



BGP Enhancements for IPv6

ISP/IXP Workshops

Adding IPv6 to BGP...

- **RFC2858**

Defines *Multi-protocol Extensions for BGP4*

Enables BGP to carry routing information of protocols other than IPv4

e.g. MPLS, IPv6, Multicast etc

Exchange of multiprotocol NLRI must be negotiated at session startup

- **RFC2545**

Use of BGP Multiprotocol Extensions for IPv6 Inter-Domain Routing

Adding IPv6 to BGP...

- **New optional and non-transitive BGP attributes:**

MP_REACH_NLRI (Attribute code: 14)

Carry the set of reachable destinations together with the next-hop information to be used for forwarding to these destinations (RFC2858)

MP_UNREACH_NLRI (Attribute code: 15)

Carry the set of unreachable destinations

- **Attribute contains one or more Triples:**

AFI Address Family Information

Next-Hop Information (must be of the same address family)

NLRI Network Layer Reachability Information

Adding IPv6 to BGP...

- **Address Family Information (AFI) for IPv6**

AFI = 2 (RFC 1700)

Sub-AFI = 1 Unicast

Sub-AFI = 2 Multicast for RPF check

Sub-AFI = 3 for both Unicast and Multicast

Sub-AFI = 4 Label

Sub-AFI = 128 VPN

BGP Considerations

- **Rules for constructing the NEXTHOP attribute:**
 - When two peers share a common subnet, the NEXTHOP information is formed by a global address and a link local address**
 - Redirects in IPv6 are restricted to the usage of link local addresses**

Routing Information

- **Independent operation**

 - One RIB per protocol

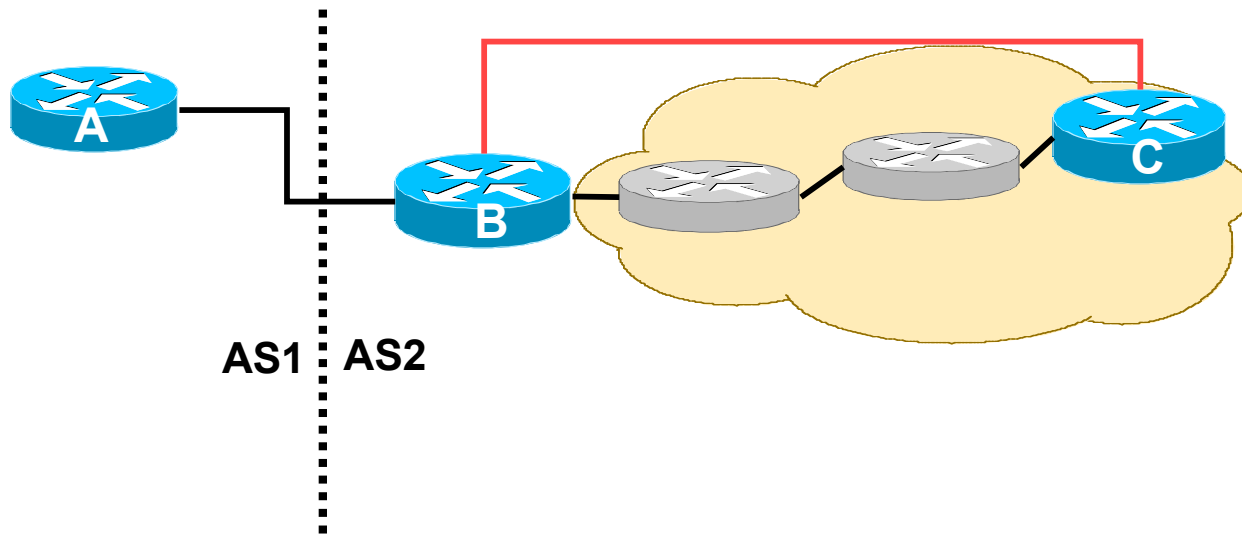
 - e.g. IPv6 has its own BGP table

 - Distinct policies per protocol

- **Peering sessions can be shared when the topology is congruent**

BGP next-hop attribute

- **Next-hop contains a global IPv6 address (or potentially a link local address)**
- **Link local address as a next-hop is only set if the BGP peer shares the subnet with both routers (advertising and advertised)**



