



Enterprise networking

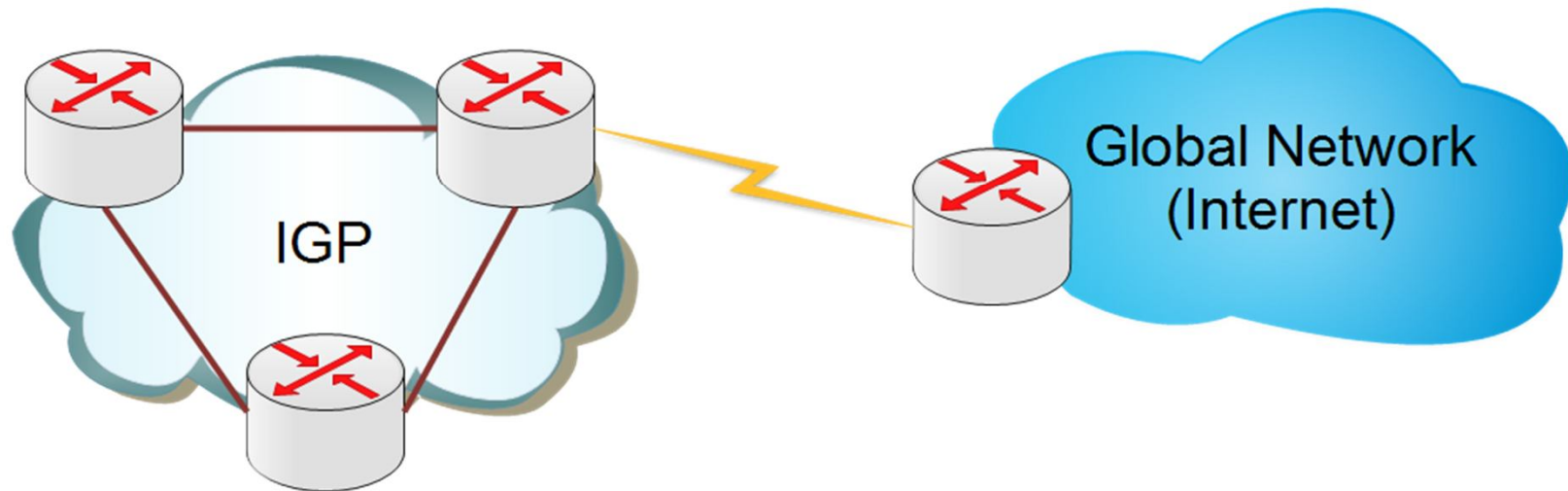
IGP and iBGP/MPLS, eBGP

MANAGE YOUR NETWORK WITH NO LIMITATION
MIKROTIK ROUTER OS
MUM DUBAI 2012
BY- ALI SAMI & HAYDAR FADEL

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INTERIOR GATEWAY PROTOCOL

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




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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

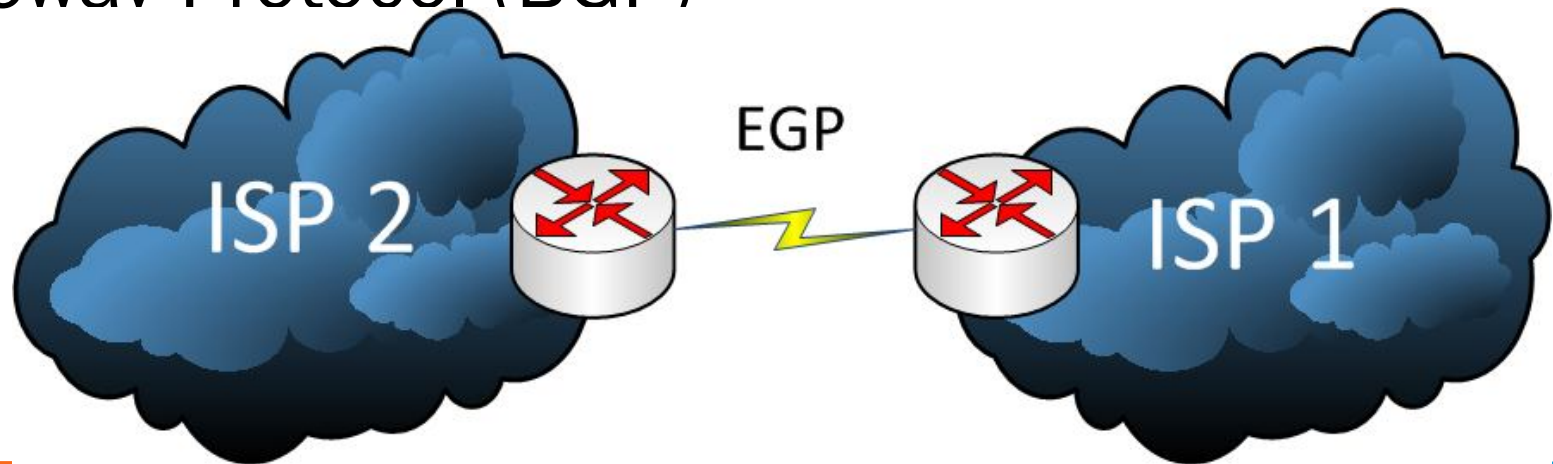


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EXTERIOR GATEWAY PROTOCOL

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




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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)

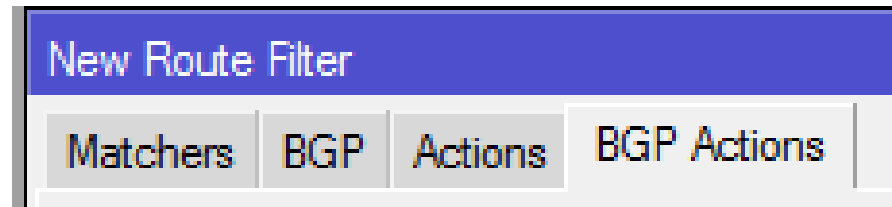
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BORDER GATEWAY PROTOCOL (CONTINUED...)

- ✓ 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.




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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.

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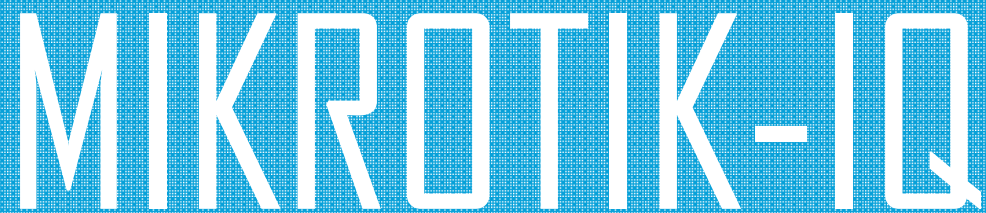
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EXTERNAL BGP

- ✓ 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

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BGP ROUTER 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

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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 Multihomed.
5. Transit

