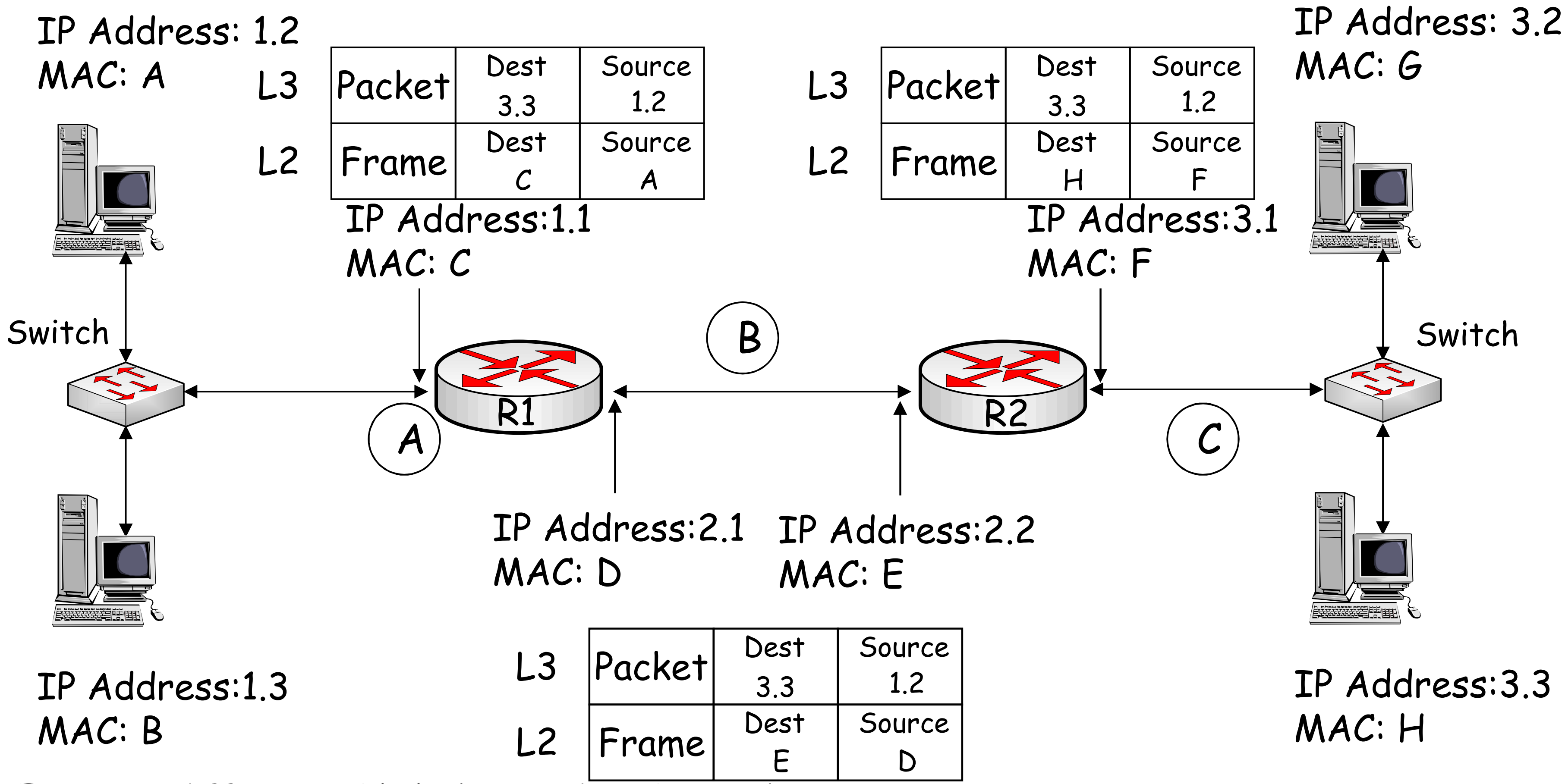
Chapter 5 – Maintaining & Troubleshooting Routing Solutions
Objectives

- Describe EIGRP operation & troubleshooting techniques.
- Describe OSPF operation & troubleshooting techniques.
- Describe BGP operation & troubleshooting techniques.
- Describe route redistribution operation & troubleshooting techniques.

Packet Forwarding



L3	Packet	Dest 3.3	Source 1.2
L2	Frame	Dest C	Source A

L3	Packet	Dest 3.3	Source 1.2
L2	Frame	Dest E	Source D

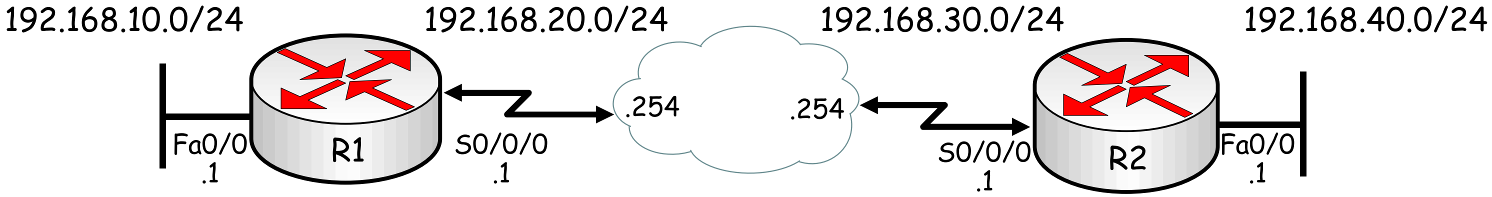
L3	Packet	Dest 3.3	Source 1.2
L2	Frame	Dest H	Source F

- Executing different table lookups and combining the information to construct a frame every time a packet needs to be routed is an inefficient approach to forwarding IP packets.
- To improve this process and increase the performance of IP packet switching operations, Cisco routers employ CEF.

Identify the correct destination and source addresses at points A, B & C

If 1.2 sends a packet to 3.3

Verify IP Routing



Control Plane:

R1#show ip route 192.168.40.1

- Display the best route that matches the address and all associated control plane details. (Note that the default route will never be displayed as a match for an IP address).

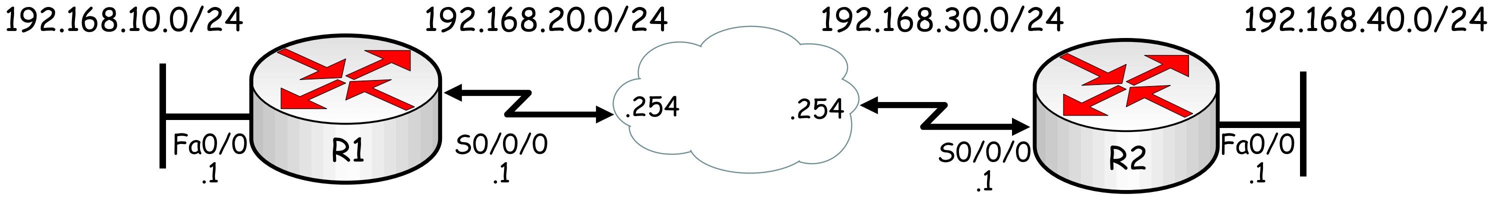
R1#show ip route 192.168.40.0 255.255.255.0

- Request the routing table to be searched for an exact match (for that network and mask).

R1#show ip route 192.168.40.0 255.255.255.0 longer-prefixes

- Display all prefixes in the routing table that fall within the prefix specified by the *network* and *mask* parameters. This command can be very useful to diagnose problems related to route summarization.

Verify IP Routing



Data Plane:

R1#show ip cef **192.168.40.1**

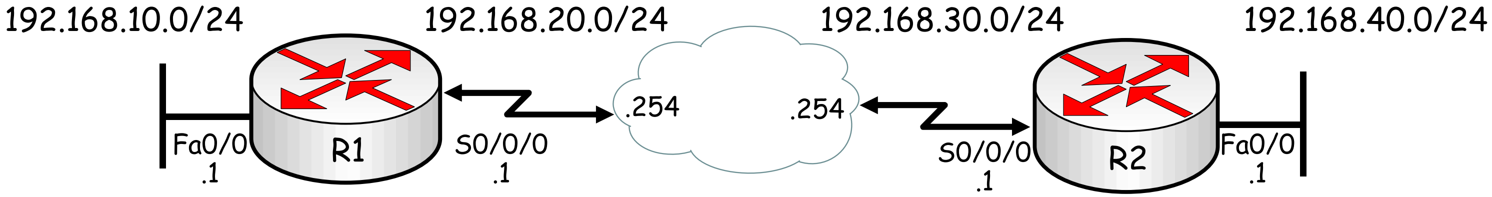
- Displayed results do not include any routing protocol related information, but only the information that is necessary to forward packets.

R1# **show ip cef 192.168.40.1**
192.168.1.0/24, version 42, epoch 0, cached adjacency 192.168.20.254
0 packets, 0 bytes
via 192.168.20.254, serial 0/0/0, 0 dependencies
next hop 192.168.20.254, serial 0/0/0,
valid cached adjacency

R1#show ip cef 192.168.40.0 255.255.255.0

- Displays information from the FIB instead of the routing table (RIB).

Verify IP Routing



R1#show ip cef exact-route 192.168.10.1 192.168.40.1

- Exact adjacency that will be used to forward a packet with source and destination IP addresses, as specified by the source and destination parameters.

R2# show ip cef exact-route 192.168.10.1 192.168.40.1
192.168.10.1 -> 192.168.40.1 : S0/0/0 (next hop 192.168.20.254)

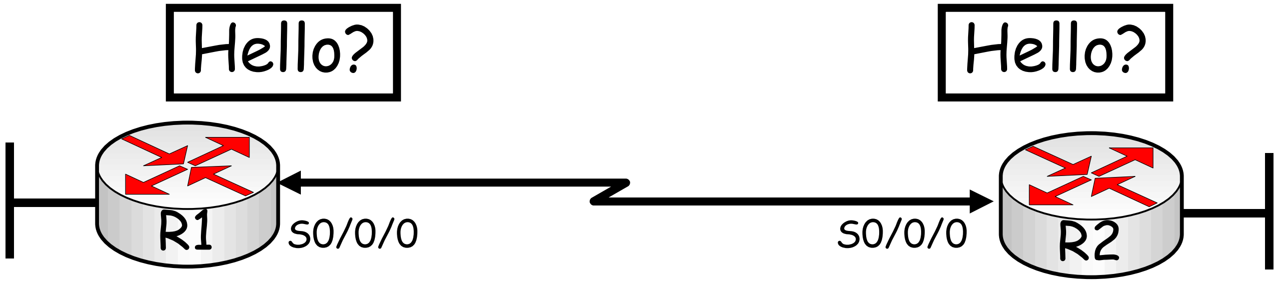
EIGRP Features

- EIGRP is an *advanced* distance vector routing protocol but also acts as a *link-state* protocol in the way that it updates neighbors and maintains routing information.