More BGP considerations

- **TCP Interaction**

BGP runs on top of TCP

This connection could be set up either over IPv4 or IPv6

- **Router ID**

When no IPv4 is configured, an explicit bgp router-id needs to be configured

BGP identifier is a 32 bit integer currently generated from the router identifier – which is generated from an IPv4 address on the router

This is needed as a BGP identifier, this is used as a tie breaker, and is send within the OPEN message

A Simple MP-BGP Session



```
Router1#  
interface Ethernet0  
  ipv6 address 2001:db8:c18:2:1::f/64  
!  
router bgp 65001  
  bgp router-id 10.10.10.1  
  no bgp default ipv4-unicast  
  neighbor 2001:db8:c18:2:1::1 remote-as 65002  
  address-family ipv6  
    neighbor 2001:db8:c18:2:1::1 activate  
    neighbor 2001:db8:c18:2:1::1 prefix-list bgp65002in in  
    neighbor 2001:db8:c18:2:1::1 prefix-list bgp65002out out  
  exit-address-family
```

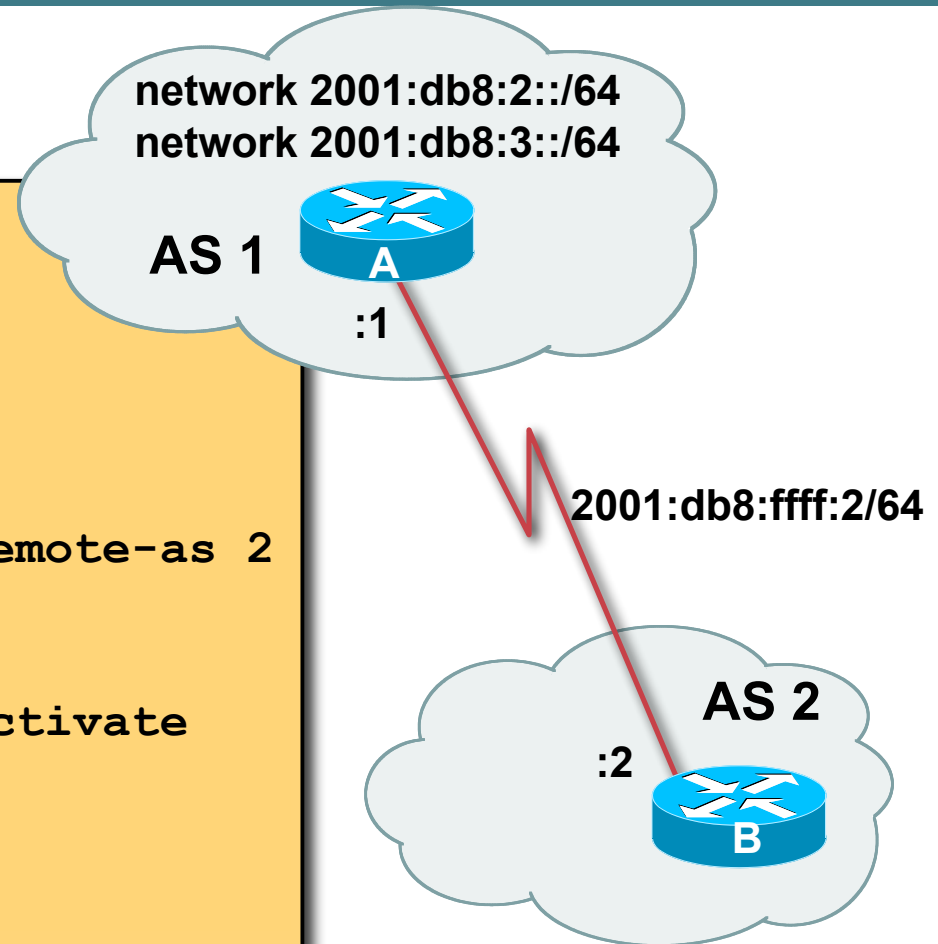
BGP Configuration

- **Two options for configuring iBGP peering**
- **Using link local addressing**
 - ISP uses FE80:: addressing for iBGP neighbours
 - NOT RECOMMENDED**
 - There are plenty of IPv6 addresses
 - Unnecessary configuration complexity
- **Using global unicast addresses**
 - As with IPv4
 - RECOMMENDED**

