

APNIC eLearning: BGP Attributes

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Overview

- BGP Attributes
- Well-known and Optional Attributes
- AS Path
- AS Loop Detection
- iBGP and eBGP Next Hop
- Next Hop Best Practice
- BGP Origin, Local Preference, MED, and Community Attributes
- BGP Route Selection Process

BGP Attributes

- Well-known attributes – must be supported by every BGP implementation
- Mandatory attributes – must be included with every route entry. If one attribute is missing, it will result in an error message
 - Ex: ORIGIN, AS_PATH, NEXT_HOP, LOCAL_PREF
- Discretionary attributes – every BGP router must recognize, but they don't have to be present with every route entry
 - Ex. ATOMIC_AGGREGATE
- Optional attributes – not necessarily supported by all BGP implementations. It can be either transitive or non-transitive.
 - AGGREGATOR, COMMUNITY, MULTI_EXIT_DISC

BGP Attributes

BGP metrics are called path attributes. Here is the classifications BGP attributes:

Well-known mandatory

- AS-Path
- Next-hop
- Origin

Well-known discretionary

- Local preference
- Atomic aggregate

Optional transitive

- Community
- Aggregator

Optional non-transitive

- Multi-exit-discriminator (MED)

Well-Known Attributes

- Must be recognized by all compliant BGP implementations
- Are propagated to other neighbors

Well-Known Mandatory Attributes

- Must be present in all update messages
- ***AS Path***
- ***Next-hop***
- ***Origin***

Well-Known Discretionary Attributes

- May be present in update messages
- ***Local preference***
- ***Atomic aggregate***

Optional Attributes

- Recognized by some implementations (could be private) expected not to be recognized by everyone
- Recognized optional attributes are propagated to other neighbors based on their meaning

