

# BGP in Large Scale Networks

Scalable

Stable

Simple

## Avoid the Problem in the First Place

- Use **simple** configurations  
maintain a consistent policy  
throughout the AS
- Promote **stable** networks  
nail-down your routes  
use loopback interfaces
- Grow into your network  
use peer-groups and RRs for **scalability**

# Agenda

- **Basic Tools**
- **Peer Establishment**
- **UPDATE Exchange**
- **Selection Algorithm**
- **Route Reflectors**



## Tool Time

## Basic Tools

# BGP Troubleshooting Tools

- ***show* commands**
- ***debug* output**
- **Log messages**

## *show* Commands

```
router#show ip bgp ?
A.B.C.D          IP prefix <network>/<length>, e.g., 35.0.0.0/8
A.B.C.D          Network in the BGP routing table to display
cidr-only        Display only routes with non-natural netmasks
community        Display routes matching the communities
community-list   Display routes matching the community-list
dampened-paths   Display paths suppressed due to dampening
filter-list      Display routes conforming to the filter-list
flap-statistics  Display flap statistics of routes
inconsistent-as  Display only routes with inconsistent origin ASs
neighbors        Detailed information on TCP and BGP neighbor connections
paths            Path information
peer-group        Display information on peer-groups
quote-regexp     Display routes matching the AS path "regular expression"
regexp           Display routes matching the AS path regular expression
summary          Summary of BGP neighbor status
|               Output modifiers
<cr>
```

# show Commands (Cont.)

```
router#show ip bgp neighbors x.x.x.x ?
advertised-routes  Display the routes advertised to a BGP neighbor
dampened-routes   Display the dampened routes received from neighbor
flap-statistics    Display flap statistics of the routes learned from
                  neighbor
paths              Display AS paths learned from neighbor
received           Display information received from a BGP neighbor
received-routes    Display the received routes from neighbor
routes            Display routes learned from neighbor
|
Output modifiers
<cr>
```

# The BGP Table

```
router#show ip bgp

BGP table version is 9, localrouter ID is 7.72.6.1
Status codes: s suppressed, d dampened, h history, * valid, > best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network        NextHop        Metric LocPrfW eightPath
*> 3.0.0.0        0.0.0.0         0    32768 i
*> 5.0.0.0        0.0.0.0         0    32768 i
*> 6.0.0.0        6.72.6.2       4294967294    0 2 i
* i              6.72.6.2       4294967294 100 0 2 i
*> 7.0.0.0        0.0.0.0         0    32768 i
*> 8.0.0.0/5      0.0.0.0         0    32768 i
*> 17.0.0.0       6.72.6.2       4294967294    0 2 i
* i              6.72.6.2       4294967294 100 0 2 i
*> 23.0.0.0       6.72.6.2       4294967294    0 2 i
* i              6.72.6.2       4294967294 100 0 2 i
*> 35.0.0.0       6.72.6.2       4294967294    0 2 i
* i              6.72.6.2       4294967294 100 0 2 i
```

# The BGP Table (Cont.)

```
router#show ip bgp 6.0.0.0
BGP routing table entry for 6.0.0.0/8, version 2
Paths: (2 available, best #1)
  Advertised to non-peer-group peers:
    7.25.14.4 7.72.6.3 7.75.7.1
  2
    6.72.6.2 from 6.72.6.2 (7.72.6.2)
      Origin IGP, metric 4294967294, localpref 100, valid, external, best
  2
    6.72.6.2 from 7.75.7.1 (7.75.7.1)
      Origin IGP, metric 4294967294, localpref 100, valid, internal
```

# show ip bgp Summary

```
router#show ip bgp summary
BGP router identifier 7.72.6.1, local AS number 1
BGP table version is 9, main routing table version 9
8 network entries and 12 paths using 1176 bytes of memory
3 BGP path attribute entries using 144 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
BGP activity 8/0 prefixes, 12/0 paths

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
6.72.6.2 4 2 6885 6882 9 0 0 4d18h 4
7.25.14.4 4 3 6882 6883 9 0 0 4d18h 0
7.72.6.3 4 1 6880 6886 9 0 0 4d18h 0
7.75.7.1 4 1 6884 6885 9 0 0 4d18h 4
```

# show ip bgp neighbors

```
router#show ip bgp neighbors 6.72.6.2
BGP neighbor is 6.72.6.2, remote AS 2, external link
Index 1, Offset 0, Mask 0x2
BGP version 4, remote router ID 7.72.6.2
BGP state = Established, table version = 9, up for 4d21h
Last read 00:00:56, last send 00:00:48
Hold time 180, keepalive interval 60 seconds
Neighbor NLRI negotiation:
  Configured for unicast routes only
  Peer negotiated unicast and multicast routes
  Exchanging unicast routes only
Received route refresh capability from peer
Minimum time between advertisement runs is 30 seconds
Received 7041 messages, 0 notifications, 0 in queue
Sent 7041 messages, 0 notifications, 0 in queue
Prefix advertised 4, suppressed 0, withdrawn 0
Route refresh request: received 0, sent 0
Inbound path policy configured
Route map for incoming advertisements is k
Connections established 1; dropped 0
Last reset never
Number of unicast/multicast prefixes received 4/0
External BGP neighbor may be up to 255 hops away.
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Localhost: 3.72.6.1, Local port: 179
Foreign host: 6.72.6.2, Foreign port: 11014
```

# debug ip bgp

```
router#debug ip bgp ?
A.B.C.D   BGP neighbor address
dampening BGP dampening
events     BGP events
keepalives BGP keepalives
updates    BGP updates
<cr>
```

- **Remember—can be dangerous!**  
**Use only in the lab or if advised by the TAC**
- **To make a little safer:**  
logging buffered <size>  
no logging console

# Session Establishment (*debug ip bgp*)

16:06:30: BGP: 7.72.6.1 sending OPEN, version 4  
16:06:31: BGP: 7.72.6.1 OPEN rcvd, version 4  
16:06:31: BGP: 7.72.6.1 rcv OPEN w/ OPTION parameter len: 12  
16:06:31: BGP: 7.72.6.1 rcv OPEN w/ option parameter type 2 (Capability) len 6  
16:06:31: BGP: 7.72.6.1 OPEN has CAPABILITY code: 1, length 4  
16:06:31: BGP: 7.72.6.1 OPEN has MP\_EXT CAP for afi/safi: 1/1  
16:06:31: BGP: 7.72.6.1 rcv OPEN w/ option parameter type 2 (Capability) len 2  
16:06:31: BGP: 7.72.6.1 OPEN has CAPABILITY code: 128, length 0

