TRANSITIONING TO 4 BYTES ASN

GPF 4.0

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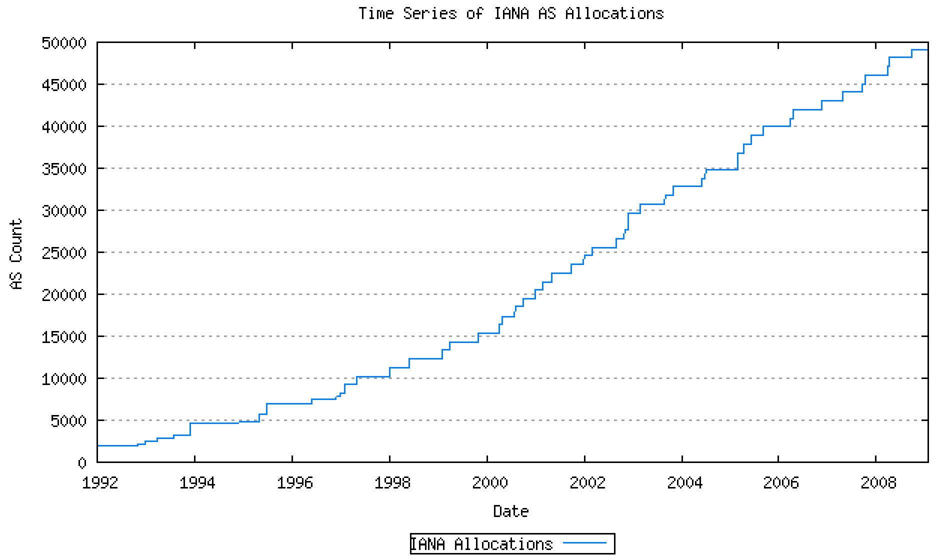
Agenda

- Changes For 4-bytes ASN
- Provider Considerations
- Do Routers Need To Be Upgraded
- Examples
- Best Practices

The need for 4-bytes ASN



source: http://www.potaroo.net/tools/asn16/

- AS numbers running out rapidly
- 2-bytes ASN extended to 4-bytes by IANA in Nov, 2006
  - 4,294,967,296 possible AS values now
- Effective Jan 1, 2009, all RIRs will allocate 4-bytes ASN by default

What are they telling you about changes for 4-bytes ASN

- Allocation and management of 4-bytes ASN by IANA and RIRs
- BGP protocol changes for handling 4-bytes ASN
  - Defined in RFC 4893
    - Backwards compatible
    - Definition of AS 23456 for interacting between NEW and OLD peers
    - NEW speakers: Routers which understand 4-bytes ASN
    - OLD speakers: Routers which are ignorant of 4-bytes ASN

IS THAT ALL?

Really, there are lot more changes!!

- Potential router code upgrade
- Define/modify network-wide routing and peering policies to handle 4-bytes ASN to avoid security issues
- Apply new policies to routers
  - Route Maps, AS-Path Lists, Extended Communities
- Potential upgrade of management and monitoring tools
- Decision on how to consistently store and display the 4-bytes ASN
- Train personnel to manage, operate and troubleshoot network with 4-bytes ASN awareness

Provider considerations

- Security, Security, Security
  - Cannot filter 4-bytes ASNs with OLD routers
  - Can be a potential security loophole
- Flexibility:
  - Have better visibility of Internet routing topology
  - Remove limitations in peering with new 4-bytes ASN peers
- Cost, time, resources:
  - Routers upgrade
  - Upgrades to management systems, packet sniffers, testing equipment, traffic analyzers, etc
  - Personnel training

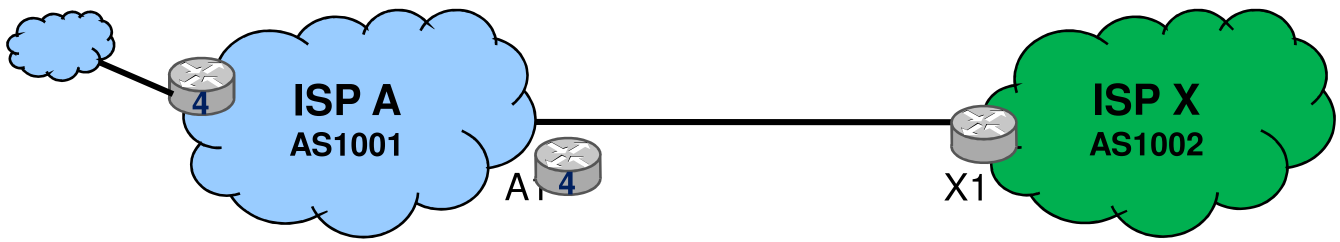
Do providers need to upgrade routers

- NOT NEEDED
  - Backwards compatible as per RFC 4893

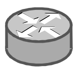
- However, let’s look at some examples!

