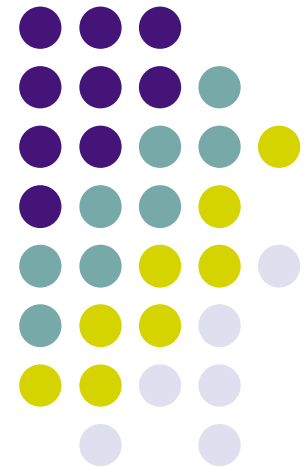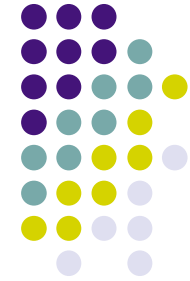# 32-bit ASNs

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APRICOT 2009

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
- RIR 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
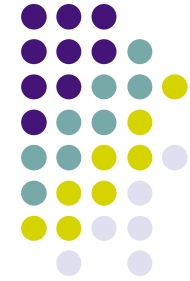
Background

- We are running out of 16-bit ASNs
- The first RIR could run out by June 14, 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 by request

January 1, 2009:
- 32-bit ASN default
- 16-bit ASN by request

January 1, 2010:
- 32-bit ASNs are allocated
- No distinction between 16-bit only and 32-bit only ASNs

You are here!

| RIR[1]	32-bit ASNs Allocated	32-bit ASNs Advertised
AfriNIC	4	1
APNIC	89	6
ARIN	7	2
RIPE NCC	47	7
LACNIC	3	0

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

Interesting RIR Facts

- Received questions about changing the policy, but so far no proposals have been submitted
- Always ask if you are sure you really want a 32-bit ASN
- ARIN allocations 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 total ASNs issued
- ARIN allocations for 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
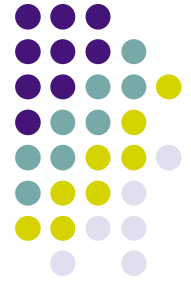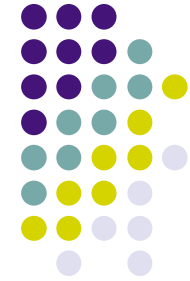
- People have already started using 32-bit ASNs
- However, everything in your network still thinks ASNs are 16-bits long
  - Routers/routing software
  - Routing policies
  - Peering policies
  - Engineering and NOC staff knowledge
  - Network management tools
  - Network monitoring tools
  - Customer management tools
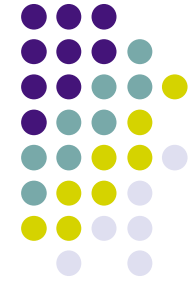 - Sales staff knowledge
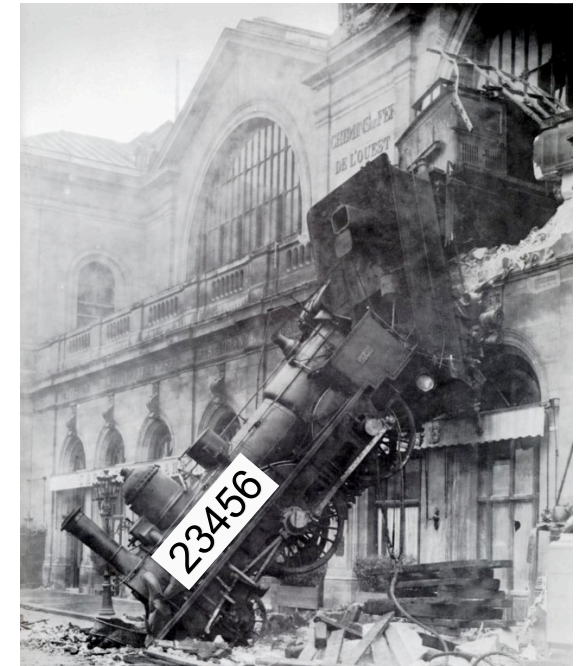
Avoid Train Wrecks!

