



32-bit ASNs

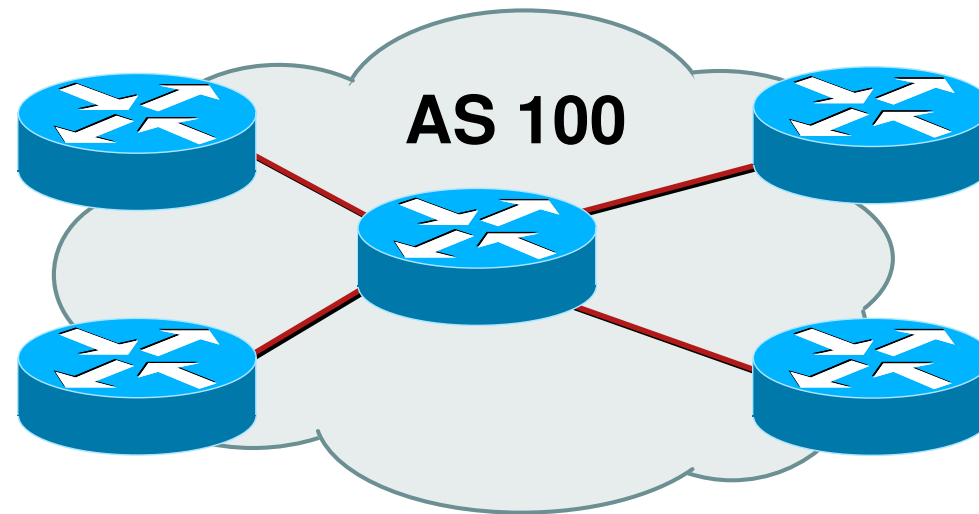


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Autonomous System (AS)



- Collection of networks with same routing policy
- Single routing protocol
- Usually under single ownership, trust and administrative control
- Identified by a unique number

Autonomous System Number

- An ASN is a 16-bit integer
 - 1-64511 are assigned by the Regional Internet Registries
 - 64512-65534 are private ASNs and should never be used on the Internet
 - 0 and 65535 are reserved
- Current allocations up to 49151 have been made to the RIRs