16:06:31: BGP: 7.75.7.1 **passive open**  
16:06:31: BGP: 7.75.7.1 OPEN rcvd, version 4  
16:06:31: BGP: 7.75.7.1 sending OPEN, version 4  
16:06:31: BGP: 7.75.7.1 rcv OPEN w/ OPTION parameter len: 12  
16:06:31: BGP: 7.75.7.1 rcv OPEN w/ option parameter type 2 (Capability) len 6  
16:06:31: BGP: 7.75.7.1 OPEN has CAPABILITY code: 1, length 4  
16:06:31: BGP: 7.75.7.1 OPEN has MP\_EXT CAP for afi/safi: 1/1  
16:06:31: BGP: 7.75.7.1 rcv OPEN w/ option parameter type 2 (Capability) len 2  
16:06:31: BGP: 7.75.7.1 OPEN has CAPABILITY code: 128, length 0

# Session Establishment (*debug ip bgp events*)

17:31:39: BGP: 7.72.6.1 went from Idle to Active  
17:32:00: BGP: 7.72.6.1 went from Active to OpenSent  
17:32:00: BGP: 7.72.6.1 went from OpenSent to OpenConfirm  
17:32:00: BGP: 7.72.6.1 went from OpenConfirm to Established

17:31:59: BGP: 7.75.7.1 went from Idle to Active  
17:32:00: BGP: 7.75.7.1 went from Active to Idle  
17:32:00: BGP: 7.75.7.1 went from Idle to Connect  
17:32:00: BGP: 7.75.7.1 went from Connect to OpenSent  
17:32:00: BGP: 7.75.7.1 went from OpenSent to OpenConfirm  
17:32:00: BGP: 7.75.7.1 went from OpenConfirm to Established



# Looking at the Updates

```
router#debug ip bgp updates?  
<1-199>          Access list  
<1300-2699>     Access list (expanded range)  
<cr>
```

```
router#debug ip bgp x.x.x.x updates?  
<1-199>          Access list  
<1300-2699>     Access list (expanded range)  
<cr>
```

**Use an access-list to limit the output!**

## *debug ip bgp Updates*

Peer Address

Prefix Being Advertised

NEXT\_HOP

```
BGP: 6.72.6.2 com puting updates,neighbor version 0, table version 13, starting  
at 0.0.0.0  
BGP: 6.72.6.2 send UPDATE 3.0.0.0/8,next 3.72.6.1  
BGP: ,m etric 0,path 1  
BGP: 6.72.6.2 send UPDATE 5.0.0.0/8 (chgflags: 0x0),next 3.72.6.1  
BGP: 6.72.6.2 send UPDATE 7.0.0.0/8 (chgflags: 0x0),next 3.72.6.1  
BGP: 6.72.6.2 1 updates enqueued (average=56,m axim um =56)  
BGP: 6.72.6.2 update run com pleted,ran for 0m s,neighbor version 0, start version 13,  
throttled to 13,check pointnet 0.0.0.0
```

## debug ip bgp Updates (Cont.)

```
BGP: 6.72.6.2 rcv UPDATE w /attr: nexthop 6.72.6.2, origin i, metric
494, path 2
BGP: 6.72.6.2 rcv UPDATE about 6.0.0.0/8
BGP: 6.72.6.2 rcv UPDATE about 17.0.0.0/8
BGP: 6.72.6.2 rcv UPDATE about 23.0.0.0/8
BGP: 6.72.6.2 rcv UPDATE about 35.0.0.0/8
```

Peer Address

Prefixes in the Same  
UPDATE

Attributes Apply  
to  
All Prefixes

```
BGP: 6.72.6.2 rcv UPDATE w /attr: nexthop 6.72.6.2, origin i, metric
294, path 2 1
BGP: 6.72.6.2 rcv UPDATE about 3.0.0.0/8 —DENIED due to: as-path
contains our own AS;
BGP: 6.72.6.2 rcv UPDATE about 7.0.0.0/8 —DENIED due to: as-path
contains our own AS;
```

2210  
1351\_06\_2000\_c2 © 2000, Cisco Systems, Inc.

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## Logging Neighbor Changes

- Generate a log message whenever a BGP neighbor changes state, also indicate reason for reset
- Syntax (router subcommand):

**[no] bgp log-neighbor-changes**

Typical log messages:

**%BGP-5-ADJCHANGE: neighbor x.x.x.x Up**

**%BGP-5-ADJCHANGE: neighbor x.x.x.x Down-Remote AS changed**

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## *show ip bgp neighbors x.x.x.x*

```
router#show ip bgp neighbors 7.75.7.1
BGP neighbor is 7.75.7.1, remote AS 2, external link
...
Received 194 messages, 1 notifications, 0 in queue
Sent 194 messages, 0 notifications, 0 in queue
Prefix advertised 0, suppressed 0, withdrawn 0
Route refresh request: received 0, sent 0
Connections established 7; dropped 7
Last reset 00:04:11, due to BGP Notification received, hold time expired
Number of unicast/multicast prefixes received 0/0
External BGP neighbor may be up to 255 hops away.
No active TCP connection
```



# Come Meet the Neighbors!

## Peer Establishment

## Peer Establishment

- **Routers establish a TCP session**
  - Port 179—permit in ACLs**
  - IP connectivity (route from IGP)**
- **OPEN messages are exchanged**
  - Peering addresses must match the TCP session**
  - Local AS configuration parameters**
  - Capabilities negotiation**

## Common Problems

- **Sessions are not established**
  - No IP reachability**
  - Incorrect configuration**
    - Peering addresses**
    - OPEN parameters**