- The following are advantages of EIGRP over simple distance vector protocols:

    - Rapid convergence
    - Efficient use of bandwidth
    - Support for VLSM and CIDR
    - Multiple network layer support
    - Independence from routed protocols
    - Routing update Authentication

Default Hello Intervals and Hold Times for EIGRP

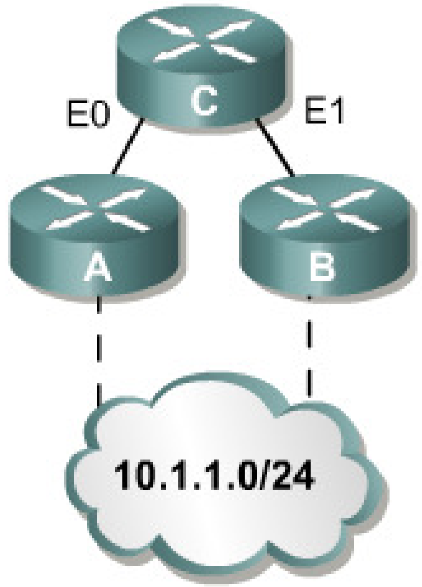


Bandwidth	Example Link	Default Hello Interval	Default Hold Time
1.544 Mbps or less	Multipoint Frame Relay	60 seconds	180 seconds
Greater than 1.544 Mbps	T1, Ethernet	5 seconds	15 seconds

- Hellos at a fixed (default 5 seconds), but configurable interval called the *hello interval*.
- The default hello interval depends on the *bandwidth* of the interface.
- Default *hold time* = 3 x hello interval.

EIGRP Tables

Router C's tables:



IP EIGRP Neighbor Table

Next-Hop Router	Interface
Router A	Ethernet 0
Router B	Ethernet 1

IP EIGRP Topology Table

Network	Feasible Distance (EIGRP Metric)	Advertised Distance	EIGRP Neighbor
10.1.1.0/24	2000	1000	Router A (E0)
10.1.1.0/24	2500	1500	Router B (E1)

IP EIGRP Routing Table

Network	Metric (Feasible Distance)	Outbound Interface	Next Hop (EIGRP Neighbor)
10.1.1.0/24	2000	Ethernet 0	Router A

EIGRP Neighbor Table

- *Adjacency* information is stored within a neighbour table. The router must have an entry for each neighbouring router in order to function.

- For an adjacency to form, EIGRP neighbours must share the same subnet, AS number, k-values and authentication parameters

```
Router#show ip eigrp neighbors
IP-EIGRP neighbors for process 100
M   Address         Interface Hold Uptime   SRTT  RTO   Q   SEQ
                              (sec)         (ms)       CNT  NUM
2   200.10.10.10    Se1        13 00:19:09   26   200   0   10
1   200.10.10.5     Se0        12 03:31:36   50   300   0   39
0   199.55.32.10    Et0        11 03:31:40   10   200   0   40
```

EIGRP Topology Table

- When the router dynamically discovers a new neighbour, it sends an *update* about the routes that it knows to its new neighbour.

- These updates populate the topology table, which contains all the destinations *advertised* by neighbouring routers.

```
R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(100)/ID(192.168.1.101)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status
P 192.168.1.96/27, 1 successors, FD is 40512000
        via Connected, Serial0/0/1
P 192.168.1.0/24, 1 successors, FD is 40512000
        via Summary (40512000/0), Null0
P 172.16.0.0/16, 1 successors, FD is 28160
        via Summary (28160/0), Null0
P 172.16.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 172.17.0.0/16, 1 successors, FD is 40514560
        via 192.168.1.102 (40514560/28160), Serial0/0/1
```

- The topology table is updated when a directly connected route or interface changes or when a *neighbouring* router reports a change to a route.

EIGRP Topology Table

- To view detailed information about the metrics of a specific entry in the topology table, add the optional parameter [network] to the *show ip eigrp topology* command:

```
R2#show ip eigrp topology 192.168.1.0
IP-EIGRP topology entry for 192.168.1.0/24
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 3014400
  Routing Descriptor Blocks:
  192.168.10.10 (Serial0/0/1), from 192.168.10.10, Send flag is 0x0
      Composite metric is (3014400/28160), Route is Internal
      Vector metric:
        Minimum bandwidth is 1024 Kbit
        Total delay is 20100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  172.16.3.1 (Serial0/0/0), from 172.16.3.1, Send flag is 0x0
      Composite metric is (41026560/2172416), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 40100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
```

EIGRP Routing Table

```
R1#show ip route eigrp
D    172.17.0.0/16 [90/40514560] via 192.168.1.102, 00:07:01, Serial0/0/1
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
D       172.16.0.0/16 is a summary, 00:05:13, Null0
     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
D       192.168.1.0/24 is a summary, 00:05:13, Null0

R1#show ip route
<output omitted>
Gateway of last resort is not set
D    172.17.0.0/16 [90/40514560] via 192.168.1.102, 00:06:55, Serial0/0/1
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
D       172.16.0.0/16 is a summary, 00:05:07, Null0
C       172.16.1.0/24 is directly connected, FastEthernet0/0
     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.96/27 is directly connected, Serial0/0/1
D       192.168.1.0/24 is a summary, 00:05:07, Null0
```

Monitoring EIGRP

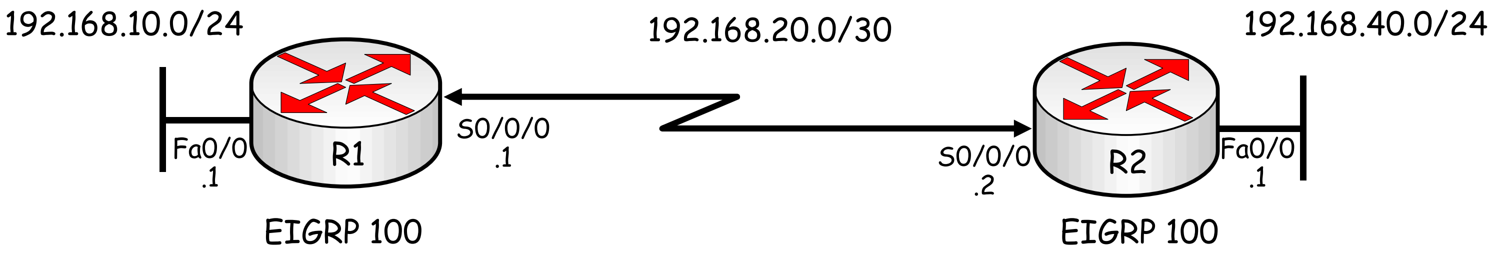
- The following debug commands can be used to observe the transmission and reception of EIGRP packets and the exchange of routing information:

1. **debug ip routing**: This command is not specific to EIGRP, but displays any changes that are made to the routing table, such as installation or removal of routes. This can be useful to diagnose routing protocol *instabilities*.

2. **debug eigrp packets**: This command displays the transmission and reception of EIGRP packets. Either all packets can be displayed, or packets of a particular type, such as hellos, updates, queries, and replies can be selected.

3. **debug ip eigrp**: This command displays EIGRP routing events, such as updates, queries, and replies sent to or received from neighbours. Focuses on the routing information contained in the packets and the actions that EIGRP takes as a result of the information received.

Monitoring EIGRP



- The output of the debug eigrp packets and debug ip eigrp commands can be further limited by use of two additional debug commands:

R1#debug ip eigrp neighbor 100 192.168.20.2

- By imposing this extra condition, the output of the **debug eigrp packets** and **debug ip eigrp** commands will be limited to information that is associated with the specified neighbour.

