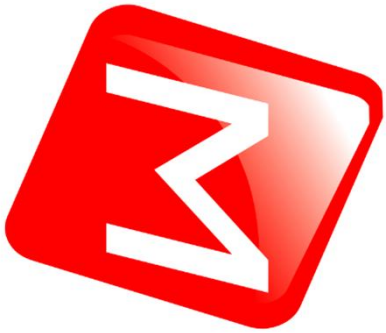


# Enterprise networking
## IGP and iBGP/MPLS , eBGP

MANAGE YOUR NETWORK WITH NO LIMITATION

MIKROTIK ROUTER OS

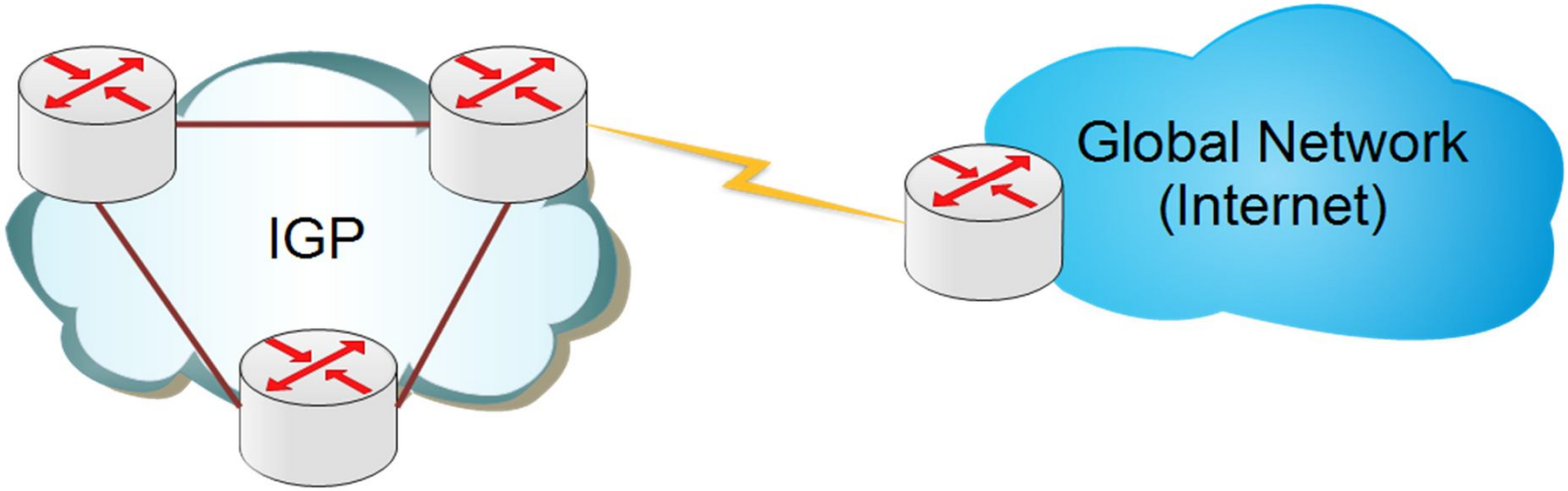
MUM DUBAI 2012

BY- ALI SAMI & HAYDAR FADEL

MIKROTIK-IQ

## INTERIOR GATEWAY PROTOCOL

(**IGP**) is a routing protocol that is used to exchange routing information within an autonomous system (AS).

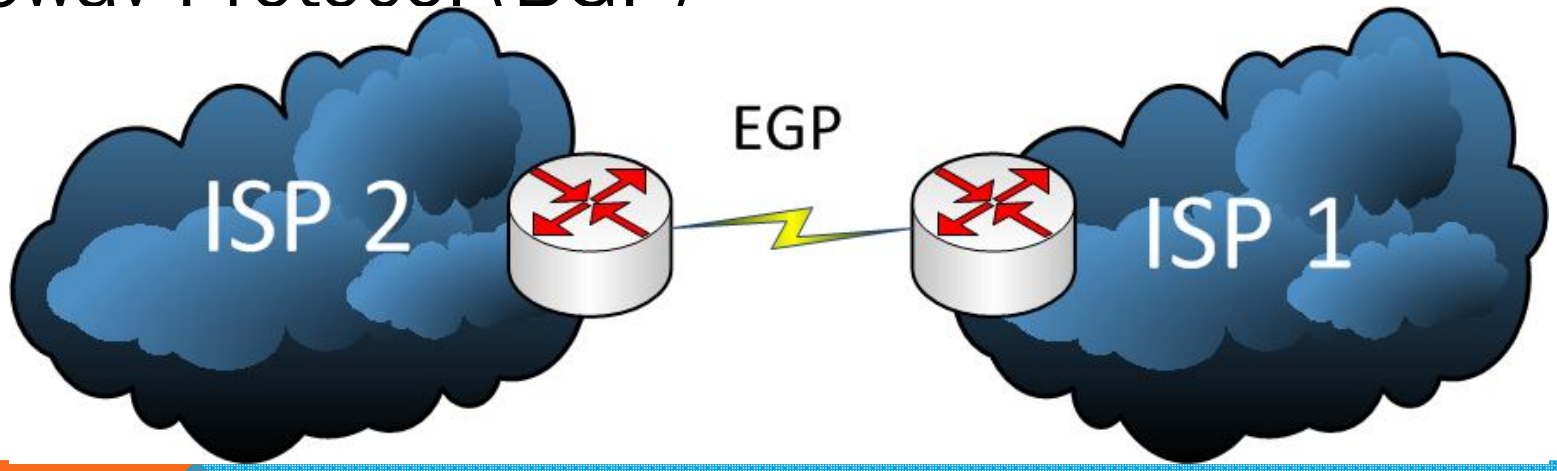


## INTERIOR GATEWAY PROTOCOL

- Designed for networks that are controlled by an organization.
- Design criteria to find the best path to reach neighbor network within AS
- OSPF is Commonly in use

## EXTERIOR GATEWAY PROTOCOL

EGP allow to exchange of routing summary information between autonomous systems. An example of this type of routing protocol is Border Gatewav Protocol (BGP)

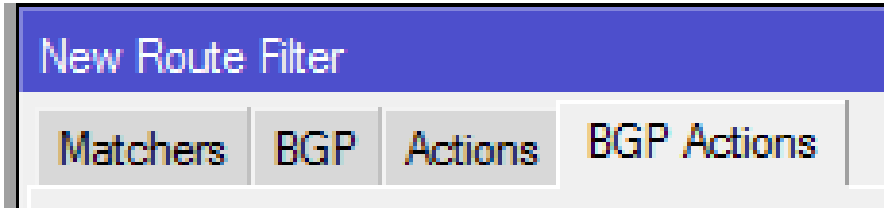


## BORDER GATEWAY PROTOCOL

- ✓ Its called a Path vector routing protocol
- ✓ BGP calls each routing domain an autonomous system (AS)
- ✓ Main metric is “shortest AS path”
- ✓ Using TCP transmission port 179 for neighbor relationship.
- ✓ Full and Incremental routing update (partial update)
- ✓ Contain two Type ( Internal ) and ( External)

# BORDER GATEWAY PROTOCOL (CONTINUED…)

- ✓ Learns multiple paths via internal and external BGP peers
- ✓ Select the best path and installs in the routing table
- ✓ Best path advertised to BGP peers
- ✓ Policies (path attribute) applied by choosing the best path selection set by BGP action.



## INTERNAL BGP

- ✓ BGP peer within the same AS.
- ✓ Not required to be directly connected
- ✓ Internal peer need to be fully meshed :
  - Help to reach remote network using best path.
  - Redundant connectivity between internal peers
- ✓ iBGP peer do not re-advertise networks learned from other internal peers, its can re-advertise to eBGP peer
- ✓ IBGP will act as decision make from which external peer should reach the remote networks.

# EXTERNAL BGP

- ✓ BGP peer between deferent AS.
- ✓ Required to be directly connected. Why???

**Cause there is no IGP can carry your data to remote peer**

- ✓ eBGP peer recommended to be fully meshed :
  - Redundant connectivity between external peers
- ✓ eBGP learn from External BGP peers
- ✓ Learned route from eBGP can be re-advertise to another eBGP and iBGP peers
- ✓ eBGP advertisement and data traffic controlled by path attribute.
- ✓ Default path attribute of eBGP is AS Path

## BGP ROTUER SELECTION CONDITION

- ✓ NEXT_HOP of router should valid and reachable
- ✓ AS_PATH received from External peer does not contain the local AS
- ✓ Route is not rejected by routing filter

# AUTONOMOUS SYSTEM

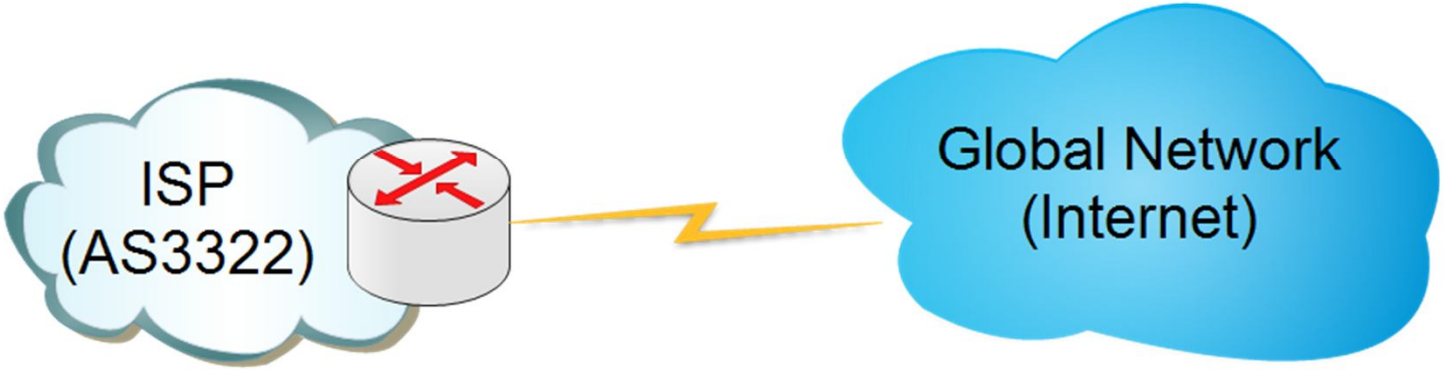
AS is a collection of networks that are controlled by single entity like ISP or very large organization

AS connectivity type

1. Single Homed.
2. Dual Homed.
3. Single Multihomed.
4. Dual Multihued.
5. Transit

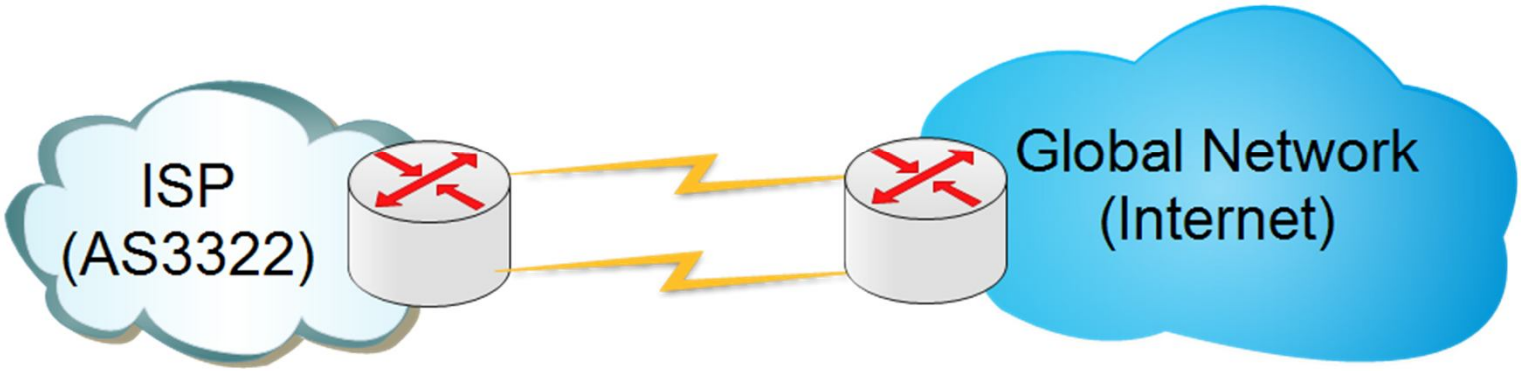
# SINGLE HOMED

- Connection design uses a single ISP
- Single link between ISP and enterprise.
- Only one possible next-hop router exists use only as Default route



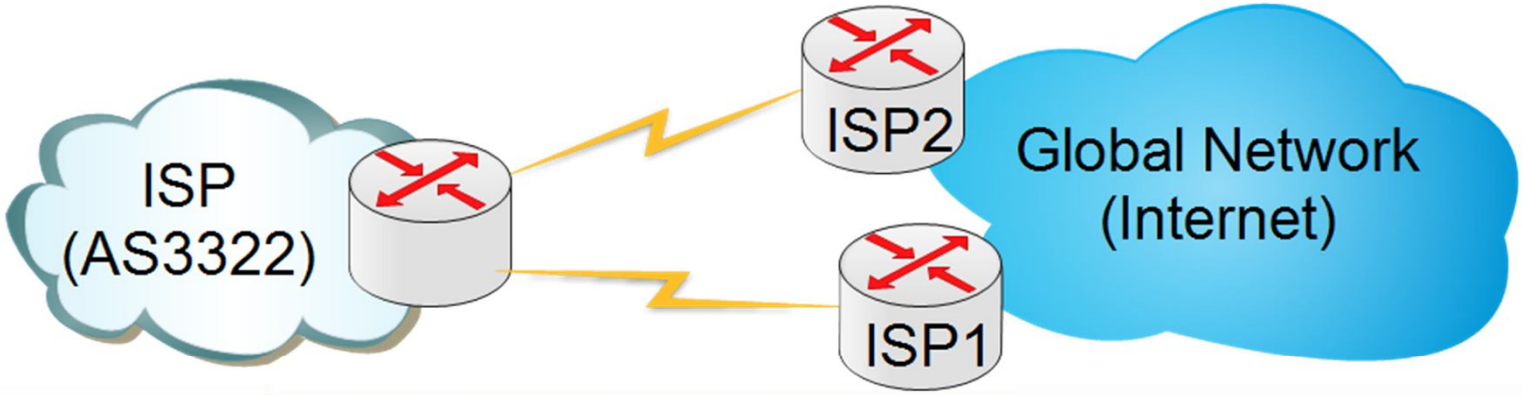
# DUAL HOMED

- Connection design uses a single ISP.
- Dual link between ISP and enterprise.
- Can use a pair of routers.
- Case of use Load balancing and fail over.