# Can't Establish Session - Symptoms

```
routerA #show ip bgp summary
BGP router identifier 7.72.6.1, localAS number 1
BGP table version is 4, main routing table version 4
6 network entries and 6 paths using 774 bytes of memory
2 BGP path attribute entries using 96 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
BGP activity 6/0 prefixes, 6/0 paths

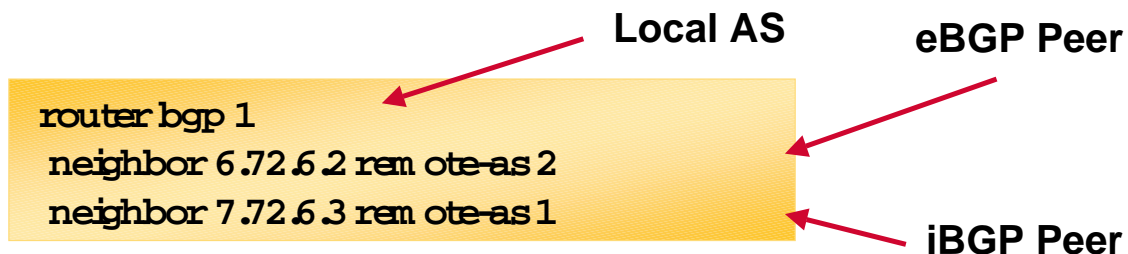
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
6.72.6.2 4 2 0 0 0 0 never Idle
7.25.14.4 4 3 4 5 4 0 00:01:43 0
7.72.6.3 4 1 0 0 0 0 never Active
7.75.7.1 4 1 7 5 4 0 00:01:55 3
```

- The peering session is not **established!**

State may change between **active**,  
**idle** and **connect**

# Can't Establish Session— Troubleshooting I

- Is the **remote-as** assigned correctly?



## Can't Establish Session— Troubleshooting I (Cont.)

- **Verify IP connectivity**
  - check the routing table
  - use ping/trace to verify two way reachability
  - inspect for ACLs in the path to the neighbor

```
routerA#show ip route 7.72.6.3
Routing entry for 7.72.6.3/32
  Known via "ospf123", distance 110, metric 87, type intra area
  Last update from 27.27.27.254 on PO S5/0, 00:09:33 ago
  Routing Descriptor Blocks:
    * 27.27.27.254, from 7.72.6.3, 00:09:33 ago, via PO S5/0
      Route metric is 87, traffic share count is 1
```

```
routerA#ping 7.72.6.3
Sending 5, 100-byte ICMP Echos to 7.72.6.3, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/30/32 ms
```

## Can't Establish Session— Troubleshooting I (Cont.)

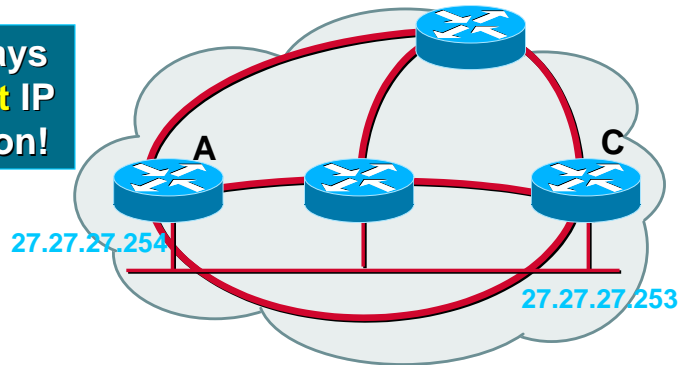
```
routerA#debug ip bgp
BGP debugging is on
10:51:02: BGP: 7.72.6.3 open active, delay 6864ms
10:51:09: BGP: 7.72.6.3 open active, localaddress 27.27.27.253
10:51:09: BGP: 7.72.6.3 open failed: Connection refused by remote host
```

- **Is the remote router configured for BGP?**
  - What IP address is the remote router configured to receive?

```
router bgp 1
no synchronization
bgp log-neighbor-changes
neighbor 7.72.6.1 remote-as 1
```

# Can't Establish Session— Troubleshooting I (Cont.)

The TCP session is always sourced from the **closest** IP address to the destination!



- **Configuration:**

Router A

```
router bgp 1  
neighbor 27.27.27.254 remote-as 1
```

Router C

```
router bgp 1  
neighbor 27.27.27.253 remote-as 1
```

If redundant paths exist, use **loopback interfaces** to establish the session.

# Can't Establish Session— Troubleshooting I (Cont.)

```
router bgp 1  
neighbor 7.72.6.3 remote-as 1  
neighbor 7.72.6.3 update-source Loopback0
```

Information sourced from the IP address in interface Loopback0

```
routerA #debug ip tcp transactions  
11:19:48: BGP: 7.72.6.3 open active, delay 9916ms  
11:19:53: TCP: sending RST, seq 0, ack 3098129121  
11:19:53: TCP: sent RST to 7.7.7.6:11719 from 7.72.6.1:179
```

- **Solution:**

make sure both routers source the information from the appropriate interface

# Can't Establish Session—Symptoms

```
routerA#show ip bgp summary
BGP router identifier 7.72.6.1, local AS number 1
BGP table version is 4, main routing table version 4
6 network entries and 6 paths using 774 bytes of memory
2 BGP path attribute entries using 96 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
BGP activity 6/0 prefixes, 6/0 paths

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
6.72.6.2 4 2 0 0 0 0 never Idle
7.25.14.4 4 3 385 385 4 0 0 06:22:17 0
7.72.6.3 4 1 42 49 4 0 0 00:00:15 0
7.75.7.1 4 1 388 385 4 0 0 06:22:30 3
```

- The eBGP session is still having trouble!

# Can't Establish Session - Troubleshooting II

- Verify IP connectivity  
check the routing table  
use ping/trace to verify two way reachability

```
routerA#show ip route 6.72.6.2
% Network not in table
```

```
routerA#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
routerA (config)#ip route 6.72.6.2 255.255.255.255 1.1.1.5
```

```
routerA#ping 6.72.6.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 6.72.6.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```



## Can't Establish Session— Troubleshooting II (Cont.)

- **Peering with a loopback interface**

### Advantages

Interface is always up

Multiple physical paths may exist to reach it

### Disadvantages

Physical link failure may take longer to detect

## Can't Establish Session— Troubleshooting II (Cont.)

```
routerA #debug ip bgp
routerA #debug ip tcp transactions
13:25:30:TCP:sending RST,seq 0,ack 2030100669
13:25:30:TCP:sent RST to 6.72.6.2:11041 from 3.72.6.1:179
```

```
router bgp 1
neighbor 6.72.6.2 remote-as 2
neighbor 6.72.6.2 update-source Loopback1
```

Neighbor is trying to peer with this IP address

- **The debug output indicates the neighbor's configured peering address**

## Can't Establish Session— Troubleshooting II (Cont.)

```
13:33:30: TCP: sending RST, seq 0, ack 2510129645  
13:33:30: TCP: sent RST to 6.72.62:11045 from 3.72.61:179
```

- **Hint: by default, eBGP peers should be directly connected**

**in this case, the peering address  
doesn't match a connected interface  
in the local router**

## Can't Establish Session— Troubleshooting II (Cont.)

