers" refers to AS numbers in the range 0 – 65,535
  - "32-bit only AS numbers" refers to AS numbers in the range 65,536 – 4,294,967,295
  - "32-bit AS numbers" refers to AS numbers in the range 0 – 4,294,967,295
- Throughout this presentation we will use 16-bit and 32-bit terminology when needed
Background

- We are running out of 16-bit ASNs
- The first RIR could run out by June 4, 2011\(^1\) at the current allocation rate
- So, we need to increase the number of ASNs
  - 16-bit: 65,536 ASNs
  - 32-bit: 4,294,967,296 ASNs
- Allocation and deployment of 32-bit ASNs will affect everyone
  - Even if you have a 16-bit ASN

\(^1\) [http://www.potaroo.net/tools/asns/index.html](http://www.potaroo.net/tools/asns/index.html)
RIR ASN Allocation Schedule

2007 and 2008:
• 16-bit ASN default
• 32-bit ASN optional

January 1, 2009:
• 32-bit ASN default
• 16-bit ASN optional

January 1, 2010:
• No distinction between 16-bit and 32-bit ASNs
• 32-bit ASN only
• Unallocated 16-bit ASNs are reserved

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You are here!

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Interesting ARIN Facts

- Received questions about changing the policy, but so far no proposals have been submitted via the policy change process
- Always ask if you are sure you really want a 32-bit ASN
- Since the policy was implemented in 2007:
  - 169 requests for 32-bit ASNs
  - 162 of them changed their request to a 16-bit ASNs
  - 7 32-bit ASNs issued
- January 2008:
  - 3 requests for 32-bit ASNs
  - All 3 changed their request to a 16-bit ASN
  - Zero 32-bit ASNs issued
Operational Issues are Right Around the Corner

- People have already started using 32-bit ASNs
- However, everything in your network still thinks ASNs are 16-bits long
  - Routers/routing software
  - Routing policies
  - Peering policies
  - Engineering and NOC staff knowledge
  - Network management tools
  - Network monitoring tools
  - Customer management tools
  - Sales staff knowledge

Avoid Train Wrecks!
32-bit ASN Design Goals

- Change as little as possible
  - Specified in RFC 4893 and implemented using a new capability (capability code 65)
  - Two new optional transitive attributes: AS4_PATH and AS4_AGGREGATOR
- Compatibility
  - 32-bit capability is negotiated when establishing a BGP session
  - 32-bit mode when peering with 32-bit peers (NEW)
  - 16-bit mode when peering with 16-bit peers (OLD)
- Gentle transition and incremental deployment
  - Both implementations operate together
  - Several prefixes have been advertised with 32-bit ASNs for months and you probably didn’t even notice
32-bit ASN Compatibility With 16-bit ASNs

- AS 23456 (IANA-ASTRANS) is used as the ASN each time a 32-bit ASN needs to be represented on a router that doesn’t understand them
  - In the AS path
  - As the peer AS between routers with 16-bit and 32-bit ASNs
  - This is a valid, reserved ASN – not a bogon

ft9.pao1#sh ip bgp 192.26.93.0

BGP routing table entry for 192.26.93.0/24, version 24833360
Paths: (1 available, table Default-IP-Routing-Table.)
Not advertised to any peer

Received from :
198.32.176.14  (129.250.0.2)
  AS_PATH : 2914 4697 23456
Next-Hop : 198.32.176.14, Cost : 0
Origin IGP, Metric 259, LocalPref 100, Weight 0, external
Optional Transitive attributes : 02010002 00030000
Communities : 2914:410
Two Views of 192.26.93.0

- **This router understands 16-bit ASNs**
  
  route-views.oregon-ix.net>sh ip bgp 192.26.93.0
  
  BGP routing table entry for 192.26.93.0/24, version 1476096
  
  Paths: (35 available, best #1, table Default-IP-Routing-Table)
  
  Not advertised to any peer
  
  2914 4697 23456
  
  129.250.0.11 from 129.250.0.11 (129.250.0.51)
  
  Origin IGP, metric 259, localpref 100, valid, external, best
  
  Community: 2914:410 2914:2401 2914:3400

- **This router understands 32-bit ASNs**
  
  route-server.cluepon.net>sh ip bgp 192.26.93.0
  
  BGP routing table entry for 192.26.93.0/24, version 642007
  
  Paths: (1 available, table Default-IP-Routing-Table.)
  