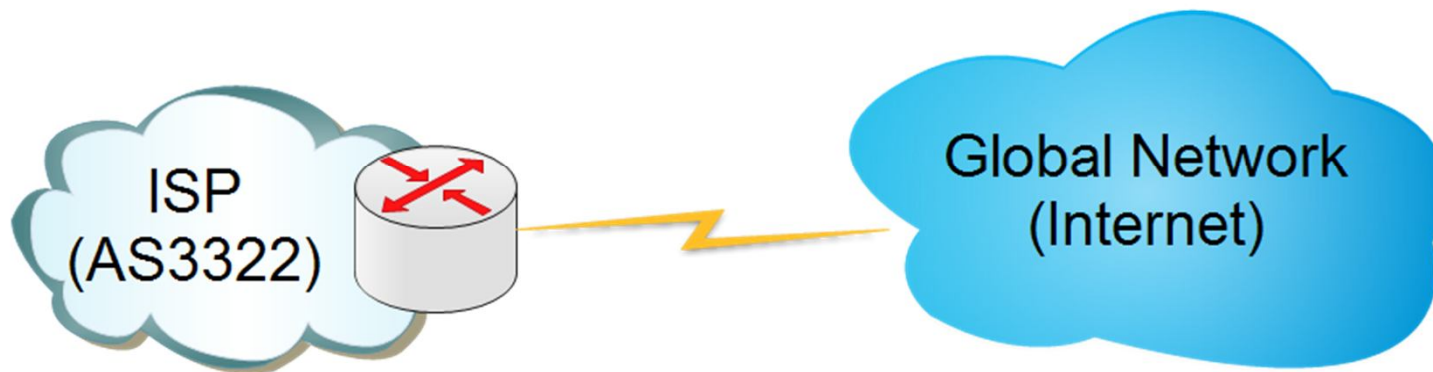


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SINGLE HOMED

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

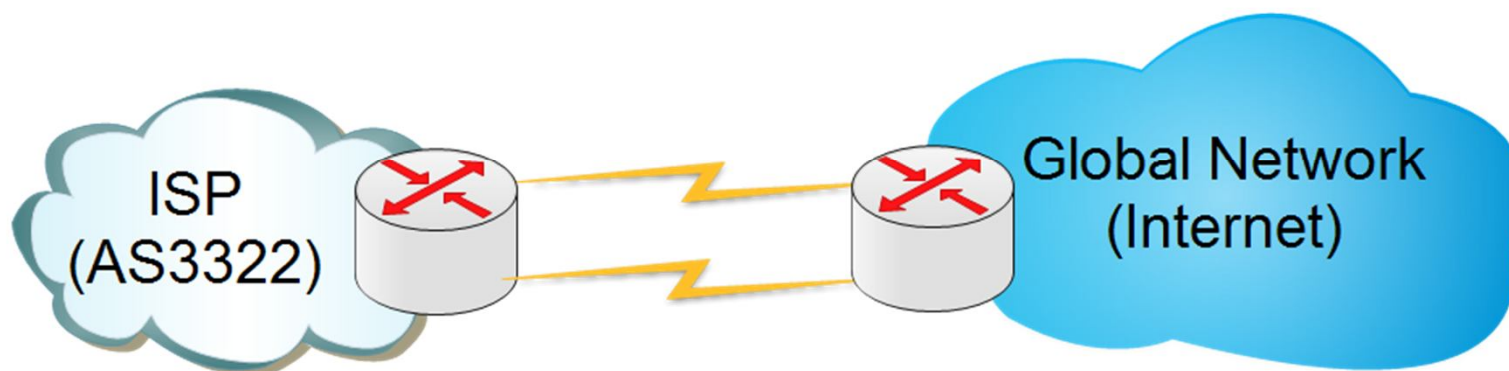


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DUAL HOMED

- 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.