```
routerA #show ip bgp neighbors 6.72.62  
BGP neighbor is 6.72.62, remote AS 2, external link  
Index 1, Offset 0, Mask 0x2  
BGP version 4, remote router ID 0.0.0.0  
BGP state = Idle, table version = 0  
Last read 00:00:06, last send never  
Hold time 180, keepalive interval 60 seconds  
Neighbor NLRI negotiation:  
  Configured for unicast routes only  
  Minimum time between advertisement runs is 30 seconds  
Received 0 messages, 0 notifications, 0 in queue  
Sent 0 messages, 0 notifications, 0 in queue  
Prefix advertised 0, suppressed 0, withdrawn 0  
Route refresh request: received 0, sent 0  
Connections established 0; dropped 0  
Last reset never  
Number of unicast/multicast prefixes received 0/0  
External BGP neighbor not directly connected.  
No active TCP connection
```

## Can't Establish Session— Troubleshooting II (Cont.)

```
router bgp 1
neighbor 6.72.6.2 remote-as 2
neighbor 6.72.6.2 ebgp-multihop 255
neighbor 6.72.6.2 update-source Loopback1
```

- At this point, the session should come up

## Can't Establish Session— Symptoms

```
routerA #show ip bgp summary
BGP router identifier 7.72.6.1, local AS number 1
...
Neighbor V AS/MsRcvd M sgsent TblVer InQ OutQ Up/Down State/PfxRcd
6.72.6.2 4 2 10 26 0 0 0 never Active
```

```
router bgp 1
neighbor 6.72.6.2 remote-as 2
neighbor 6.72.6.2 ebgp-multihop 255
neighbor 6.72.6.2 update-source Loopback1
```

- Still having trouble!  
Connectivity issues have already been checked and corrected.

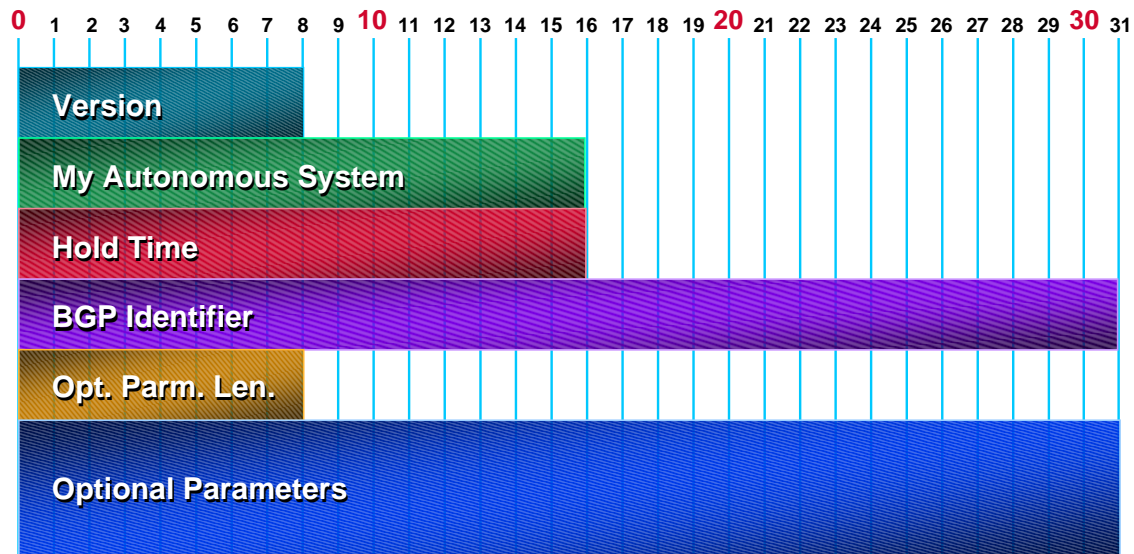
# Can't Establish Session— Troubleshooting II (Cont.)

```
14:06:37:BG P: 6.72.6.2 open active, localaddress 3.72.6.1
14:06:37:BG P: 6.72.6.2 went from Active to OpenSent
14:06:37:BG P: 6.72.6.2 sending OPEN ,version 4
14:06:37:BG P: 6.72.6.2 received NOTIFICATION 2/2
      (peer in wrong AS) 2 bytes 0001
14:06:37:BG P: 6.72.6.2 remote close, state CLOSING
14:06:37:BG P: service reset requests
14:06:37:BG P: 6.72.6.2 went from OpenSent to Idle
14:06:37:BG P: 6.72.6.2 closing
```

- If an error is detected, a **notification** is sent and the session is closed

In this case the remote router had  
a bad configuration

## OPEN Message



# Capabilities Negotiation

- Allows for the advertisement of capabilities (type 2)
- Backwards compatible

New error subcode introduced to indicate which capabilities are not supported—the session must be reset

Capability Code (1 Octet)

Capability Length (1 Octet)

Capability Value (Variable)

draft-ietf-idr-bgp4-cap-neg, Mar. 2000



## Where's the Beef?

## UPDATE Exchange

## UPDATE Exchange

- **Once the session has been established, UPDATES are exchanged**
  - all the locally known routes**
  - only the bestpath is advertised**
- **Incremental UPDATE messages are exchanged afterwards**

## Propagation Decisions

- **bestpath received from eBGP peer**
  - advertise to all peers**
- **bestpath received from iBGP peer**
  - advertise only to eBGP peers**
  - a full iBGP mesh must exist**

## Common Problems

- **Missing routes**
  - No iBGP full mesh**
  - Filters: routes are not received/sent**
- **Slow convergence**

## UPDATE Filters

- **Type of filters**
  - Prefix filters**
  - AS\_PATH filters**
  - Community filters**
  - Any attribute may be used in a route-map**
- **Applied incoming and/or outgoing**

## Missing Routes— Troubleshooting Steps

- **Determine which filters are applied to the BGP session**

**show ip bgp neighbors x.x.x.x**

**Look at the configuration**

- **Examine the route and pick out the relevant attributes**

**show ip bgp x.x.x.x**

## Missing Routes— Troubleshooting Steps (Cont.)

- **Compare the route against the filters**

- **If no match is found**

**Use route-refresh or soft-reconfiguration**

**Filter the updates through an ACL to determine where the problem is**



## Missing Routes—Symptoms

- **Missing 4.0.0.0/8 in 7.75.7.1 (routerA)  
not received from 7.72.6.3 (routerB)**

```
routerB#sh ip bgp nei 7.75.7.1 advertised-routes | include 4.0.0.0
*> 4.0.0.0      0.0.0.0      0      32768 i
```

**routerB shows that the route was advertised to routerA!**

## Missing Routes—Troubleshooting

```
routerA#show access-lists 10
Standard IP access list 10
  permit 4.0.0.0
```

```
routerA#debug ip bgp 7.72.6.3 updates 10
BGP updates debugging is on for access list 10 for neighbor 7.72.6.3
```

```
routerA#clear ip bgp 7.72.6.3 in
01:22:41: BGP: 7.72.6.3 rcv UPDATE w/ attr: nexthop 7.72.6.3,  origin i,
metric 0, path 2
01:22:41: BGP: 7.72.6.3 rcv UPDATE about 4.0.0.0/8 -- DENIED due
to: distribute/prefix-list;
```

# Missing Routes— Troubleshooting (Cont.)