  Received from:
  
  72.37.255.12 (72.37.255.1) Best
  
  AS_PATH : 2914 4697 131075
  
  Next-Hop : 72.37.255.12, Cost : 0
  
  Origin IGP, Metric 4294967295 (Default), LocalPref 100, Weight 0, external
  
  Communities : 2914:410
Brief Overview of How Compatibility Works

16-bit AS_PATH: 65000 23456 23456
32-bit AS4_PATH: 131000 100000

16-bit AS_PATH: 65200 65000 23456 23456
32-bit AS4_PATH: 131000 100000

Peers with AS 23456

Merge on AS 121000 router:
65200 65000 131000 100000

16-bit AS_PATH: 65200 65000 23456 23456
32-bit AS4_PATH: 131000 100000
New AS Number Notations

<table>
<thead>
<tr>
<th>Name</th>
<th>Notation</th>
<th>16-bit (AS 18508)</th>
<th>32-bit (AS 393222)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>asplain</td>
<td>Decimal integer</td>
<td>18508</td>
<td>393222</td>
<td>Proposed as the textual notation in RFC 5396 and widely implemented</td>
</tr>
<tr>
<td>asdot+</td>
<td><code>&lt;high order 16-bit value in decimal&gt;..&lt;low order 16-bit value in decimal&gt;</code></td>
<td>0.18508</td>
<td>6.6</td>
<td>Very little support</td>
</tr>
<tr>
<td>asdot</td>
<td>16-bit uses asplain</td>
<td>18508</td>
<td>6.6</td>
<td>Widely implemented and used by RIRs</td>
</tr>
<tr>
<td>ascolon</td>
<td><code>&lt;high order 16-bit value in decimal&gt;::&lt;low order 16-bit value in decimal&gt;</code></td>
<td>0:18508</td>
<td>6:6</td>
<td>Redback</td>
</tr>
</tbody>
</table>
A Brief Discussion About Notation

- asplain was just proposed as the textual notation to use for AS numbers in RFC 5396 on December 9, 2008

- Arguments for asplain
  - asplain has wide support in the operator community
  - Compatible with existing AS path regular expressions
    - `^[0-9]+$` matches any ASN (16-bit and 32-bit asplain)
    - asdot equivalent is `^([0-9]+)|([0-9]+\.[0-9]+)$`
  - Compatible with SNMP references to ASNs
  - asdot could be interpreted as a floating point number
  - Already widely implemented in routing implementations and tools
  - IANA uses asplain again now, RIRs are planning to use asplain

- Arguments for asdot
  - Easier to remember and read
    - 0.0 - 0.65535 16-bit ASN block
    - 2.0 - 2.1023 APNIC
    - 3.0 - 3.1023 RIPE NCC
    - 4.0 - 4.1023 LACNIC
    - 5.0 - 5.1023 AfriNIC
    - 6.0 - 6.1023 ARIN
  - RIRs already use it, existing 32-bit only assignments have been made in asdot
You Need to Upgrade Now, or Start Liking 23456 a Lot

- Everything in your network needs to be upgraded to understand 32-bit ASNs.
- Since AS 23456 is used to represent all 32-bit ASNs, it is impossible to know the real ASN.
- The implications are:
  - You could peer with AS 23456, which represents different ASNs, multiple times.
  - You will see prefixes with 23456 everywhere in the AS path.
  - Routing policies using AS path or communities cannot match on 32-bit ASNs.
  - MEDs could cause best path to change if peering with multiple AS 23456 peers.
  - Flow data will have lots of 23456 ASNs.
Will the real ASN please stand up?