Peering with a 2-bytes ASN peer (1)

Provider X with OLD routers



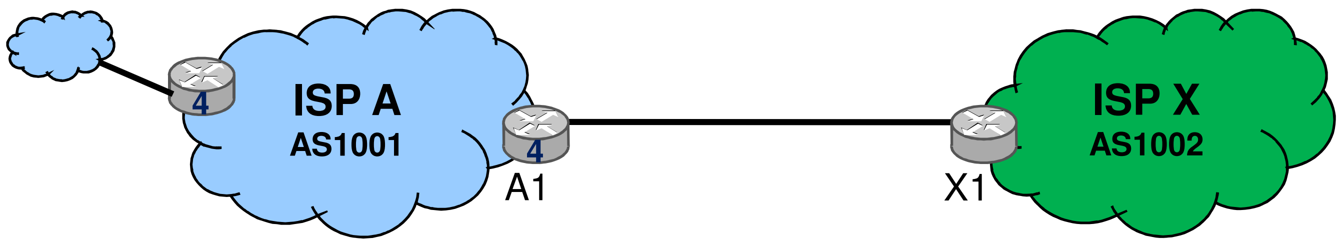
- ISP A routers support 4 bytes ASN
- ISP X routers don’t support 4 bytes ASN
- ISP A has routes with 4 bytes ASN (received from other sources)
- ISP A sends these routes to ISP X

Note:  denotes OLD speaker, 

denotes NEW speaker

Peering with a 2-bytes ASN peer (2)

Provider X with OLD routers



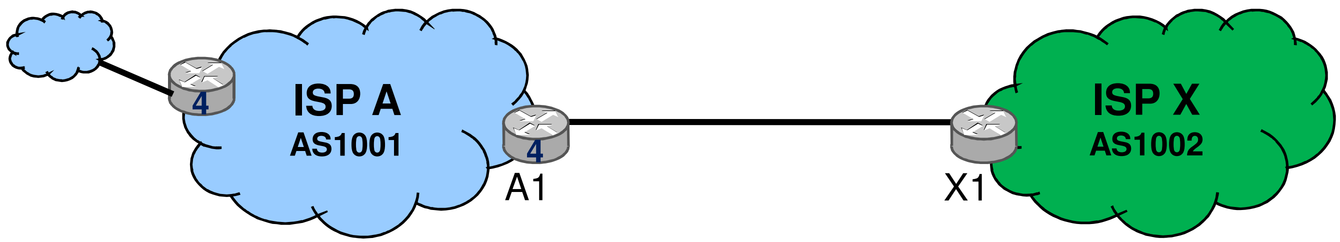
BGP routes on A1 (partial output of sh ip bgp route)

	Prefix	Next Hop	Metric	LocPrf	Weight	Status
1	111.111.111.0/24	0.0.0.0	1	100	32768	BL
	AS_PATH: **82000**					
2	121.121.121.0/24	0.0.0.0	1	100	32768	BL
	AS_PATH: 43					
3	131.131.131.0/24	0.0.0.0	1	100	32768	BL
	AS_PATH: **80000**					
4	141.141.0.0/16	0.0.0.0		100	32768	BAL
	AS_PATH: **{81000 82000}**					

Routes with 4 bytes AS path (highlighted in BOLD) correctly interpreted and displayed

Peering with a 2-bytes ASN peer (3)

Provider X with OLD routers



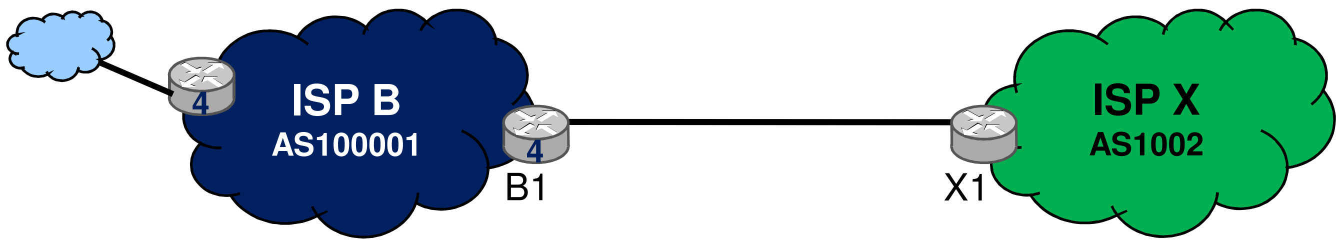
BGP routes on X1 (partial output of sh ip bgp route)