```
router bgp 1
no synchronization
bgp lg-neighbor-changes
neighbor 7.72.6.3 remote-as 2
neighbor 7.72.6.3 ebgp-multihop 255
neighbor 7.72.6.3 update-source Loopback0
neighbor 7.72.6.3 prefix-list filter in
!
ip prefix-list filter seq 5 deny 4.0.0.0/8
ip prefix-list filter seq 10 permit 0.0.0.0/0 le 32
```

# Slow Convergence—Symptoms

- The eBGP peering is established, but convergence is not complete even after several hours

```
routerA#show ip bgp summary
...
Neighbor      V AS   M  SgRcvd M  SgSent TblVer InQ  OutQ  Up/Down State/PfxRcd
150.10.10.1   4  1    3550  3570  847  0 206 05:53:51  100
```

- Possible causes

Remote router is not healthy (OutQ)

Lower layer problems (IP)

# Slow Convergence— Troubleshooting

```
router bgp 1
neighbor 150.10.10.1 remote-as 2
neighbor 150.10.10.1 ebgp-multihop 2
neighbor 150.10.10.1 update-source Loopback0
```

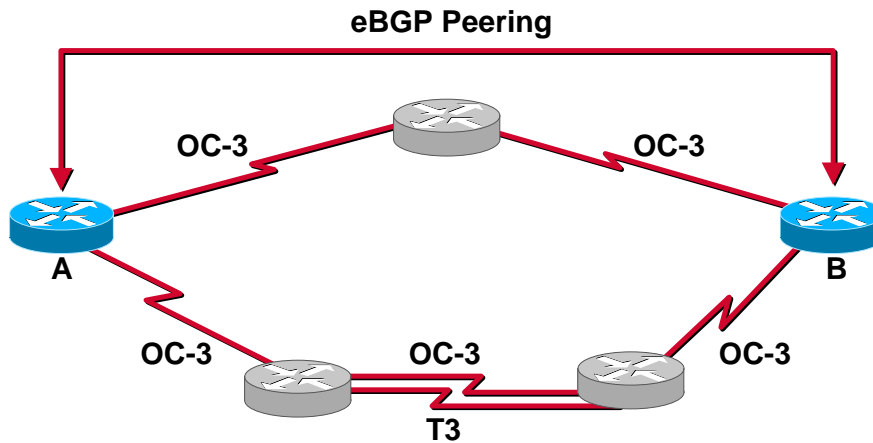
```
routerA#show ip route 150.10.10.1
Routing entry for 150.10.10.1/32
Routing Descriptor Blocks:
  10.105.1.71, from 150.20.20.1, 00:06:14 ago, via POS2/1/0
  * 156.1.1.1, from 150.20.20.1, 00:06:14 ago, via POS2/1/1
routerA#ping 150.10.10.1
Sending 5, 100-byte ICMP Echos to 150.10.10.1:  !!!!!
Success is 100 percent, round-trip min/avg/max = 4/64/296 ms
```

```
Reply to request 0
Record route:
(156.1.1.2)
(195.5.5.1)
(10.105.1.134)
(150.10.10.1)
(10.105.1.76)
(195.5.5.2)
(156.1.1.1)
(211.211.211.1) <*>
```

```
Reply to request 1
Record route:
(10.105.1.69)
(140.10.50.5)
(150.10.10.1)
(140.10.50.6)
(10.105.1.71)
(211.211.211.1) <*>
```

Ping with route record option.

# Slow Convergence— Troubleshooting (Cont.)



```
router bgp 1
neighbor 150.10.10.1 remote-as 2
neighbor 150.10.10.1 ebgp-multihop 2
neighbor 150.10.10.1 update-source Loopback0
```

Longest path has more than 2 hops to the destination. Use higher TTL!



## Route Selection Process

- **A common policy should be maintained across the AS to guarantee loop-free operation**
  - Not all routers may select the same path
- **Filters may be used to modify or add attributes, affecting the selection algorithm**

# Common Problems

- **Inconsistent decision/policy**

**MED**

**External paths**

**Communities**

**By default, communities are not propagated**

**neighbor x.x.x.x send-community**

## Inconsistent Decision— Symptom I

- **The bestpath changes every time the peering is reset.**

```
routerA #sh ip bgp 160.100.0.0
BGP routing table entry for 160.100.0.0/16, version 40
Paths: (3 available, best #3, advertised over IBGP, EBGP)
 1
 204.146.33.10 from 204.146.33.10 (204.146.33.1)
   Origin IGP, metric 0, localpref 100, valid, internal
 3
 204.146.33.66 from 204.146.33.66 (204.146.33.2)
   Origin IGP, metric 20, localpref 100, valid, internal
 3
 204.146.33.6 from 204.146.33.6 (10.4.1.1)
   Origin IGP, metric 30, valid, external, best
```

## Inconsistent Decision— Symptom I (Cont.)

```
routerA#sh ip bgp 160.100.0.0
BGP routing table entry for 160.100.0.0/16, version 2
Paths: (3 available, best #3, advertised over EBGP)
 1
 204.146.33.10 from 204.146.33.10 (204.146.33.1)
   Origin IGP, metric 0, localpref 100, valid, internal
 3
 204.146.33.6 from 204.146.33.6 (10.4.1.1)
   Origin IGP, metric 30, valid, external
 3
 204.146.33.66 from 204.146.33.66 (204.146.33.2)
   Origin IGP, metric 20, localpref 100, valid, internal, best
```

- Same paths, but different result!

## Inconsistent Decision— Symptom I (Cont.)