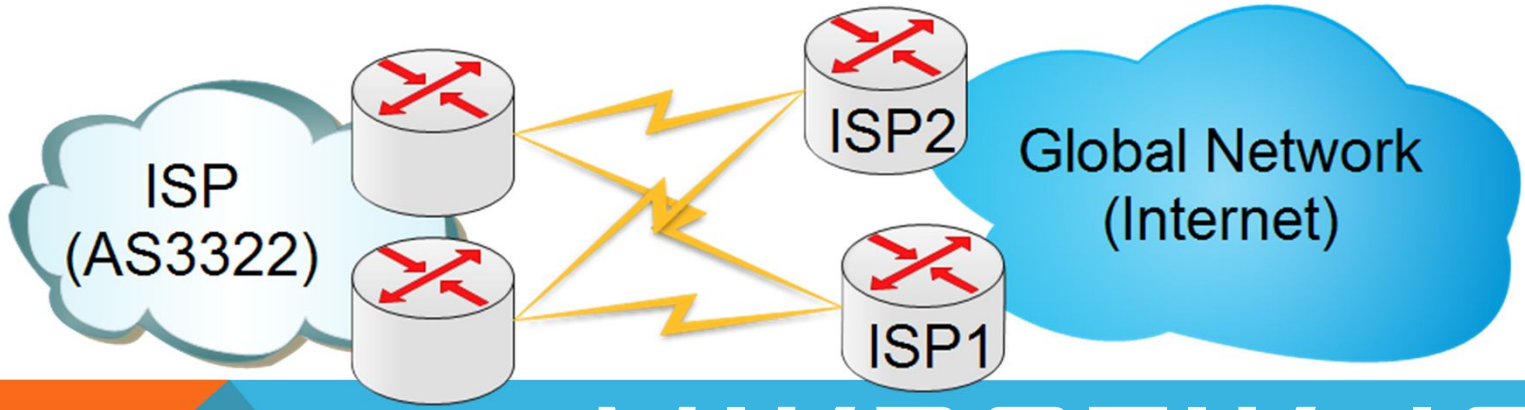
# SINGLE MULTIHOMED

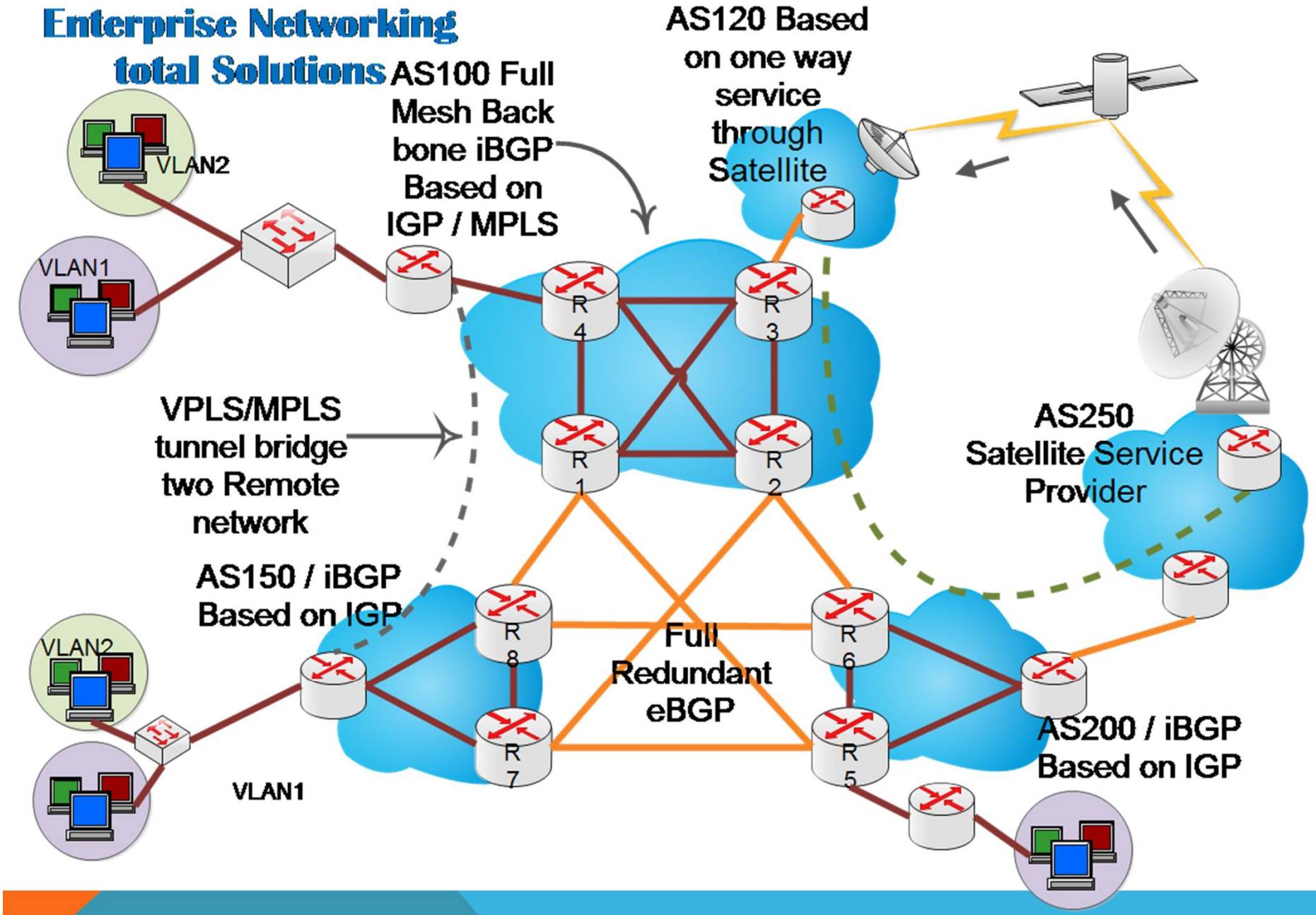
- Connection design is a single link per ISP.
- Multiple link to enterprise ( at least two ISP)
- Redundant and load balancing for up stream.
- Redundant and Load balancing for down steam



# DUAL MULTIHOMED

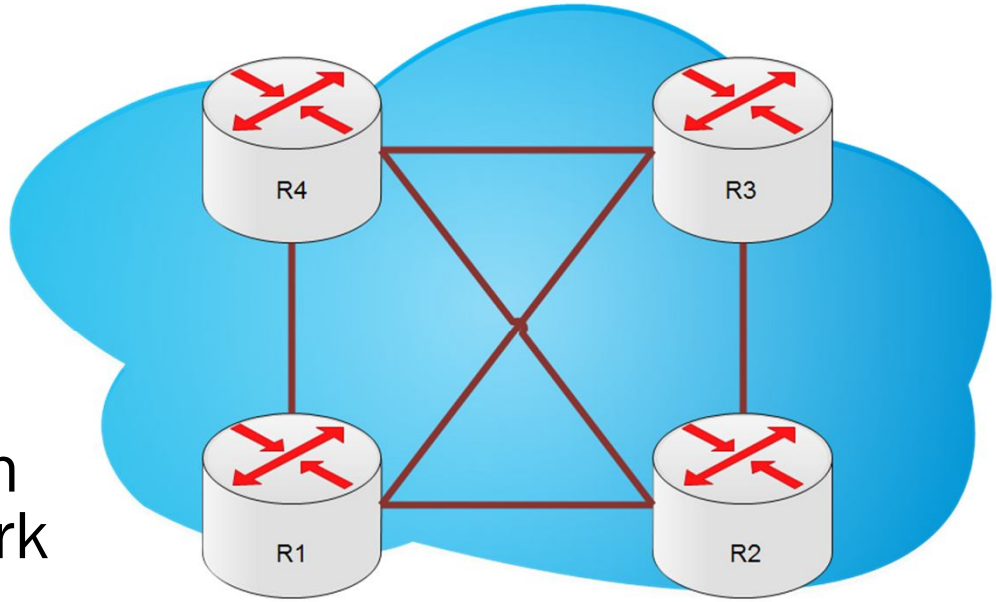
- Connection design is a Multi link per ISP.
- Multiple link to enterprise ( at least two ISP)
- Redundant and load balancing for Up stream.
- Redundant and Load balancing for down steam




Enterprise Networking
total Solutions
AS100 Full Mesh Back bone iBGP Based on IGP / MPLS
AS120 Based on one way service through Satellite
VLAN2
VLAN1
VPLS/MPLS tunnel bridge two Remote network
AS250 Satellite Service Provider
AS150 / iBGP Based on IGP
Full Redundant eBGP
AS200 / iBGP Based on IGP
VLAN2
VLAN1
R 1
R 2
R 3
R 4
R 5
R 6
R 7
R 8

# AS 100 GENERAL LAYOUT & DESIGN

- Full Mesh physical connectivity
- Using OSPF as IGP
- Back bone forwarding using MPLS
- iBGP to select best path to access Global network



# ADVANTAGE OF DESIGN

- ✓ Mesh will provide full redundant connectivity at backbone
- ✓ IGP will provide full IP level connectivity between routers as mesh design
- ✓ IGP will help to keep iBGP away of network change
- ✓ iBGP will use loopback address to all neighbor relation ship …. Why….? **Loopback interface never goes down!!!**
- ✓ each iBGP router need have one peer to each iBGP routers to achieve full mesh iBGP network.
- ✓ MPLS will increase forwarding performance at core network

# IMPLEMENTATION AS 100 STEPS

1- Physical connectivity using Giga bit cooper or fiber

2- IP level connectivity between router using /30 subnet

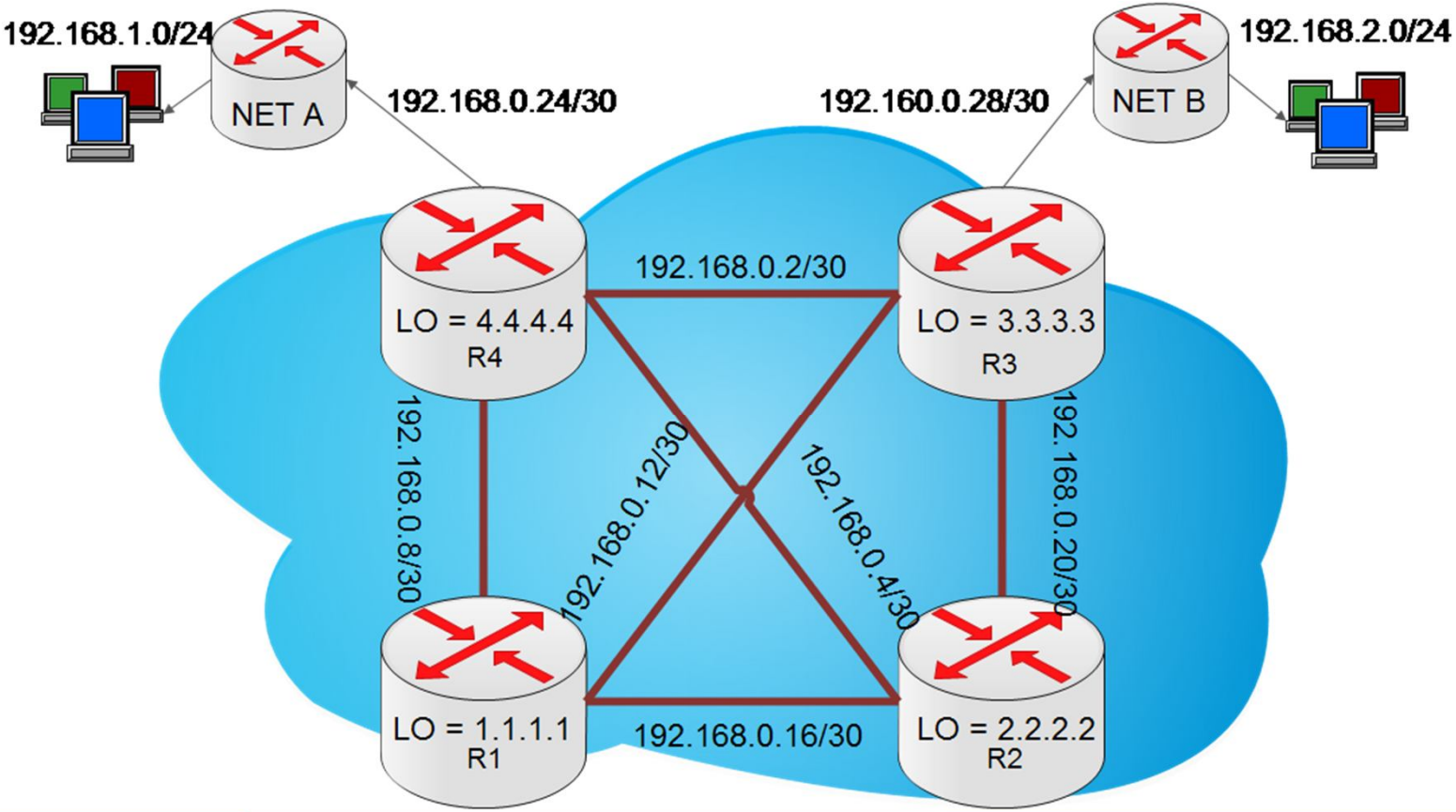
3- Create Logical interface using bridge inside each core router

4- Use OSPF as carrier and network advertisements between routers .