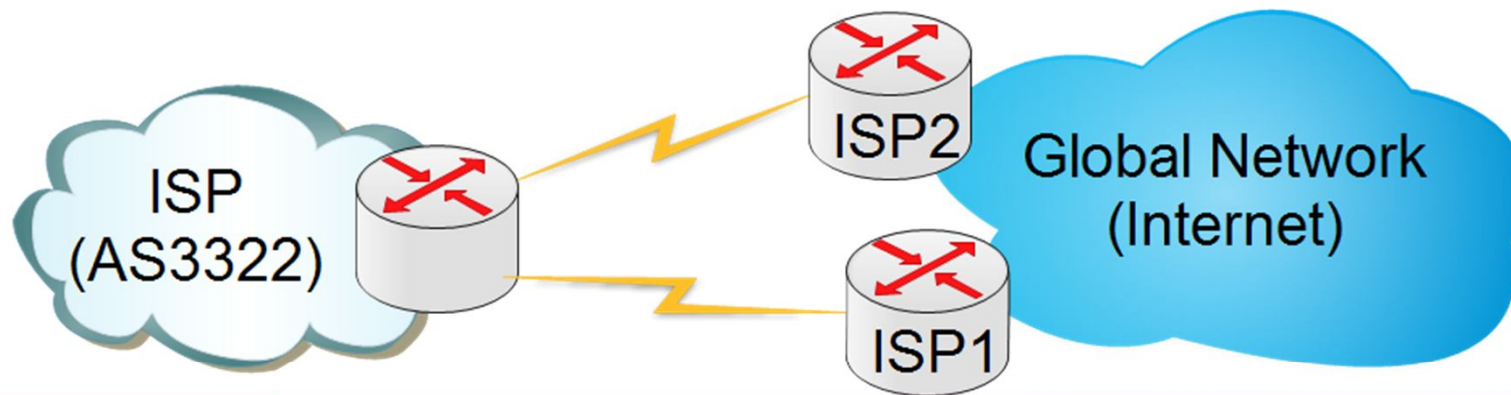


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SINGLE MULTIHOME

- 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

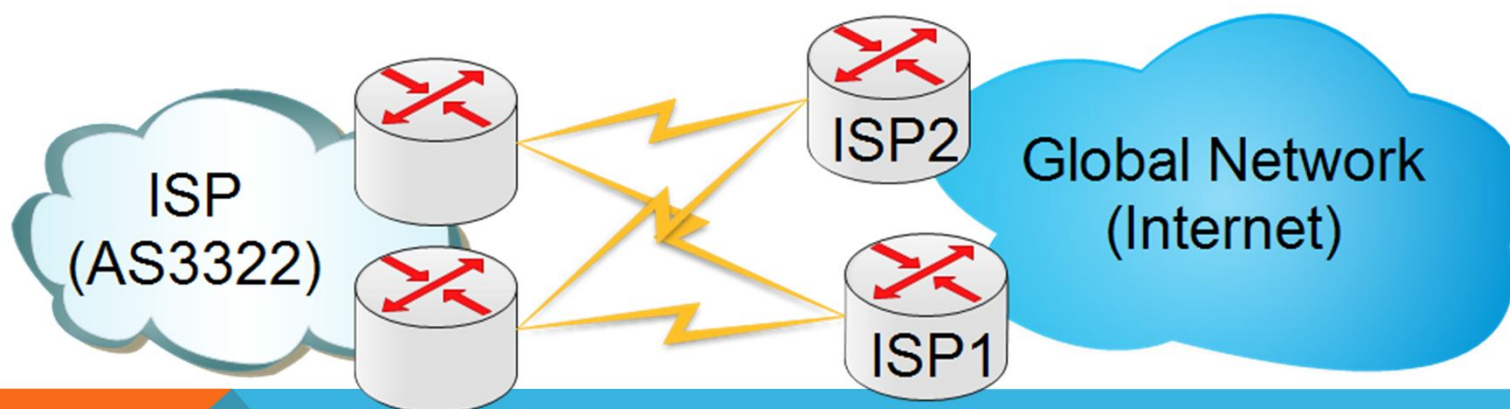


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DUAL MULTIHOME

- 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

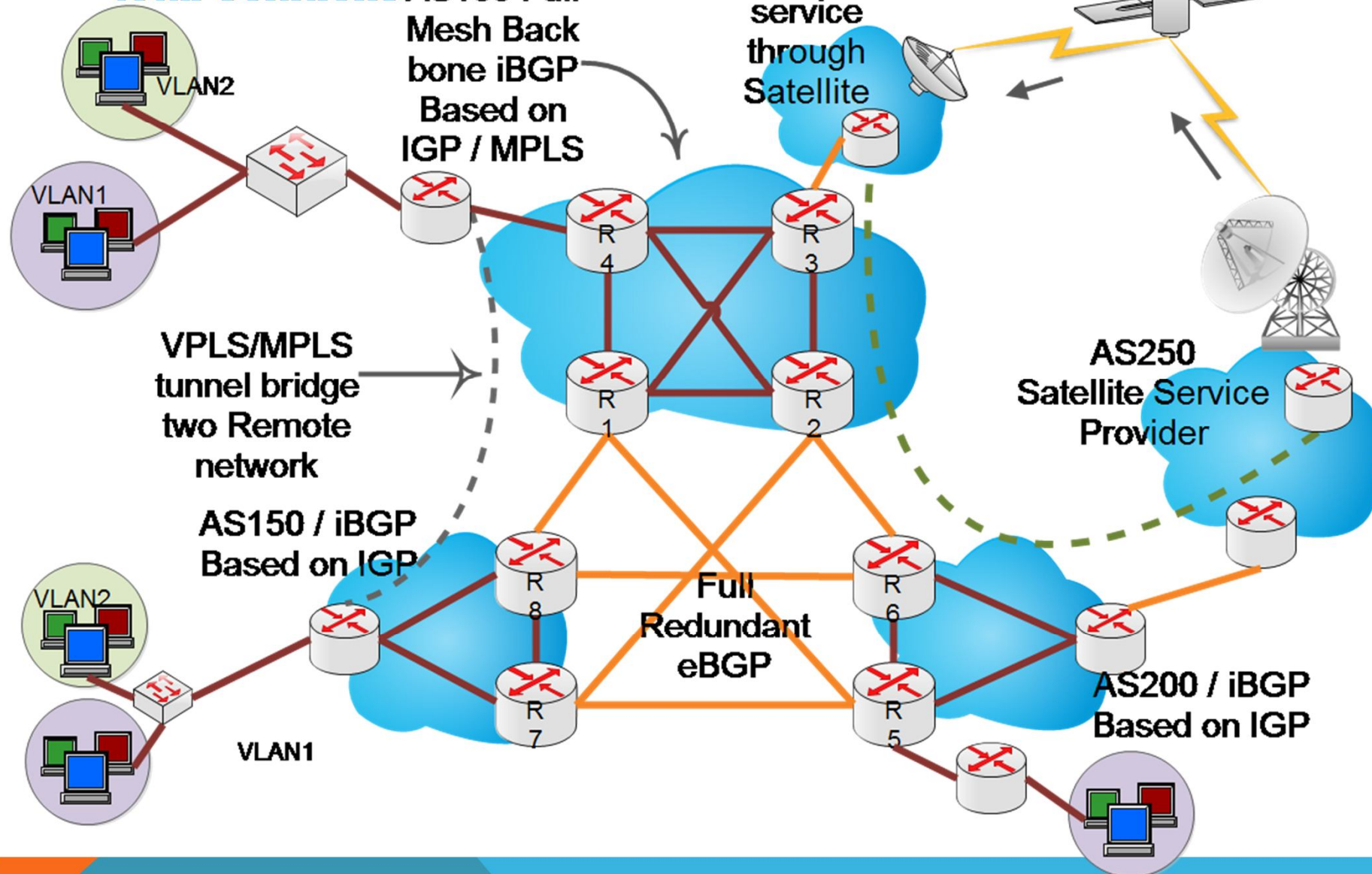


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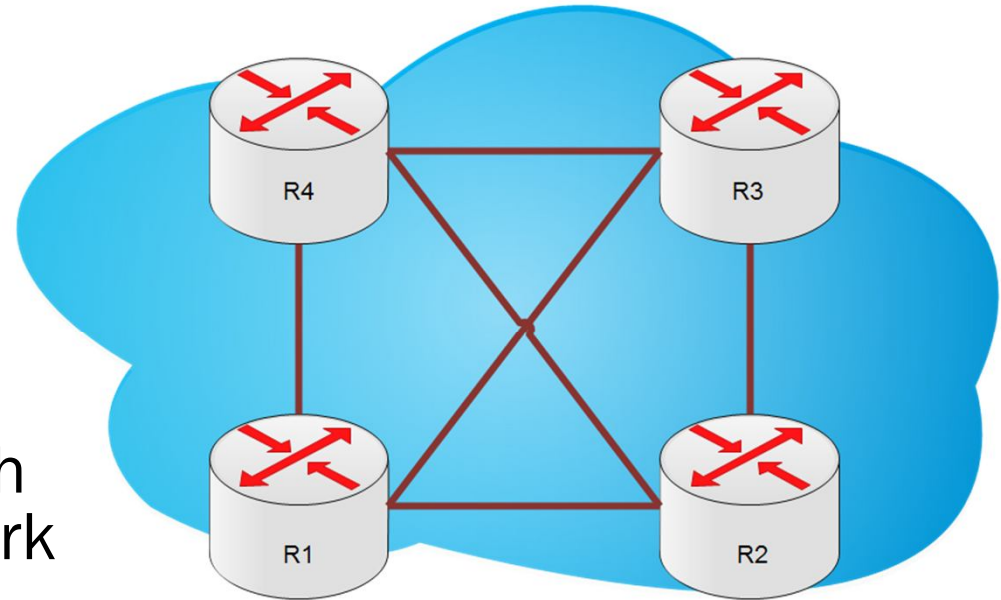
Enterprise Networking

total Solutions



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




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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


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IMPLEMENTATION AS 100 STEPS

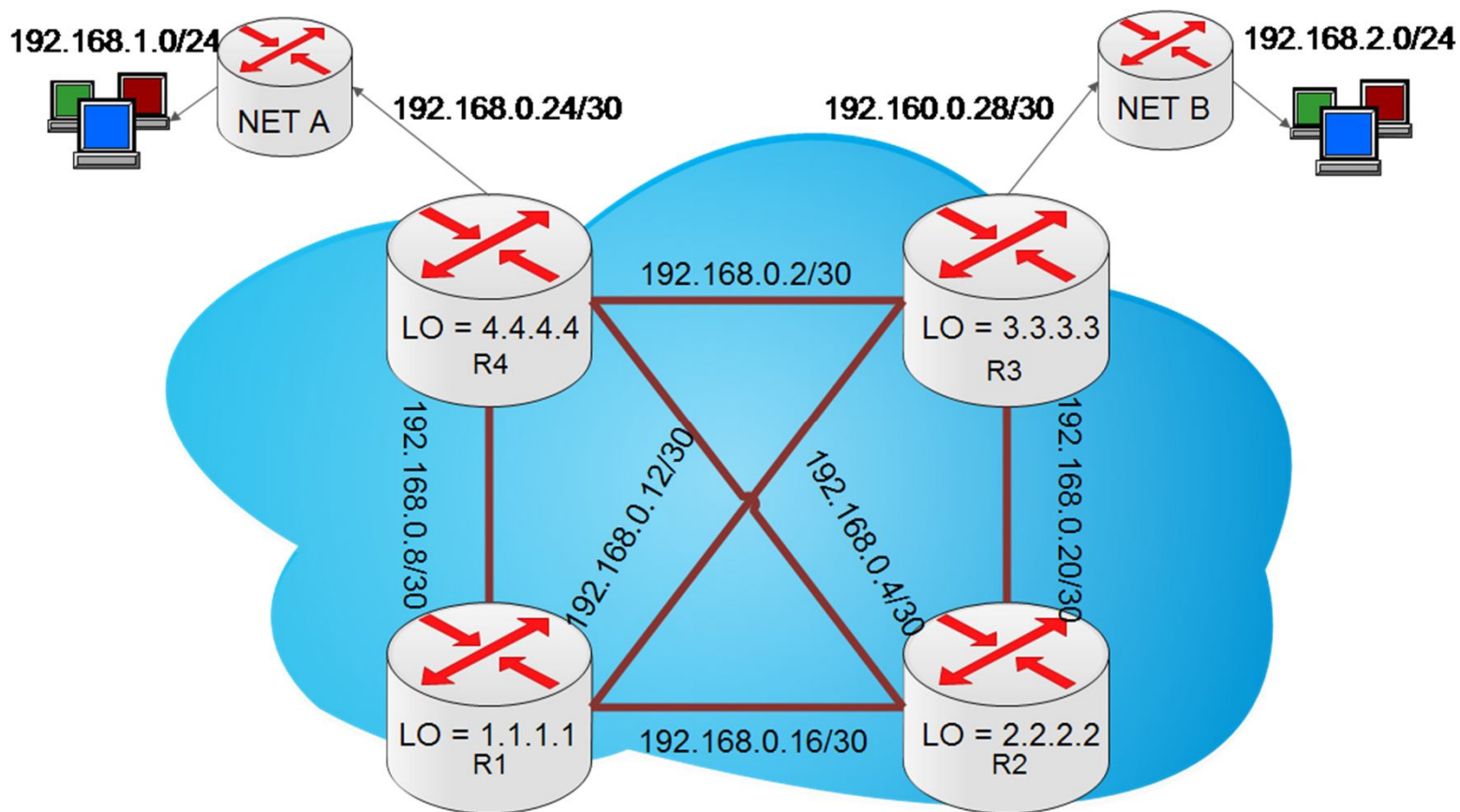
- 1- Physical connectivity using Giga bit cooper or fiber
- 2- IP level connectivity between router using /30 subnet
- 3- Create Logical interface using bridge inside each core router
- 4- Use OSPF as carrier and network advertisements between routers .
- 5- MPLS between iBGP routers
- 6- Peer between iBGP routers



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IP LEVEL LAYOUT



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IMPLEMENTING OSPF

OSPF Instance <Router1>

General Metrics MPLS Status

Name: Router1

Router ID: 1.1.1.1

R1

OSPF

Interfaces Instances Networks Areas Area Ranges Virtual Links Neighbors

Y

	Instance /	Router ID	Address	Interface	State Changes
	Router1	3.3.3.3	192.168.0.14	ether2	6
	Router1	2.2.2.2	192.168.0.18	ether1	5
	Router1	4.4.4.4	192.168.0.9	ether3	5

OSPF Instance <Router2>

General Metrics MPLS Status

Name: Router2

Router ID: 2.2.2.2

R2

OSPF

Interfaces Instances Networks Areas Area Ranges Virtual Links Neighbors

Y

	Instance /	Router ID	Address	Interface	State Changes
	Router2	3.3.3.3	192.168.0.22	ether2	6
	Router2	4.4.4.4	192.168.0.5	ether3	6
	Router2	1.1.1.1	192.168.0.17	ether1	5