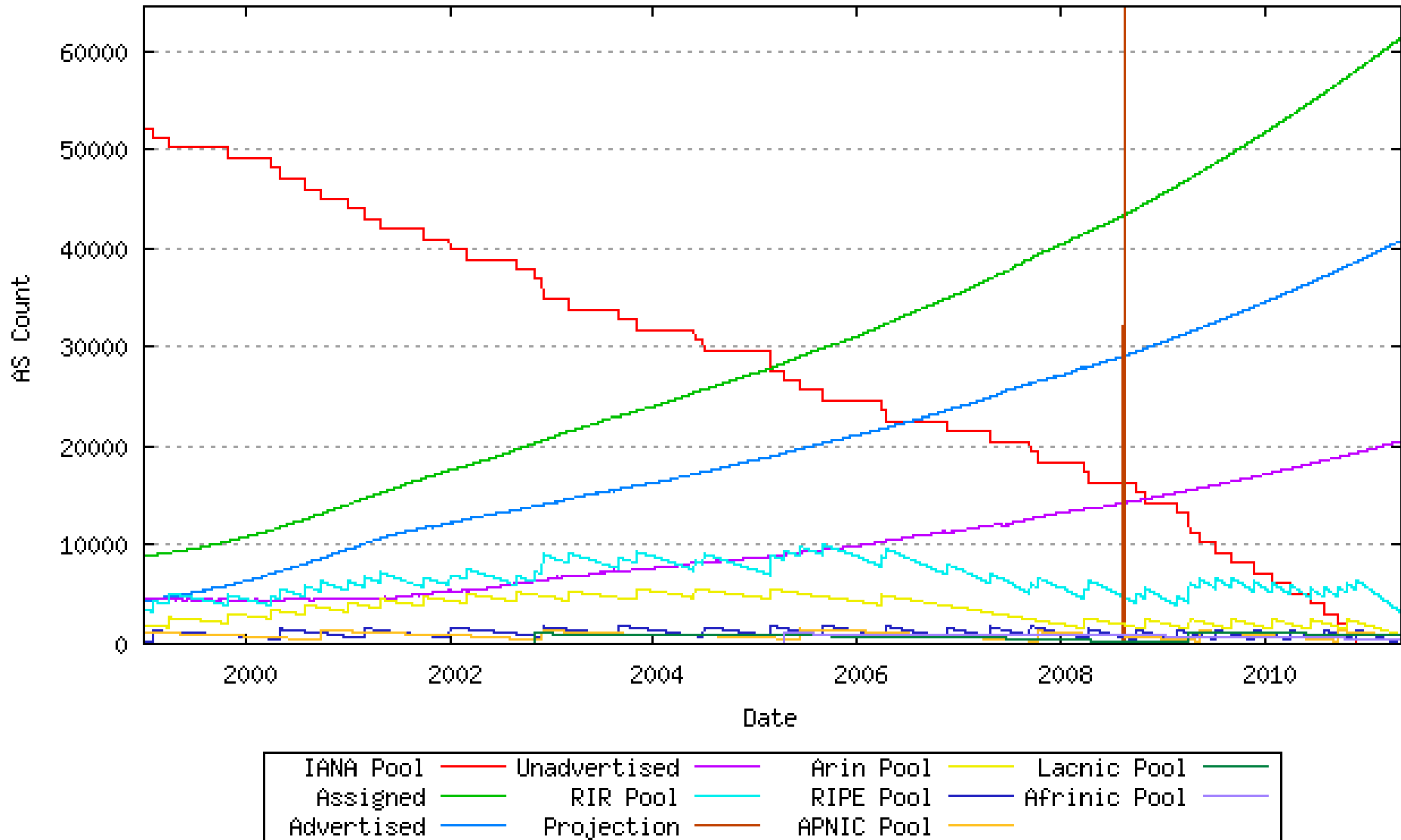
ASN status

- The pool of 16-bit ASNs will soon be exhausted

Analysis at <http://www.potaroo.net/tools/asns/>

Current estimates are that the 16-bit ASN pool will be exhausted in 2011

- Work started in 2001 to extend the ASN pool to 32-bits



Source: <http://www.potaroo.net/tools/asns/fig28.png>

32-bit ASNs

- Standards documents

 - Description of 32-bit ASNs

 - www.rfc-editor.org/rfc/rfc4893.txt

 - New extended community (draft)

 - www.ietf.org/internet-drafts/draft-rekhter-as4octet-ext-community-03.txt

 - Textual representation (draft)

 - www.ietf.org/internet-drafts/draft-ietf-idr-as-representation-01.txt

- AS 23456 is reserved as interface between 16-bit and 32-bit ASN world

Getting a 32-bit ASN

- Sample RIR policy
www.apnic.net/docs/policy/asn-policy.html
- From 1st January 2007
32-bit ASNs available on request
- From 1st January 2009
32-bit ASNs assigned by default
16-bit ASNs only available on request
- From 1st January 2010
No distinction – ASNs assigned from 32-bit pool

Representation

- 32-bit ASNs extend the pool:
0-65535 extended to 0-4294967295
- Representation of 65536-4294967295 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+ !!!

asplain vs asdot(+)

- Problem:
 - $^{[0-9]+}$ 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
 - $^{[0-9]+\.[0-9]+}$
- \Rightarrow BGP policy regular expressions will need to be rewritten

IANA Assignments

- Using dot notation for readability
- 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
- Remainder are reserved or held by IANA

Changes (1)

- 32-bit ASNs are backwardly 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

Changes (2)

- 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
- If you have a proper BGP implementation, 32-bit ASNs will be transported silently across your network

How does it work (1)?