```
routerA#sh ip bgp 160.100.0.0
BGP routing table entry for 160.100.0.0/16, version 12
Paths: (3 available, best #3, advertised over EBGP)
 3
 204.146.33.6 from 204.146.33.6 (10.4.1.1)
   Origin IGP, metric 30, valid, external
 3
 204.146.33.66 from 204.146.33.66 (204.146.33.2)
   Origin IGP, metric 20, localpref 100, valid, internal
 1
 204.146.33.10 from 204.146.33.10 (204.146.33.1)
   Origin IGP, metric 0, localpref 100, valid, internal, best
```

- Different result...again!!

## Deterministic MED

- By default, the prefixes are compared in order of arrival

it may result in inconsistent decisions

use **bgp deterministic-med**

the bestpath is recalculated as soon as the command is entered

enable in all the routers in the AS

## Deterministic MED—Operation

- The paths are ordered by peer-AS
- The bestpath for each group is selected
- The overall bestpath results from comparing the winners in each group

## Deterministic MED—Result

```
routerA#sh ip bgp 160.100.0.0
BGP routing table entry for 160.100.0.0/16, version 15
Paths: (3 available, best #1, advertised over EBGP)
 1
 204.146.33.10 from 204.146.33.10 (204.146.33.1)
   Origin IGP, metric 0, localpref 100, valid, internal, best
 3
 204.146.33.66 from 204.146.33.66 (204.146.33.2)
   Origin IGP, metric 20, localpref 100, valid, internal
 3
 204.146.33.6 from 204.146.33.6 (10.4.1.1)
   Origin IGP, metric 30, valid, external
```

- The bestpath will always be the same!

## Inconsistent Decision— Symptom II

- The bestpath changes every time the peering is reset

```
routerA#show ip bgp 7.0.0.0
BGP routing table entry for 7.0.0.0/8, version 15
Paths: (2 available, best #2)
Not advertised to any peer
 2
 1.1.1.5 from 1.1.1.5 (1.1.1.1)
   Origin IGP, metric 0, localpref 100, valid, external
 2
 21.21.21.254 from 21.21.21.254 (7.75.7.1)
   Origin IGP, metric 0, localpref 100, valid, external, best
```



# Inconsistent Decision— Symptom II (Cont.)

```
routerA#show ip bgp 7.0.0.0
BG P routing table entry for 7.0.0.0/8 ,version 17
Paths: (2 available,best#2)
Not advertised to any peer
2
 21.21.21.254 from 21.21.21.254 (7.75.7.1)
  Origin IGP ,m etric 0 ,localpref100 ,valid ,external
2
 1.1.1.5 from 1.1.1.5 (1.1.1.1)
  Origin IGP ,m etric 0 ,localpref100 ,valid ,external,best
```

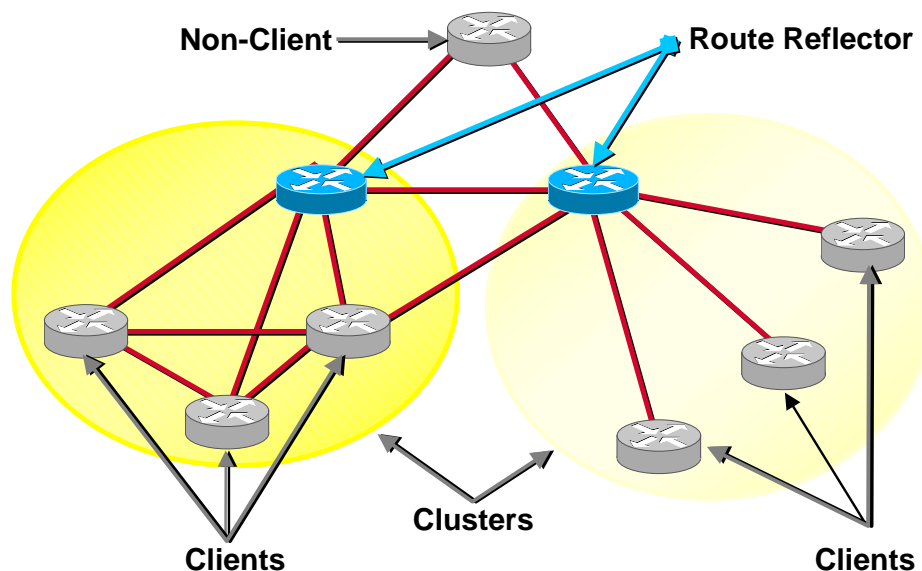
- The “oldest” external is the bestpath.  
All other attributes are the same  
Stability enhancement!



# Route Reflectors

- **Provide additional control to allow router to advertise (reflect) iBGP learned routes to other iBGP peers**  
Method to reduce the size of the iBGP mesh
- **Normal BGP speakers can coexist**  
Only the RR has to support this feature

## Route Reflectors—Terminology



**Lines Represent Both Physical Links and BGP Logical Connections**

## Reflection Decisions

- **Once the best path is selected:**
  - From non-client reflect to all clients**
  - From client → reflect to all non-clients AND other clients**
  - From eBGP peer → reflect to all clients and non-clients**

## Common Problems

- **Missing routes**
- **Routing loops and “close calls”**

# Missing Routes—Symptoms

- At least one route is missing from at least one router in the network.

```
routerA #show ip bgp 4.0.0.0
% Network not in table
routerA #show ip bgp summary
BGP router identifier 7.25.14.4, local AS number 1
BGP table version is 1, main routing table version 1
...
Neighbor V AS M sRcvd M sSent TbVer InQ OutQ Up/Down State/PfxRcd
7.72.6.24 1 7 7 1 0 000:04:18 0
```

# Missing Routes—Troubleshooting

- Check routers for filters

```
routerB #
router bgp 1
no synchronization
bgp cluster-id 0.0.0.5
neighbor 7.25.14.4 remote-as 1
neighbor 7.25.14.4 route-reflector-client
neighbor 7.72.6.1 remote-as 1
```

```
routerA #
router bgp 1
no synchronization
neighbor 7.72.6.2 remote-as 1
```

← routerC

```
routerB #show ip bgp 4.0.0.0
% Network not in table
```

## Missing Routes— Troubleshooting I

- Follow the path where the routes should have been learned

```
routerC #
router bgp 1
no synchronization
bgp cluster-id 0.0.0.5
neighbor 7.72.6.2 remote-as 1
neighbor 7.75.7.1 remote-as 1
neighbor 7.75.7.1 route-reflector-client
```

Same  
Cluster-ID!