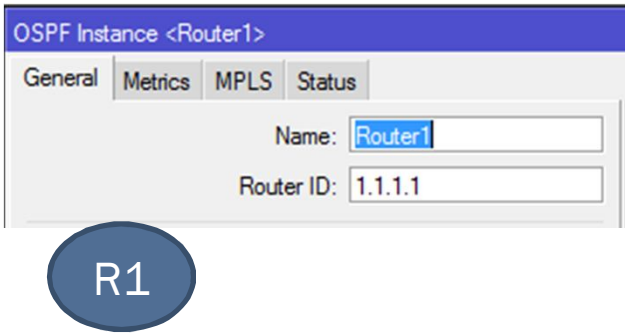
5- MPLS between iBGP routers

6- Peer between iBGP routers

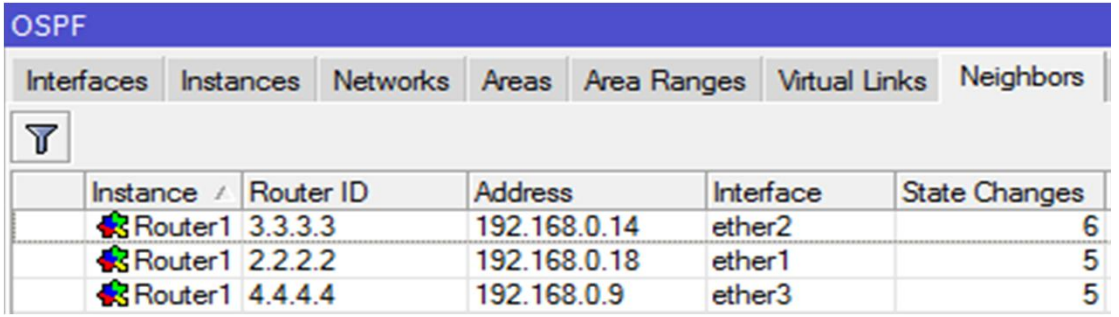
# IP LEVEL LAYOUT

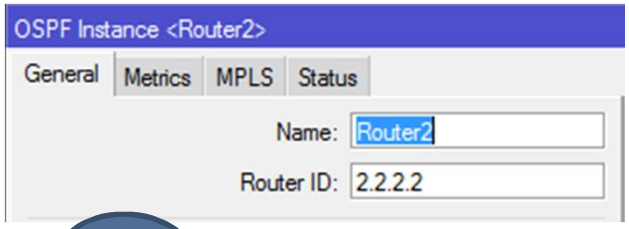


# IMPLEMENTING OSPF

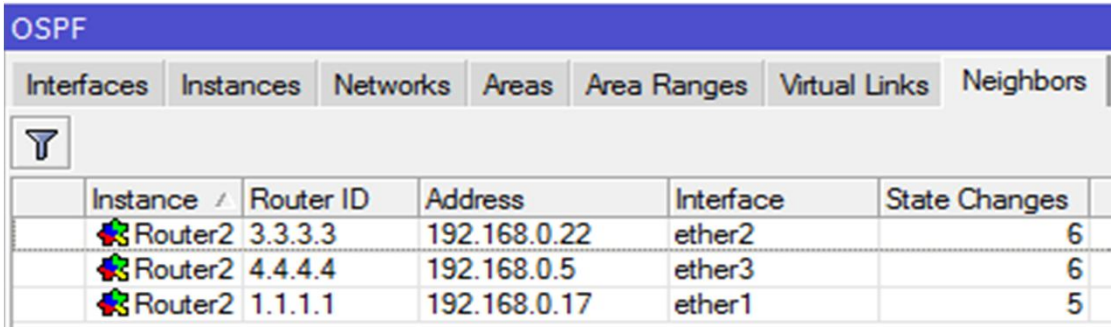



R1

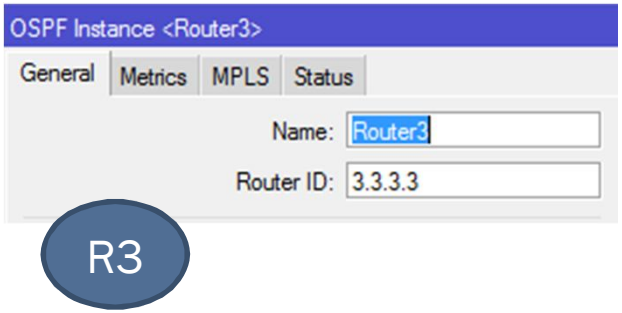


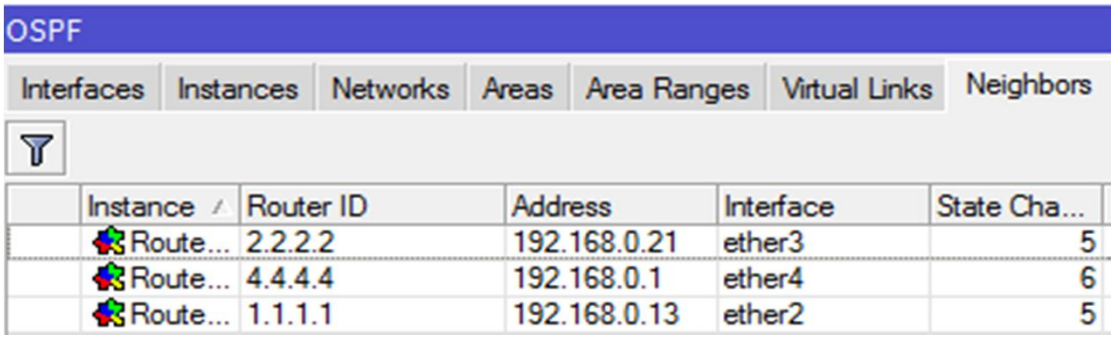



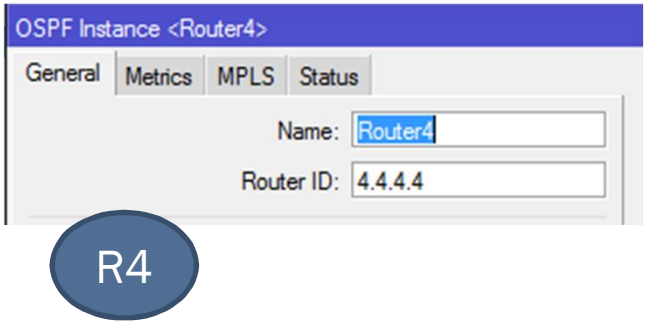

R2

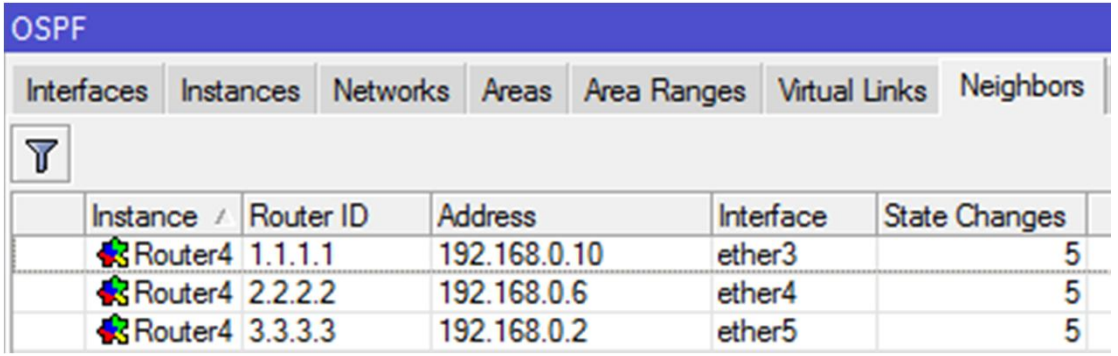


# IMPLEMENTING OSPF

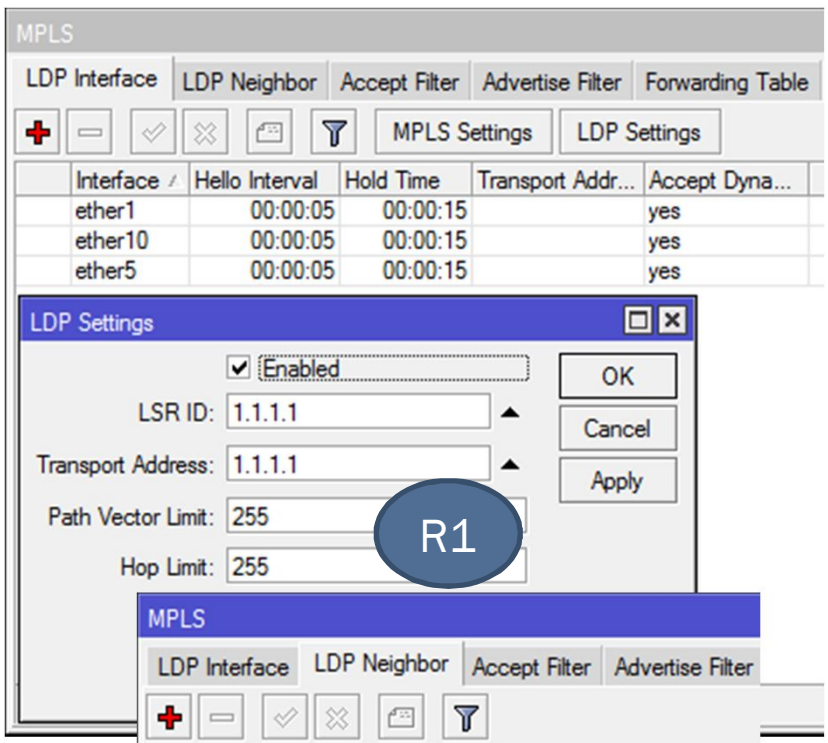


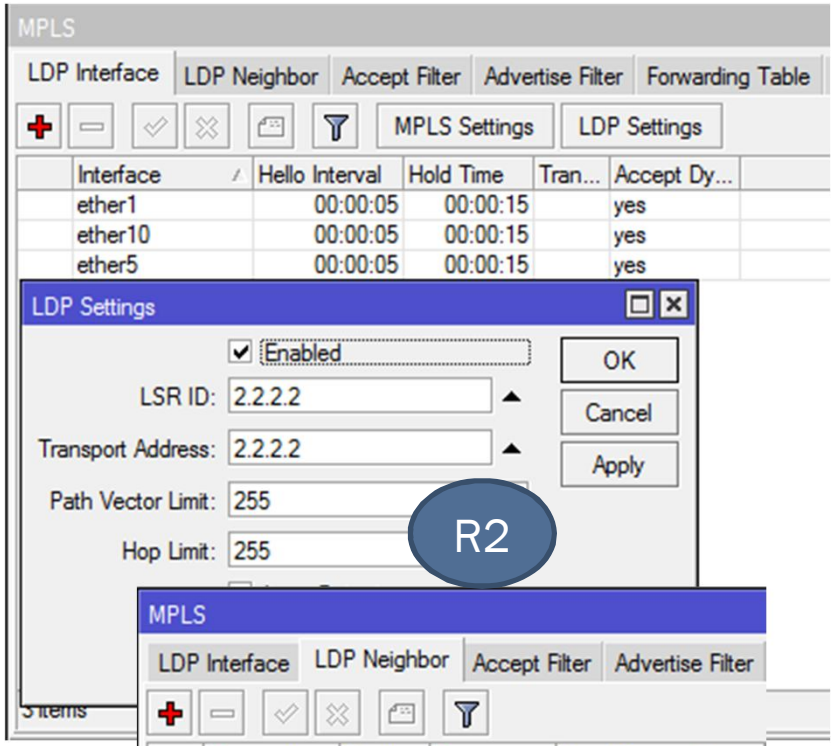



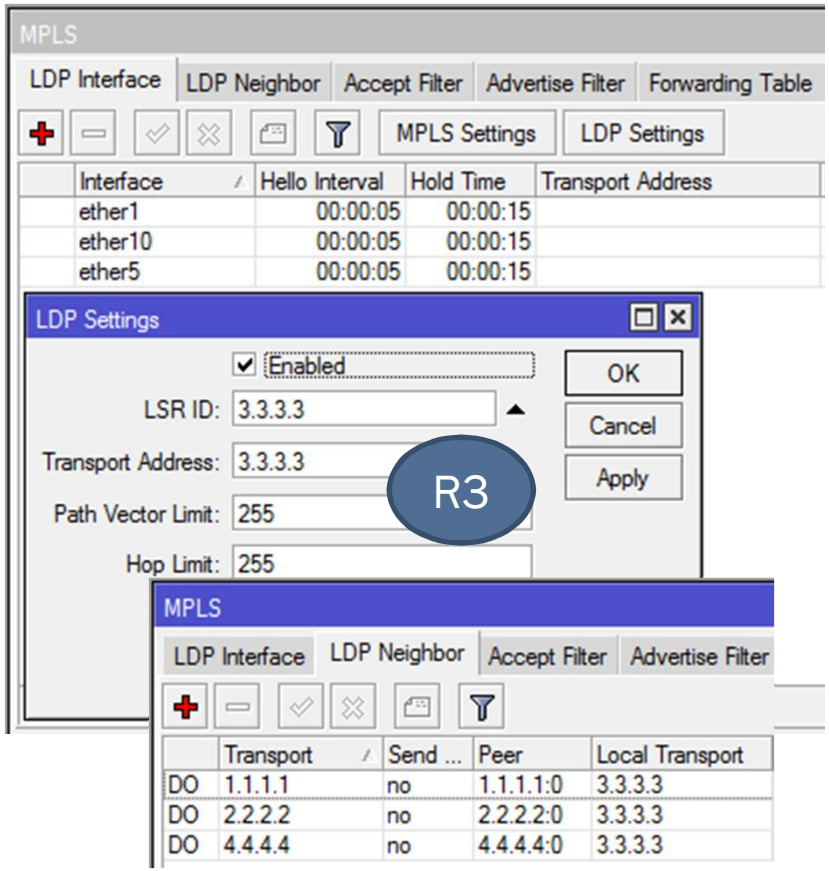



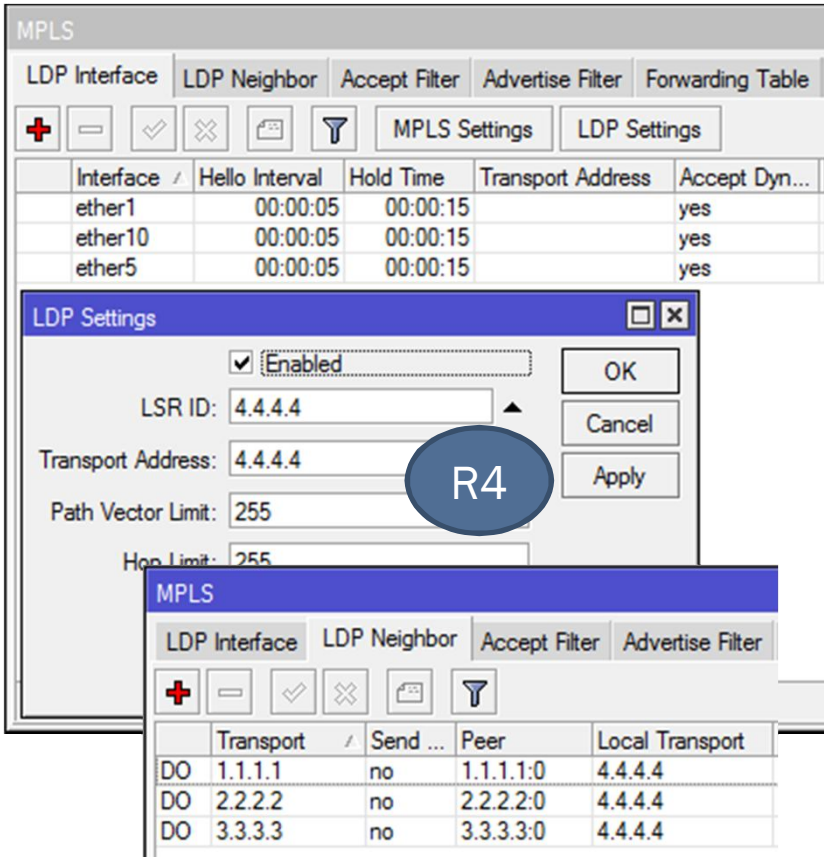
# IMPLEMENTING MPLS



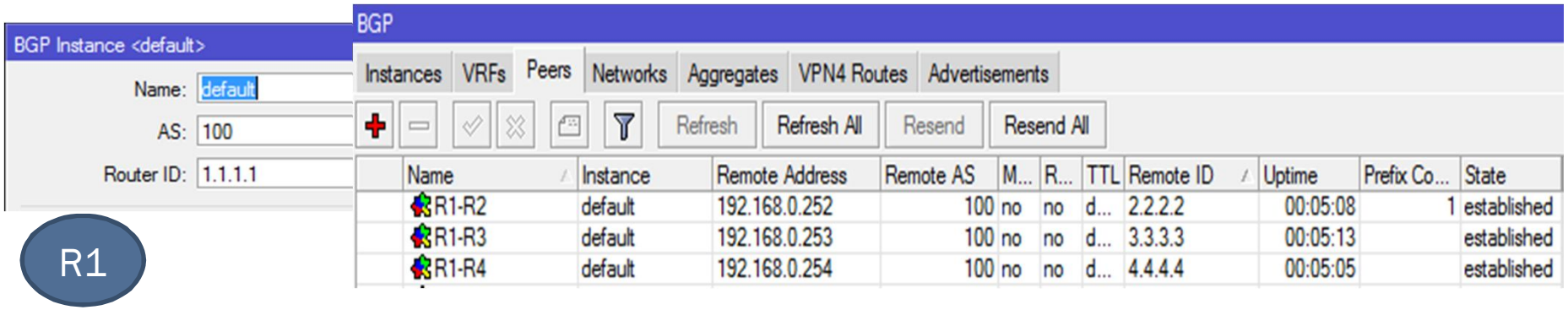



# IMPLEMENTING MPLS

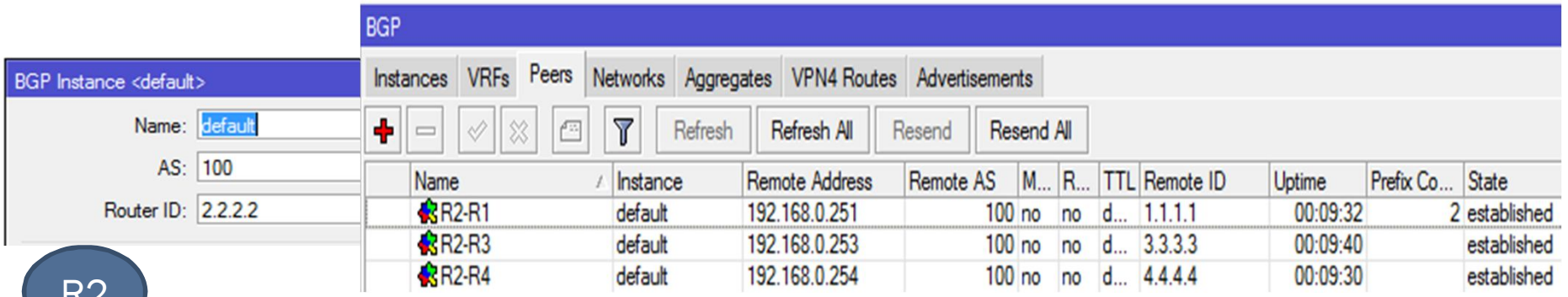


# IMPLEMENTING I-BGP

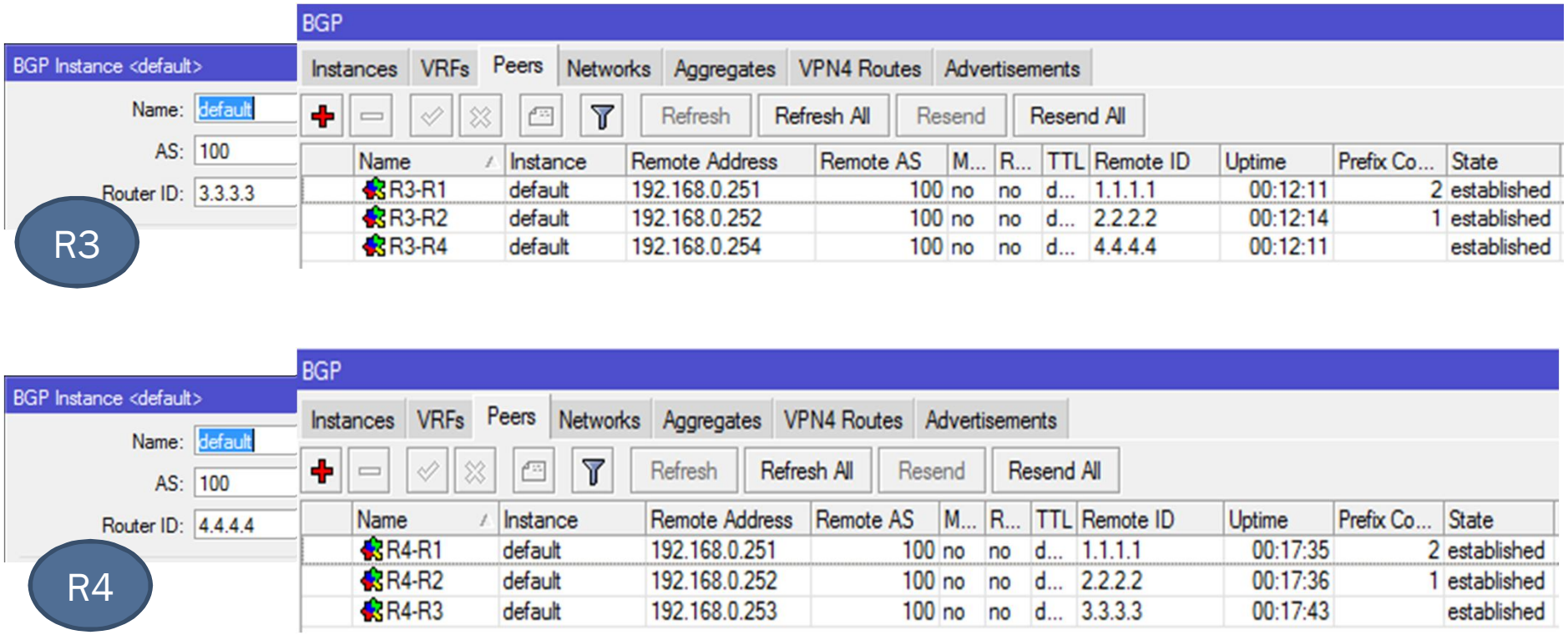



R1

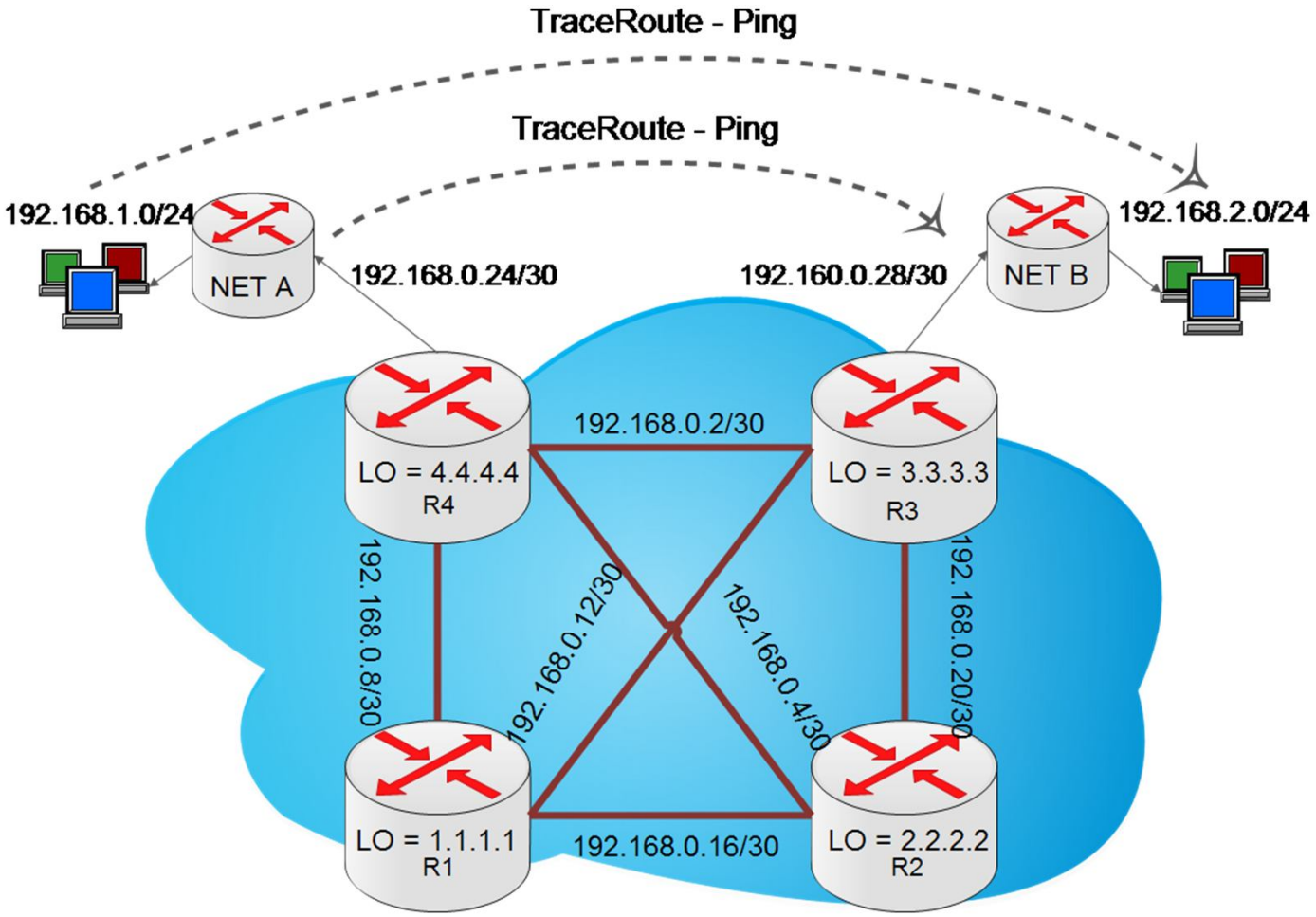



R2

# IMPLEMENTING I-BGP



# TESTING NETWORK CONNECTIVITY USING TRACE ROUTE AND PING TOOLS



Connectivity test from R-A to R-B

```
[admin@MikroTik] > tool traceroute 192.168.2.1
 # ADDRESS                                  RT1     RT2     RT3     STATUS
 1 192.168.0.25                             1ms     1ms     1ms
 2 192.168.0.2                              1ms     1ms     1ms     <MPLS:L=27,E=0>
 3 192.168.2.1                              1ms     1ms     1ms
```

