

32-bit ASNs

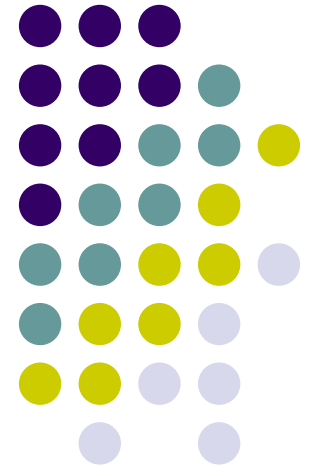
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NANOG45



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>



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

**You
are
here!**

RIR ^[1]	32-bit ASNs Allocated	32-bit ASNs Advertised
AfriNIC	4	1
APNIC	84	6
ARIN	7	2
RIPE NCC	24	7
LACNIC	1	0

[1] <http://www.potaroo.net/tools/asn32/>

Interesting ARIN Facts

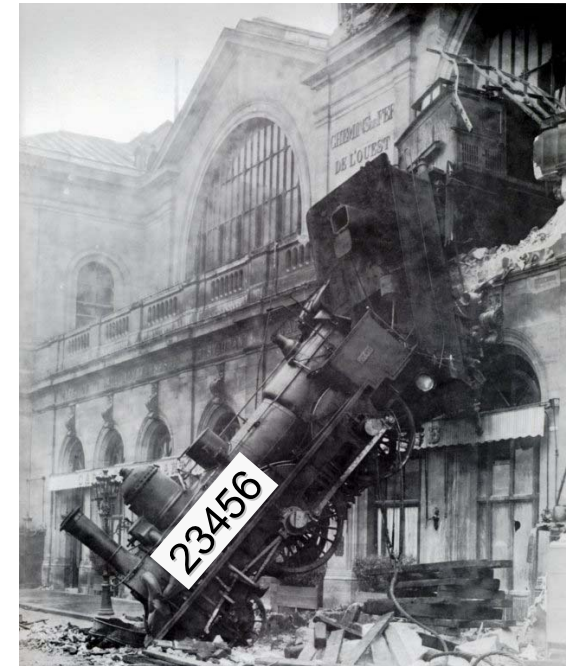


- Received questions about changing the policy, but so far no proposals have been submitted via the policy change process
- Always ask if you are sure you really want a 32-bit ASN
- Since the policy was implemented in 2007:
 - 169 requests for 32-bit ASNs
 - 162 of them changed their request to a 16-bit 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.paol1#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
```

2914 4697 23456

AS4_PATH



Two Views of 192.26.93.0

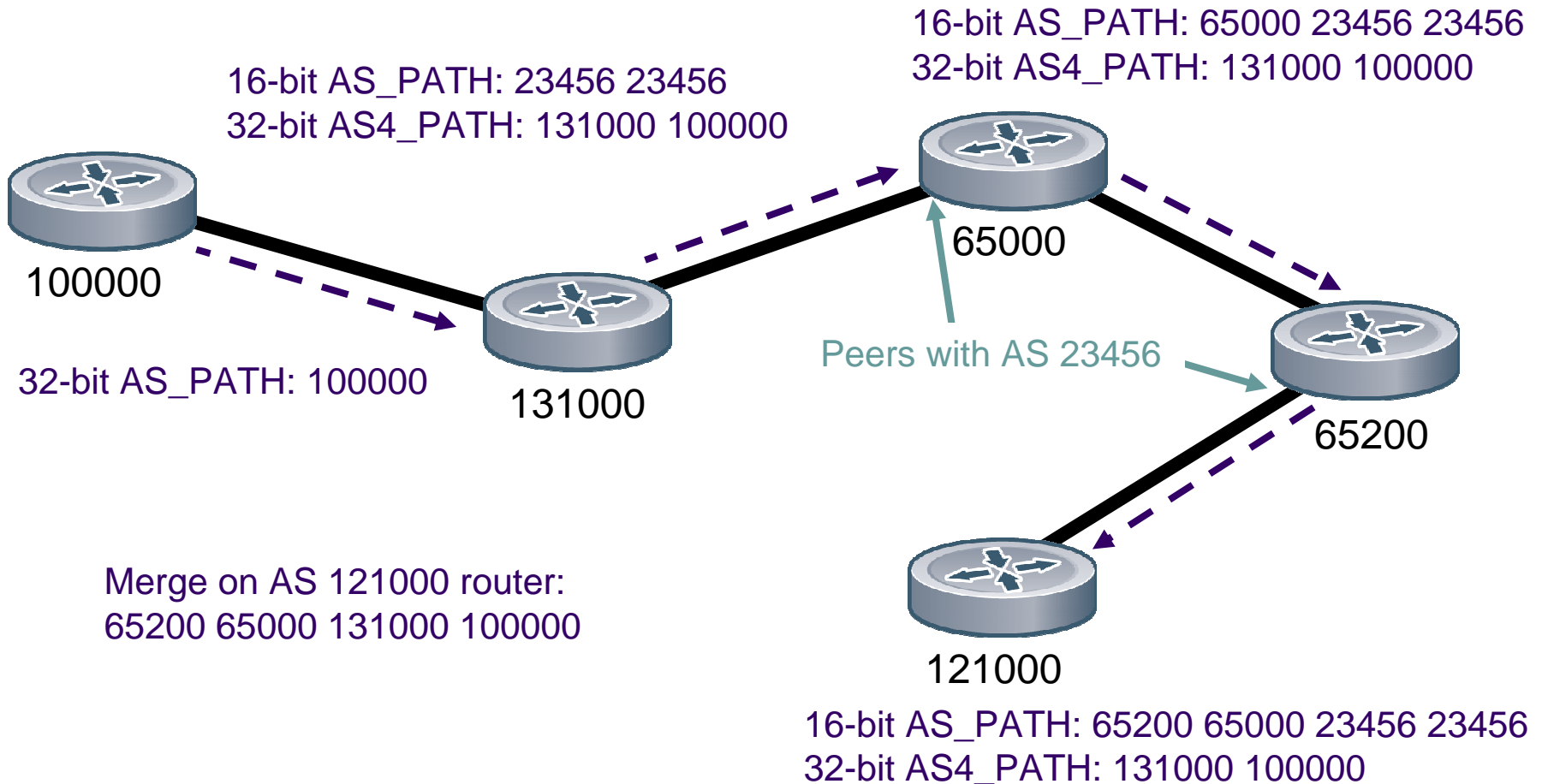
- This router understands 16-bit ASNs

```
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



New AS Number Notations



Name	Notation	16-bit (AS 18508)	32-bit (AS 393222)	Comments
asplain	Decimal integer	18508	393222	Proposed as the textual notation in RFC 5396 and widely implemented
asdot+	<high order 16-bit value in decimal>.<low order 16-bit value in decimal>	0.18508	6.6	Very little support