BGP Configurations Non Link Local Peering

Router A

```
router bgp 1
  no bgp default ipv4 unicast
  bgp router-id 1.1.1.1
  neighbor 2001:db8:ffff:2::2 remote-as 2
  !
  address-family ipv6
  neighbor 2001:db8:ffff:2::2 activate
  network 2001:db8:2::/64
  network 2001:db8:3::/64
  !
```

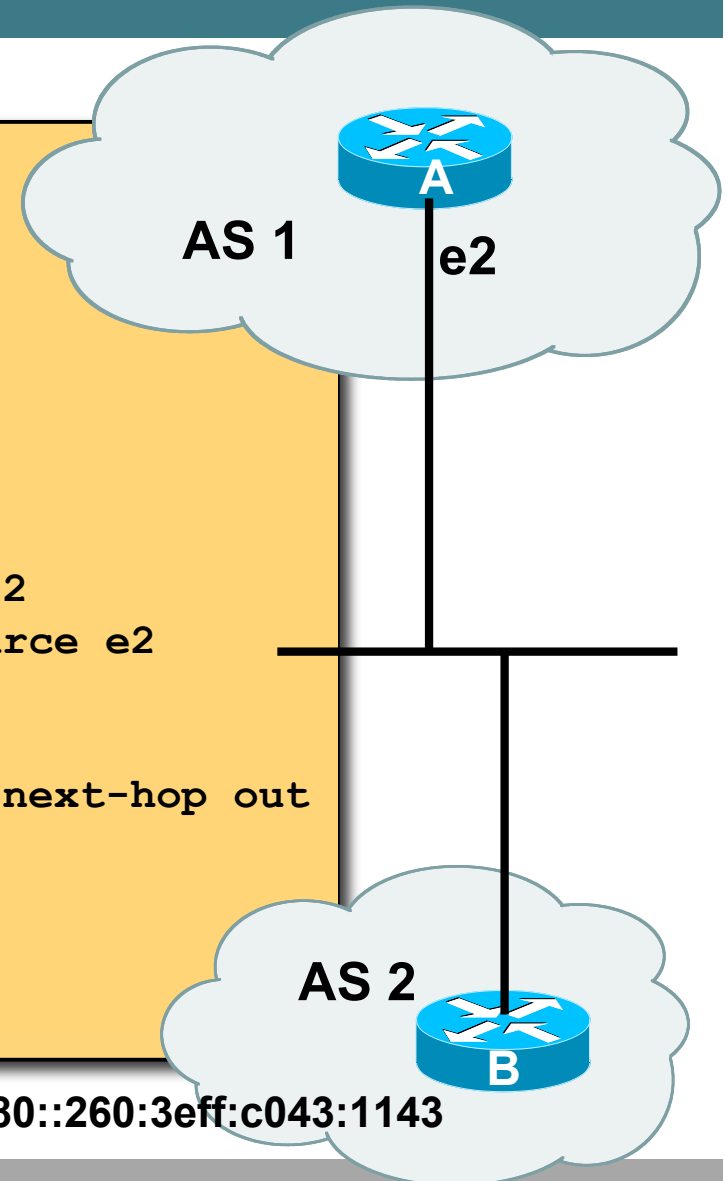


BGP Configurations

Link Local Peering

Router A

```
interface e2
  ipv6 address 2001:db8:ffco:1::1/64
  !
router bgp 1
  no bgp default ipv4 unicast
  bgp router-id 1.1.1.1
  neighbor fe80::260:3eff:c043:1143 remote-as 2
  neighbor fe80::260:3eff:c043:1143 update source e2
address-family ipv6
  neighbor fe80::260:3eff:c043:1143 activate
  neighbor fe80::260:3eff:c043:1143 route-map next-hop out
  !
route-map next-hop permit 5
  set ipv6 next-hop 2001:db8:ffco:1::1
  !
```