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IMPLEMENTING OSPF

OSPF Instance <Router3>

General Metrics MPLS Status

Name: Router3

Router ID: 3.3.3.3

R3

OSPF Instance <Router4>

General Metrics MPLS Status

Name: Router4

Router ID: 4.4.4.4

R4

OSPF					
Interfaces Instances Networks Areas Area Ranges Virtual Links Neighbors					
Instance /	Router ID	Address	Interface	State Cha...	
Route...	2.2.2.2	192.168.0.21	ether3	5	
Route...	4.4.4.4	192.168.0.1	ether4	6	
Route...	1.1.1.1	192.168.0.13	ether2	5	

OSPF					
Interfaces Instances Networks Areas Area Ranges Virtual Links Neighbors					
Instance /	Router ID	Address	Interface	State Changes	
Router4	1.1.1.1	192.168.0.10	ether3	5	
Router4	2.2.2.2	192.168.0.6	ether4	5	
Router4	3.3.3.3	192.168.0.2	ether5	5	

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IMPLEMENTING MPLS

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table

+ - ✓ ✕ [icon] [icon] MPLS Settings LDP Settings

Interface	Hello Interval	Hold Time	Transport Addr...	Accept Dyna...
ether1	00:00:05	00:00:15		yes
ether10	00:00:05	00:00:15		yes
ether5	00:00:05	00:00:15		yes

LDP Settings

☒ Enabled

LSR ID: 1.1.1.1

Transport Address: 1.1.1.1

Path Vector Limit: 255

Hop Limit: 255

OK Cancel Apply

R1

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter

+ - ✓ ✕ [icon] [icon]

Transport	Send ...	Peer	Local Transport
DO 2.2.2.2	no	2.2.2.2:0	1.1.1.1
DO 3.3.3.3	no	3.3.3.3:0	1.1.1.1
DO 4.4.4.4	no	4.4.4.4:0	1.1.1.1

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table

+ - ✓ ✕ [icon] [icon] MPLS Settings LDP Settings

Interface	Hello Interval	Hold Time	Tran...	Accept Dy...
ether1	00:00:05	00:00:15		yes
ether10	00:00:05	00:00:15		yes
ether5	00:00:05	00:00:15		yes

LDP Settings

☒ Enabled

LSR ID: 2.2.2.2

Transport Address: 2.2.2.2

Path Vector Limit: 255

Hop Limit: 255

OK Cancel Apply

R2

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter

+ - ✓ ✕ [icon] [icon]

Transport	Send ...	Peer	Local Transport
DO 1.1.1.1	no	1.1.1.1:0	2.2.2.2
DO 3.3.3.3	no	3.3.3.3:0	2.2.2.2
DO 4.4.4.4	no	4.4.4.4:0	2.2.2.2

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IMPLEMENTING MPLS

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table

+ - ✓ ✕ [icon] [icon] MPLS Settings LDP Settings

Interface	/	Hello Interval	Hold Time	Transport Address
ether1		00:00:05	00:00:15	
ether10		00:00:05	00:00:15	
ether5		00:00:05	00:00:15	

LDP Settings

☒ Enabled

LSR ID: 3.3.3.3

Transport Address: 3.3.3.3

Path Vector Limit: 255

Hop Limit: 255

OK Cancel Apply

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter

+ - ✓ ✕ [icon] [icon]

Transport	/	Send ...	Peer	Local Transport
DO 1.1.1.1		no	1.1.1.1:0	3.3.3.3
DO 2.2.2.2		no	2.2.2.2:0	3.3.3.3
DO 4.4.4.4		no	4.4.4.4:0	3.3.3.3

R3

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table

+ - ✓ ✕ [icon] [icon] MPLS Settings LDP Settings

Interface	/	Hello Interval	Hold Time	Transport Address	Accept Dyn...
ether1		00:00:05	00:00:15		yes
ether10		00:00:05	00:00:15		yes
ether5		00:00:05	00:00:15		yes

LDP Settings

☒ Enabled

LSR ID: 4.4.4.4

Transport Address: 4.4.4.4

Path Vector Limit: 255

Hop Limit: 255

OK Cancel Apply

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter

+ - ✓ ✕ [icon] [icon]

Transport	/	Send ...	Peer	Local Transport
DO 1.1.1.1		no	1.1.1.1:0	4.4.4.4
DO 2.2.2.2		no	2.2.2.2:0	4.4.4.4
DO 3.3.3.3		no	3.3.3.3:0	4.4.4.4

R4

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IMPLEMENTING I-BGP

BGP Instance <default>

Name: default
AS: 100
Router ID: 1.1.1.1

BGP

Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements

+ - ✓ ✕ [icon] Refresh Refresh All Resend Resend All

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
R1-R2	default	192.168.0.252	100	no	no	d...	2.2.2.2	00:05:08	1	established
R1-R3	default	192.168.0.253	100	no	no	d...	3.3.3.3	00:05:13		established
R1-R4	default	192.168.0.254	100	no	no	d...	4.4.4.4	00:05:05		established

R1

BGP Instance <default>

Name: default
AS: 100
Router ID: 2.2.2.2

BGP

Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements

+ - ✓ ✕ [icon] Refresh Refresh All Resend Resend All

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
R2-R1	default	192.168.0.251	100	no	no	d...	1.1.1.1	00:09:32	2	established
R2-R3	default	192.168.0.253	100	no	no	d...	3.3.3.3	00:09:40		established
R2-R4	default	192.168.0.254	100	no	no	d...	4.4.4.4	00:09:30		established

R2

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IMPLEMENTING I-BGP

BGP

BGP Instance <default>

Name: default

AS: 100

Router ID: 3.3.3.3

R3

Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements

+ - ✓ ✗ [Icon] [Icon] Refresh Refresh All Resend Resend All

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
R3-R1	default	192.168.0.251	100	no	no	d...	1.1.1.1	00:12:11	2	established
R3-R2	default	192.168.0.252	100	no	no	d...	2.2.2.2	00:12:14	1	established
R3-R4	default	192.168.0.254	100	no	no	d...	4.4.4.4	00:12:11		established

BGP

BGP Instance <default>

Name: default

AS: 100

Router ID: 4.4.4.4

R4

Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements


+ - ✓ ✗ [Icon] [Icon] Refresh Refresh All Resend Resend All

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
R4-R1	default	192.168.0.251	100	no	no	d...	1.1.1.1	00:17:35	2	established
R4-R2	default	192.168.0.252	100	no	no	d...	2.2.2.2	00:17:36	1	established
R4-R3	default	192.168.0.253	100	no	no	d...	3.3.3.3	00:17:43		established

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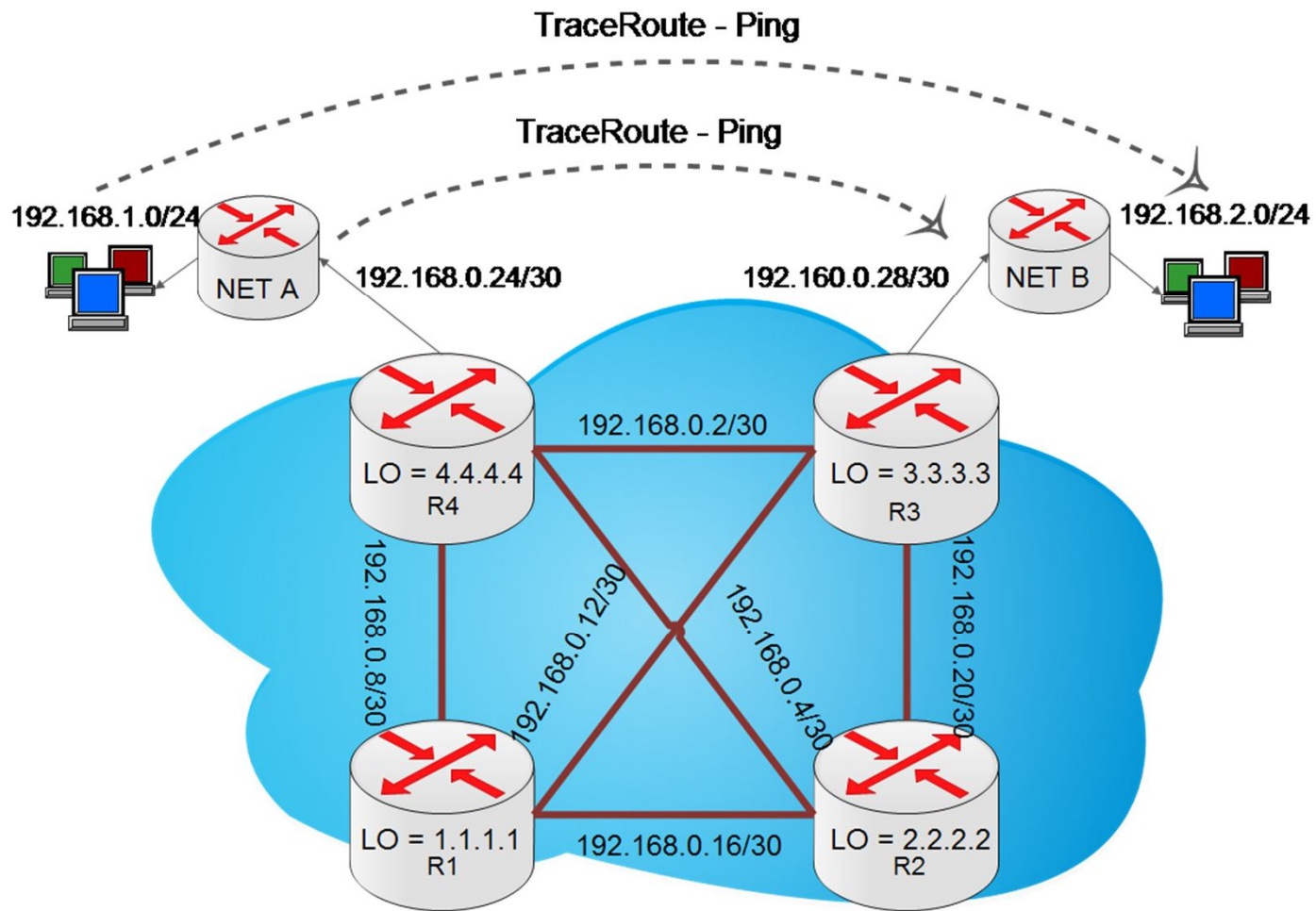
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TESTING NETWORK CONNECTIVITY USING TRACE ROUTE AND PING TOOLS