```
routerC #show ip bgp | include 4.0.0.0
*> 4.0.0.0 7.72.6.3 0 100 0 2 i
```

## Missing Routes— Troubleshooting II

- Alternative way to find duplicate cluster-id

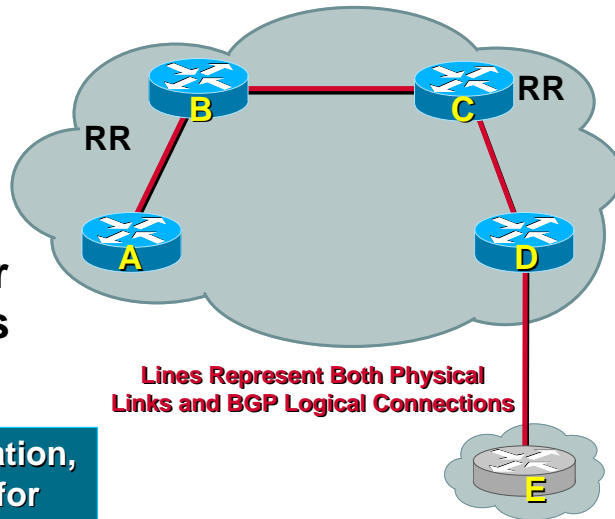
use route-refresh + *debug ip bgp updates ACL*

```
routerB #clear ip bgp 7.72.6.1 in
21:45:40: BGP: 7.72.6.1 rcv UPDATE w /attr: nexthop 7.72.6.3,
origin i, localpref 100, metric 0, path 2
21:45:40: BGP: 7.72.6.1 rcv UPDATE about 4.0.0.0/8 — DENIED due
to: reflected from the same cluster;
```

# Missing Routes— Troubleshooting (Cont.)

- **Clusters with multiple RRs**

If the RRs have the same cluster-id, all the clients must peer with all the reflectors



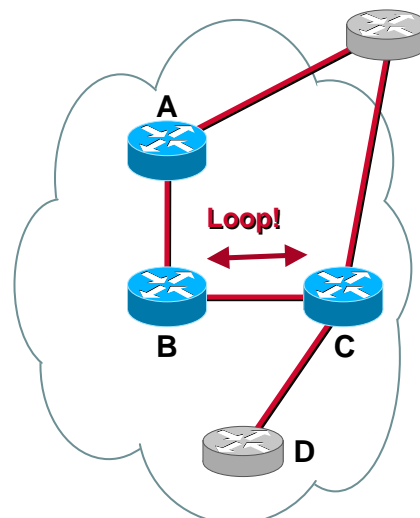
If not needed for administration, don't assign a cluster-id for added flexibility!

# Routing Loop—Symptom

```
routerD#traceroute 7.1.1.1
```

```

1 1.1.1.2 24 msec 24 msec 40 msec
rtrB 2 156.1.1.1 28 msec 48 msec 24 msec
rtrC 3 156.1.1.2 24 msec 24 msec 24 msec
4 156.1.1.1 28 msec 28 msec 24 msec
5 156.1.1.2 28 msec 28 msec 28 msec
6 156.1.1.1 28 msec 28 msec 32 msec
```



# Routing Loop—Troubleshooting

## Verify Routing Information

```
routerC#show ip bgp 7.0.0.0
BGP routing table entry for 7.0.0.0/8
1
  150.10.10.1 (metric 115) from 150.10.10.1 (150.20.20.1)
    Origin IGP, valid, external, best
routerC#show ip route 150.10.10.1
Routing entry for 150.10.10.1/32
Routing Descriptor Blocks:
  * 156.1.1.1, from 150.20.20.1, via Ethernet2/1/1
```

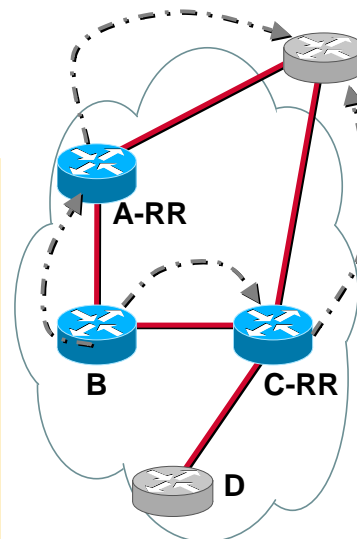
```
routerB#show ip bgp 7.0.0.0
BGP routing table entry for 7.0.0.0/8
1
  156.1.1.2 from 156.1.1.2 (212.212.212.1)
    Origin IGP, valid, internal, best
routerB#show ip route 156.1.1.2
Routing entry for 156.1.1.0/24
Routing Descriptor Blocks:
  * directly connected, via Ethernet1
```

Addresses on Same Subnet!

# Routing Loop— Troubleshooting (Cont.)

- Check configuration

```
routerC#
router bgp 134
neighbor 150.10.10.1 remote-as 1
neighbor 150.10.10.1 ebgp-multihop 255
neighbor 150.10.10.1 update-source Loopback0
neighbor 156.1.1.1 remote-as 134
neighbor 156.1.1.1 route-reflector-client
neighbor 156.1.1.1 next-hop-self
!
ip route 150.10.10.1 255.255.255.255 s0 250
```



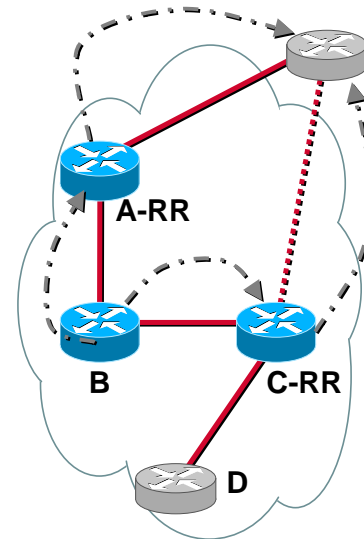
Lines Represent  
Physical Connections

# Routing Loop— Troubleshooting (Cont.)

- **Solution**

**Establish the eBGP peering permanently through the “backup” link**

**Use LOCAL\_PREF or MED to break any tie!**



**Lines Represent  
Physical Connections**

# Close Call—Symptom

- **The bestpath is not being followed to an external destination**

```
routerA #show ip route 4.4.4.4
Routing entry for 4.0.0.0/8
  Known via "bgp 1", distance 200, metric 0
  Tag 2, type internal
  Last update from 6.72.6.3 00:25:45 ago
  Routing Descriptor Blocks:
  * 6.72.6.3, from 7.75.7.1, 00:25:45 ago
    Route metric is 0, traffic share count is 1
    AS Hops 1, BGP network version 0
```

Expected to go out though the NEXT\_HOP in the update.



## Close Call—Symptom (Cont.)