	Prefix	Next Hop	Metric	LocPrf	Weight	Status
1	111.111.111.0/24	100.1.1.1	1	100	0	BE
	AS_PATH: 1001 **23456**					
2	121.121.121.0/24	100.1.1.1	1	100	0	BE
	AS_PATH: 1001 43					
3	131.131.131.0/24	100.1.1.1	1	100	0	BE
	AS_PATH: 1001 **23456**					
4	141.141.0.0/16	100.1.1.1		100	0	BE
	AS_PATH: 1001 **{23456 23456}**					

4 bytes AS path not interpreted and displayed.
Same AS_TRANS (23456) used for different 4 bytes ASN

Peering with a 4 bytes ASN peer

Provider X with OLD routers



- ISP B ASN is 4 bytes
- ISP X routers don't support 4 bytes ASN
- Remote-AS config has to be different on X1 for peering to come up

Partial config on B1

```
router bgp
 local-as 100001
 neighbor 100.1.1.2 remote-as 1002
```

Partial config on X1

```
router bgp
 local-as 1002
 neighbor 100.1.1.1 remote-as 23456
```

X1 peers with remote-AS 23456 instead of the real ASN
Multiple 4-bytes ASN peers will all show up in the same ASN: 23456

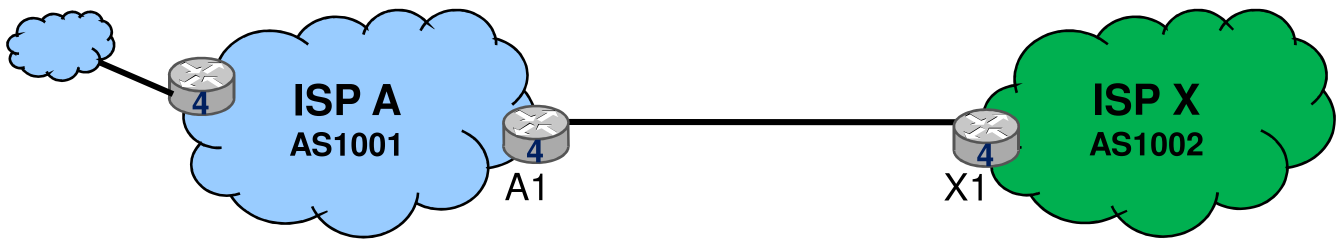
Why Upgrade Routers?

Things to consider

- Cannot apply policies on AS4 paths and communities
- Incomplete AS topology view: Loss of AS info for prefixes and aggregates
- AS_TRANS (23456) may appear multiple times non-consecutively. Possible issues with MED due to AS 23456
- All 4-bytes ASN peers will appear in the same AS 23456
- Larger BGP updates. Includes both AS-path and AS4-path. Will take incremental additional memory on OLD routers
- In some cases, loops will only be detected by NEW speakers. Increases loop detection times

Peering with a 2-bytes ASN peer (4)

Provider X with NEW router



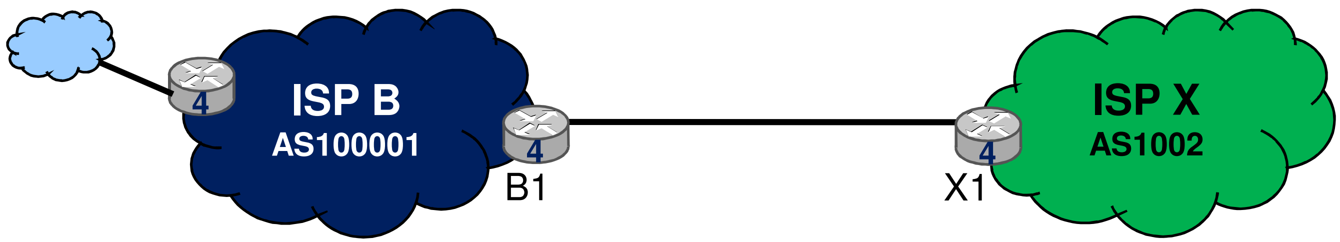
BGP routes on X1 (partial output of sh ip bgp route)

	Prefix	Next Hop	Metric	LocPrf	Weight	Status
1	111.111.111.0/24	100.1.1.1	1	100	0	BE
	AS_PATH: 1001 **82000**					
2	121.121.121.0/24	100.1.1.1	1	100	0	BE
	AS_PATH: 1001 43					
3	131.131.131.0/24	100.1.1.1	1	100	0	BE
	AS_PATH: 1001 **80000**					
4	141.141.0.0/16	100.1.1.1		100	0	BE
	AS_PATH: 1001 **{81000 82000}**					