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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
```

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IMPLEMENTING E-BGP

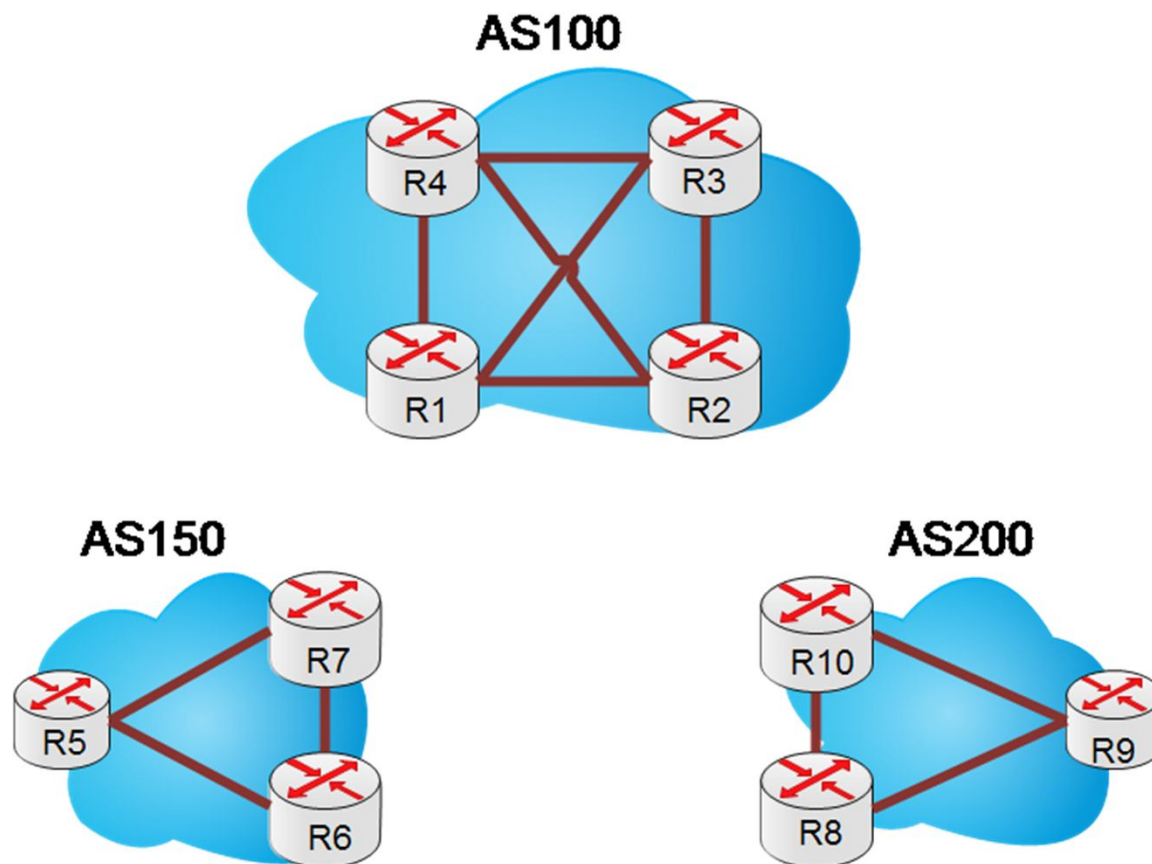
- ✓ Configuration at other ASes will be similar at AS100
- ✓ To communicate All ASes to gather need to establish eBGP peer to remote AS
- ✓ Current AS type designed as Dual Multihomed To provide full redundant connection with other ASes

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IMPLEMENTING E-BGP



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IMPLEMENTING E-BGP (AS100 R1&R2)

R1

BGP												
Instances		VRFs	Peers	Networks	Aggregates	VPN4 Routes	Advertisements					
+	-	✓	✗	📄	🔍	Refresh		Refresh All		Resend		Resend All
	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

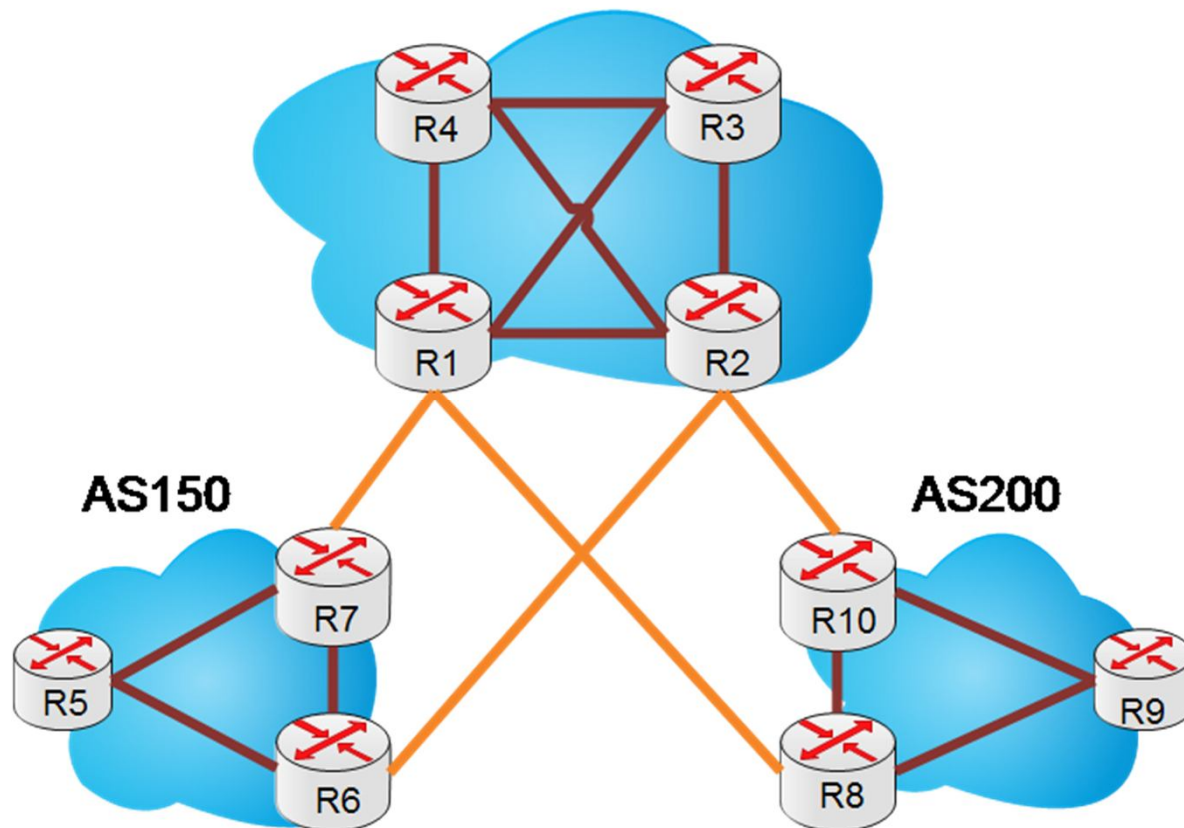
BGP												
Instances		VRFs	Peers	Networks	Aggregates	VPN4 Routes	Advertisements					
+	-	✓	✗	📄	🔍	Refresh		Refresh All		Resend		Resend All
	Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	/	Uptime	Prefix Co...	State
	eBGP R2-R6	default	192.168.0.42	150	no	no	d...	6.6.6.6		00:11:20	1	established
	eBGP R2-R10	default	192.168.0.46	200	no	no	d...	10.10.10.10		00:11:32	1	established

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IMPLEMENTING E-BGP (AS100 R1&R2)

AS100



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IMPLEMENTING E-BGP (AS150 R6&R7)

R6

BGP											
Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements											
<div><div><div>+</div><div>-</div><div>✓</div><div>✗</div><div>📄</div><div>🔍</div></div><div>Refresh Refresh All Resend Resend All</div></div>											
Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State	
eBGP R6-...	default	192.168.15.18	200	no	no	d...	9.9.9.9	00:15:15	1	established	
eBGP R6-...	default	192.168.0.41	100	no	no	d...	2.2.2.2	00:15:53	1	established	

R7

BGP											
Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements											
<div><div><div>+</div><div>-</div><div>✓</div><div>✗</div><div>📄</div><div>🔍</div></div><div>Refresh Refresh All Resend Resend All</div></div>											
Name	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State		
eBGP R7-R10	192.168.15.13	200	no	no	d...	10.10.10.10	00:19:28	1	established		
eBGP R7-R1	192.168.0.33	100	no	no	d...	1.1.1.1	00:19:34	1	established		