```
routerA #traceroute 4.4.4.4
```

```
1 1.1.1.4    0 m sec 0 m sec 0 m sec
2 8.25.14.3  8 m sec 4 m sec 4 m sec
3 172.18.176.1 8 m sec 4 m sec 4 m sec
4 161.44.0.56 8 m sec 8 m sec 8 m sec
5 161.44.0.18 8 m sec 8 m sec 4 m sec
6 4.4.4.4    4 m sec 5 m sec 4 m sec
```

- All eBGP peers are configured with their interface address

The NEXT\_HOP is expected in the trace

## Close Call— Troubleshooting (Cont.)

- Verify configuration

Check for alternate routes

```
router bgp 1
no synchronization
neighbor 7.75.7.1 remote-as 1
neighbor 7.75.7.1 update-source Loopback0
```

← routerC

```
routerA #show ip bgp 4.0.0.0
BGP routing table entry for 4.0.0.0/8, version 2
Paths: (1 available, best #1)
Not advertised to any peer
2
6.72.6.3 (metric 103) from 7.75.7.1 (7.75.7.1)
Origin IGP, metric 0, localpref 100, valid, internal, best
```

## Close Call— Troubleshooting (Cont.)

```
router bgp 1
no synchronization
bgp lg-neighbor-changes
neighbor 7.72.6.1 rem ote-as 1
neighbor 7.72.6.1 update-source Loopback0
neighbor 7.72.6.1 route-reflector-client
neighbor 7.72.6.2 rem ote-as 1
neighbor 7.72.6.2 update-source Loopback0
neighbor 7.72.6.2 route-reflector-client
neighbor 6.72.6.3 rem ote-as 2
```



routerA



routerB

- routerC is a RR with two clients

## Close Call— Troubleshooting (Cont.)

```
routerC#show ip bgp 4.0.0.0
BGP routing table entry for 4.0.0.0/8, version 2
 2, (Received from a RR-client)
 8.25.14.3 (metric 3) from 7.72.6.1 (7.72.6.1)
   Origin IGP, metric 0, localpref 100, valid, internal
 2
 6.72.6.3 (metric 2) from 6.72.6.3 (6.72.6.3)
   Origin IGP, metric 0, localpref 100, valid, external, best
```

```
routerC#traceroute 4.4.4.4

 1 6.72.6.3  0 m sec 4 m sec 0 m sec
 2 161.44.0.56 0 m sec 4 m sec 0 m sec
 3 161.44.0.18 0 m sec 4 m sec 0 m sec
 4 4.4.4.4  0 m sec 4 m sec 0 m sec
```



Expected  
Path!

## Close Call— Troubleshooting (Cont.)

```
routerB#traceroute 4.4.4.4
```

```
1 8.25.14.3 8 m sec 16 m sec 8 m sec  
2 172.18.176.1 16 m sec 12 m sec 16 m sec  
3 161.44.0.48 12 m sec 16 m sec 12 m sec  
4 161.44.0.15 16 m sec 12 m sec 16 m sec  
5 4.4.4.4 8 m sec 8 m sec 8 m sec
```

- **Output from the other client follows the same exit as routerA**

## Close Call— Troubleshooting (Cont.)

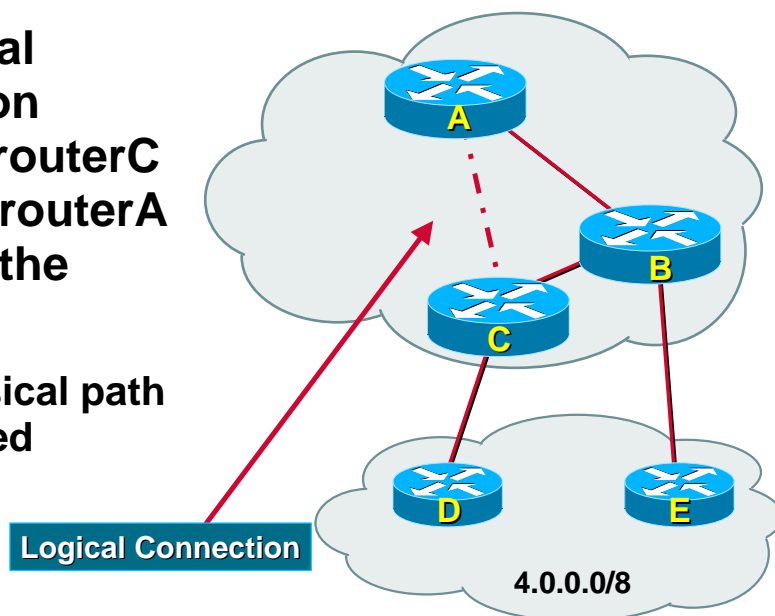
```
routerB#show ip bgp 4.0.0.0  
BGP routing table entry for 4.0.0.0/8, version 13  
2  
8.25.14.3 (metric 2) from 8.25.14.3 (8.25.14.3)  
Origin IGP, metric 0, localpref 100, valid, external, best  
2  
6.72.6.3 (metric 50) from 7.75.7.1 (7.75.7.1)  
Origin IGP, metric 0, localpref 100, valid, internal
```

- **routerB is following the correct path!**

## Close Call— Troubleshooting (Cont.)

- The logical connection between router C (RR) and router A provides the route

The physical path is followed



## Summary/Tips

- Isolate the problem!
- Use ACLs when enabling debug commands
- Enable **bgp log-neighbor-changes**
- IP reachability must exist for sessions to be established

Learned from IGP

Make sure the source and destination addresses match the configuration

## Summary/Tips

- **Use loopback interfaces for stability and where multiple paths exist**
- **Use common filters**  
**Keep them simple!**
- **Maintain a consistent policy throughout the AS**
- **Use deterministic-med**

## Summary/Tips

- **Select the appropriate knob/attribute for the job**  
**Learn the decision algorithm**
- **Route reflectors**  
**Follow the physical topology**  
**Define a cluster-id only if administratively needed**



**Troubleshooting BGP in  
Large IP Networks**

**Session 2210**

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# CISCO SYSTEMS



## EMPOWERING THE INTERNET GENERATION<sup>SM</sup>