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:

<table>
<thead>
<tr>
<th>Well-known mandatory</th>
<th>Optional transitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>- AS-Path</td>
<td>- Community</td>
</tr>
<tr>
<td>- Next-hop</td>
<td>- Aggregator</td>
</tr>
<tr>
<td>- Origin</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Well-known discretionary</th>
<th>Optional non-transitive</th>
</tr>
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<tr>
<td>- Local preference</td>
<td>- Multi-exit-discriminator (MED)</td>
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<td>- Atomic aggregate</td>
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</table>
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:**

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 2001::/32</td>
<td>2406:6400:F:41::1</td>
<td>0</td>
<td>23456</td>
<td>38610</td>
<td>6939 I</td>
</tr>
<tr>
<td>* i</td>
<td>2406:6400:D::5</td>
<td>0</td>
<td>100</td>
<td>45192</td>
<td>4608 4826 6939 i</td>
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<td>6939 2500 i</td>
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eBGP Next Hop

- The IP address to reach the next AS
  - Router A advertise 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

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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.
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

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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

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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 polices (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
APNIC Helpdesk Chat

Services

Registration services
Informing the community
Routing Registry
Resource certification
Training & education
Policy development
Helpdesk
Using VoIP

Apply for resources
Become a Member
Make a payment
Manage Internet resources
Helpdesk

Helpdesk

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Phone
+61 7 3658 3188

VoIP
helpdesk@voip.apnic.net

Fax
+ 61 7 3658 3199

Multi-language phone support
Basa Indonesia, Bengali, Cantonese, English, Filipino (Tagalog), Hindi, and Mandarin.

Frequently asked questions
Thank you!

End of Session