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IMPLEMENTING E-BGP (AS200 R9&10)

R9

BGP										
Instances		VRFs	Peers	Networks	Aggregates	VPN4 Routes	Advertisements			
						Refresh	Refresh All	Resend	Resend All	
	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

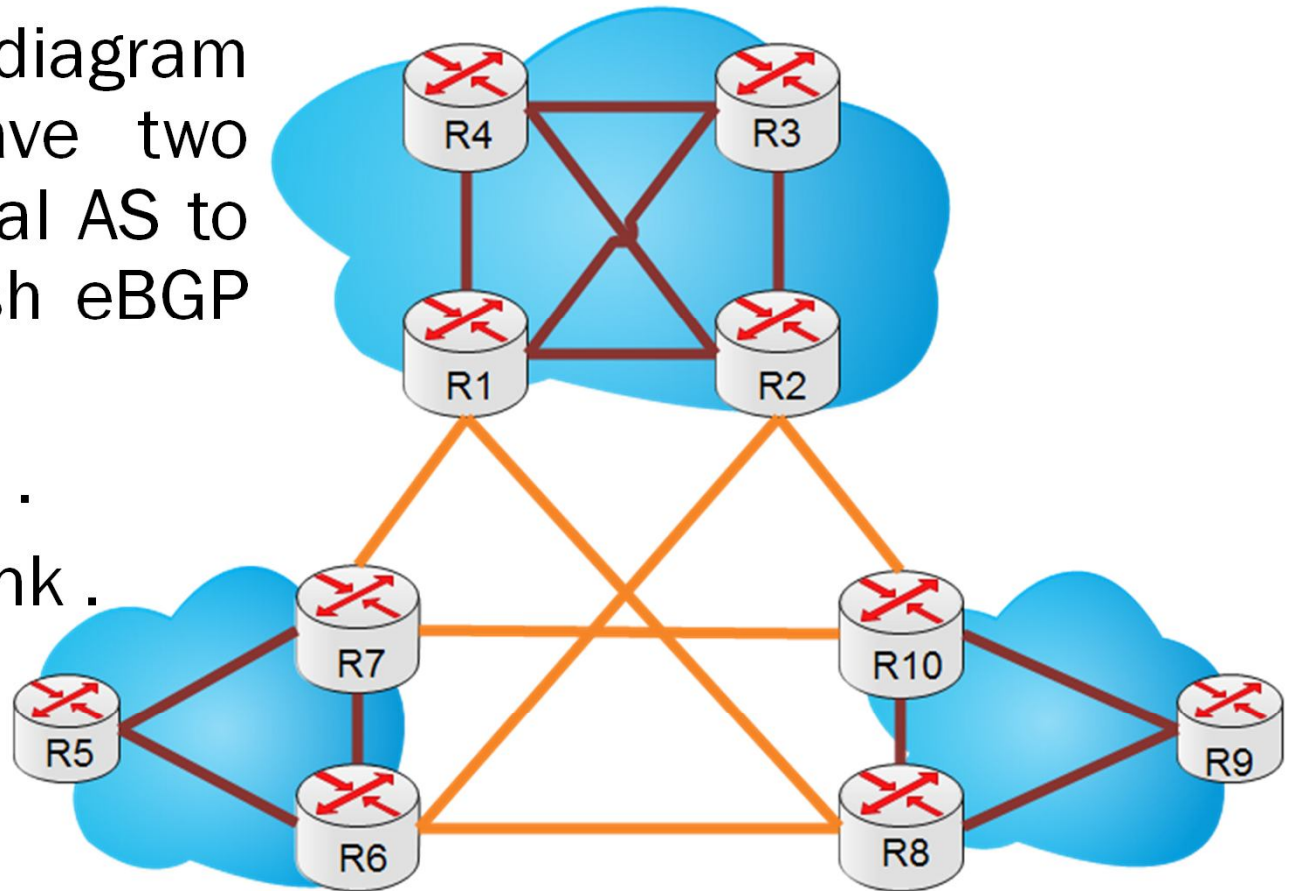
BGP										
Instances		VRFs	Peers	Networks	Aggregates	VPN4 Routes	Advertisements			
						Refresh	Refresh All	Resend	Resend All	
	Name	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
	eBGP R10-R7	192.168.15.14	150	no	no	d...	7.7.7.7	00:26:13	2	established
	eBGP R10-R2	192.168.0.45	100	no	no	d...	2.2.2.2	00:26:34	2	established

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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 .

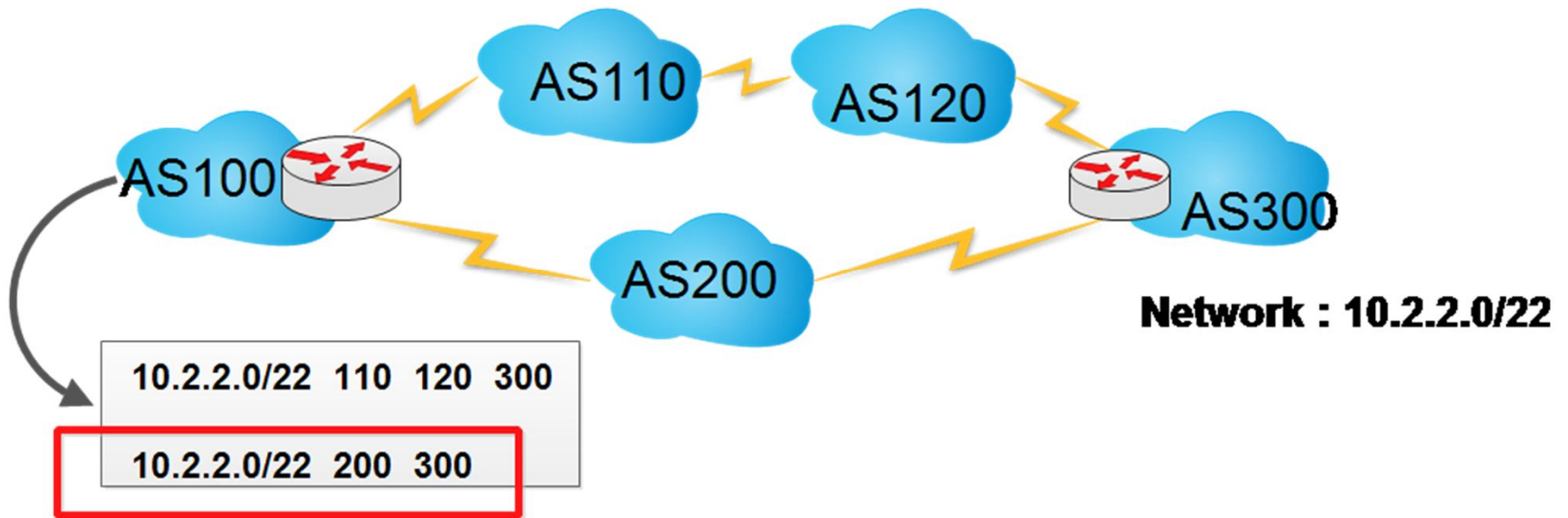


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BGP PATH ATTRIBUTE

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



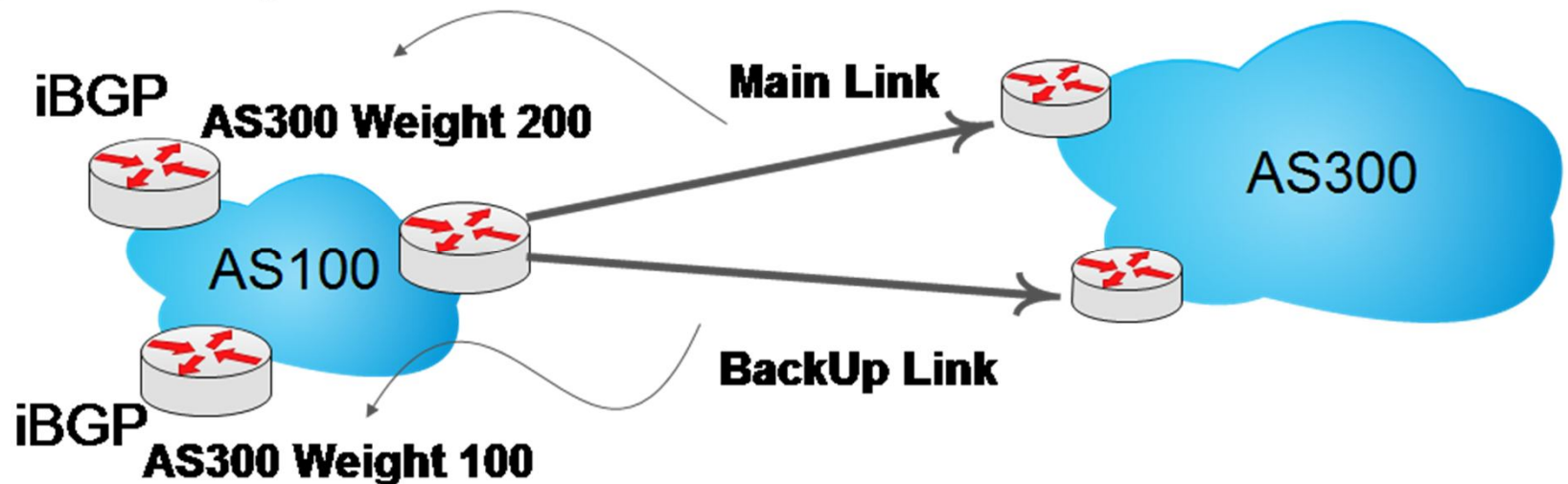
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BGP PATH ATTRIBUTE (CONTINUED)

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



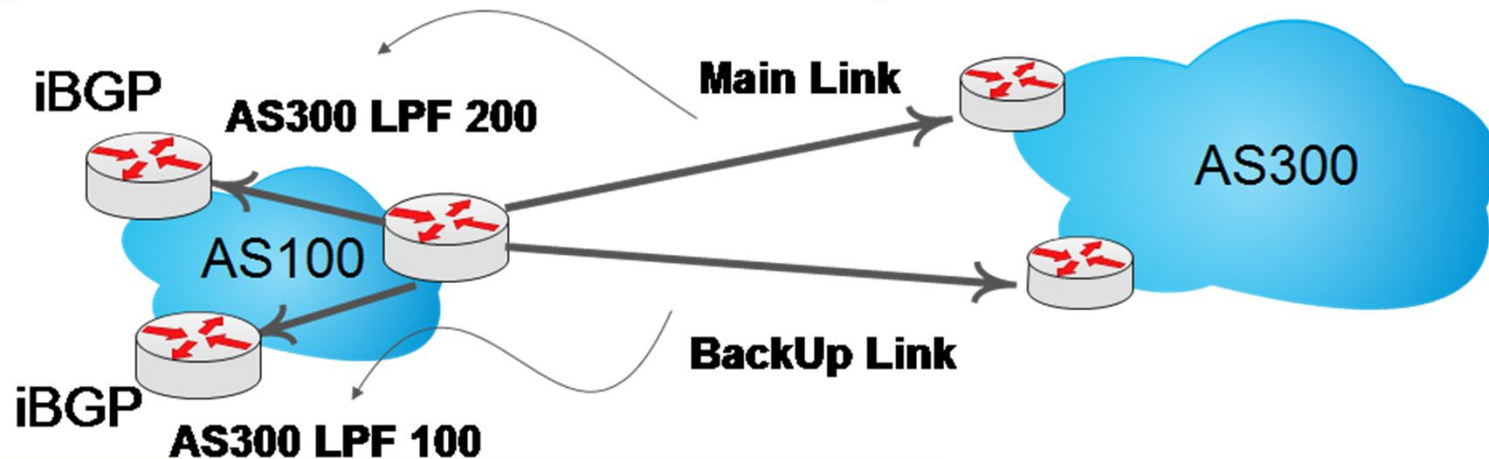
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BGP PATH ATTRIBUTE (CONTINUED)

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



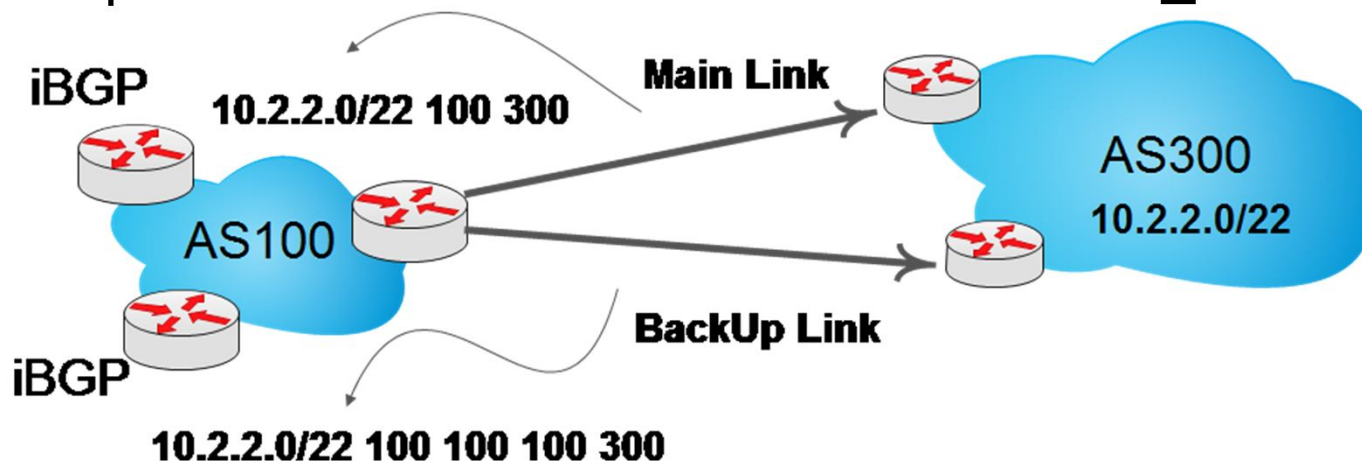
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BGP PATH ATTRIBUTE (CONTINUED)

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




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- 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!!


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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

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EBGP NETWORK ADVERTISEMENT (AS100R1 & R2)

R1

BGP			
Instances	VRFs	Peers	Networks
<div><div></div><div></div><div></div><div></div><div></div></div>			
Network		/	Synchroni...
192.168.0.0/21			no

R2

BGP			
Instances	VRFs	Peers	Networks
<div><div></div><div></div><div></div><div></div><div></div></div>			
Network		/	Synchroni...
192.168.0.0/21			no

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EBGP NETWORK ADVERTISEMENT (AS150 R6& R7)

R6

BGP			
Instances	VRFs	Peers	Networks
<div><div>+</div><div>-</div><div>✓</div><div>✗</div><div>Y</div></div>			