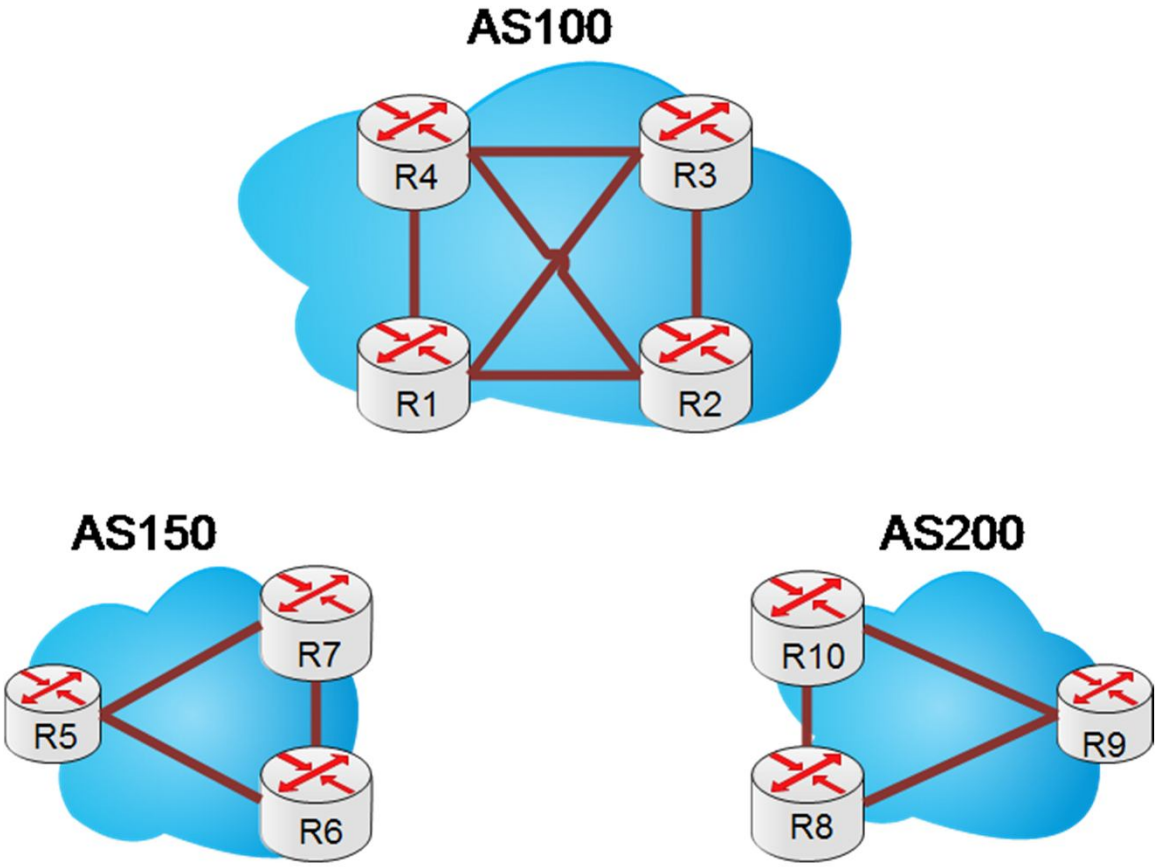
Connectivity test from Host-A to remote Host-B

```
Tracing route to 192.168.2.2 over a maximum of 30 hops

  1    <1 ms    <1 ms    <1 ms  192.168.1.1
  2   251 ms    <1 ms    <1 ms  192.168.0.25
  3    <1 ms    45 ms   318 ms  192.168.0.2
  4    <1 ms   494 ms    <1 ms  192.168.0.30
  5     1 ms    <1 ms    45 ms  192.168.2.2

Trace complete.

C:\Users\Ali>ping 192.168.2.2

Pinging 192.168.2.2 with 32 bytes of data:
Reply from 192.168.2.2: bytes=32 time<1ms TTL=124
Reply from 192.168.2.2: bytes=32 time<1ms TTL=124
Reply from 192.168.2.2: bytes=32 time<1ms TTL=124
Reply from 192.168.2.2: bytes=32 time<1ms TTL=124

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

# IMPLEMENTING E-BGP

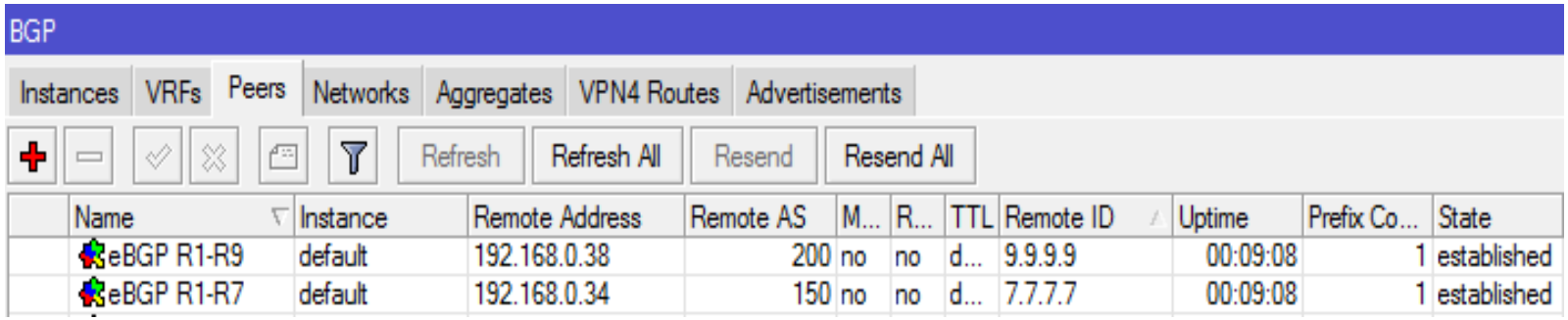
- ✓ Configuration at other ASes will be similar at AS100
- ✓ To communicate All ASes to gather need to establish eBGP peer to remote AS
- ✓ Current AS type designed as Dual Multihomed To provide full redundant connection with other ASes

# IMPLEMENTING E-BGP



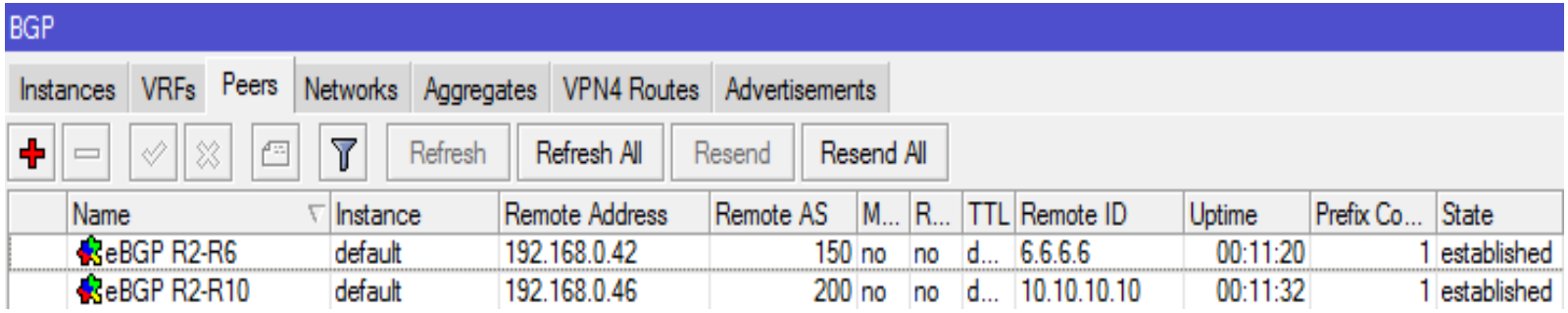
# IMPLEMENTING E-BGP (AS100 R1&R2)

R1



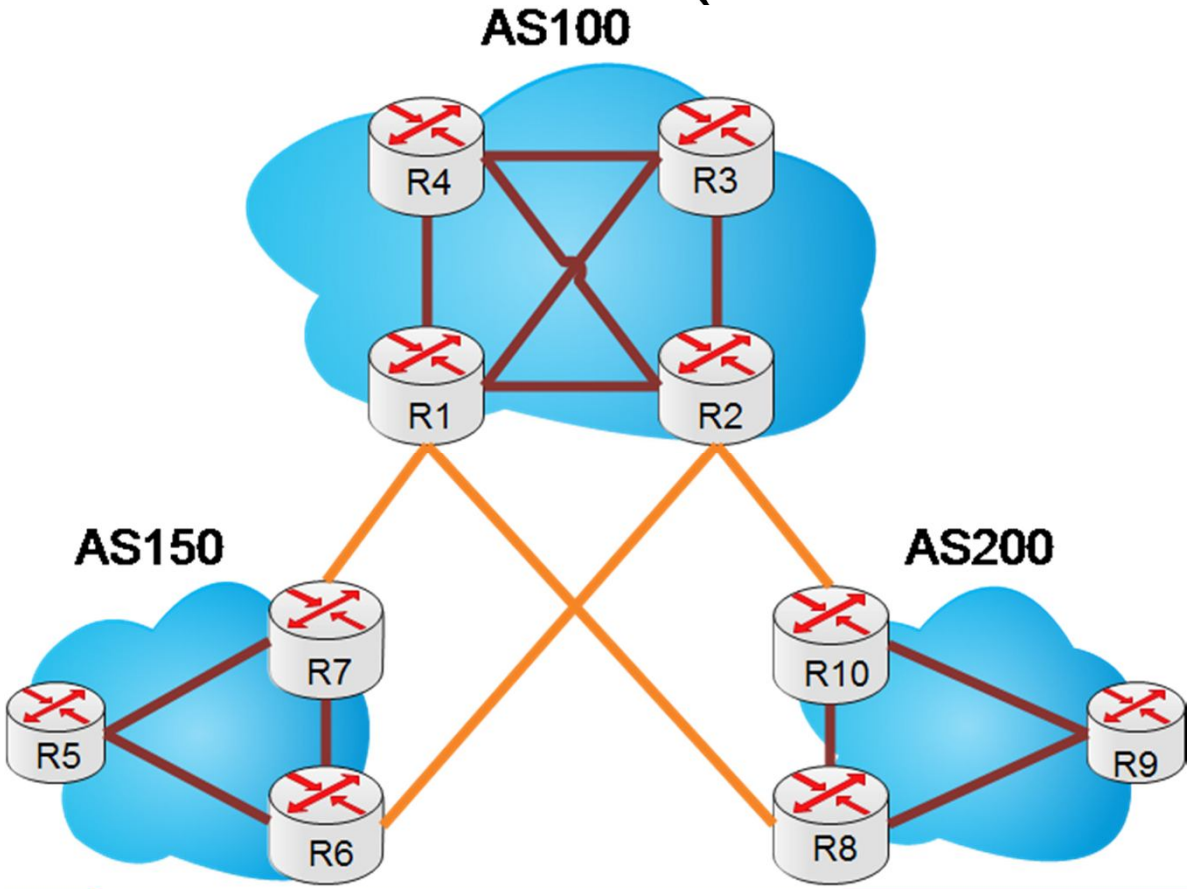

| Name | Instance | Remote Address | Remote AS | M... | R... | TTL | Remote ID | Uptime | Prefix Co... | State |
|---|---|---|---|---|---|---|---|---|---|---|
| eBGP R1-R9 | default | 192.168.0.38 | 200 | no | no | d... | 9.9.9.9 | 00:09:08 | 1 | established |
| eBGP R1-R7 | default | 192.168.0.34 | 150 | no | no | d... | 7.7.7.7 | 00:09:08 | 1 | established |

R2



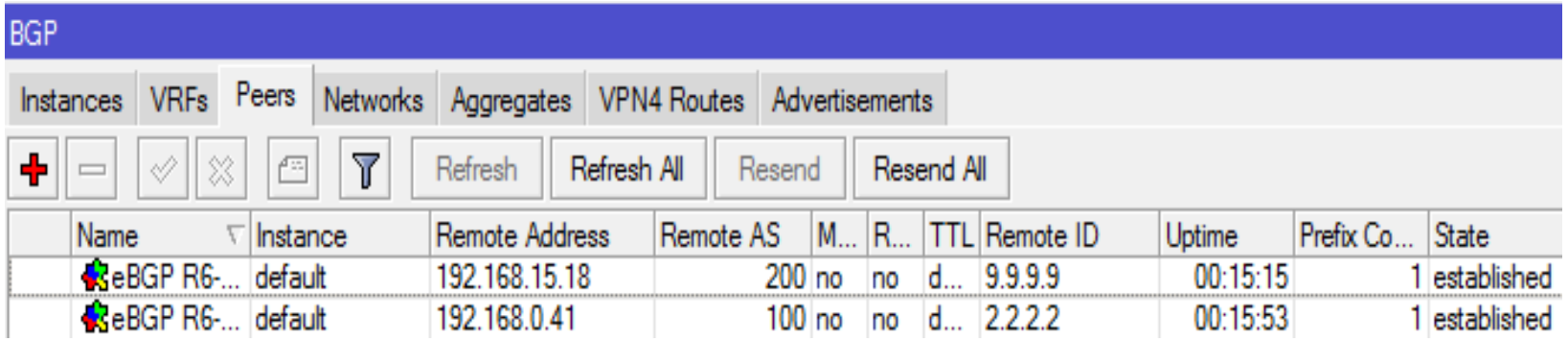

| Name | Instance | Remote Address | Remote AS | M... | R... | TTL | Remote ID | Uptime | Prefix Co... | State |
|---|---|---|---|---|---|---|---|---|---|---|
| eBGP R2-R6 | default | 192.168.0.42 | 150 | no | no | d... | 6.6.6.6 | 00:11:20 | 1 | established |
| eBGP R2-R10 | default | 192.168.0.46 | 200 | no | no | d... | 10.10.10.10 | 00:11:32 | 1 | established |

# IMPLEMENTING E-BGP (AS100 R1&R2)

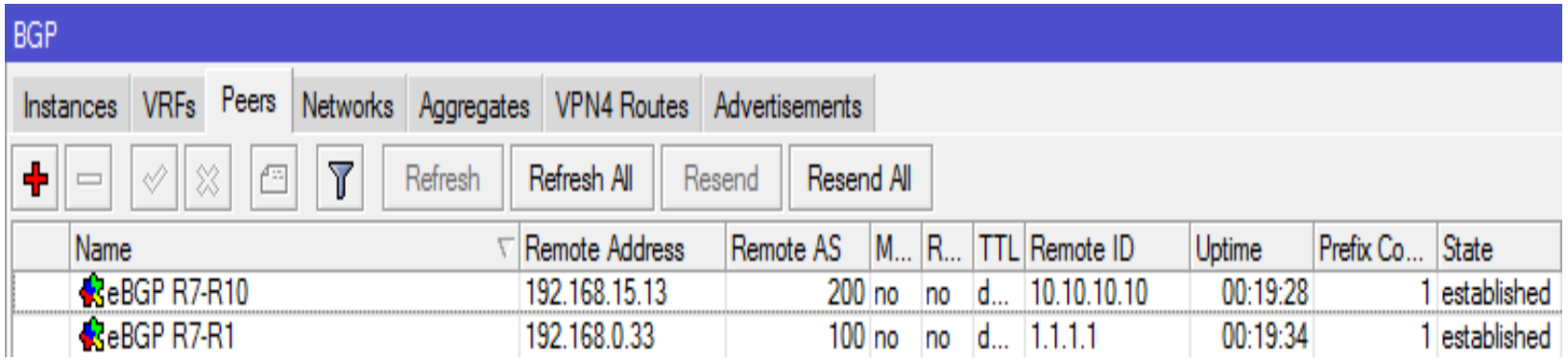


# IMPLEMENTING E-BGP (AS150 R6&R7)

R6

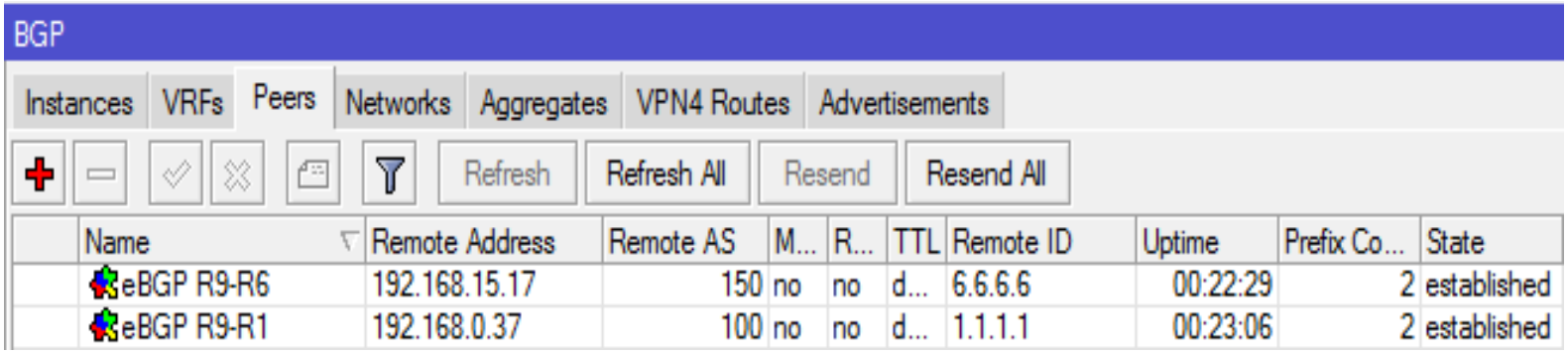



R7



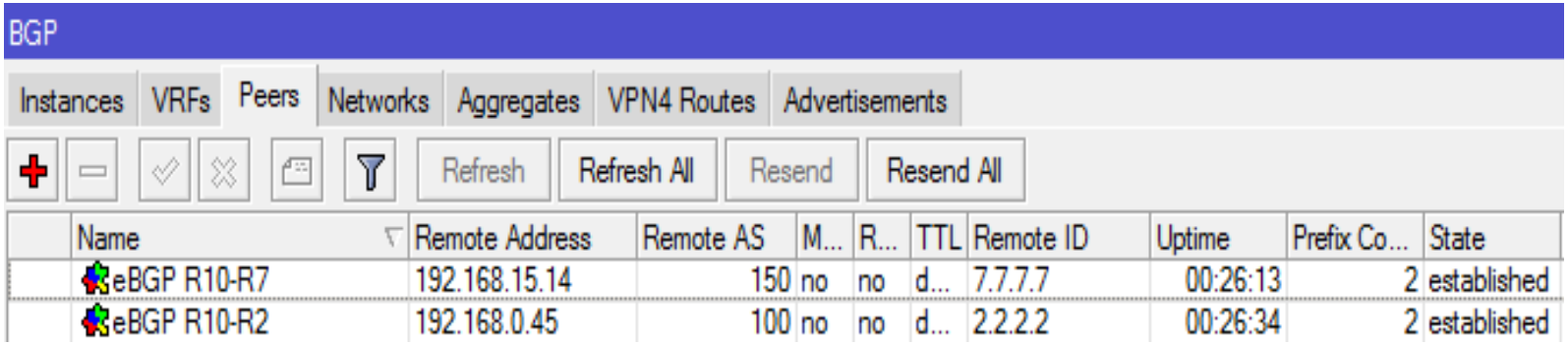
# IMPLEMENTING E-BGP (AS200 R9&10)

R9




| Name | Remote Address | Remote AS | M... | R... | TTL | Remote ID | Uptime | Prefix Co... | State |
|---|---|---|---|---|---|---|---|---|---|
| eBGP R9-R6 | 192.168.15.17 | 150 | no | no | d... | 6.6.6.6 | 00:22:29 | 2 | established |
| eBGP R9-R1 | 192.168.0.37 | 100 | no | no | d... | 1.1.1.1 | 00:23:06 | 2 | established |

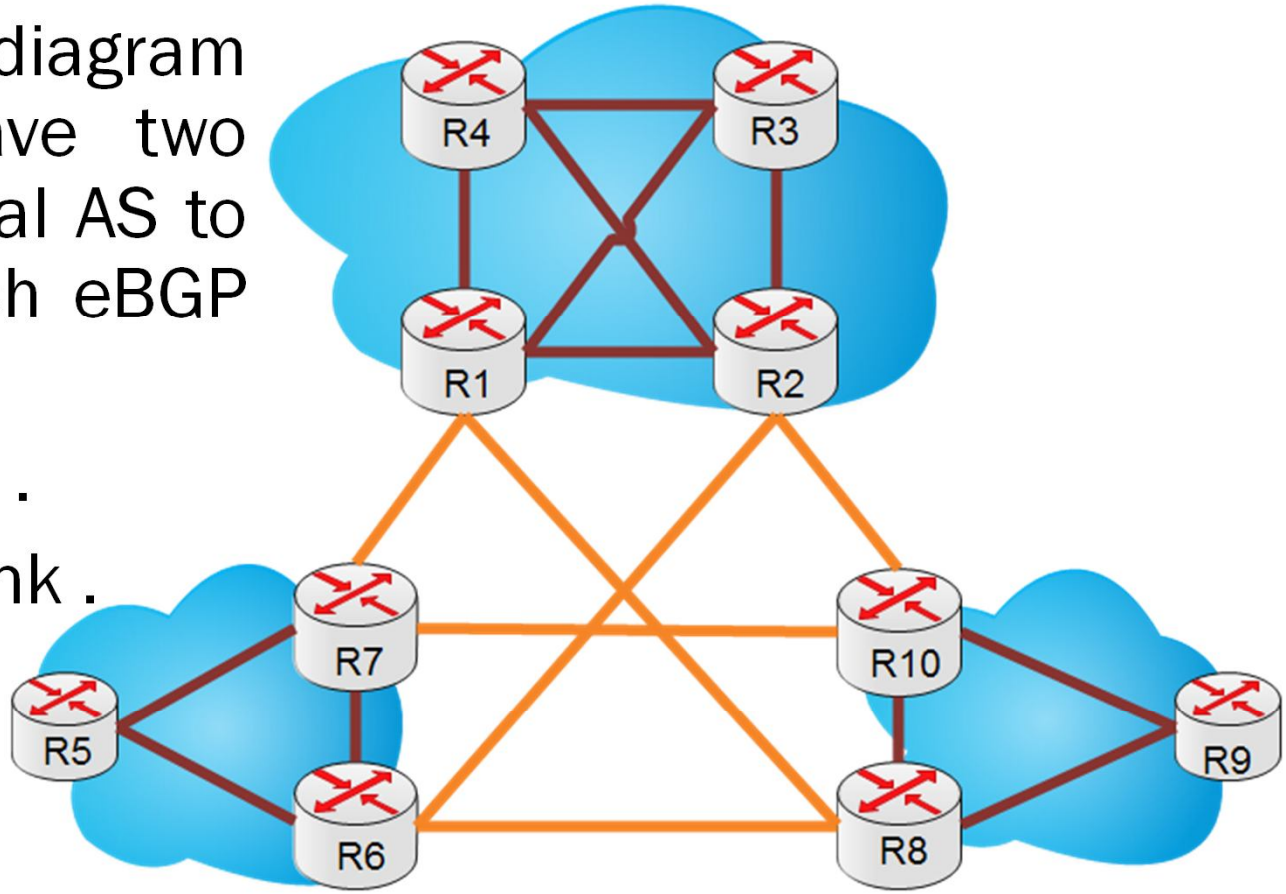
R10




| Name | Remote Address | Remote AS | M... | R... | TTL | Remote ID | Uptime | Prefix Co... | State |
|---|---|---|---|---|---|---|---|---|---|