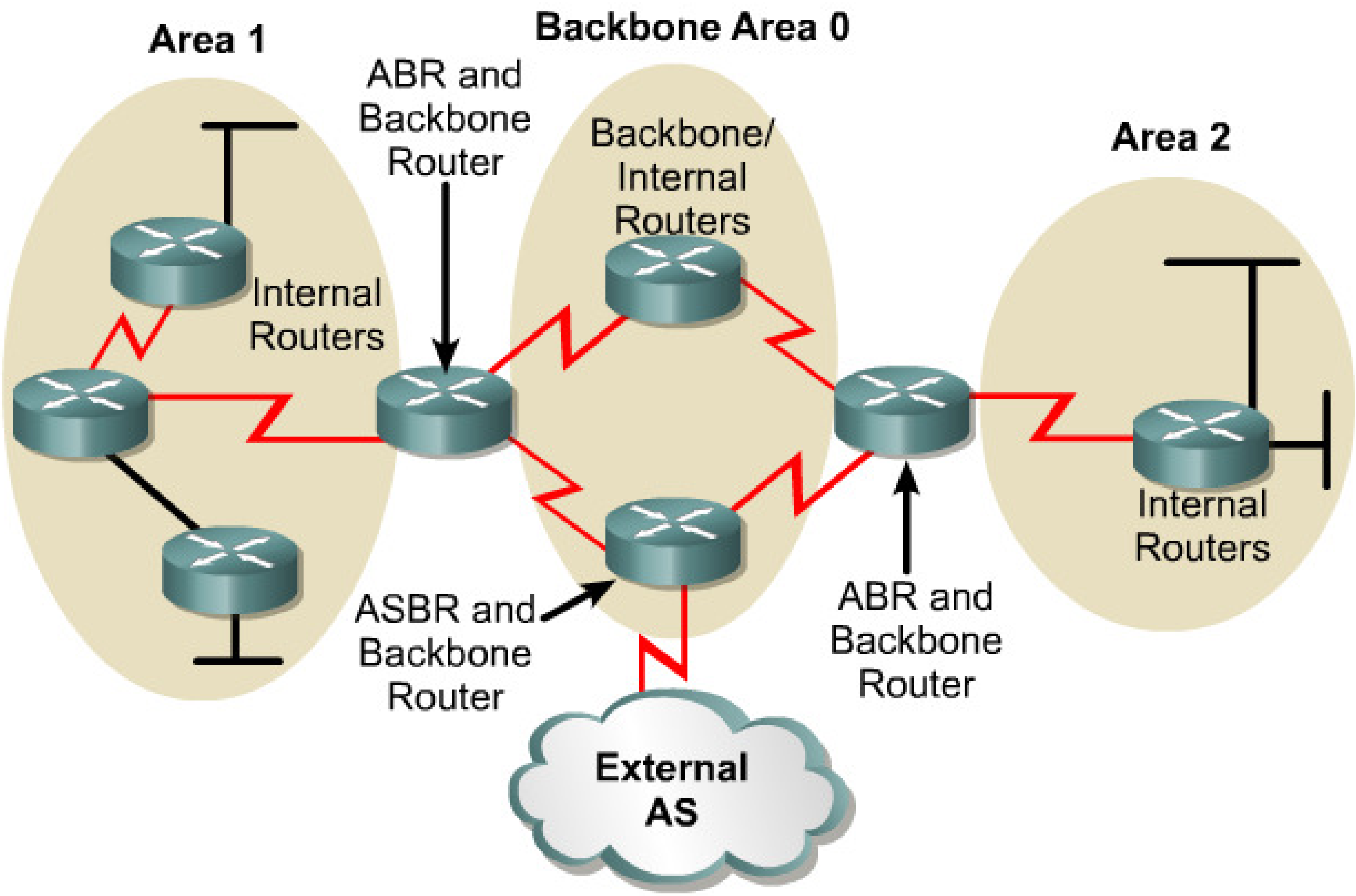
R1#debug ip eigrp 100 192.168.20.0 255.255.255.252

- By imposing this extra condition, the output of the **debug eigrp packets** and **debug ip eigrp** commands will be limited to information that is associated with the network specified by the *network* and *mask* options.

Features of OSPF

- OSPF is link-state routing protocol, so is not susceptible to routing loops, split-horizon, and other issues.
- Generate routing updates only when a change occurs in the network topology. When a link-state changes, the device that detected the change creates a *link-state advertisement* (LSA) concerning that link.
- LSAs are *reliable*; there is a method for acknowledging the delivery of LSAs.
- LSAs are flooded throughout the *area* (or throughout the domain if there is only one area).
- LSAs have a sequence number and a set lifetime so that each router recognizes that it has the most up-to-date version of the LSA.

OSPF Router Types



Link State Advertisements (LSA)

Link-state information must be synchronized between routers, which means the following:

- LSAs are *reliable*; there is a method for acknowledging the delivery of LSAs.
- LSAs are *flooded* throughout the area (or throughout the domain if there is only one area).
- LSAs have a *sequence number* and a set lifetime so that each router recognizes that it has the most up-to-date version of the LSA.
- LSAs are periodically *refreshed* to confirm topology information before the information ages out of the link-state database.

OSPF Neighbour Relationship

- OSPF discovers neighbours through the transmission of periodic Hello packets. Two routers will become neighbours only if the following parameters match in the Hello packets:

1. *Hello and dead timers:* Neighbours must use the same Hello and dead time. OSPF area number: Two routers will become neighbours on a link only if they both consider that link to be in the same area.

2. *OSPF area type:* Neighbours must both consider the area to be the same type of area (normal, stub, or not-so-stubby area [NSSA]).

3. *IP subnet and subnet mask:* Two routers will not become neighbours if they are not on the same subnet. The exception to this rule is on a point-to-point link, where the subnet mask is not verified.

4. *Authentication type and authentication data:* Neighbours must use the same authentication type (null, clear text, or MD5). If they use authentication, the authentication data (password or hash value) also needs to match.

OSPF Databases

- OSPF maintains three databases:

1. Interface Database (**`show ip ospf interface brief`**)
2. Adjacency Database (**`show ip ospf neighbor`**)
3. Link-state Database (**`show ip ospf database`**)
4. Routing Information Database (**`show ip route`**)

Interpreting the OSPF Database

```
RouterA#show ip ospf database
     OSPF Router with ID (10.0.0.11) (Process ID 1)
                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link
count
10.0.0.11       10.0.0.11       548         0x80000002 0x00401A 1
10.0.0.12       10.0.0.12       549         0x80000004 0x003A1B 1
100.100.100.100 100.100.100.100 548         0x800002D7 0x00EEA9 2

                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
172.31.1.3      100.100.100.100 549         0x80000001 0x004EC9

                Summary Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
10.1.0.0        10.0.0.11       654         0x80000001 0x00FB11
10.1.0.0        10.0.0.12       601         0x80000001 0x00F516
<output omitted>
```

Interpreting the Routing Table

```
         172.31.0.0/24 is subnetted, 2 subnets
O IA     172.31.2.0 [110/1563] via 10.1.1.1, 00:12:35, FastEthernet0/0
O IA     172.31.1.0 [110/782] via 10.1.1.1, 00:12:35, FastEthernet0/0
         10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C        10.200.200.13/32 is directly connected, Loopback0
C        10.1.3.0/24 is directly connected, Serial0/0/0
O        10.1.2.0/24 [110/782] via 10.1.3.4, 00:12:35 Serial0/0/0
C        10.1.1.0/24 is directly connected, FastEthernet0/0
O        10.1.0.0/24 [110/782] via 10.1.1.1, 00:12:37, FastEthernet0/0
O E2     10.254.0.0/24 [110/50] via 10.1.1.1, 00:12:37, FastEthernet0/0
```

- O – Describes routes found within an area, carried by *Router* (1) and *Network* (2) LSAs.

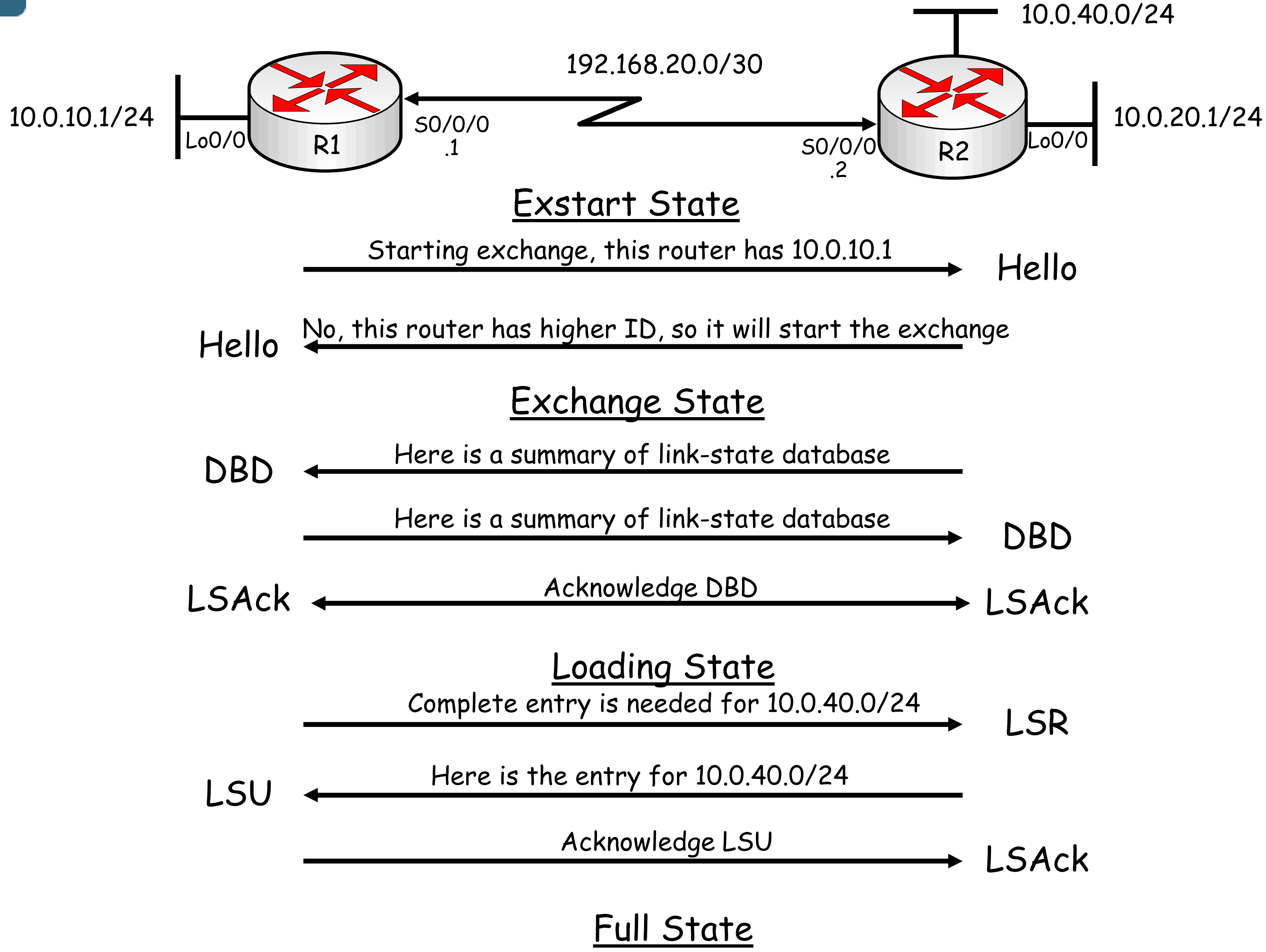
- O IA – Describes routes from other areas, carried by *Summary* LSA (3 & 4).

- O E1/E2 – Describes routes from other autonomous systems, carried by *AS External* LSA (5).