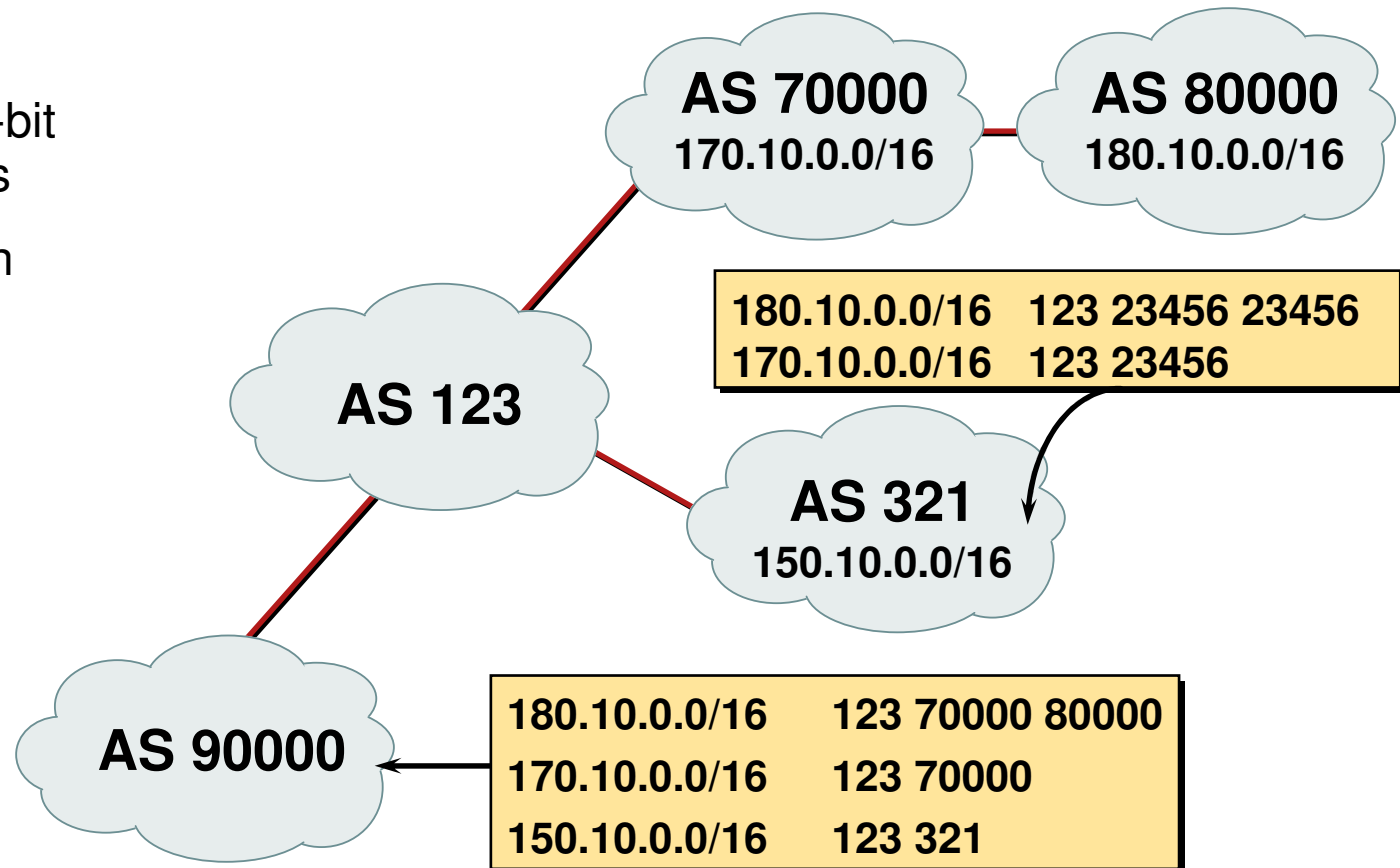
- Local router only supports 16-bit ASN
- Remote router uses 32-bit ASN
- BGP peering initiated:
 - Remote asks local if 32-bit supported (BGP capability negotiation)
 - When local says “no”, remote then presents AS23456
 - Local needs to be configured to peer with remote using AS23456

How does it work (2)?

- 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 has changed?

- Two new BGP attributes:

AS4_PATH

Carries 32-bit ASN path info

AS4_AGGREGATOR

Carries 32-bit ASN aggregator info

Well-behaved BGP implementations will simply pass these along if they don't understand them

- AS23456 (AS_TRANS)

What do they look like?

- IPv4 prefix originated by AS 1.202

In 32-bit ASN world:

```
# bgpctl show rib 203.10.62.0/24
flags: * = Valid, > = Selected, I = via IBGP, A = Announced
origin: i = IGP, e = EGP, ? = Incomplete
```

In 16-bit ASN world:

```
flags destination gateway lpref med aspath origin
*> 203.10.62.0/24 147.28.0.1 100 0 0.3130 0.1239 0.4637 0.1221 1.202 i
```

```
router# sh ip bgp 203.10.62.0
```

```
Network Next Hop Metric LocPrf Weight Path
*> 203.10.62.0 202.249.2.169 0 2497 4637 1221 23456 i
```

What do they look like?

- IPv6 prefix originated by AS 2.9

```
RP/0/0/CPU0:as4byte#sh bgp ipv6 uni 2403:2000::/32
BGP routing table entry for 2403:2000::/32
Versions:
  Process                bRIB/RIB    SendTblVer
  Speaker                 93          93
Paths: (1 available, best #1)
  Not advertised to any peer
  Path #1: Received by speaker 0
  109 6175 2497 2500 18146 2.9
    2001:420:0:8001::1 from 2001:420:0:8001::1 (204.69.200.22)
      Origin IGP, localpref 100, valid, external, best
RP/0/0/CPU0:as4byte#
```

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!)