| eBGP R10-R7 | 192.168.15.14 | 150 | no | no | d... | 7.7.7.7 | 00:26:13 | 2 | established |
| eBGP R10-R2 | 192.168.0.45 | 100 | no | no | d... | 2.2.2.2 | 00:26:34 | 2 | established |

as shown in the diagram each router have two peer with external AS to achieve full Mesh eBGP the reason is :

- ✓ Path Attribute .
- ✓ Redundant Link .



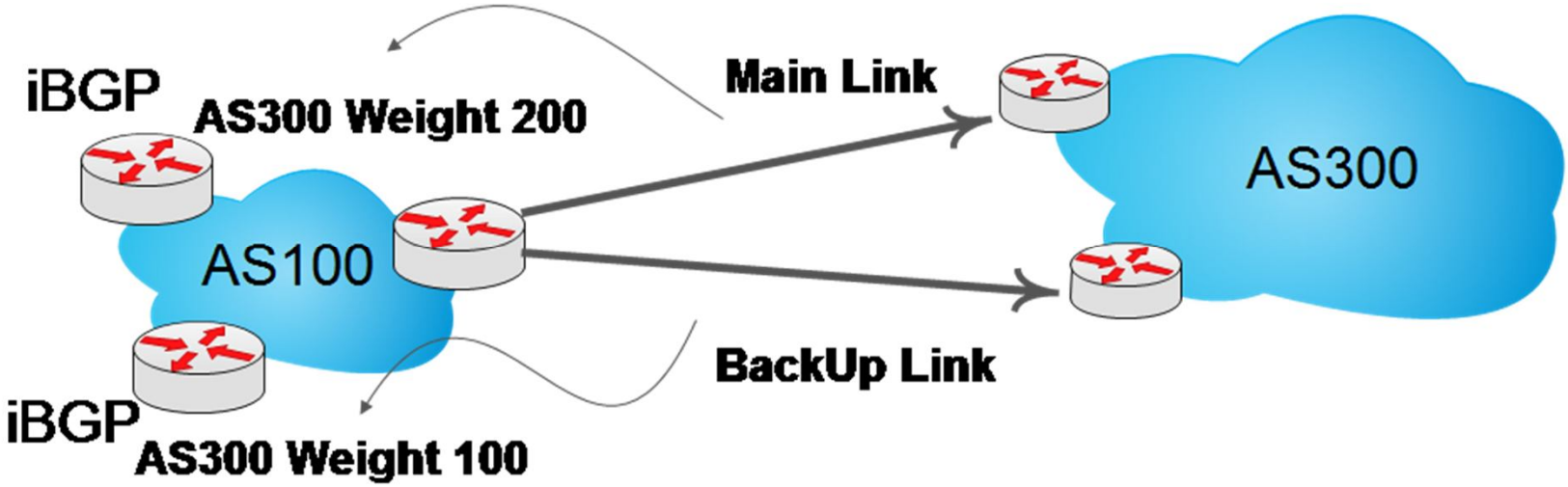
## BGP PATH ATTRIBUTE

1. AS_PATH : router choose best bath according to less AS_PATH

## BGP PATH ATTRIBUTE (CONTINUED)

2. WEIGHT : configure locally on router to select route over another i.e. One link as primary and second as redundant.

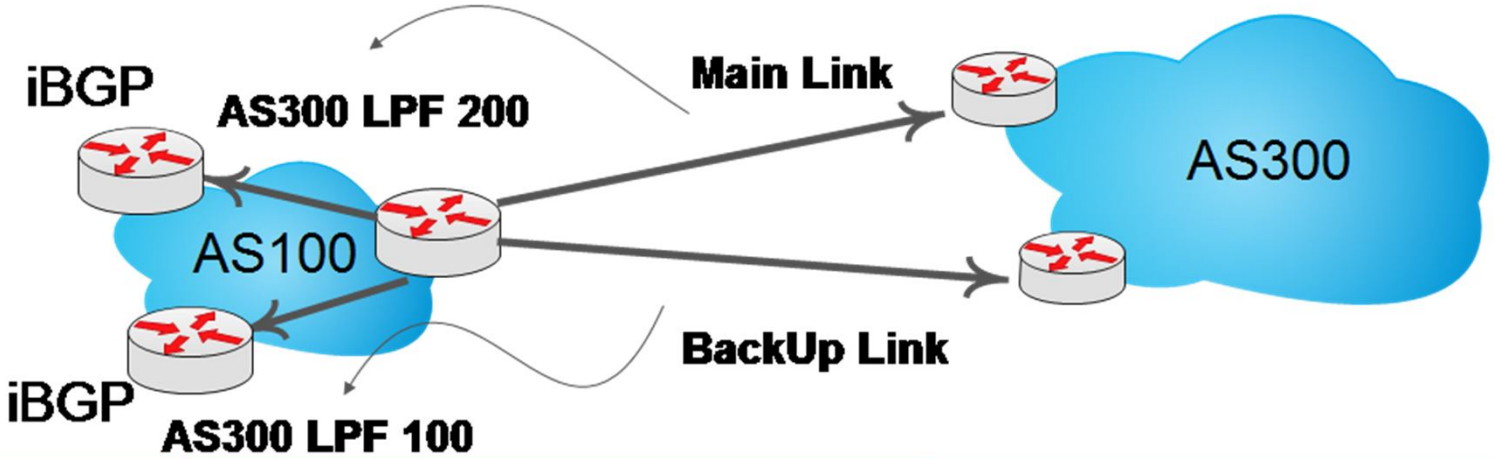
- ✓ Cannot propagate to iBGP router to update changes
- ✓ Highest Weight wins over all valid paths



## BGP PATH ATTRIBUTE (CONTINUED)

3. LOCAL_PREF : configure locally on router to select best path over another i.e. One link as primary and second as redundant.

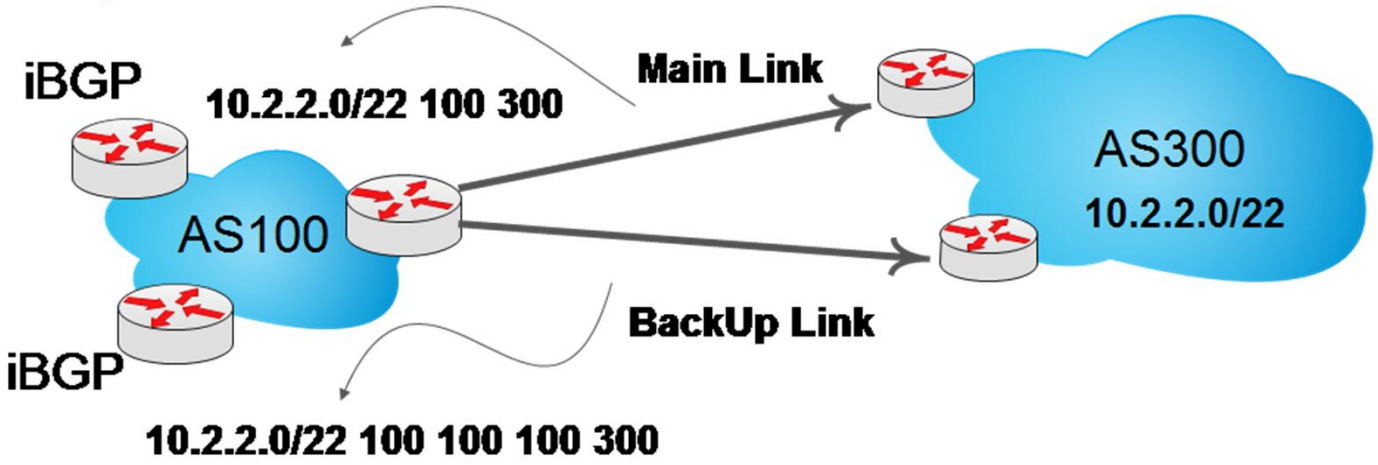
- ✓ Can propagate to iBGP router to update the changes
- ✓ Highest value wins over all valid paths



## BGP PATH ATTRIBUTE (CONTINUED)

4. Prepend : to influencing BGP route selection in the enterprise network or Internet is the extension of AS_PATH attribute , route with the shorts AS_PATH preferred.

- ✓ configure locally on router based on outbound advertise.
- ✓ Multi copies of own AS number added on AS_PATH



- Now We have full IP level connectivity between all BGP
- Neighbors (iBGP & eBGP)

Its possible to have data connectivity between ASes?

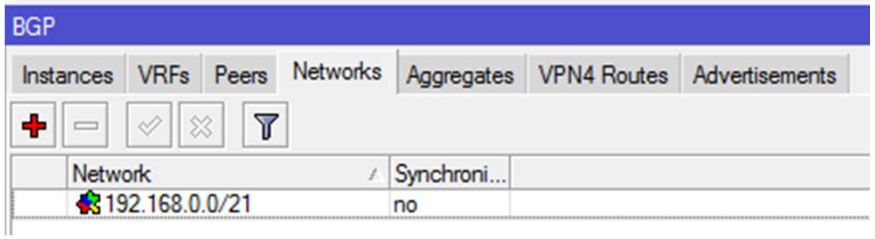
If yes how? If NO! Please explain!!

## EBGP NETWORK ADVERTISEMENT

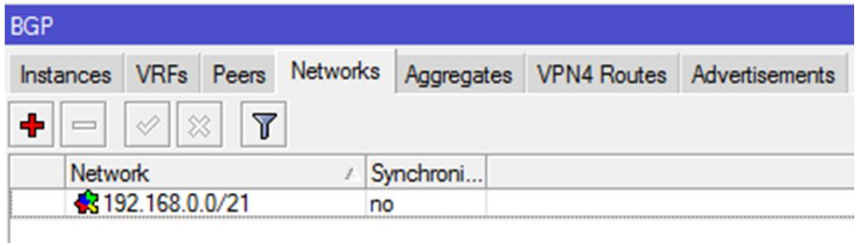
- ✓ To achieve data connectivity between all remote networks
- ✓ Let other ASes to know about Other available Network.
- ✓ Should advertise the Network via eBGP peers

# EBGP NETWORK ADVERTISEMENT (AS100R1 & R2 )

R1

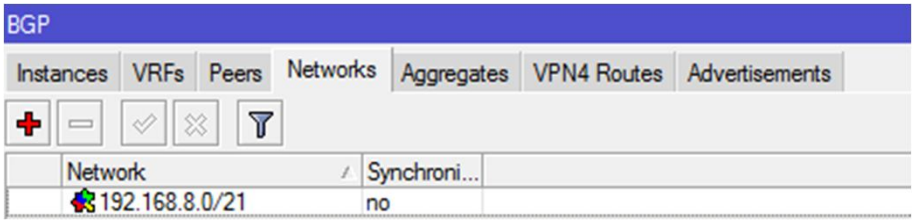



R2

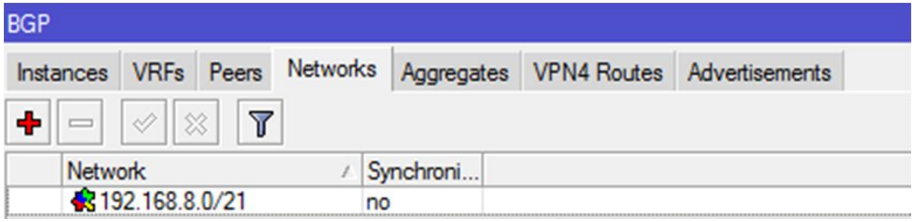


# EBGP NETWORK ADVERTISEMENT (AS150 R6& R7 )

R6

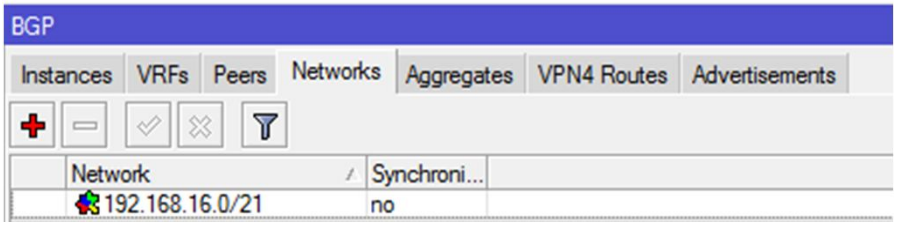



R7

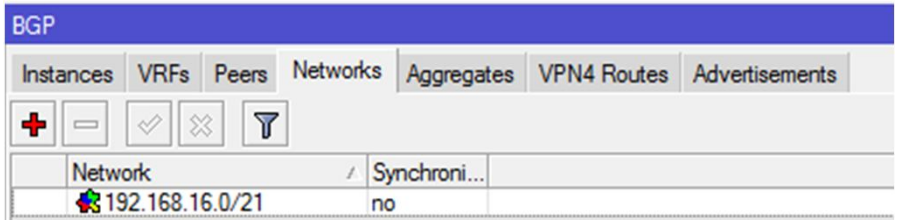


# EBGP NETWORK ADVERTISEMENT (AS200 R9& R10 )

R9




R10



## EBGP NETWORK ADVERTISEMENT (CONTINUED)

- ✓ Networks advertised on all you eBGP peers
- ✓ Each eBGP peer also receive other network advertised for direct connect peers.
- ✓ All eBGP router will re-advertise learned network from other peers and listed in BGP data base to direct connected peers

Note : eBGP will drop its own network at received update from other peers

# BGP DATA BASE UPDATE TYPES (CONTINUED)

Full Update occurred When you turn on router first time or after hardware fail