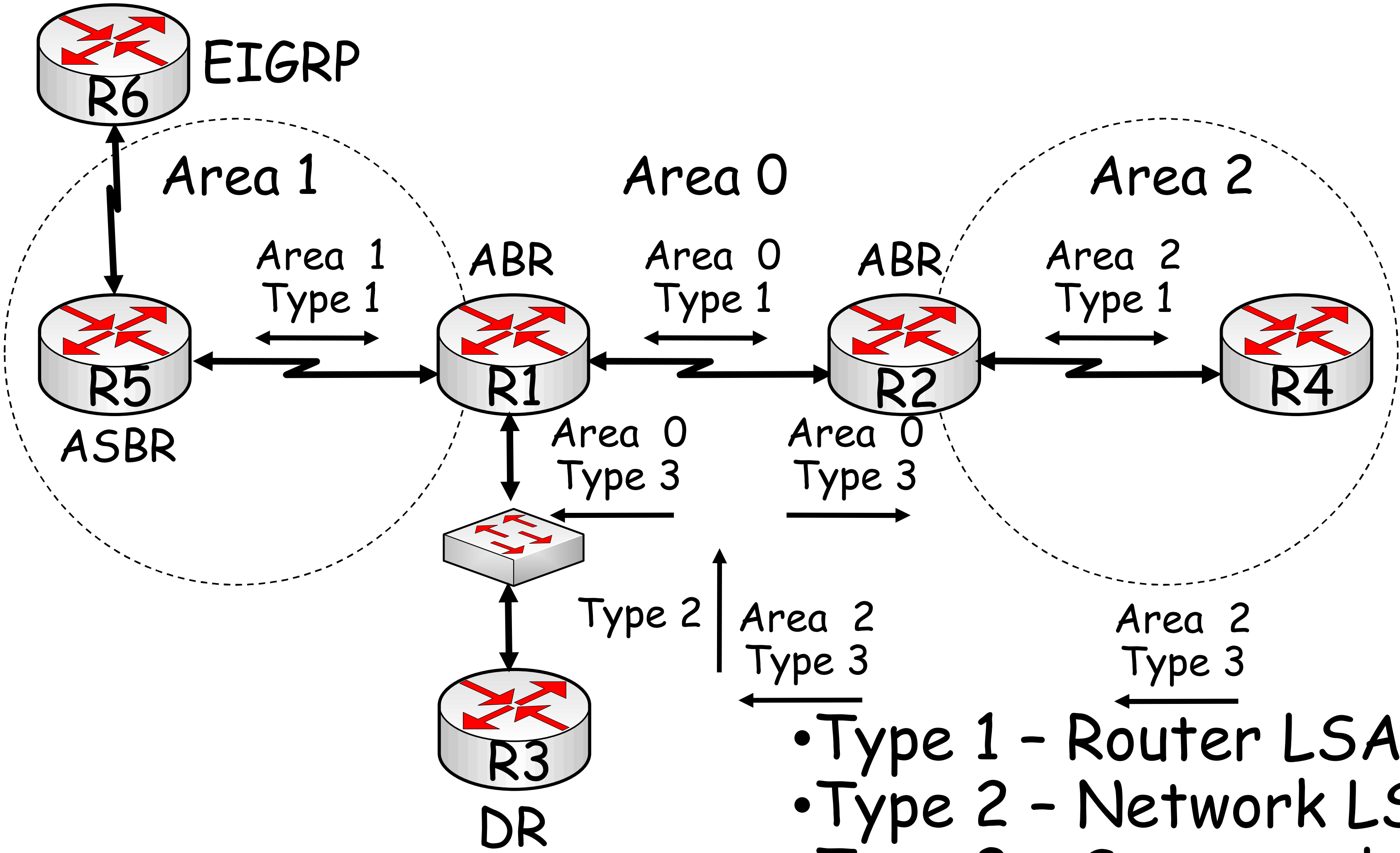
Steps to OSPF Operation with States

1. **Establishing router adjacencies (Routers are adjacent)**
   - Down State – No Hello received
   - Init State – Hello received, but not with this router's Router ID
     - "Hi, my name is R1." "Hi, my name is R2."
   - Two-way State – Hello received, and with this router's Router ID
     - "Hi, R1, my name is R2." "Hi, R2, my name is R1."
2. **Electing DR and BDR – Multi-access (broadcast) segments only**
   - ExStart State with DR and BDR
   - Two-way State with all other routers
3. **Discovering Routes**
   - ExStart State
   - Exchange State
   - Loading State
   - Full State (Routers are "fully adjacent")
4. **Calculating the Routing Table**
5. **Maintaining the LSDB and Routing Table**