32-bit ASN not supported:

- 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

Cisco Implementations

- **IOS XR 3.4 - September 2007**

For: GSR and CRS-1

Only supports non-standard "asdot" format - standard format might appear in 3.9 or later

- **NX-OS 4.0 - August 2008**

For: Nexus 7000

Only supports non-standard "asdot" format - standard format will appear in 4.1.3

- **IOS 12.0(32)S12 - end 2008**

- **IOS 12.0(32)SY9 - early 2009**

- **IOS 12.0(33)S3 - early 2009**

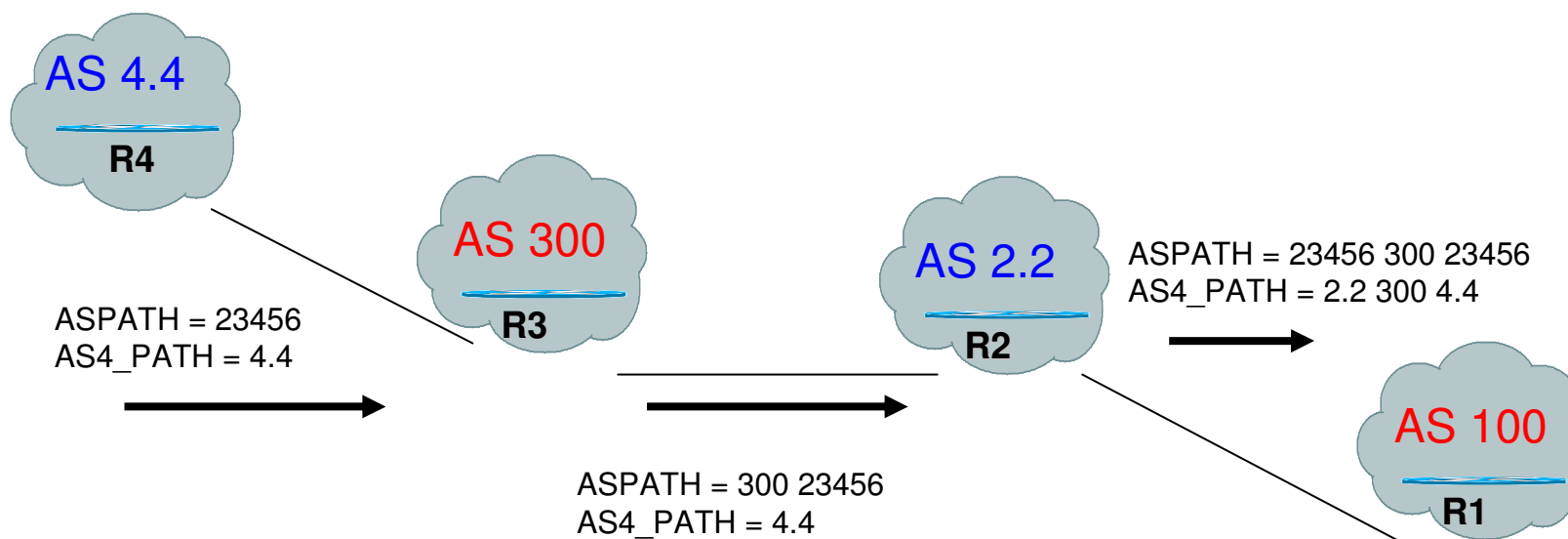
For: 7200, 10700, GSR

Supports standard format with "asdot" as an option

Cisco Implementations

- IOS 12.4T - April 2009
For: ISRs, 2400, 3200, 5350, 5400, 720x, 730x, VG
Supports standard format with "asdot" as an option
- IOS 12.2SRE - late 2009
For: 7200, 7600
- IOS 12.2SB - TBD
For: 10000
- IOS 12.2SXI - late 2009
For: Cat6500
- IOS XE - TBD
For: ASR 1000

Old Peer Example one: Constructing ASPATH and AS4_PATH



Example

For the incoming message contains the following
AS_PATH and AS4_PATH attribute:

AS_PATH = 101 23456 300 400

AS4_PATH = 2.2 300 400

Before processing the update, IOS-BGP first
reconstructs AS_PATH as follows:

AS_PATH = 101 2.2 300 400

For incoming message contains both
AS_SEQUENCE and AS_SET

AS_PATH = 101 23456 300 {23456, 600}

AS4_PATH = 2.2 300 {7.7, 600}

Before processing the update, IOS-BGP first
reconstructs AS_PATH as follows:

AS_PATH = 101 2.2 300 {7.7, 600}

Command

- Dot_notation_as (disable)
- ip as-path access-list 1 permit ^1\.10\$
- set extcommunity

What next?

- Pester your router vendors for 32-bit ASN support

Do you really want to run beta software in your core network?

Depletion of the 16-bit pool is not far away

Stable software, deployment cycles &c

Insist your vendors support “asplain”

Otherwise prepare to rewrite all your regular expressions!!

Conclusion

- The Internet will not break
- Your network will not break
- If you have an ASN today:
 - You don't need to change anything
 - 32-bit ASNs appear as AS 23456
- If you have no ASN today:
 - Your routers will need 32-bit ASN support after 1st January 2009

Q and A