4 bytes AS path correctly interpreted and displayed

Peering with a 4 bytes ASN peer

Provider X with NEW routers



Partial config on B1

```
router bgp
 local-as 100001
 neighbor 100.1.1.2 remote-as 1002
```

Partial config on X1

```
router bgp
 local-as 1002
 neighbor 100.1.1.1 remote-as 100001
```

Remote-AS config on X1 is consistent with B1 AS

Other changes to consider during router upgrades

- 4-bytes ASN display
- Policies changes
  - AS-Path lists
  - Extended Communities
  - Route Maps
- sflow/netflow
  - Router must send sflow/netflow packets with 4-bytes ASN
- Support of SNMP MIBs for 4-bytes ASN

ASN representation

- Multiple ways defined in RFC 5396
  - asplain format:
    - All AS numbers represented in decimal integer notation i.e. 1 - 4,294,967,296
  - asdot+ format:
    - <high order 16-bit value>.<low order 16-bit value> (all in decimal)
  - asdot format:
    - ASN < 65536 ➔ use asplain, ASN >= 65536 ➔ use asdot+
- For consistency, providers should standardize using one format. RFC 5396 recommends asplain format
- However, for maximum flexibility and interoperability
  - Routers must be able to display 4bytes ASN in any format
  - Routers must accept all formats for configuration including neighbor AS, AS-Path regular expressions, route maps, etc.

Policies Enhancements

AS-Path

- Routers must be able to apply policies on AS4
  - Matching on AS4 and AS2 simultaneously
  - AS-Path list regular expressions must be able to match using any of AS4 representation formats
    - Use a backslash to escape in front of "dot" to match using asdot
    - `#ip as-path access-list testasn permit` **`(_1\.14464_)`**
  - Be able to prepend or set tags using AS4
    - `#set as-path prepend` **`90000`** `5000` **`3.40000`**

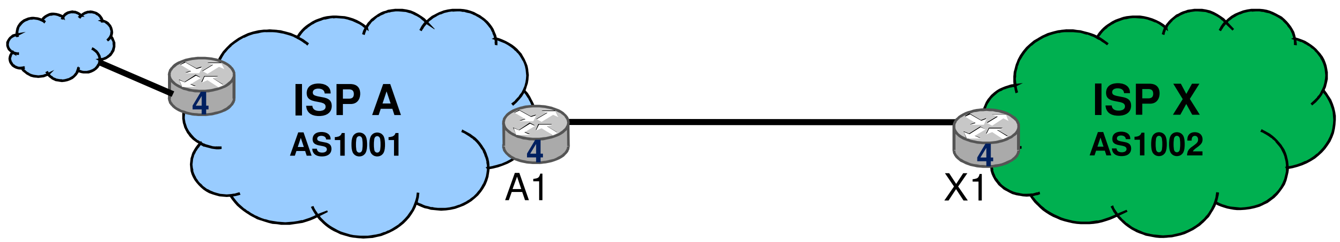
Policies Enhancements

Extended Communities

- Only RT and SOO defined to encode 4-bytes AS in extended communities
  - draft-ietf-l3vpn-as4octet-ext-community-02
  - However, maybe useful to apply these in certain situations if need to encode the AS number
  - Routers should be able to match these extended communities
    - Example on matching on rt
      - `#ip extcommunity-list 210 permit rt` **`121801:600`**
  - Routers should be able to set these extended communities
    - Example on setting rt
      - `#set extcommunity rt` **`7701000:10`**

Peering example using policies (1)

X1 with no policies



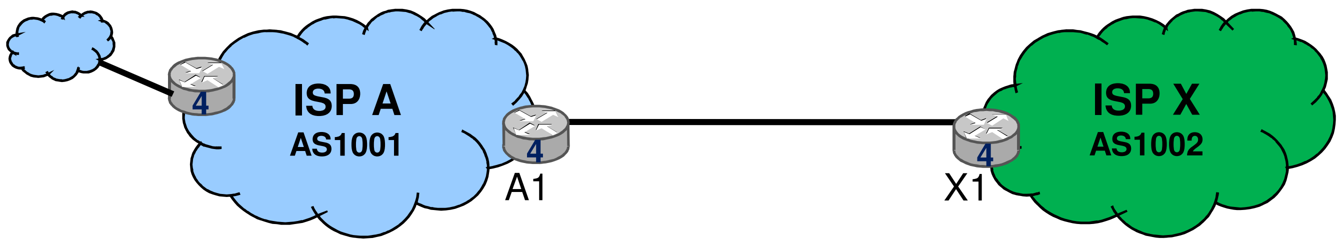
BGP routes on X1 (partial output of sh ip bgp route)

```
        Prefix              Next Hop        Metric     LocPrf     Weight  Status
1       111.111.111.0/24    100.1.1.1       1          100        0       BE
          AS_PATH: 1001 82000
2       121.121.121.0/24    100.1.1.1       1          100        0       BE
          AS_PATH: 1001 43
3       131.131.131.0/24    100.1.1.1       1          100        0       BE
          AS_PATH: 1001 80000
4       141.141.0.0/16      100.1.1.1                  100        0       BE
          AS_PATH: 1001 {81000 82000}
```