fe80::260:3eff:c043:1143

BGP Configuration IPv4 and IPv6

```
router bgp 10
  no bgp default ipv4-unicast
  neighbor 2001:db8:1:1019::1 remote-as 20
  neighbor 172.16.1.2 remote-as 30
  !
  address-family ipv4
  neighbor 172.16.1.2 activate
  neighbor 172.16.1.2 prefix-list ipv4-ebgp in
  neighbor 172.16.1.2 prefix-list v4out out
  network 172.16.0.0
  exit-address-family
  !
  address-family ipv6
  neighbor 2001:db8:1:1019::1 activate
  neighbor 2001:db8:1:1019::1 prefix-list ipv6-ebgp in
  neighbor 2001:db8:1:1019::1 prefix-list v6out out
  network 2001:db8::/32
  exit-address-family
  !
```

BGP Configuration

Filtering Prefixes

- **IOS Prefix-list is used for filtering prefixes in IPv4**

And for IPv6 too!

- **Example:**

```
ipv6 prefix-list in-filter seq 5 permit 2001::/16 le 32
```

```
ipv6 prefix-list in-filter seq 6 permit 2004::/16 le 48
```

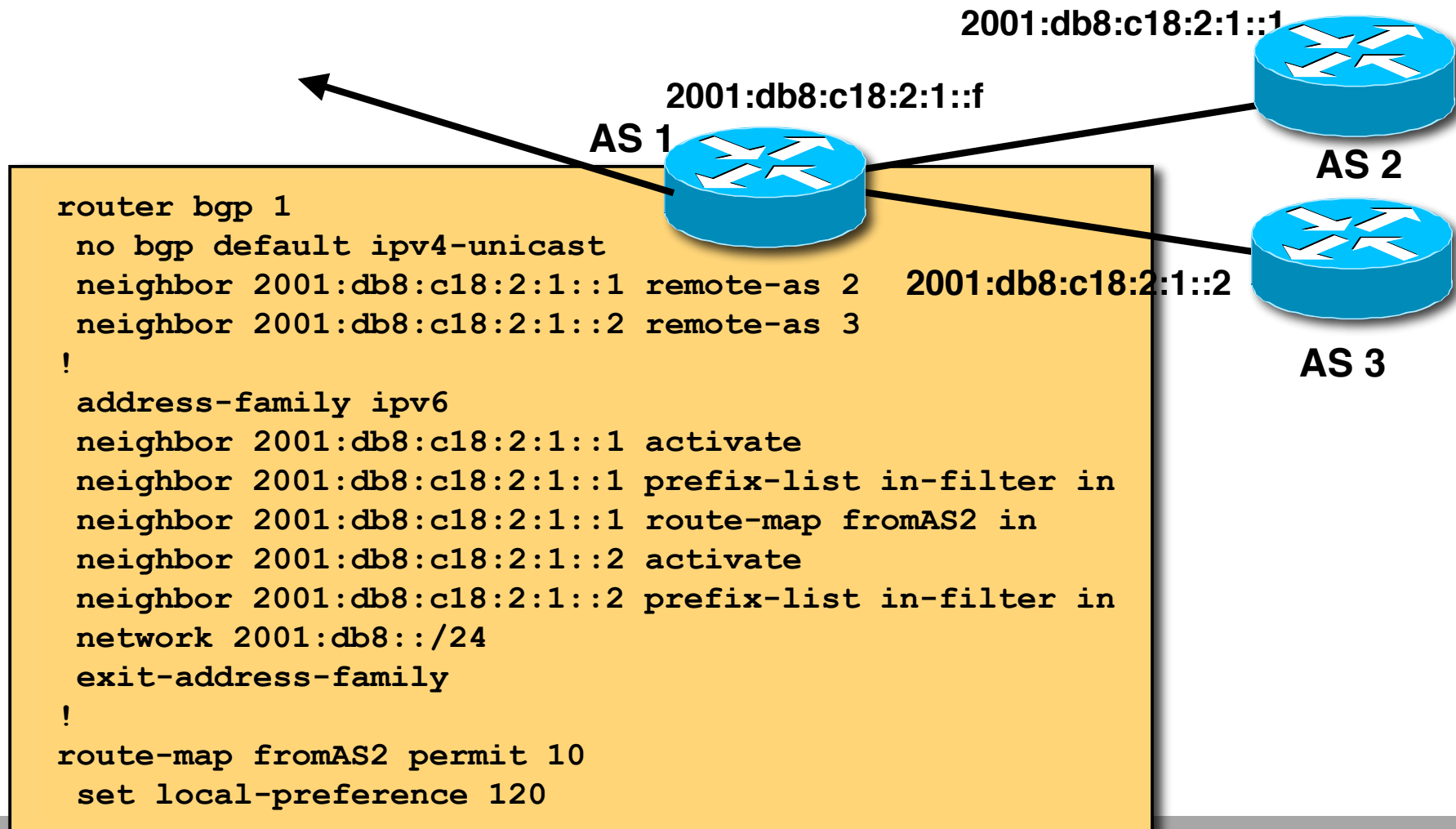
- **Apply to the BGP neighbor:**

```
router bgp 1
  no bgp default ipv4 unicast
  bgp router-id 1.1.1.1
  neighbor 2001:db8:ffff:2::2 remote-as 2
address-family ipv6
  neighbor 2001:db8:ffff:2::2 activate
  neighbor 2001:db8:ffff:2::2 prefix-list in-filter in
```