asdot	16-bit uses asplain 32-bit uses asdot+	18508	6.6	Widely implemented and used by RIRs
ascolon	<high order 16-bit value in decimal>:<low order 16-bit value in decimal>	0:18508	6:6	Redback

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?



Prefix	AS Path
64.127.137.0/24	23456
	393222
84.205.64.0/24	23456 18508 19151 1103 1125 23456 12654
	393222 18508 19151 1103 1125 196613 12654
169.222.0.0/24	23456 23456
	393222 131076
202.255.47.0/24	23456 18508 19151 2516 7667 23456
	393222 18508 19151 2516 7667 131078

- Now, imagine 23456 multiple times in paths of 10s, 100s, and 1000s of prefixes

Router and Routing Code Support for 32-bit ASNs



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

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

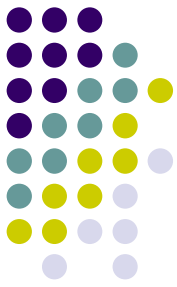
- The Internet will keep running
- Your network will keep running
- If you have a 16-bit ASN today
 - Plan to upgrade Real Soon Now
 - 32-bit ASNs appear as AS 23456
- If you have no ASN today
 - Your network will need 32-bit ASN support
 - Or make sure to ask for a 16-bit ASN



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
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 - Philip Smith
 - ras
- AS4 Peering Router: Switch and Data
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