Optional Transitive Attributes

- If not recognized, are marked as partial and propagated to

other

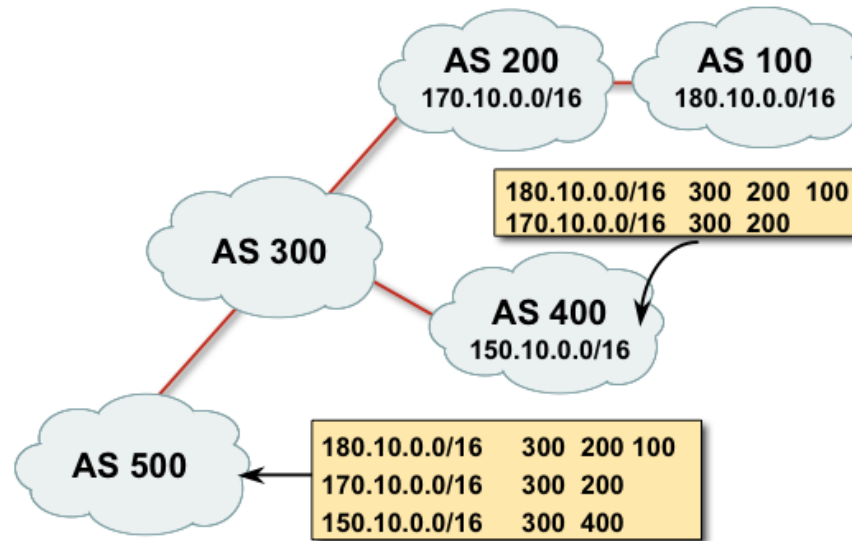
neighbors

- **Community**
- **Aggregator**

Optional Non Transitive attributes

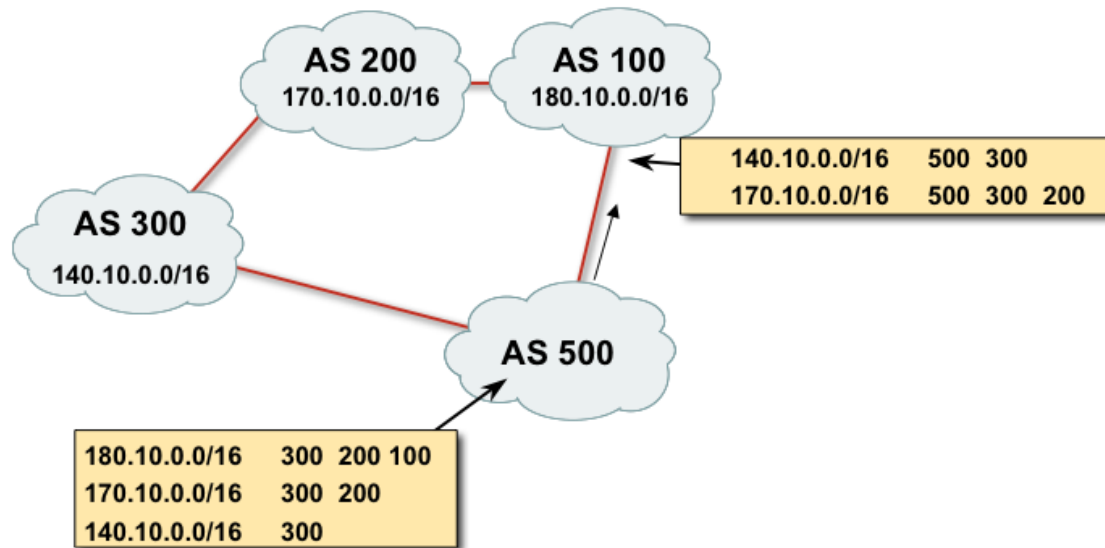
- Discarded if not recognized
- **Multi Exit Discriminator (MED)**

AS Path Attribute



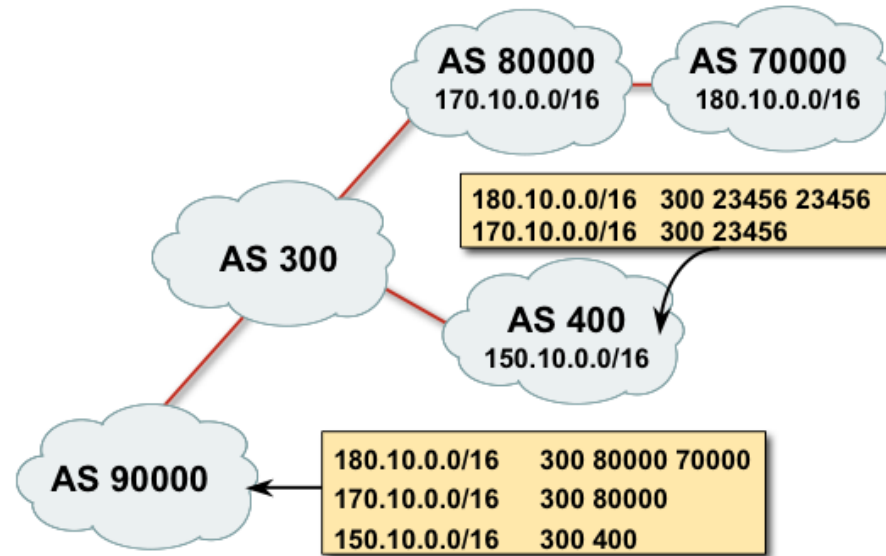
- Sequence of ASes a route has traversed
- Used for
 - Loop detection
 - Path metrics where the length of the AS Path is used as in path selection

AS Path Loop Detection



- 180.10.0.0/16 is not accepted by AS100 as the prefix has AS100 in its AS-PATH
- This is loop detection in action

AS Path Attribute (2 byte and 4 byte)