Partial Update occurred when any new change happened at BGP data base i.e. added new network!

- Network with Local Preference 100 will update only to i-BGP peers
- Network with Local Preference 0 will update only to eBGP peers

# BGP DATA BASE UPDATE TYPES (CONTINUED)

Networks belong AS100

Networks learned from eBGP advertise to iBGP

Networks learned from eBGP re-advertise to eBGP

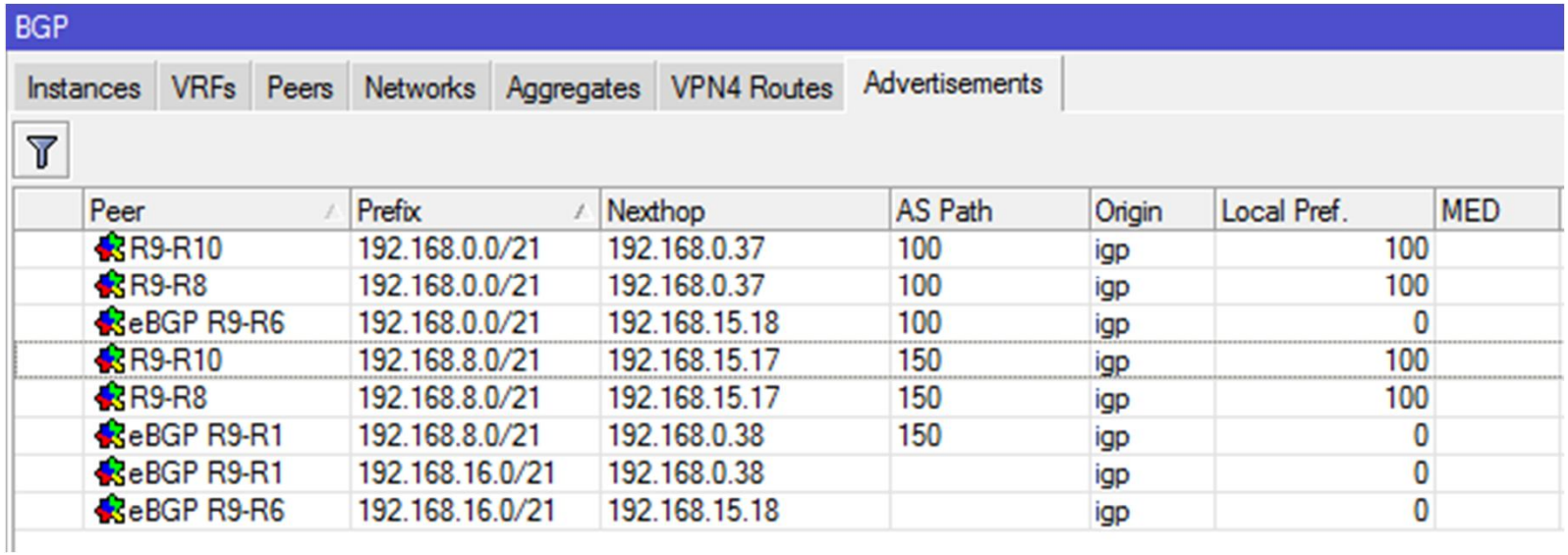
BGP

Instances | VRFs | Peers | Networks | Aggregates | VPN4 Routes | Advertisements

| Peer | Prefix | Nexthop | AS Path | Origin | Local P... | MED |
|---|---|---|---|---|---|---|
| eBGP R2-R10 | 192.168.0.0/21 | 192.168.0.45 | | igp | 0 | |
| eBGP R2-R6 | 192.168.0.0/21 | 192.168.0.41 | | igp | 0 | |
| R2-R1 | 192.168.8.0/21 | 192.168.0.42 | 150 | igp | 100 | |
| R2-R3 | 192.168.8.0/21 | 192.168.0.42 | 150 | igp | 100 | |
| R2-R4 | 192.168.8.0/21 | 192.168.0.42 | 150 | igp | 100 | |
| eBGP R2-R10 | 192.168.8.0/21 | 192.168.0.45 | 150 | igp | 0 | |
| R2-R1 | 192.168.16.0/21 | 192.168.0.46 | 200 | igp | 100 | |
| R2-R3 | 192.168.16.0/21 | 192.168.0.46 | 200 | igp | 100 | |
| R2-R4 | 192.168.16.0/21 | 192.168.0.46 | 200 | igp | 100 | |
| eBGP R2-R6 | 192.168.16.0/21 | 192.168.0.41 | 200 | igp | 0 | |

# BGP DATA BASE UPDATE TYPES (CONTINUED)

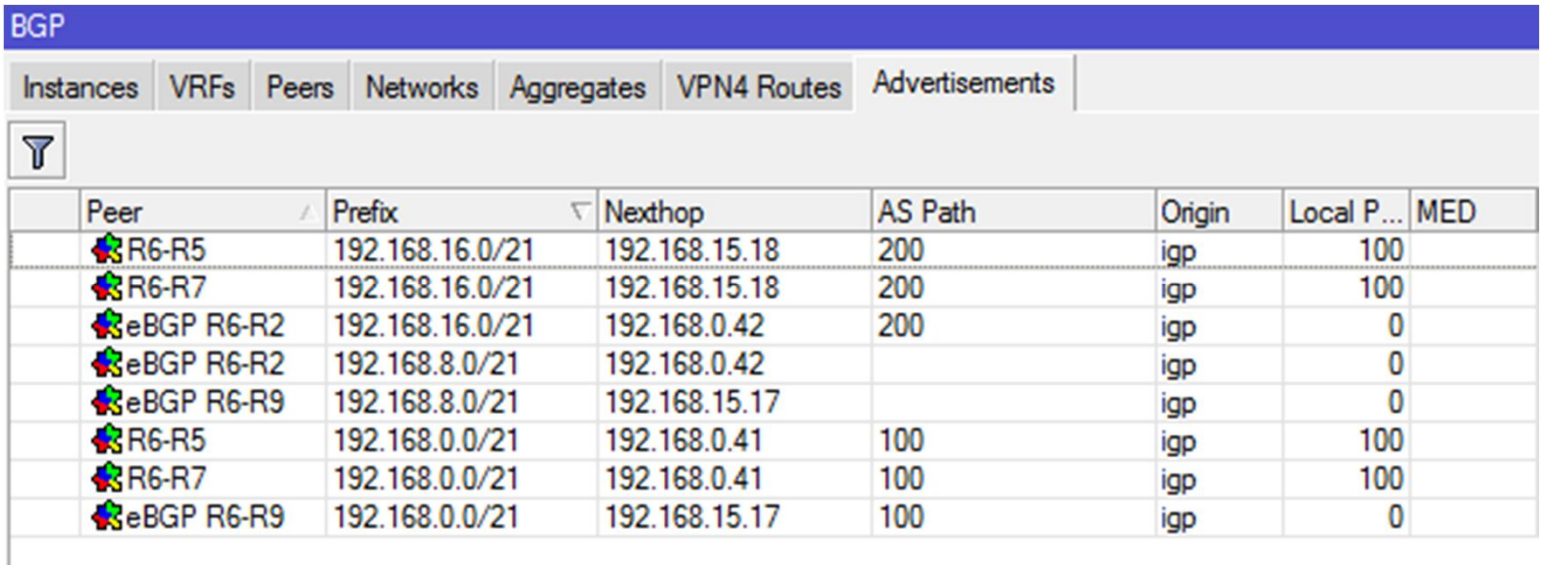
AS 200




| Peer | Prefix | Nexthop | AS Path | Origin | Local Pref. | MED |
|---|---|---|---|---|---|---|
| R9-R10 | 192.168.0.0/21 | 192.168.0.37 | 100 | igp | 100 | |
| R9-R8 | 192.168.0.0/21 | 192.168.0.37 | 100 | igp | 100 | |
| eBGP R9-R6 | 192.168.0.0/21 | 192.168.15.18 | 100 | igp | 0 | |
| R9-R10 | 192.168.8.0/21 | 192.168.15.17 | 150 | igp | 100 | |
| R9-R8 | 192.168.8.0/21 | 192.168.15.17 | 150 | igp | 100 | |
| eBGP R9-R1 | 192.168.8.0/21 | 192.168.0.38 | 150 | igp | 0 | |
| eBGP R9-R1 | 192.168.16.0/21 | 192.168.0.38 | | igp | 0 | |
| eBGP R9-R6 | 192.168.16.0/21 | 192.168.15.18 | | igp | 0 | |

# BGP DATA BASE UPDATE TYPES (CONTINUED)

AS 150




| Peer | Prefix | Nexthop | AS Path | Origin | Local P... | MED |
|---|---|---|---|---|---|---|
| R6-R5 | 192.168.16.0/21 | 192.168.15.18 | 200 | igp | 100 | |
| R6-R7 | 192.168.16.0/21 | 192.168.15.18 | 200 | igp | 100 | |
| eBGP R6-R2 | 192.168.16.0/21 | 192.168.0.42 | 200 | igp | 0 | |
| eBGP R6-R2 | 192.168.8.0/21 | 192.168.0.42 | | igp | 0 | |
| eBGP R6-R9 | 192.168.8.0/21 | 192.168.15.17 | | igp | 0 | |
| R6-R5 | 192.168.0.0/21 | 192.168.0.41 | 100 | igp | 100 | |
| R6-R7 | 192.168.0.0/21 | 192.168.0.41 | 100 | igp | 100 | |
| eBGP R6-R9 | 192.168.0.0/21 | 192.168.15.17 | 100 | igp | 0 | |

## REDISTRIBUTE BGP DATA BASE TO IGP

To make lower routers reach the external network need to update the learned network from BGP to Internal routing protocol (OSPF).