Steps to OSPF Operation with States

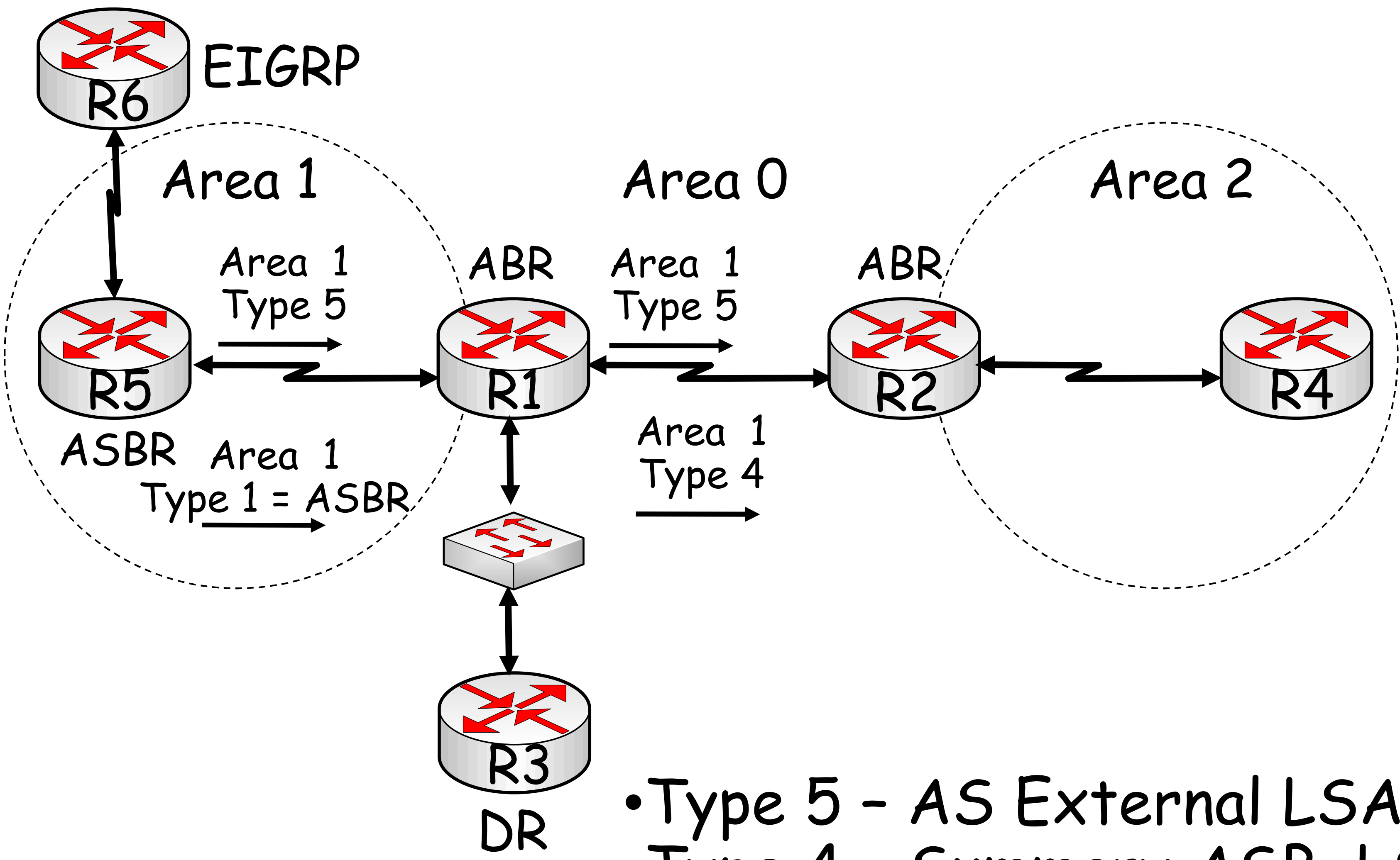


OSPF LSA Types



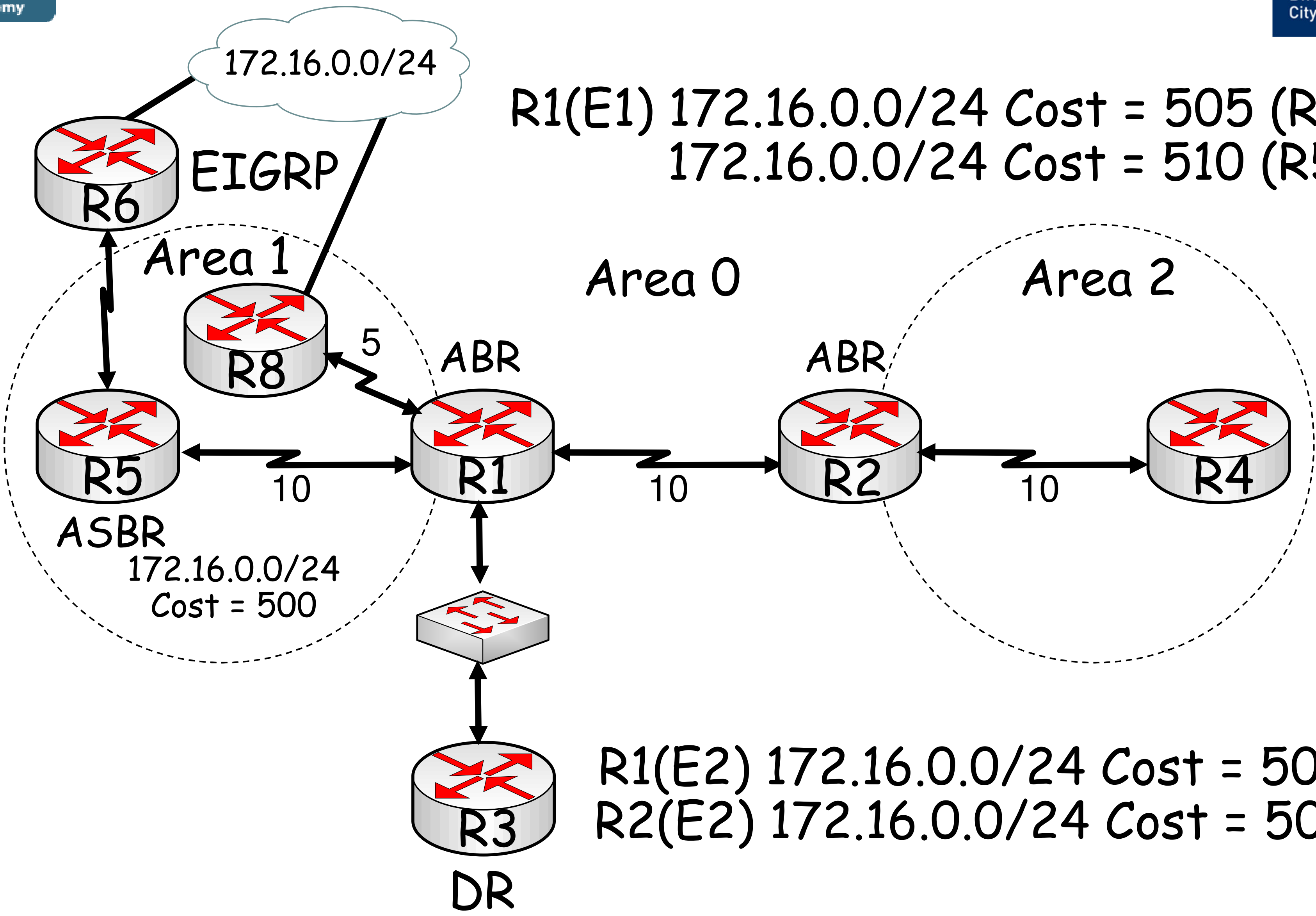
- Type 1 – Router LSA
- Type 2 – Network LSA
- Type 3 – Summary LSA

OSPF LSA Types



- Type 5 – AS External LSA
- Type 4 – Summary ASB LSA

OSPF E1 & E2 Routes



R1(E1) 172.16.0.0/24 Cost = 505 (R8)
172.16.0.0/24 Cost = 510 (R5)

R1(E2) 172.16.0.0/24 Cost = 500
R2(E2) 172.16.0.0/24 Cost = 500

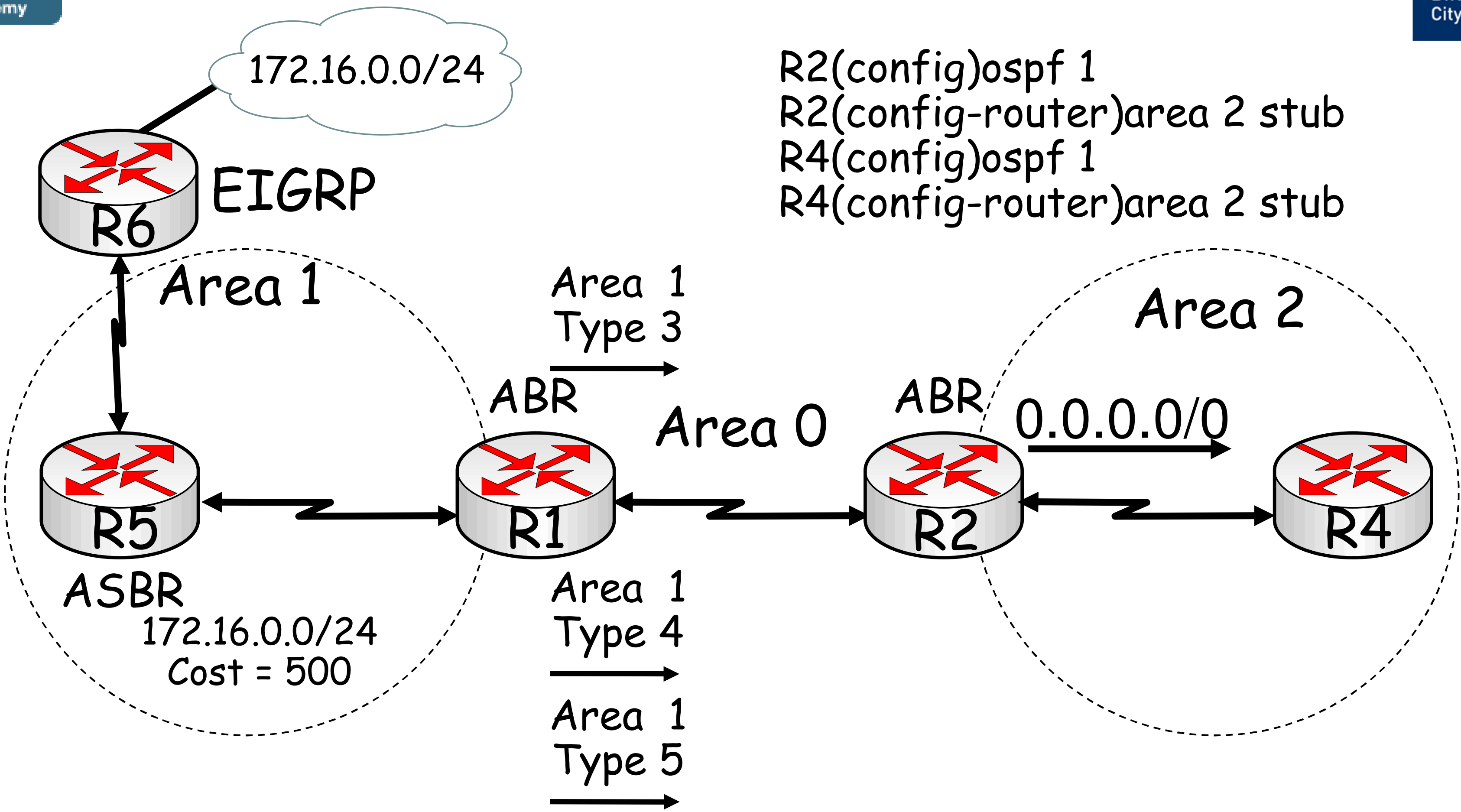
OSPF Stub Areas

- *Stub area:* Does not accept information about routes external to the autonomous system, such as routes from non-OSPF sources. This means that no type 5 LSAs are known inside the area, and consequently type 4 LSAs are unnecessary. Type 4 and 5 LSAs are blocked.

- *Totally stubby area:* Does not accept external autonomous system routes or summary routes from other areas internal to the autonomous system. The ABR of the totally stubby area blocks type 4 and 5 LSAs as well as all summary LSAs (type 3), with an exception of a single type 3 LSA to advertise the default route.

- *Not-so-stubby area:* Offers benefits that are similar to those of a stub or totally stubby area, but also allows external routes to be advertised into the OSPF autonomous system. Therefore, NSSAs allow ASBRs, which is against the rule in a stub area. The ASBR originates type 7 LSAs to advertise the external destinations.

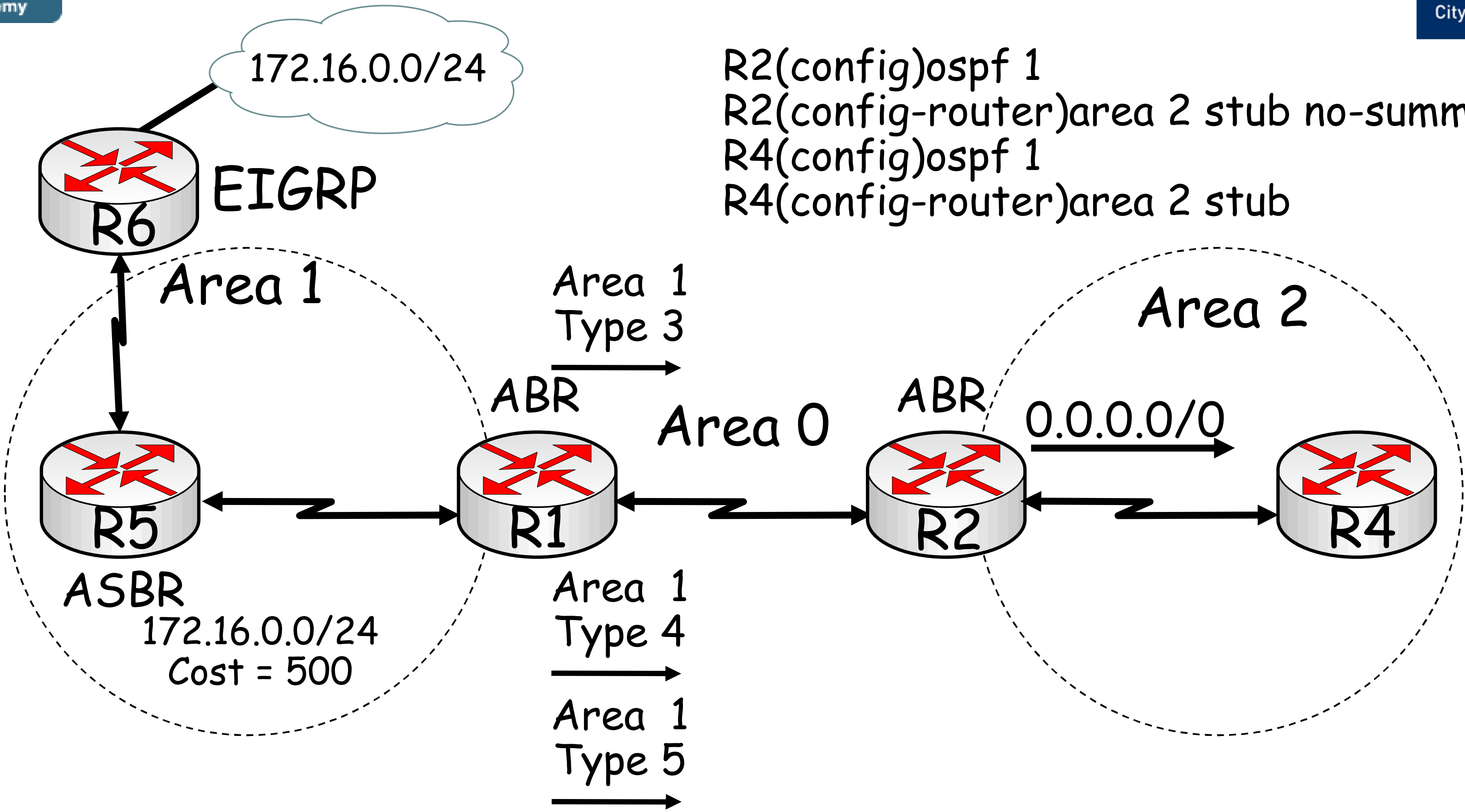
OSPF Stubby Area



- Type 4 & 5 LSAs are blocked.
- There is a *single* exit point from that area.
- All routers inside the stub area must be configured as *stub* routers.
- There is no *ASBR* inside the stub area.
- The area is not the *backbone* area (area 0).
- The area is not needed as a transit area for *virtual* links.