Router X1 is 4-bytes ASN aware

Peering example using policies (2)

Apply Policy on X1



Create Route Map

```
route-map testasn4 permit 10
 match as-path  testasn80000
 set weight 10000
 continue 30
route-map testasn4 permit 20
 match as-path  testasn81000
 set weight 20000
route-map testasn4 permit 30
 set local-preference 555
```

Create AS-Path Lists

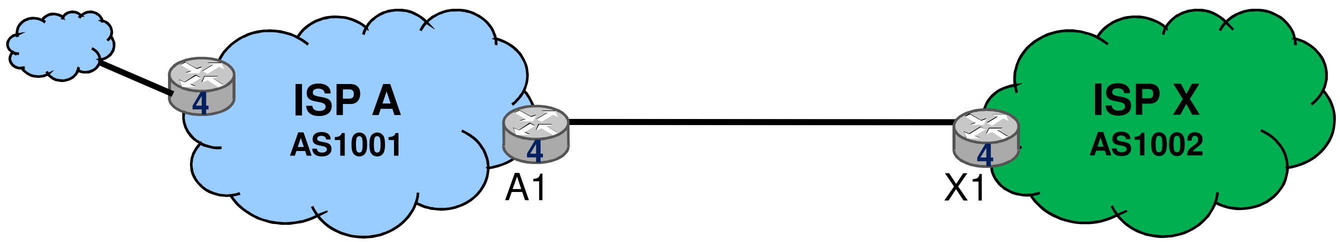
```
ip as-path access-list testasn80000
   seq 5 permit _80000_
ip as-path access-list testasn81000
   seq 5 permit _81000_
ip as-path access-list testasn82000
   seq 5 permit _82000_
```

Apply policy on X1 for neighbor A1

```
neighbor 100.1.1.1 route-map in testasn4
```

Peering example using policies (3)

Results after policy



BGP routes on X1 (partial output of sh ip bgp route)

	Prefix	Next Hop	Metric	LocPrf	Weight	Status
1	111.111.111.0/24	100.1.1.1	1	**555**	0	BE
	AS_PATH: 1001 82000					
2	121.121.121.0/24	100.1.1.1	1	**555**	0	BE
	AS_PATH: 1001 43					
3	131.131.131.0/24	100.1.1.1	1	**555**	**10000**	BE
	AS_PATH: 1001 80000					
4	141.141.0.0/16	100.1.1.1		100	**20000**	BE
	AS_PATH: 1001 {81000 82000}					

Policies successfully manipulated attributes based on 4-bytes ASN in the received path

Benefits of upgrading routers

- Correct application of network policies
  - Avoid security loopholes
- Consistent view of the network
  - AS-paths based on real AS numbers, not AS 23456
- Easier to troubleshoot
- Easier peering with new providers using 4-bytes ASN
  - No need to configure AS_TRANS for peering
  - Peers will appear in their distinct real ASN
- Avoid potential routing issues

Best Practices for transitioning to 4-bytes ASN

- Create a transition plan
- Identify necessary changes to your network-wide routing and peering policies, routers, operations and management tools
- Consider a phased approach of upgrading routers
  - For example, upgrade all the border routers first
    - Can apply policies, reduce security risks
  - Later upgrade iBGP routers to be 4 bytes capable
  - As another option, upgrade to NEW but don't exchange the 4-bytes AS capability. This may help in testing your policies and getting folks familiar with 4-bytes ASN
- Implement changes/upgrades to your operations and management tools

Summary

- 4-bytes ASN are here to stay
- You need to consider the various changes associated with transitioning to 4-bytes ASN
- Your network will not break. However, multiple benefits of upgrading your routers
  - Reduce security risks
  - Better view of the routing topology
  - Consistent operations and troubleshooting
- Work out a migration plan for a smooth transition

BROCADE

Thank You