<table>
<thead>
<tr>
<th>Prefix</th>
<th>AS Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.127.137.0/24</td>
<td>23456</td>
</tr>
<tr>
<td></td>
<td>393222</td>
</tr>
<tr>
<td>84.205.64.0/24</td>
<td>23456 18508 19151 1103 1125 23456 12654</td>
</tr>
<tr>
<td></td>
<td>393222 18508 19151 1103 1125 196613 12654</td>
</tr>
<tr>
<td>169.222.0.0/24</td>
<td>23456 23456</td>
</tr>
<tr>
<td></td>
<td>393222 131076</td>
</tr>
<tr>
<td>202.255.47.0/24</td>
<td>23456 18508 19151 2516 7667 23456</td>
</tr>
<tr>
<td></td>
<td>393222 18508 19151 2516 7667 131078</td>
</tr>
</tbody>
</table>

● Now, imagine 23456 multiple times in paths of 10s, 100s, and 1000s of prefixes
## Router and Routing Code Support for 32-bit ASNs

<table>
<thead>
<tr>
<th>Name</th>
<th>Version</th>
<th>Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcatel-Lucent SR OS</td>
<td>&gt;= 7.0</td>
<td>asplain</td>
</tr>
<tr>
<td>BIRD</td>
<td>&gt;= 1.0.12</td>
<td>asplain</td>
</tr>
<tr>
<td>Brocade (Foundry)</td>
<td>&gt;= 4.0.00 for the NetIron MLX and XMR,</td>
<td>asdot, asdot+, asplain</td>
</tr>
<tr>
<td>IronWare</td>
<td>&gt;= 2.8.00 for the BigIron RX</td>
<td></td>
</tr>
<tr>
<td>Cisco IOS</td>
<td>&gt;= 12.4(24)T, &gt;= 12.0(32)S12</td>
<td>asplain (asdot optional)</td>
</tr>
<tr>
<td>Cisco IOS XR</td>
<td>&gt;= 3.4(1)</td>
<td>asdot (asplain planned for 3.9)</td>
</tr>
<tr>
<td>Cisco NX-OS</td>
<td>&gt;= 4.0(1)</td>
<td>asdot (asplain planned for 4.1(3))</td>
</tr>
<tr>
<td>Juniper JUNOS</td>
<td>&gt;= 9.1R1</td>
<td>asplain (asdot optional)</td>
</tr>
<tr>
<td>Juniper JUNOSse</td>
<td>&gt;= 4.1.0</td>
<td>asplain</td>
</tr>
<tr>
<td>Force10 FTOS</td>
<td>&gt;= 7.7.1.0</td>
<td>asdot (asdot+, asplain optional)</td>
</tr>
<tr>
<td>OpenBGPD</td>
<td>&gt;= 4.2, patches for 3.9 and 4.0</td>
<td>asdot</td>
</tr>
<tr>
<td>Quagga</td>
<td>&gt;= 0.99.10, patches for 0.99.6 and other</td>
<td>asplain</td>
</tr>
<tr>
<td></td>
<td>versions</td>
<td></td>
</tr>
<tr>
<td>Redback SEOS</td>
<td>&gt;= 2.0</td>
<td>ascolon (asplain planned for end of 2009)</td>
</tr>
</tbody>
</table>

Tools Supporting 32-bit ASNs

- IRRd accepts and indexes asdot format AS numbers from mirrored databases
  - The parser for submissions to local databases does not yet accept 32-bit AS numbers
- RIR whois
- NetFlow v9 and sFlow v5
  - But the router needs to fill in the 32-bit ASN and the collector needs to understand it
Tools Missing 32-bit ASN Support