OSPF Totally Stubby Area

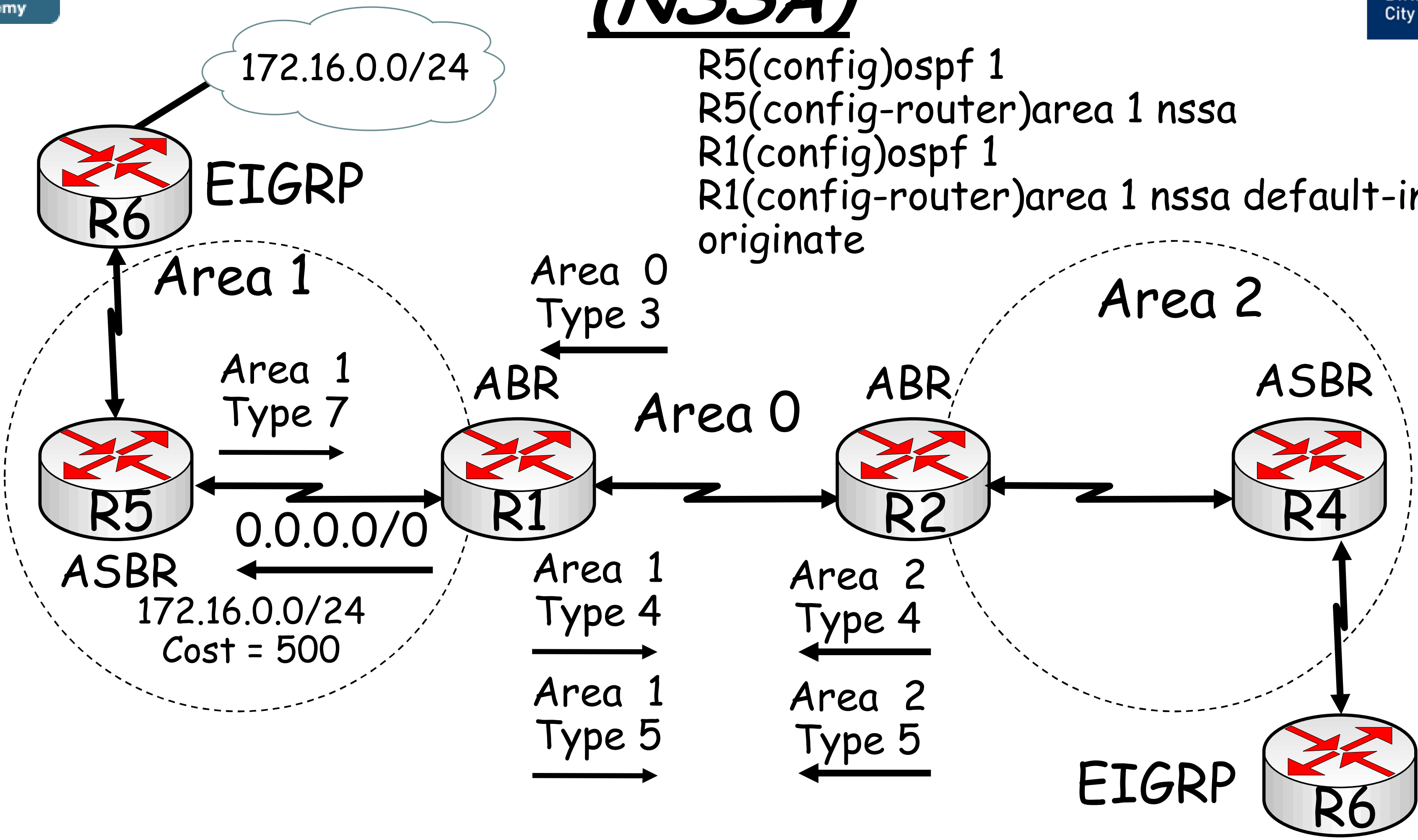
```
R2(config)ospf 1
R2(config-router)area 2 stub no-summary
R4(config)ospf 1
R4(config-router)area 2 stub
```



- Type 3, 4 & 5 LSAs are blocked.
- Routing table is reduced to a *minimum*.
- All routers must be configured as *stub*.
- ABR must be configured as *totally stubby*.
- Cisco *proprietary* feature.

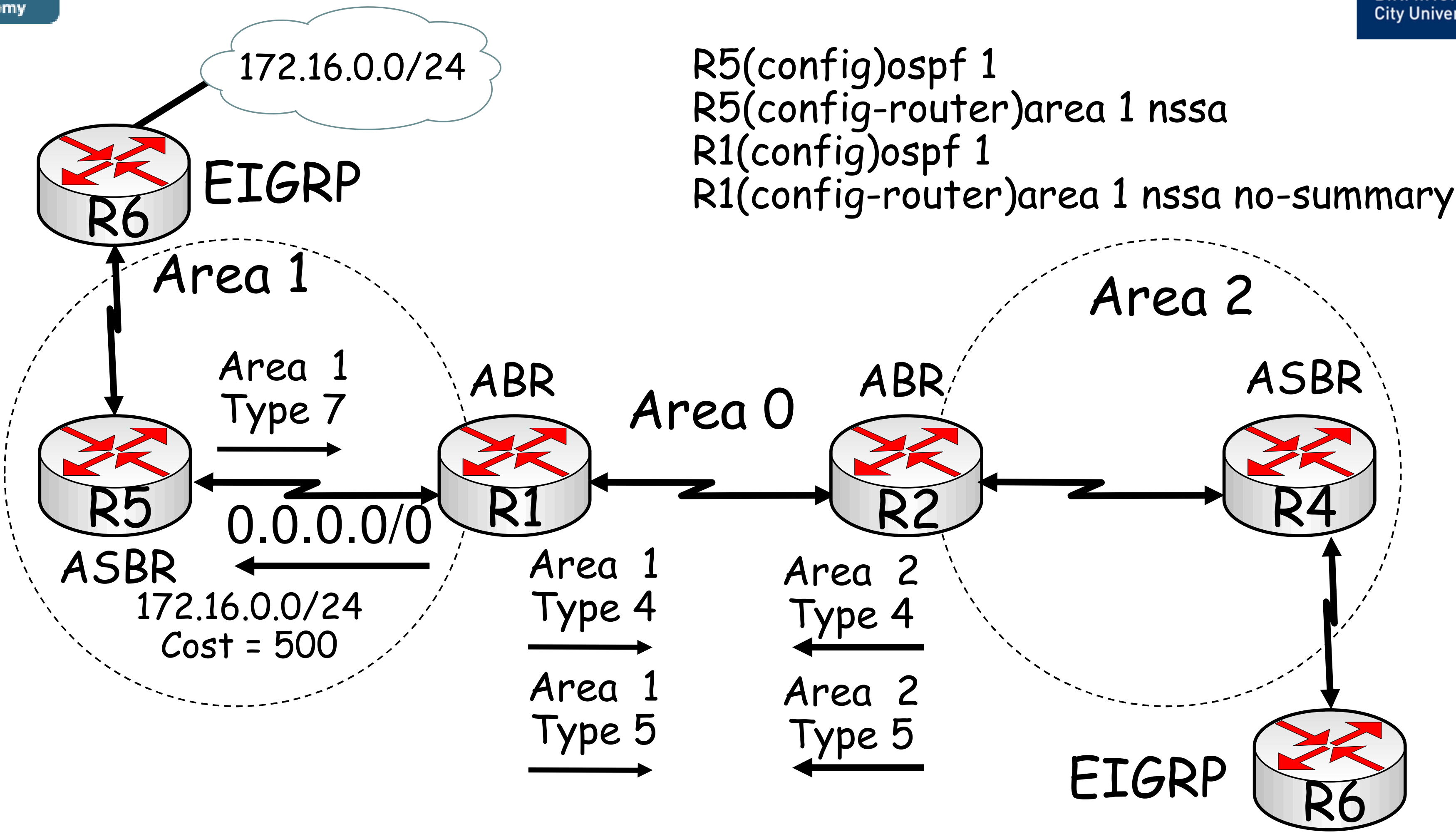
OSPF Not-So-Stubby Area (NSSA)

R5(config)ospf 1
R5(config-router)area 1 nssa
R1(config)ospf 1
R1(config-router)area 1 nssa default-info originate



- The OSPF NSSA feature is a *non-proprietary* extension of the existing stub area feature, which allows the injection of *external routes* in a limited fashion into the stub area.

