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Links visited during the webinar

- Definition of terms (all from RFC4271):
  - Next Hop is defined in Section 5.1.3
  - AS Path is defined in Section 5.1.2
  - Local Preference: Section 5.1.5
  - Origin: Section 5.1.1
  - Multi Exit Discriminator (MED): Section 5.1.4
- Best Path Selection process: Section 9.1
- BGP Route Selection Algorithm by vendor:
  - Cisco
  - Juniper
  - Mikrotik
  - Nokia
  - BIRD
  - Quagga
**BGP Routing Algorithm**

*Bolded items* were covered in this webinar.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>NextHop reachable? Continue if &quot;yes&quot;</td>
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**Local Preference** is...
- a 32bit integer value (0-4294967295)
- Propagated via iBGP inside an Autonomous System
- Usually set using rules when receiving prefixes
  - According to your routing policy
- Typical values
  - 10000 (high value) for customer prefixes
  - 1000 (medium value) for prefixes received via peering
  - 100 (low value) for prefixes received via upstream
- Rules to adjust local preference can be as complex as your router software allows it to be.

**AS Path** is...
- an ordered list of AS numbers...
- ...with the originator AS at the rightmost side
- automatically built when prefixes are sent via eBGP
- length of the path is used for selection (shorter wins)
**DE-CIX Academy: Best Path Selection**

**Links and Explanations**

**Origin Type** is...
- a historic, but mandatory attribute
- set by originator AS and forwarded unchanged
- can have the values (in order of preference):
  - IGP - prefix was originated via a network statement
  - EGP - prefix was learned from Exterior Gateway Protocol (RFC904, historic)
  - incomplete - prefix was learned by another protocol

**Multi Exit Discriminator (MED)** is...
- a 32Bit value, lower wins
- optional, if it is not there it's either treated as zero (best) or as $2^{32}-1$ (worst)
- non-transitive (set by an eBGP speaker and only sent to the next-hop AS)
- usually set using rules when sending prefixes (according to the sender's routing policy)
- only compared between eBGP speakers if next-hop AS is the same

**Router ID** is...
- also called **BGP Identifier**
- a 4 byte, unsigned integer (mostly it's the IPv4 loopback address of a router)
- unique within one AS
- set at startup and stays unchanged
- the same for all BGP sessions

**Neighbor IP** is...
- the last tie-breaker in the BGP Best Path Selection
- the IP address of the eBGP speaker a prefix was learned from
**Router Configs (Cisco IOS)**

**Example Network**

![Network Diagram]

**Experiment 1: Set outgoing MED on R4 and R5**

On R4:

```plaintext
conf t
route-map customer-out permit 100
  set metric 0
end
clear ip bgp 64500 soft out
```

On R5:

```plaintext
conf t
route-map customer-out permit 100
  set metric 1000
end
clear ip bgp 64500 soft out
```