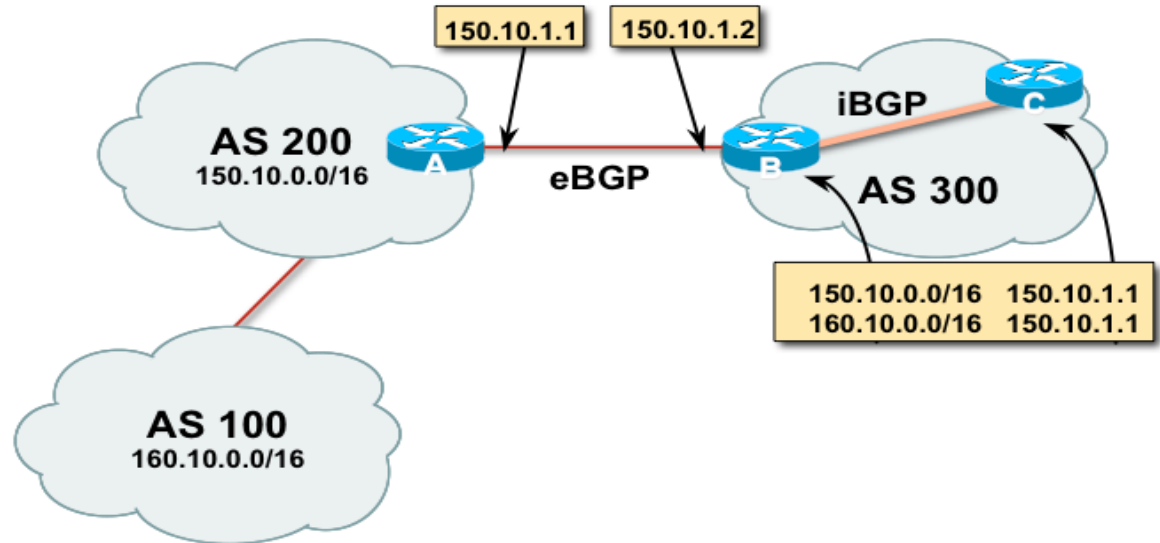
- Internet with 16-bit and 32-bit ASNs
 - 32-bit ASNs are 65536 and above
 - AS-PATH length maintained

AS Path and AS4 Path Example

Router5:

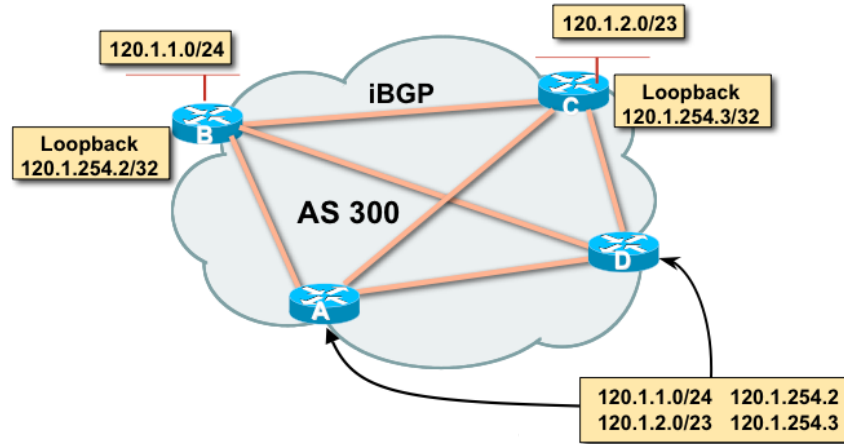
Network	Next Hop	Metric	LocPrf	Weight	Path
*> 2001::/32	2406:6400:F:41::1				
			0	23456	38610 6939 I
* i	2406:6400:D::5	0	100	0	45192 4608 4826 6939 i
*> 2001:200::/32	2406:6400:F:41::1				
			0	23456	38610 6939 2500 i
* i	2406:6400:D::5	0	100	0	45192 4608 4826 6939 2500 i

eBGP Next Hop



- The IP address to reach the next AS
 - Router A advertises 150.10.0.0/16 and 160.10.0.0/16 to router B in eBGP with next hop 150.10.1.1 (Change it to own IP)
 - Router B will update Router C in iBGP keeping the next hop unchanged
- Well known mandatory attribute

iBGP Next Hop



- Next hop is iBGP router loopback address
- Recursive route look-up
- Loopback address need to announce through IGP (OSPF)
- iBGP send update next-hop unchanged