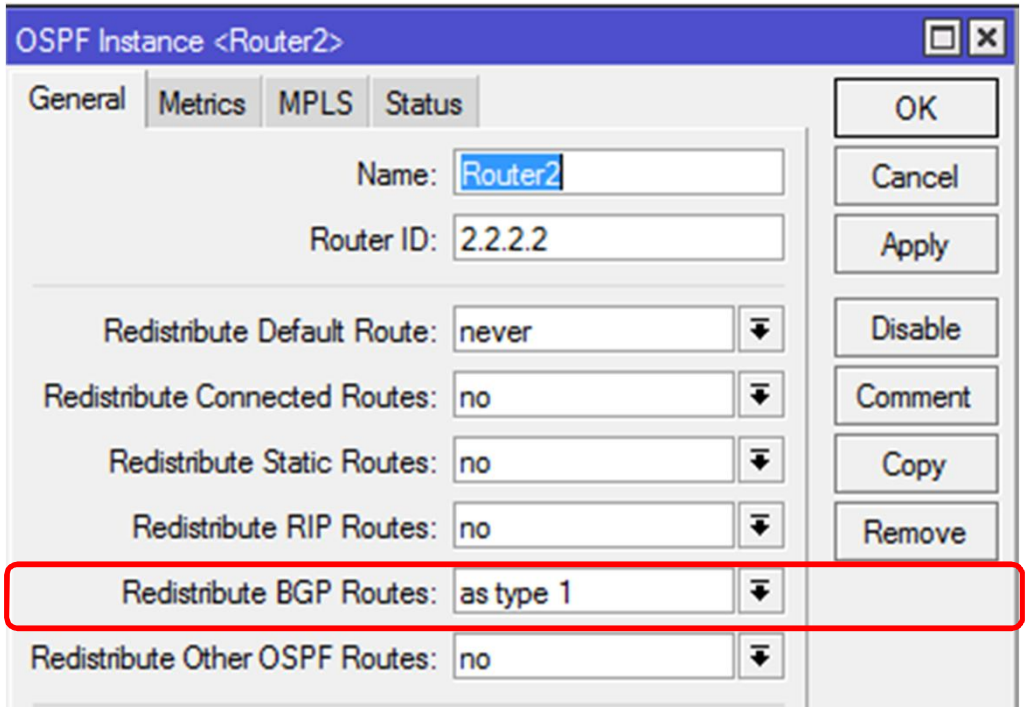
At OSPF instance should set redistribute BGP as TYPE-1 (E1)

Why should be as TYPE 1?

- (E1) TYPE 1 increment cost (OSPF metric) as moving through OSPF domain and OSPF AS.

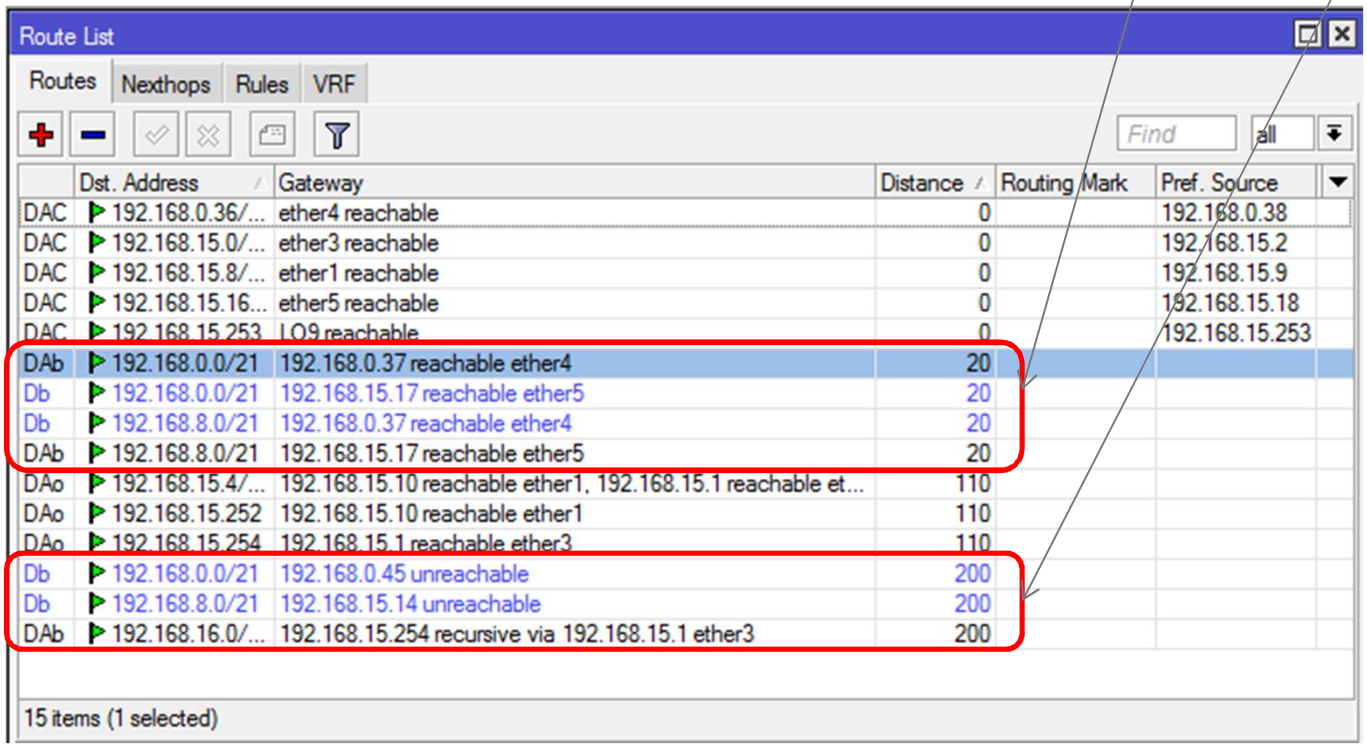
- To prevent routing loop at OSPF domain! cause there is more that on external link

# REDISTRIBUTE BGP DATA BASE TO IGP



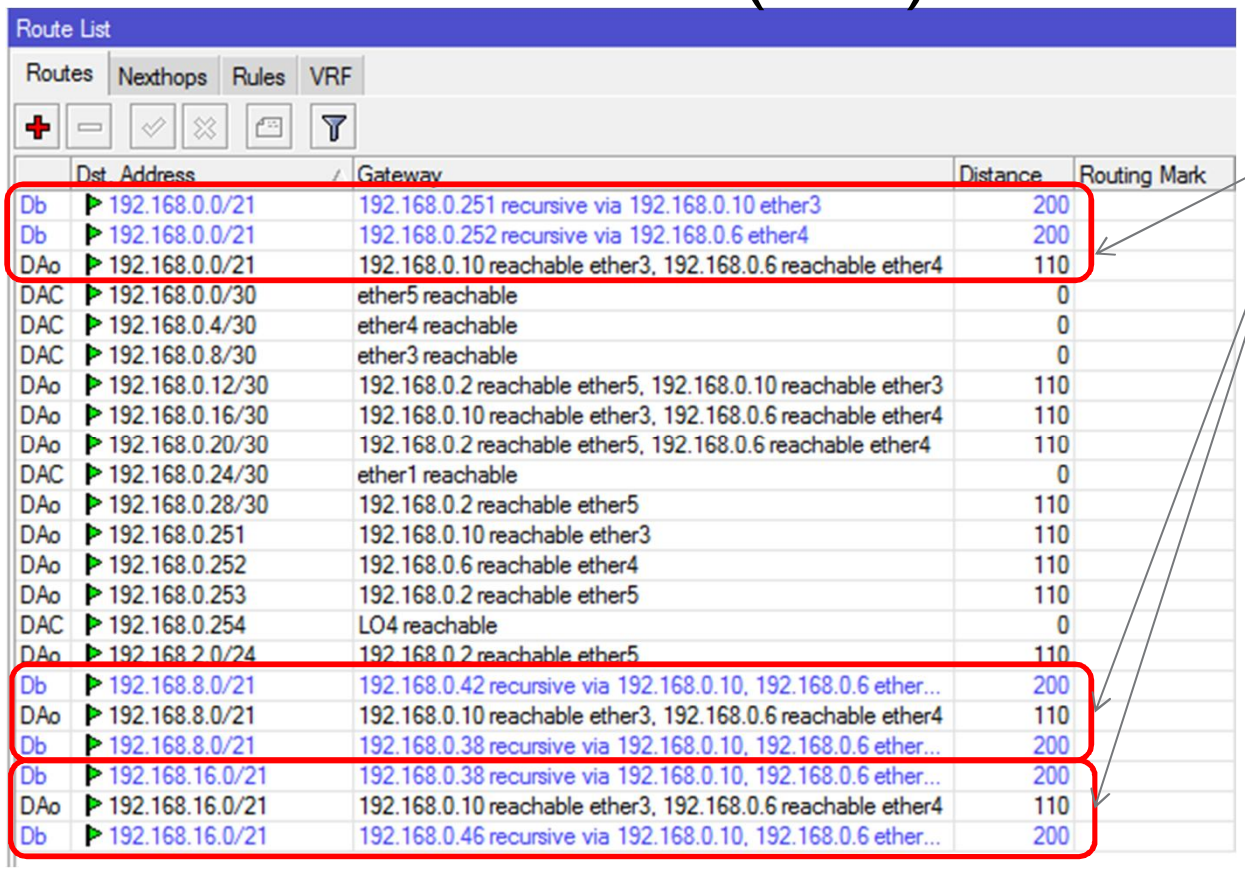
# MAIN ROUTING TABLE AT ASBR

Network reachable via eBGP and iBGP




D = Dynamic
A= Active
b = BGP
eBGP distance = 20
iBGP distance=200
Blue color = backup route

# MAIN ROUTING TABLE (ABR)

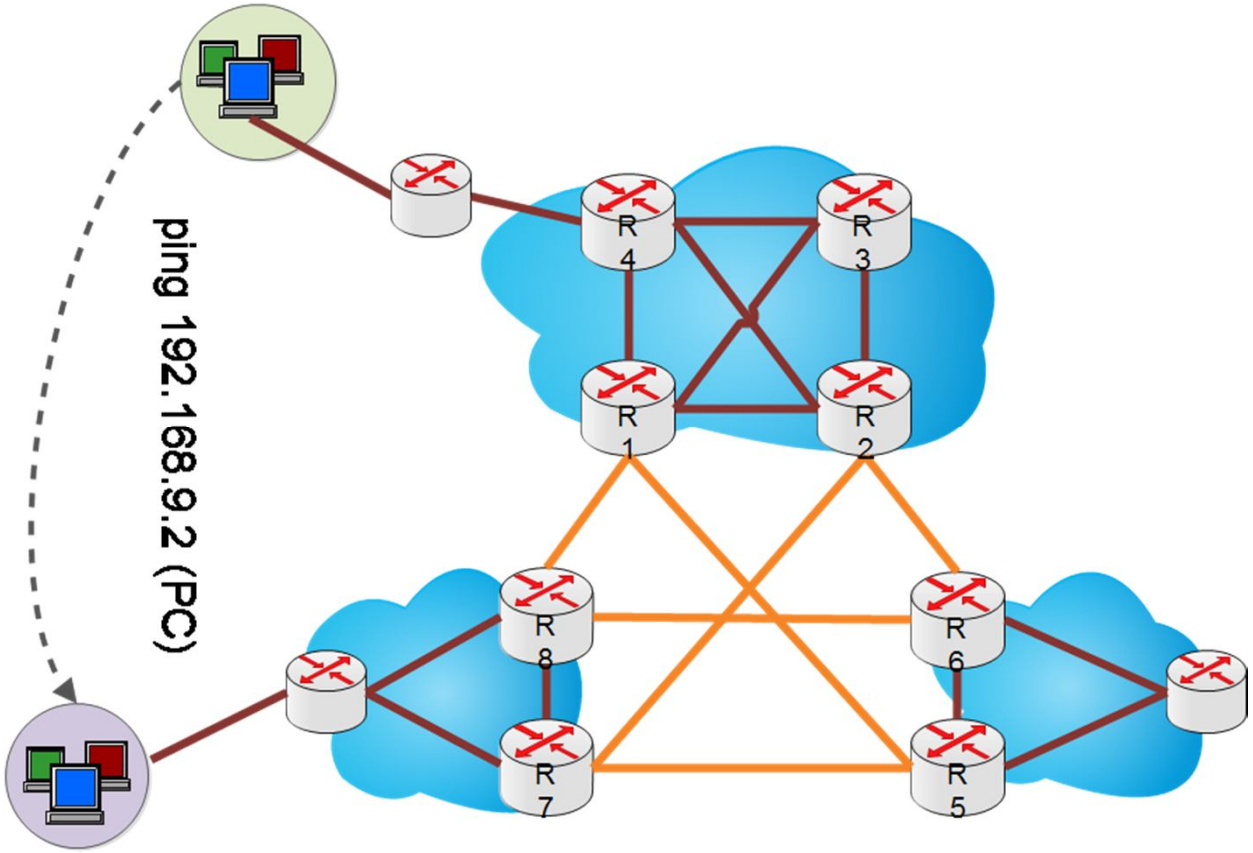



| | Dst. Address | Gateway | Distance | Routing Mark |
|---|---|---|---|---|
| Db | 192.168.0.0/21 | 192.168.0.251 recursive via 192.168.0.10 ether3 | 200 | |
| Db | 192.168.0.0/21 | 192.168.0.252 recursive via 192.168.0.6 ether4 | 200 | |
| DAo | 192.168.0.0/21 | 192.168.0.10 reachable ether3, 192.168.0.6 reachable ether4 | 110 | |
| DAC | 192.168.0.0/30 | ether5 reachable | 0 | |
| DAC | 192.168.0.4/30 | ether4 reachable | 0 | |
| DAC | 192.168.0.8/30 | ether3 reachable | 0 | |
| DAo | 192.168.0.12/30 | 192.168.0.2 reachable ether5, 192.168.0.10 reachable ether3 | 110 | |
| DAo | 192.168.0.16/30 | 192.168.0.10 reachable ether3, 192.168.0.6 reachable ether4 | 110 | |
| DAo | 192.168.0.20/30 | 192.168.0.2 reachable ether5, 192.168.0.6 reachable ether4 | 110 | |
| DAC | 192.168.0.24/30 | ether1 reachable | 0 | |
| DAo | 192.168.0.28/30 | 192.168.0.2 reachable ether5 | 110 | |
| DAo | 192.168.0.251 | 192.168.0.10 reachable ether3 | 110 | |
| DAo | 192.168.0.252 | 192.168.0.6 reachable ether4 | 110 | |
| DAo | 192.168.0.253 | 192.168.0.2 reachable ether5 | 110 | |
| DAC | 192.168.0.254 | LO4 reachable | 0 | |
| DAo | 192.168.2.0/24 | 192.168.0.2 reachable ether5 | 110 | |
| Db | 192.168.8.0/21 | 192.168.0.42 recursive via 192.168.0.10, 192.168.0.6 ether... | 200 | |
| DAo | 192.168.8.0/21 | 192.168.0.10 reachable ether3, 192.168.0.6 reachable ether4 | 110 | |
| Db | 192.168.8.0/21 | 192.168.0.38 recursive via 192.168.0.10, 192.168.0.6 ether... | 200 | |
| Db | 192.168.16.0/21 | 192.168.0.38 recursive via 192.168.0.10, 192.168.0.6 ether... | 200 | |
| DAo | 192.168.16.0/21 | 192.168.0.10 reachable ether3, 192.168.0.6 reachable ether4 | 110 | |
| Db | 192.168.16.0/21 | 192.168.0.46 recursive via 192.168.0.10, 192.168.0.6 ether... | 200 | |

Network learned from iBGP but reachable via IGP cause its less distance

D = Dynamic
A= Active
b = BGP
o = OSPF
iBGP distance=200
OSPF distance=110
Blue color = backup route

# TESTING CONNECTIVITY BETWEEN ASES



# TESTING CONNECTIVITY BETWEEN ASES