Network		/	Synchroni...
192.168.8.0/21			no

R7

BGP			
Instances	VRFs	Peers	Networks
<div><div>+</div><div>-</div><div>✓</div><div>✗</div><div>Y</div></div>			
Network		/	Synchroni...
192.168.8.0/21			no

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EBGP NETWORK ADVERTISEMENT (AS200 R9& R10)

R9

BGP		
Instances	VRFs	Peers
Networks		
Aggregates		
VPN4 Routes		
Advertisements		
<div><div></div><div></div><div></div><div></div><div></div></div>		
Network		Synchroni...
192.168.16.0/21		no

R10

BGP		
Instances	VRFs	Peers
Networks		
Aggregates		
VPN4 Routes		
Advertisements		
<div><div></div><div></div><div></div><div></div><div></div></div>		
Network		Synchroni...
192.168.16.0/21		no

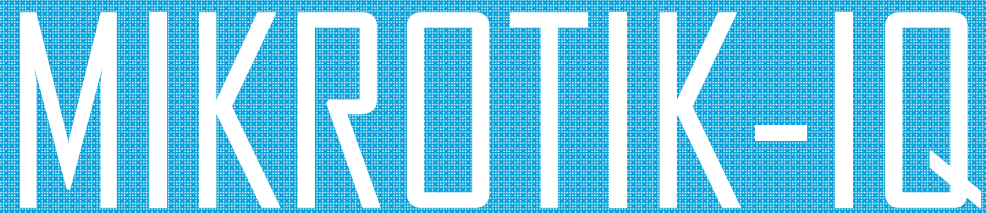
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EBGP NETWORK ADVERTISEMENT (CONTINUED)

- ✓ 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

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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

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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		

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BGP DATA BASE UPDATE TYPES (CONTINUED)

AS 200

BGP							
<div>Instances</div> <div>VRFs</div> <div>Peers</div> <div>Networks</div> <div>Aggregates</div> <div>VPN4 Routes</div> <div>Advertisements</div>							
<div></div>							
	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	

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BGP DATA BASE UPDATE TYPES (CONTINUED)

AS 150

BGP							
Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements							
⌵							
	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	

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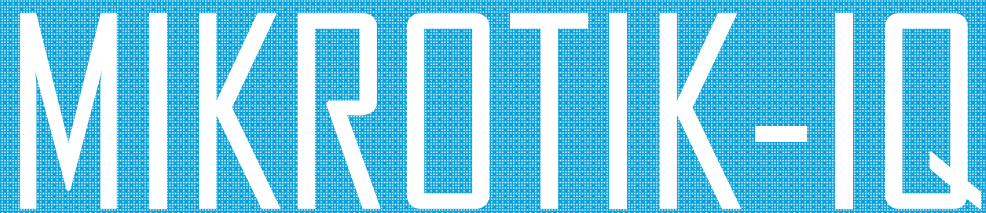
REDISTRIBUTE BGP DATA BASE TO IGP

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

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REDISTRIBUTE BGP DATA BASE TO IGP

OSPF Instance <Router2>

General Metrics MPLS Status

Name: Router2

Router ID: 2.2.2.2

Redistribute Default Route: never

Redistribute Connected Routes: no

Redistribute Static Routes: no

Redistribute RIP Routes: no

Redistribute BGP Routes: as type 1

Redistribute Other OSPF Routes: no

OK Cancel Apply Disable Comment Copy Remove