Next Hop Best Practice

- IOS default is for external next-hop to be propagated unchanged to iBGP peers
 - This means that IGP has to carry external next-hops
 - Forgetting means external network is invisible
 - With many eBGP peers, it is unnecessary extra load on IGP
- ISP Best Practice is to change external next-hop to be that of the local router
 - neighbor x.x.x.x next-hop-self

Next Hop Self Configuration

- Next hop default behavior can be changed by using next-hop-self command
- Forces all updates for this neighbor to be advertised with this router as the next hop
- The IP address used for next-hop-self will be the same as the source IP address of the BGP packet

BGP Origin Attribute

- The origin attribute informs all autonomous systems how the prefix introduced into BGP
- Well known mandatory attribute
- Three values: IGP, EGP, incomplete
 - IGP generated by BGP network statement
 - EGP generated by EGP
 - Incomplete redistributed from another routing protocol

BGP Origin Attribute Example

Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,

r RIB-failure, S Stale

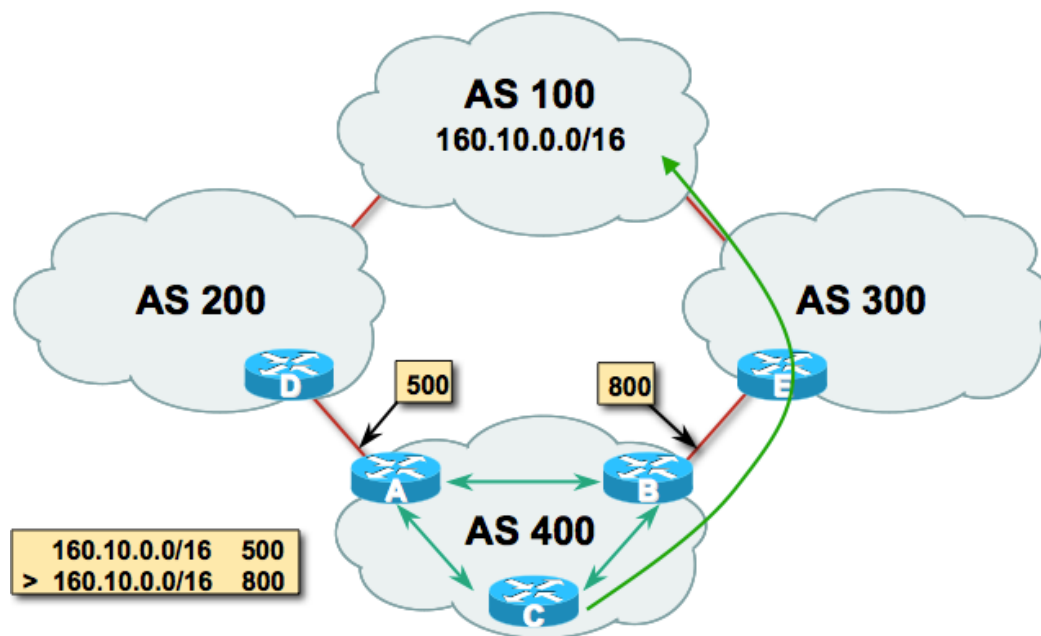
Origin codes: i - IGP, e - EGP, ? – incomplete

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 2001::/32	2406:6400:F:41::1	0	23456	38610	6939 i
* i	2406:6400:D::5	0	100	0	45192 4608 4826 6939 i

BGP Local Preference Attribute

- Local preference is used to advertise to IBGP neighbors only about how to leave their AS (Outbound Traffic).
- Paths with highest preference value are most desirable
- Local preference attribute is well-known and discretionary and is passed only within the AS
- Cisco Default Local Pref is 100

BGP Local Preference Attribute



- For destination 160.10.0.0/16 Router A advertise local pref 500 and Router B advertise local pref 800 in iBGP
- 800 will win best path (Router B)