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 years 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
```

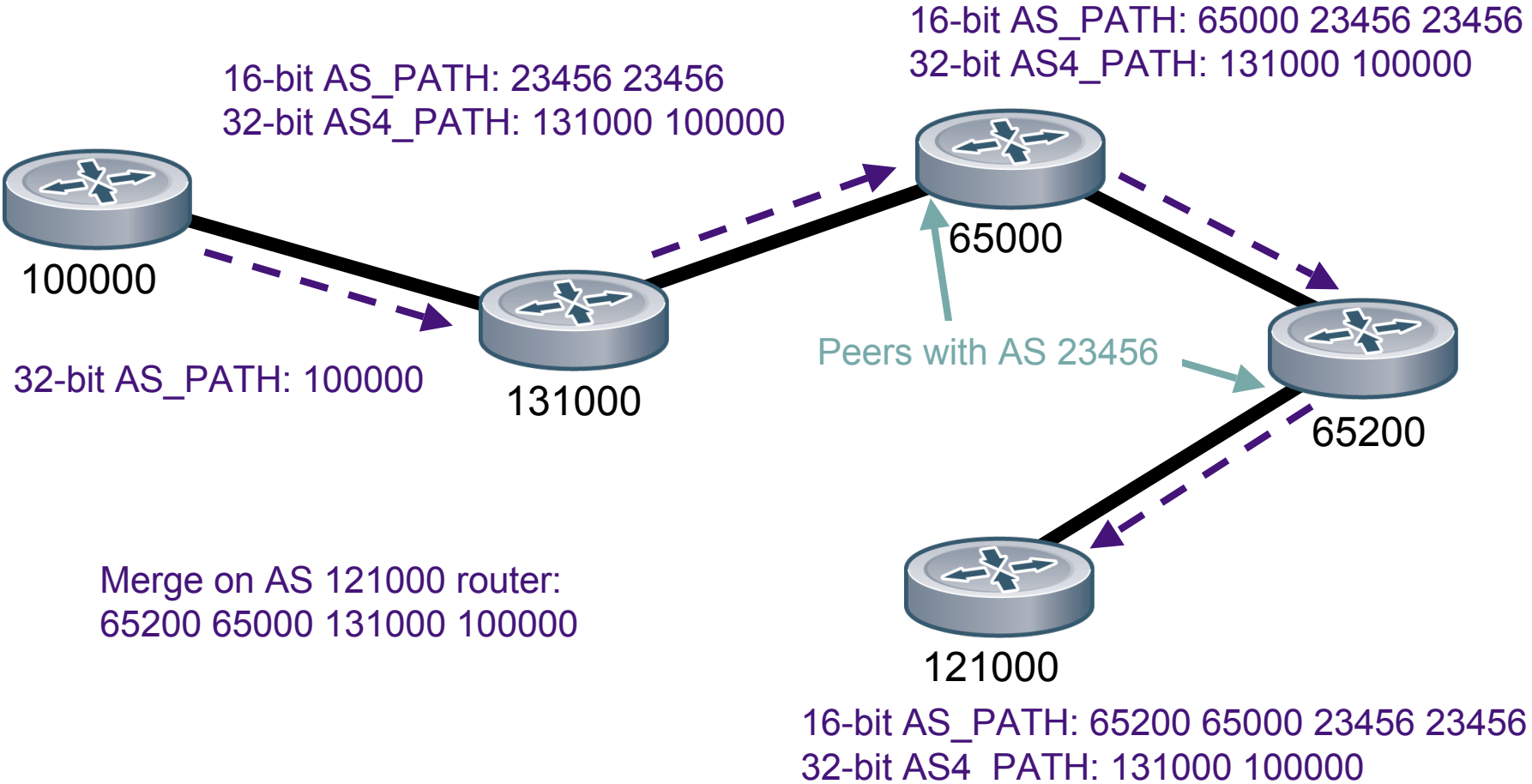**2914 4697 23456**

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

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

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

100000

65000

Peers with AS 23456

32-bit AS_PATH: 100000

131000

65200

Merge on AS 121000 router:
65200 65000 131000 100000

121000

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

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
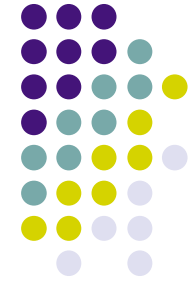
- Everything in your network needs to be upgraded to understand 32-bit ASNs
- Since AS 23456 is used to represent all 32-bit ASNs, it is impossible to know the real ASN
- The implications are
  - You could peer with AS 23456, which represents different ASNs, multiple times
  - You will see prefixes with 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
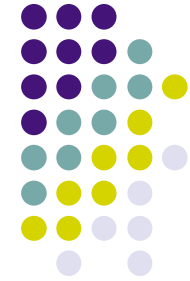 - Flow data will have lots of 23456 ASNs

Will the real ASN please stand up?
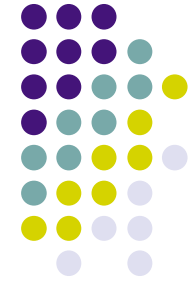
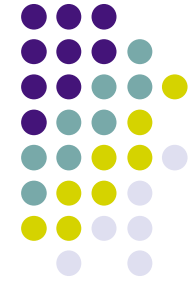| Prefix	AS Path						
64.127.137.0/24	23456						
	393222						
84.205.64.0/24	23456	18508	19151	1103	1125	23456	12654
	393222	18508	19151	1103	1125	196613	12654
169.222.0.0/24	23456	23456					
	393222	131076					
202.255.47.0/24	23456	18508	19151	2516	7667	23456	
	393222	18508	19151	2516	7667	131078	

- 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 XE	>= 2.3	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)

http://as4.cluepon.net/index.php/Software_Support

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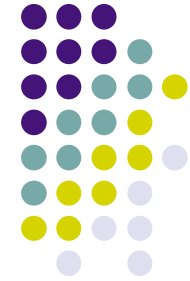
- Management systems and databases
  - peeringdb.com (future plans)
- Traffic and routing analysis tools
  - AS-based tools
  - routeviews.org (future plans)
- Looking glasses and traceroute servers

Known Operational Issues

- **`neighbor remove-private-as`** command only works on private 16-bit ASNs (64512-65535) until routing implementations are updated for RFC 5398 to remove other reserved ASNs

- Should this command even be extended to remove reserved ASNs?

  - No command to remove RFC 1918 and other reserved address space

| 64496-64511	Reserved for use in documentation and sample code
64512-65534	Designated for private use (Allocated to the IANA)
65535	Reserved
65536-65551	Reserved for use in documentation and sample code

Known Operational Issues

- 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
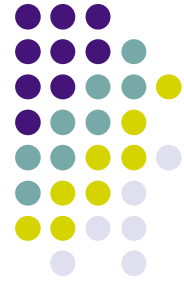
- Something is wrong here

  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 at NANOG45

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