**Experiment 2: Age of route**

- Set metric on R4 and R5 to the same value
- on R3 shut down interface Gig0/0 or Gig3/0 and see how best prefix changes
hostname R1
!
interface Loopback0
  ip address 192.168.1.1 255.255.255.255
!
interface GigabitEthernet0/0
  ip address 192.168.2.2 255.255.255.252
  description to R2
!
interface GigabitEthernet2/0
  ip address 192.168.2.9 255.255.255.252
  description to R3
!
router ospf 64500
  redistribute connected subnets route-map internal-only
  network 192.168.2.0 0.0.0.3 area 0
  network 192.168.2.8 0.0.0.3 area 0
!
router bgp 64500
  bgp log-neighbor-changes
  neighbor internal peer-group
  neighbor internal remote-as 64500
  neighbor internal update-source Loopback0
  neighbor internal next-hop-self
  neighbor internal send-community both
  neighbor 192.168.1.2 peer-group internal
  neighbor 192.168.1.3 peer-group internal
!
ip prefix-list internal seq 5 permit 192.168.0.0/16 le 32
  route-map internal-only permit 10
  match ip address prefix-list internal
!
end
hostname R2
!
interface Loopback0
  ip address 192.168.1.2 255.255.255.255
!
interface GigabitEthernet0/0
  ip address 192.168.2.1 255.255.255.252
  description to R1
!
interface GigabitEthernet1/0
  ip address 192.168.2.5 255.255.255.252
  description to R3
!
router ospf 64500
  redistribute connected subnets route-map internal-only
  network 192.168.2.0 0.0.0.3 area 0
  network 192.168.2.4 0.0.0.3 area 0
!
router bgp 64500
  bgp log-neighbor-changes
  neighbor internal peer-group
  neighbor internal remote-as 64500
  neighbor internal update-source Loopback0
  neighbor internal next-hop-self
  neighbor internal send-community both
  neighbor 192.168.1.1 peer-group internal
  neighbor 192.168.1.3 peer-group internal
!
ip prefix-list internal seq 5 permit 192.168.0.0/16 le 32
route-map internal-only permit 10
  match ip address prefix-list internal
!
end
hostname R3
!
interface Loopback0
 ip address 192.168.1.3 255.255.255.255
!
interface GigabitEthernet0/0
 description to AS64496 R5
 ip address 172.16.1.2 255.255.255.252
!
interface GigabitEthernet1/0
 description to R2
 ip address 192.168.2.6 255.255.255.252
!
interface GigabitEthernet2/0
 description to R1
 ip address 192.168.2.10 255.255.255.252
!
interface GigabitEthernet3/0
 description to AS64496 R4
 ip address 172.16.1.10 255.255.255.252
!
router ospf 64500
 redistribute connected subnets route-map internal-only
 network 192.168.2.4 0.0.0.3 area 0
 network 192.168.2.8 0.0.0.3 area 0
!
router bgp 64500
 bgp log-neighbor-changes
 neighbor internal peer-group
 neighbor internal remote-as 64500
 neighbor internal update-source Loopback0
 neighbor internal next-hop-self
 neighbor internal send-community both
 neighbor upstream peer-group
 neighbor upstream send-community both
 neighbor upstream soft-reconfiguration inbound
 neighbor upstream route-map upstream-in in
 neighbor upstream route-map upstream-out out
 neighbor 172.16.1.1 remote-as 64496
 neighbor 172.16.1.1 peer-group upstream
 neighbor 172.16.1.9 remote-as 64496
 neighbor 172.16.1.9 peer-group upstream
 neighbor 192.168.1.1 peer-group internal
 neighbor 192.168.1.2 peer-group internal
!
ip prefix-list internal permit 192.168.0.0/16 le 32
!
route-map upstream-out permit 100
!
route-map upstream-in permit 100
 set local-preference 100
!
route-map internal-only permit 10
 match ip address prefix-list internal
!
end
hostname R4
!
interface Loopback0
  ip address 172.16.2.4 255.255.255.255
!
interface GigabitEthernet1/0
  description to AS64500 R3
  ip address 172.16.1.9 255.255.255.252
!
interface GigabitEthernet2/0
  description to R5
  ip address 172.16.1.13 255.255.255.252
!
routing ospf 64496
  redistribute connected subnets
  network 172.16.1.12 0.0.0.3 area 0
!
routing bgp 64496
  network 172.16.0.0
  neighbor internal peer-group
  neighbor internal remote-as 64496
  neighbor internal update-source Loopback0
  neighbor internal next-hop-self
  neighbor internal send-community both
  neighbor customer peer-group
  neighbor customer send-community both
  neighbor customer soft-reconfiguration inbound
  neighbor customer route-map customer-in in
  neighbor customer route-map customer-out out
  neighbor 172.16.1.10 remote-as 64500
  neighbor 172.16.1.10 peer-group customer
  neighbor 172.16.2.5 peer-group internal
!
ip route 172.16.0.0 255.255.0.0 Null0
!
routing-map customer-in permit 100
  set local-preference 10000
!
routing-map customer-out permit 100
!
end
hostname R5

interface Loopback0
  ip address 172.16.2.5 255.255.255.255

interface GigabitEthernet0/0
description to AS64500 R3
  ip address 172.16.1.1 255.255.255.252

interface GigabitEthernet2/0
description to R5
  ip address 172.16.1.14 255.255.255.252

router ospf 64496
  redistribute connected subnets
  network 172.16.1.12 0.0.0.3 area 0

router bgp 64496
  network 172.16.0.0
  neighbor internal peer-group
  neighbor internal remote-as 64496
  neighbor internal update-source Loopback0
  neighbor internal next-hop-self
  neighbor internal send-community both
  neighbor customer peer-group
  neighbor customer send-community both
  neighbor customer soft-reconfiguration inbound
  neighbor customer route-map customer-in in
  neighbor customer route-map customer-out out
  neighbor 172.16.1.2 remote-as 64500
  neighbor 172.16.1.2 peer-group customer
  neighbor 172.16.2.4 peer-group internal

  ip route 172.16.0.0 255.255.0.0 Null0
  route-map customer-in permit 100
    set local-preference 10000
  !
  route-map customer-out permit 100
  !
end