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MAIN ROUTING TABLE AT ASBR

Network reachable via
eBGP and iBGP

Route List						
Routes						
Next Hops						
Rules						
VRF						
Find						
all						
	Dst. Address	Gateway	Distance	Routing Mark	Pref. Source	
DAC	192.168.0.36/...	ether4 reachable	0		192.168.0.38	
DAC	192.168.15.0/...	ether3 reachable	0		192.168.15.2	
DAC	192.168.15.8/...	ether1 reachable	0		192.168.15.9	
DAC	192.168.15.16/...	ether5 reachable	0		192.168.15.18	
DAC	192.168.15.253	LO9 reachable	0		192.168.15.253	
DAb	192.168.0.0/21	192.168.0.37 reachable ether4	20			
Db	192.168.0.0/21	192.168.15.17 reachable ether5	20			
Db	192.168.8.0/21	192.168.0.37 reachable ether4	20			
DAb	192.168.8.0/21	192.168.15.17 reachable ether5	20			
DAo	192.168.15.4/...	192.168.15.10 reachable ether1, 192.168.15.1 reachable et...	110			
DAo	192.168.15.252	192.168.15.10 reachable ether1	110			
DAo	192.168.15.254	192.168.15.1 reachable ether3	110			
Db	192.168.0.0/21	192.168.0.45 unreachable	200			
Db	192.168.8.0/21	192.168.15.14 unreachable	200			
DAb	192.168.16.0/...	192.168.15.254 recursive via 192.168.15.1 ether3	200			

D = Dynamic

A = Active

b = BGP

eBGP distance = 20

iBGP distance = 200

Blue color = backup
route

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MAIN ROUTING TABLE (ABR)

Route List				
Routes Nexthops Rules VRF				
	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

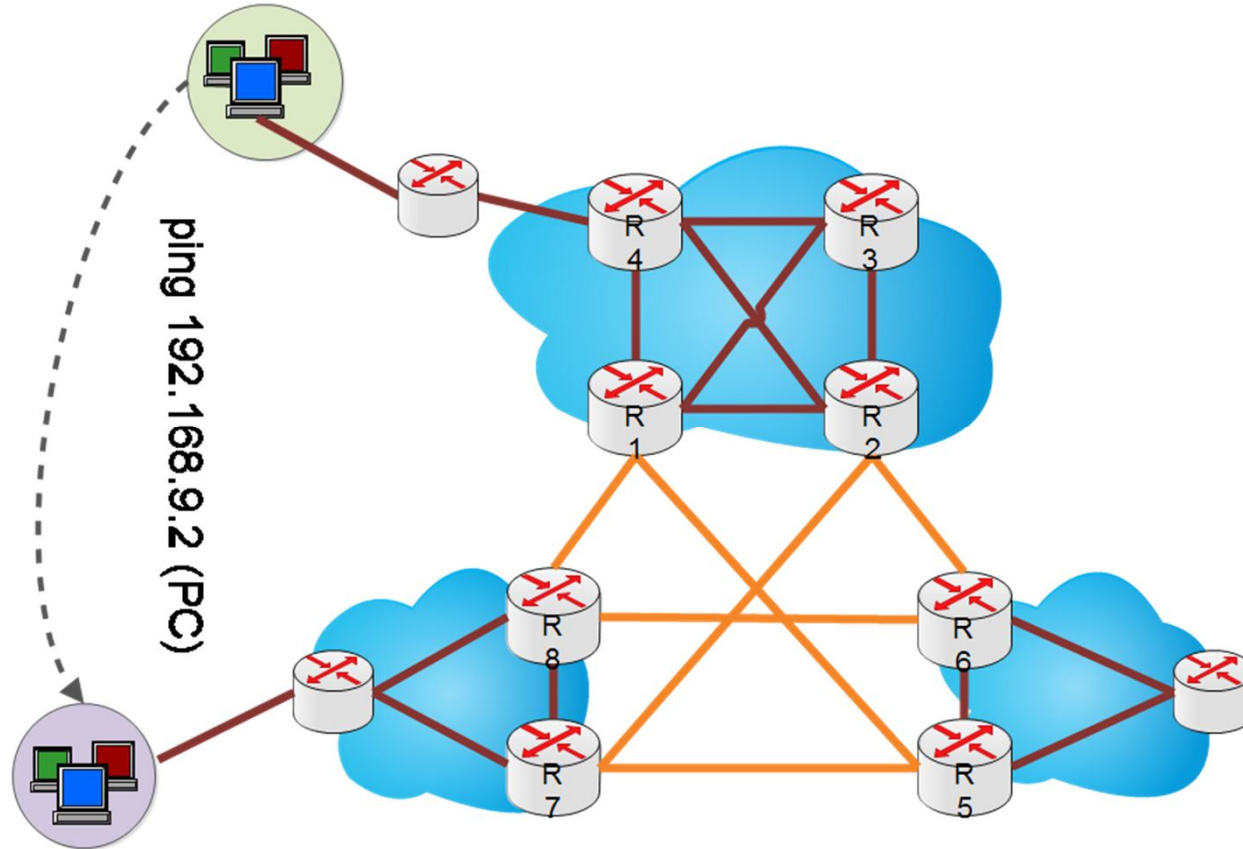
OSPF distance=110

Blue color = backup route

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TESTING CONNECTIVITY BETWEEN ASEs



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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

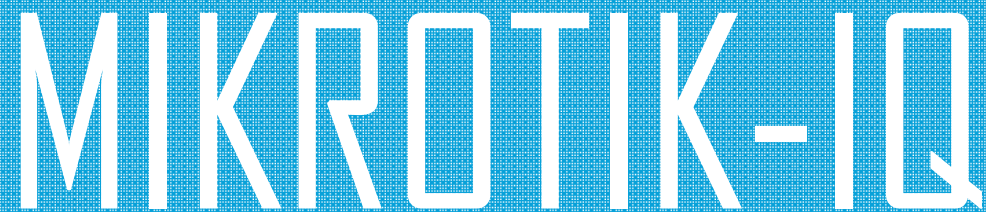
  1    261 ms    202 ms    290 ms    192.168.1.1
  2      1 ms      1 ms      1 ms    192.168.0.25
  3      1 ms      1 ms      1 ms    192.168.0.10
  4      1 ms     19 ms      1 ms    192.168.0.38
  5      1 ms      1 ms      1 ms    192.168.0.42
  6      1 ms     <1 ms      1 ms    192.168.8.10
  7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

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THANKS FOR ATTENTION



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<http://www.cisco.com>

<http://www.wikipedia.com>

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