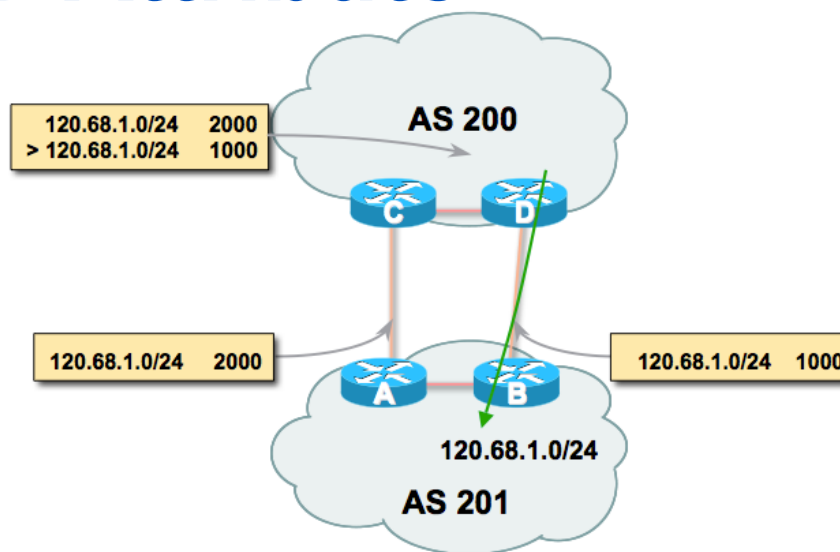
BGP Local Pref Attribute Example

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 2001::/32	2406:6400:F:41::1				
		0	23456	38610	6939 i
* i	2406:6400:D::5	0	100	0	45192 4608 4826
		6939	i		
*> 2001:200::/32	2406:6400:F:41::1				
		0	23456	38610	6939 2500 i
* i	2406:6400:D::5	0	100	0	45192 4608 4826
		6939	2500	i	

BGP MED Attribute

- MED is used to advertise to EBGP neighbors about how to exit their AS to reach networks owned by this AS (Incoming traffic).
- MED is sent to EBGP neighbors only.
- The paths with the lowest MED value are the most desirable
- The MED attribute is optional and non transitive

BGP MED Attribute



- For prefix 120.68.1.0/24 Router B send MED 1000 and router A send MED 2000 to eBGP neighbor
- Incoming traffic from AS200 will choose Router B since lowest MED will win

BGP MED Example

Network	Next Hop	Metric	LocPrf	Weight	Path
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```
*> 2001::/32 2406:6400:F:41::1
```

```
0 23456 38610 6939 i
```

```
* i 2406:6400:D::5 0 100 0 45192 4608 4826 6939 i
```

```
*> 2001:200::/32 2406:6400:F:41::1
```

```
0 23456 38610 6939 2500 i
```

```
* i 2406:6400:D::5 0 100 0 45192 4608 4826 6939 2500 i
```

BGP Community Attribute

- Community is a tagging technique to mark a set of routes
- Upstream service provider routers can then use these flags to apply specific routing policies (i.e local preference etc) within their network
- Represented as two 16 bit integers (RFC1998)
- Common format is <local-ASN>:xx
- I.e 0:0 to 0:65535 and 65535:0 to 65535:65535 are reserved
- Very useful in applying policies within and between ASes
- Optional & transitive attribute

BGP Route Selection Process

- Step 1: Prefer highest weight (local to router)
- Step 2: Prefer highest local preference (global within AS)
- Step 3: Prefer route originated by the local router
- Step 4: Prefer shortest AS path
- Step 5: Prefer lowest origin code (IGP < EGP < incomplete)
- Step 6: Prefer lowest MED (from other AS)
- Step 7: Prefer EBGP path over IBGP path
- Step 8: Prefer the path through the closest IGP neighbor
- Step 9: Prefer oldest route for EBGP paths
- Step 10: Prefer the path with the lowest neighbor BGP router ID

Questions

- Please remember to fill out the feedback form
 - `<survey-link>`
- Slide handouts will be available after completing the survey



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2001:dc0:a000:4:595f:4f90:654f:402c

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Thank you!

End of Session