BGP Configuration

Manipulating Attributes

- Prefer routes from AS 2 (local preference)



BGP Configuration

Carrying IPv4 inside IPv6 peering

- **IPv4 prefixes can be carried inside an IPv6 peering**

Note that we need to “fix” the next-hop

- **Example**

```
router bgp 1
  neighbor 2001:db8:ffff:2::2 remote-as 2
  !
  address-family ipv4
    neighbor 2001:db8:ffff:2::2 activate
    neighbor 2001:db8:ffff:2::2 route-map ipv4 in
  !
  route-map ipv4 permit 10
    set ip next-hop 131.108.1.1
```


BGP Status Commands

- IPv6 BGP show commands take *ipv6* as argument

show bgp ipv6 unicast parameter

```
Router1#show bgp ipv6 unicast 2017::/96
BGP routing table entry for 2017::/96, version 11
Paths: (1 available, best #1)
Local
    2001:db8:c18:2:1::1 from 2001:db8:c18:2:1::1 (10.10.20.2)
    Origin incomplete, localpref 100, valid, internal, best
```

BGP Status Commands

Display summary information regarding the state of the BGP neighbours
show bgp ipv6 unicast summary

```
BGP router identifier 128.107.240.254, local AS number 109
BGP table version is 400386, main routing table version 400386
585 network entries using 78390 bytes of memory
9365 path entries using 674280 bytes of memory
16604 BGP path attribute entries using 930384 bytes of memory
8238 BGP AS-PATH entries using 228072 bytes of memory
42 BGP community entries using 1008 bytes of memory
9451 BGP route-map cache entries using 302432 bytes of memory
584 BGP filter-list cache entries using 7008 bytes of memory
BGP using 2221574 total bytes of memory
Dampening enabled. 3 history paths, 11 dampened paths
2 received paths for inbound soft reconfiguration
BGP activity 63094/62437 prefixes, 1887496/1878059 paths, scan interval 60 secs
```

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
2001:1458:C000::64B:4:1									
	4	513	1294728	460213	400386	0	0	3d11h	498

↑
Neighbour Information

↑
BGP Messages Activity

Conclusion

- **BGP extended to support multiple protocols**
IPv6 is but one more address family
- **Operators experienced with IPv4 BGP should have no trouble adapting**
Configuration concepts and CLI is familiar format



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