- Management systems and databases
  - peeringdb.com (future plans)
- Traffic and routing analysis tools
  - AS-based tools
  - routeviews.org (future plans)
- Looking glasses and traceroute servers
Known Operational Issues

- `neighbor remove-private-as` command, only works on private 16-bit ASNs right now
- Possible routing loops: AS path strangeness with AS4, private ASes and remove-private-as
- MEDs and AS 23456: 4 Byte ASN with Cisco IOS Software (slides 15 – 17)
- Mixture of asplain and asdot notation means we’ll have to use both for a while
  - Until everything supports asplain
  - Longer for legacy tools
Known Operational Issues: Communities

- RFC 4893 recommends to use the Four-octet AS Specific BGP Extended Community.
- However this is an I-D on -02 revision.
- Very few implementations so far (Quagga).
- The I-D only supports uint32:uint16 format.
  - Cannot set the local administrator field to be a 32-bit ASN.
  - Breaks the BGP community prefix filtering convention used at IX route servers (DE-CIX, INEX, LINX, …).
- There is no BCP on using communities right now.
Known Operational Issues:
AS_CONFED_SEQUENCE in AS4_PATH

- Something is wrong here
  91.207.218.0/23  18508 19151 35320 196629 23456
  195.128.230.0/24  18508 19151 35320 196629 23456 35748
  195.128.231.0/24  18508 19151 35320 196629 23456 35748

- Detailed analysis
  http://www.merit.edu/mail.archives/nanog/msg14345.html

- Andy Davidson’s Lightning Talk yesterday
  http://www.nanog.org/meetings/nanog45/presentations/Monday/Davidson_asn4_breaks_light_N45.pdf
We Will Peer with You

- Peering for testing and interoperability will be setup on request using EBGP multihop for IPv4 and IPv6
  - AS: 393222
  - IPv4 peer address: 72.37.255.13
  - IPv4 advertisement: 64.127.137.0/24
  - IPv6 peer address: 2620:0:380::5
  - IPv6 advertisement: 2620:0:380:2::/64
- Peer with a 16-bit or 32-bit ASN to see what happens, test routing policies, etc
- Login to route-server.cluepon.net with username rviews to run show commands
- Send mail to peering@as4.cluepon.net
What You Should Do

- Talk to other operators this week
- Evaluate the impact on your network, tools, and staff right away
- Ask your vendors for 32-bit ASN support and tell them if you prefer asplain notation
- Develop an upgrade plan, test new code
- Upgrade
Conclusion

- The Internet will keep running
- Your network will keep running
- If you have a 16-bit ASN today
  - Plan to upgrade Real Soon Now
  - 32-bit ASNs appear as AS 23456
- If you have no ASN today
  - Your network will need 32-bit ASN support
  - Or make sure to ask for a 16-bit ASN
Resources

- **AS4 Wiki**: software versions, configuration examples, links to everything
- RFC 4893: *BGP Support for Four-octet AS Number Space*
- RFC 5396: *Textual Representation of Autonomous System (AS) Numbers*
- RFC 5398: *Autonomous System (AS) Number Reservation for Documentation Use*
- 4 Byte ASN with Cisco IOS Software has a great introduction and detailed description of how 32-bit ASN work
- Introduction to Four-byte AS Numbers at APNIC has a lot of information and resources for operators
- 32-bit ASNs by Philip Smith (MENOG 2; 21 November, 2008)
- 4-Byte AS Numbers by Geoff Huston (APRICOT 2007; 28 February, 2007)
- 2-byte AS Number Report: status report on the 2-byte AS number space and projection of when the pool will run out
- 4-byte AS Number Report: status report on the 4-byte AS number space
- Net::ASN: Perl module for converting between different 32-bit ASN notations
Thanks

● Contributors
  ● Nick Hilliard
  ● Louis Lee
  ● Leslie Nobile
  ● Philip Smith
  ● ras

● AS4 Peering Router: Switch and Data
  ● Alan Larson
  ● Ali Marashi
  ● Chris Quesada