```
C:\Users\Ali>tracert -d 192.168.9.2

Tracing route to 192.168.9.2 over a maximum of 30 hops

  1   261 ms   202 ms   290 ms  192.168.1.1
  2     1 ms     1 ms     1 ms  192.168.0.25
  3     1 ms     1 ms     1 ms  192.168.0.10
  4     1 ms    19 ms     1 ms  192.168.0.38
  5     1 ms     1 ms     1 ms  192.168.0.42
  6     1 ms    <1 ms     1 ms  192.168.8.10
  7     1 ms     1 ms     1 ms  192.168.8.14
  8     1 ms    <1 ms     1 ms  192.168.9.2

Trace complete.

C:\Users\Ali>ping  192.168.9.2

Pinging 192.168.9.2 with 32 bytes of data:
Reply from 192.168.9.2: bytes=32 time=1ms TTL=121
Reply from 192.168.9.2: bytes=32 time=1ms TTL=121
Reply from 192.168.9.2: bytes=32 time=1ms TTL=121

Ping statistics for 192.168.9.2:
    Packets: Sent = 3, Received = 3, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

# THANKS FOR ATTENTION

MikroTik-IQ
RouterBoards - Solutions - Training

Resources:

http://wiki,mikrotik.com

http://www.cisco.com

http://www.wikipedia.com