OSPF NSSA Totally Stubby Area



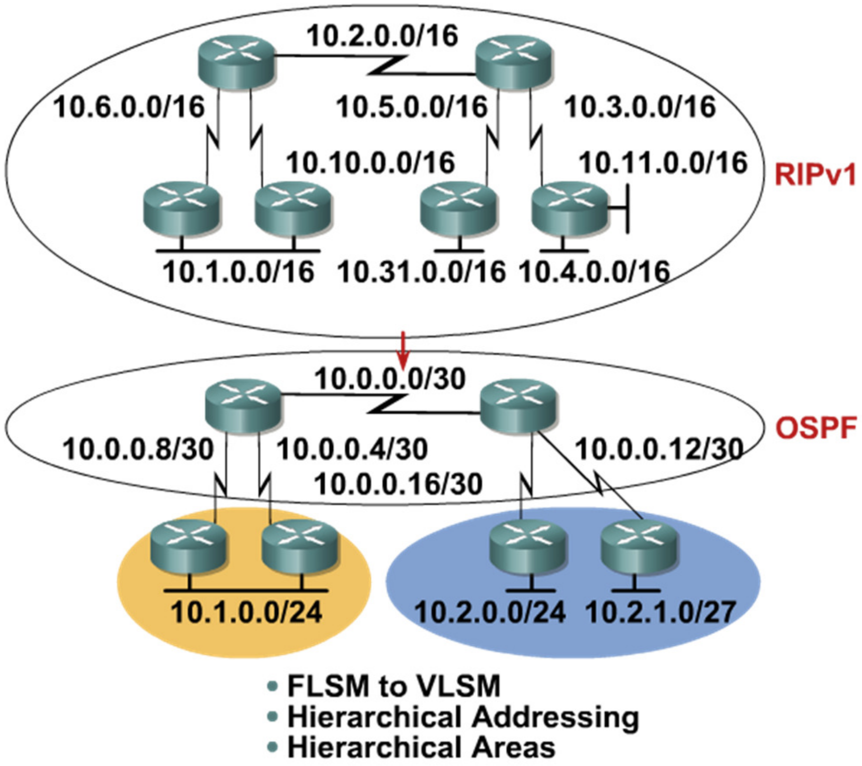
- An NSSA Totally Stubby ABR injects a single default route into the NSSA, and blocks all Type 3, 4 & 5 LSAs.

Monitoring OSPF

- The following debug commands can be used to observe the transmission and reception of OSPF packets and the exchange of routing information:

1. **debug ip routing:** displays any changes that are made to the routing table, such as installation or removal of routes.
2. **debug ip ospf packet:** displays the transmission and reception of OSPF packets. Useful to verify if Hellos are sent and received as expected.
3. **debug ip ospf events:** displays reception and transmission of Hellos, establishment of neighbor relationships and the reception or transmission of LSAs.
4. **debug ip ospf adj:** displays neighbor relationship transition from one state to the next.
5. **debug ip ospf monitor:** displays when the SPF algorithm is scheduled to run and displays the triggering LSA and a summary of the results after the SPF algorithm has completed.

Redistributing IP Routing Protocols



• Two important conditions that must be met for a prefix learned from one protocol (using redistribution) to be successfully advertised through another protocol:

1. The route needs to be installed in the *routing table*: The route needs to be selected as the best route by the source protocol.

2. A proper *seed* metric is assigned to the redistributed route: The route needs to be redistributed in the *destination* protocol data structures with a valid metric for the destination protocol.

• *Access lists* and *route maps* can be used to influence the redistribution process further by filtering routes, manipulating the seed metric, or setting additional parameters, such as route-type or tags for specific routes.

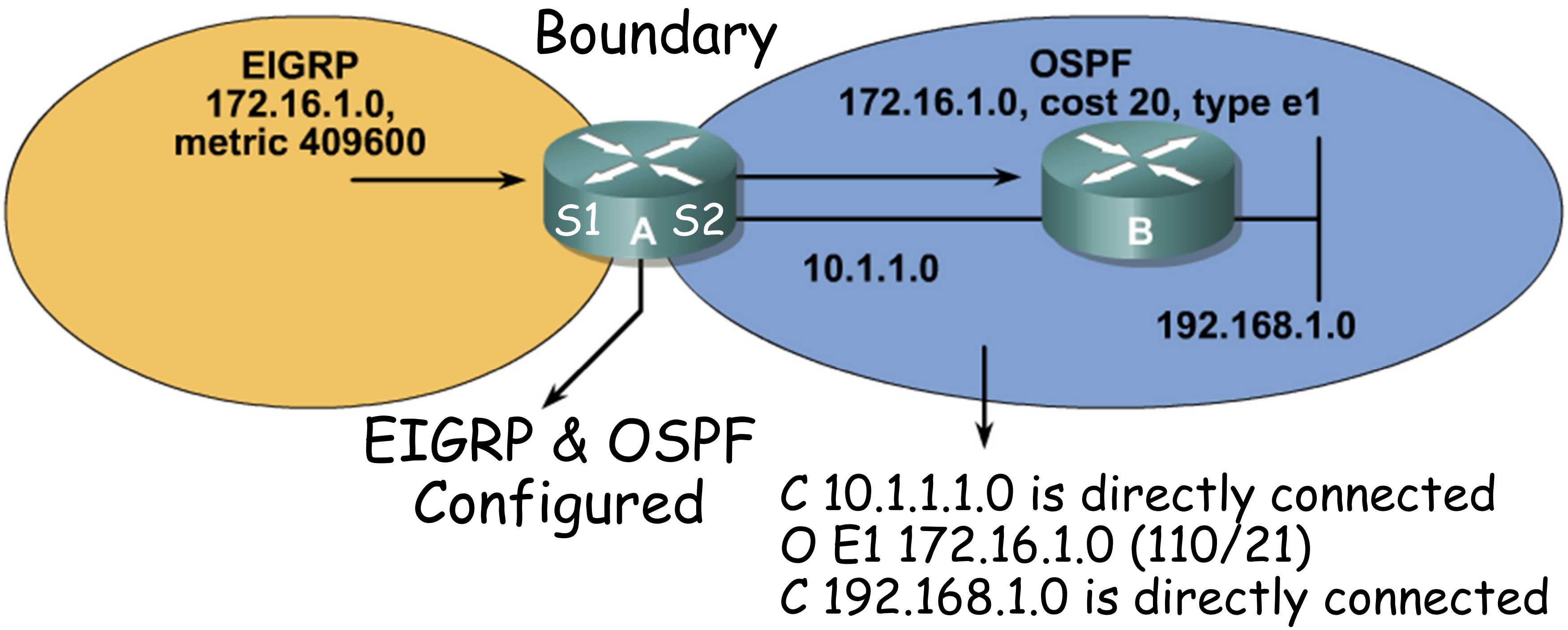
Default Seed Metrics

Protocol	Default Seed Metrics
RIP	Infinity
IGRP/EIGRP	Infinity
OSPF	20 for all except BGP, which is 1
IS-IS	0
BGP	BGP metric is set to IGP metric value

- When a router redistributes routes from one routing domain to another, *metric* information *cannot be translated* from one routing protocol to another.

- Therefore, a *seed* metric *artificially* sets the distance, cost, and so on, to each external (redistributed) network from the redistribution point.

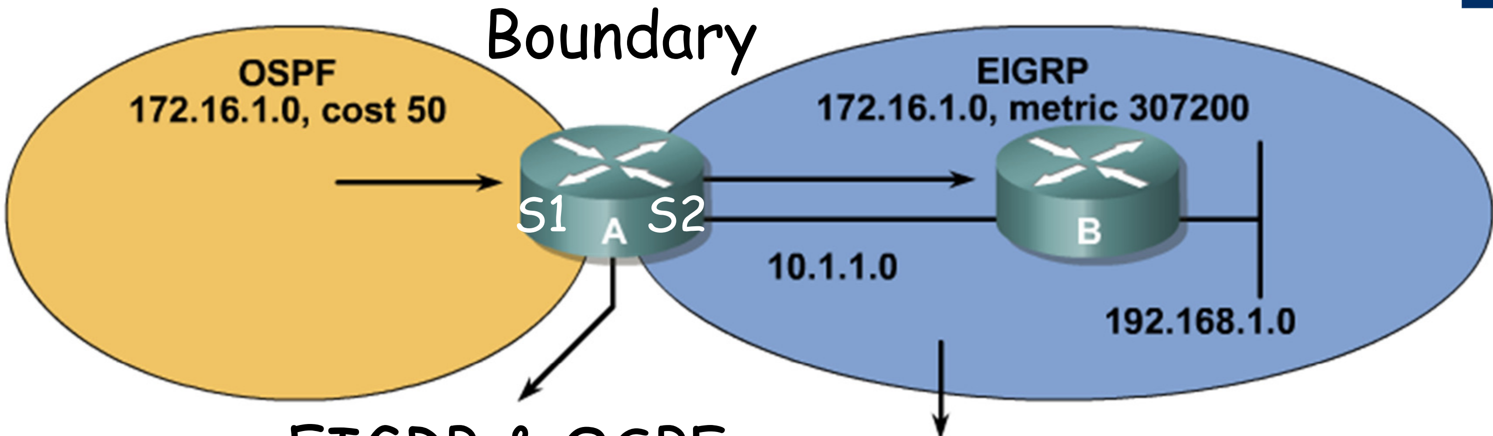
Redistributing into OSPF



RA(config)#router ospf 1
RA(config-router)#redistribute eigrp 1 metric-type 1 subnets
RA(config-router)#default-metric 20

RA(config-router)#redistribute eigrp 1 metric 20 metric-type 1 subnets

Redistributing into EIGRP



EIGRP & OSPF Configured

C 10.1.1.1.0 is directly connected
D (EX) 172.16.1.0 (170/307200)
C 192.168.1.0 is directly connected

RA(config)#router eigrp 1
RA(config-router)#redistribute ospf 1 10000 100 255 1 1500

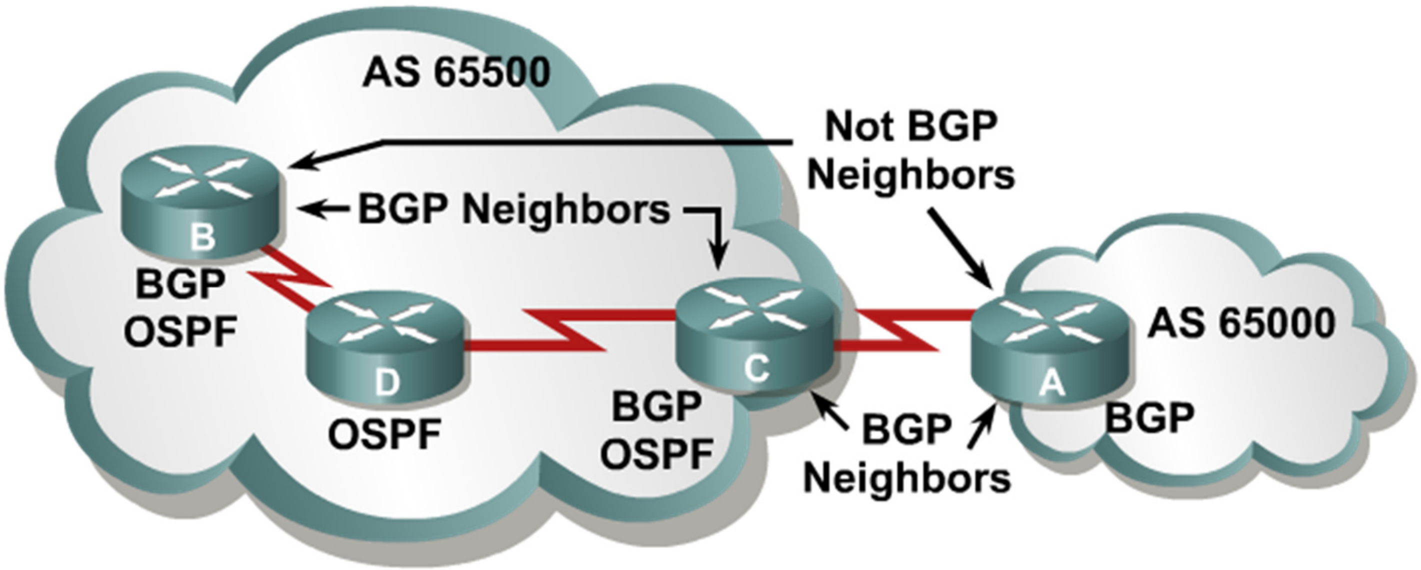
- *Bandwidth* in kilobytes = 10000
- *Delay* in tens of microseconds = 100
- *Reliability* = 255 (maximum)
- *Load* = 1 (minimum)
- *MTU* = 1,500 bytes

Route Maps and Redistribution

- Routes matching either access list 23 or 29 are redistributed with an OSPF cost of 500, external type 1.
- Routes permitted by access list 37 are not redistributed.
- All other routes are redistributed with an OSPF cost metric of 5000, external type 2.

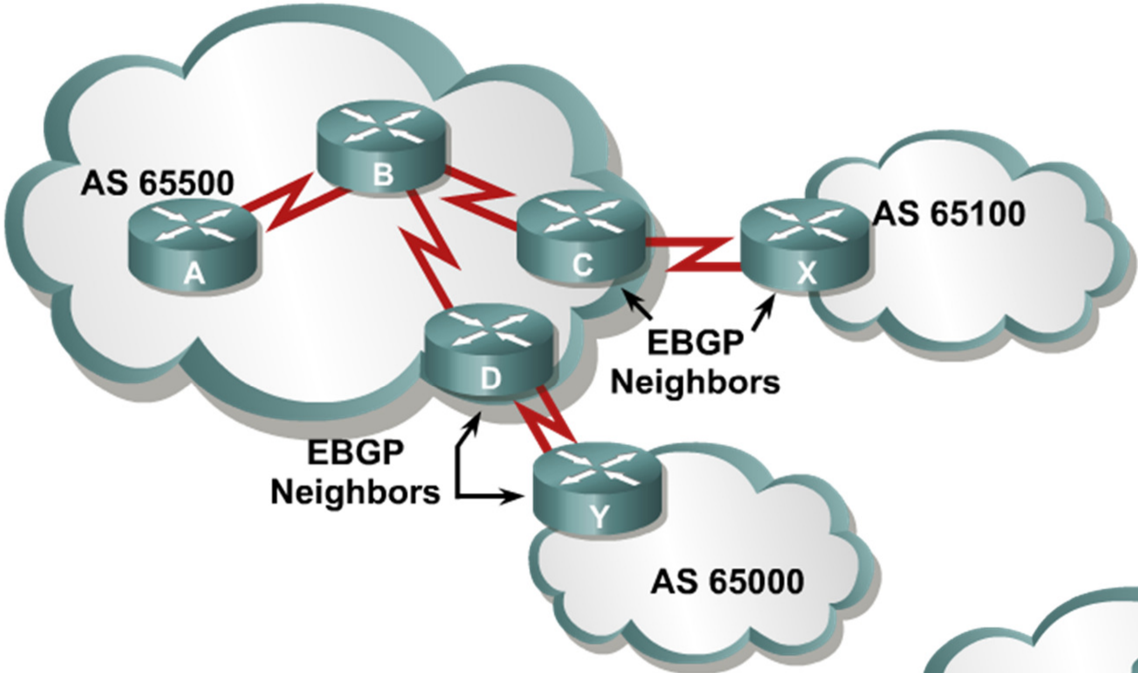
```
R1(config)#access-list 23 permit 10.1.0.0 0.0.255.255
R1(config)# access-list 29 permit 172.16.1.0 0.0.0.255
R1(config)# access-list 37 permit 10.0.0.0 0.255.255.255

R1(config)#route-map REDIS_RIP permit 10
R1(config-route-map)#match ip address 23  29
R1(config-route-map)#set metric 500
R1(config-route-map)#set metric-type type-1
R1(config-route-map)#route-map REDIS_RIP deny 20
R1(config-route-map)#match ip address 37
R1(config-route-map)#route-map REDIS_RIP permit 30
R1(config-route-map)#set metric 5000
R1(config-route-map)# set metric-type type-2

R1(config)# router ospf 10
R1(config-router)# redistribute rip route-map REDIS_RIP
```

BGP Peers = BGP Neighbors

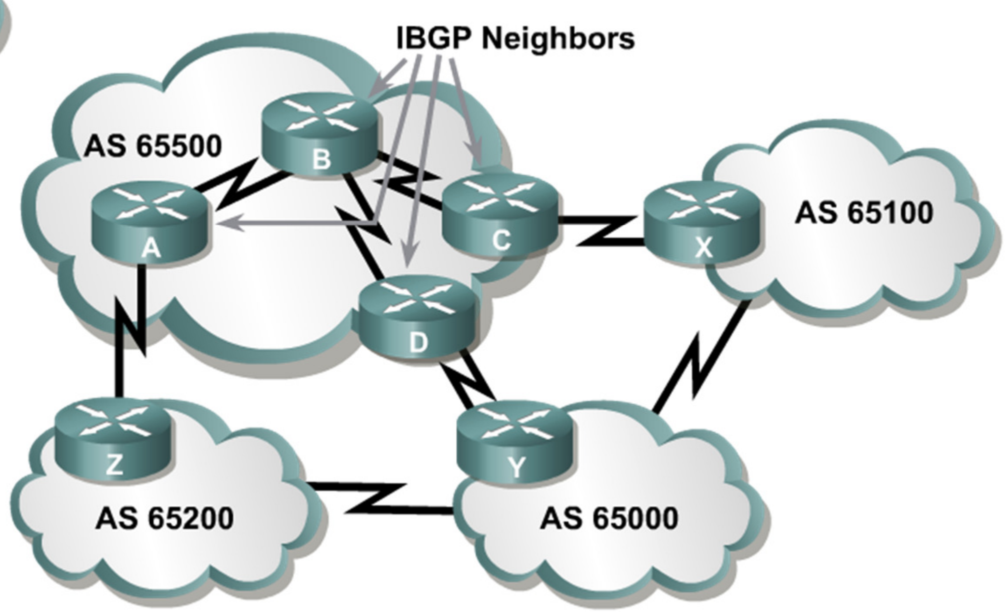


- A "BGP peer," also known as a "BGP neighbor," is a specific term that is used for BGP speakers that have established a neighbor relationship.
- Any two routers that have formed a TCP connection to exchange BGP routing information are called BGP peers or BGP neighbors.

Internal & External BGP



- When BGP is running between neighbors that belong to *different* autonomous systems, it is called EBGP.
- EBGP neighbors, by default, need to be *directly* connected.



- When BGP is running between neighbors within the *same* AS, it is called IBGP.
- The neighbors *do not* have to be directly connected.

BGP Features

- BGP is used by *ISPs* so that they can communicate and exchange packets. The ISPs have multiple connections to each other and agreements to exchange updates.
- BGP is categorized as an *advanced distance vector* protocol, but it is actually a path-vector protocol. BGP is very different from standard distance vector protocols, such as RIP.
- BGP uses TCP (port 179) as its transport protocol, which provides connection-oriented reliable delivery.
- Two routers using BGP form a TCP connection with one another and exchange messages to open and confirm the connection parameters. These two BGP routers are called *peer* routers, or *neighbors*.

BGP Features

- After the connection is made, BGP peers exchange full routing tables. However, since the connection is reliable, BGP peers subsequently send only changes (incremental or triggered updates) after that.
- Reliable links do not require periodic routing updates; therefore, routers use triggered updates instead. BGP sends *keepalive* messages, similar to the hello messages sent by OSPF, IS-IS, and EIGRP.
- BGP is the only IP routing protocol to use TCP as its transport layer. OSPF and EIGRP reside directly above the IP layer, and RIPv1 and RIPv2 use User Datagram Protocol (UDP) for their transport layer.

BGP Attributes

Attribute	Category	Description
Aggregator	Optional, Transitive	Router IS and AS of router that summarised. Not used in path selection.
AS-Path	Well-Known, Mandatory	List of AS route has passed through. Prefer shortest path.
Atomic Aggregate	Well-Known, Discretionary	Summary includes multiple AS. Not used in path selection.
Cluster ID	Optional, Non-transitive	Originating cluster. Not used in path selection.
Community	Optional, Transitive	Route tag. Not used in route selection.
Local Preference	Well-Known, Discretionary	Metric for external paths, for internal neighbours. Prefer highest.
Multiple Exit Discriminator (MED)	Optional, Non-transitive	Inform external peers which path to take into the autonomous system. Prefer lowest.
Next Hop	Well-Known, Mandatory	External peer in neighbouring AS. Not used in path selection.
Origin	Well-Known, Mandatory	Lowest origin type preferred: (i) IGP is lower than (e) EGP, and EGP is lower that (?) incomplete.
Originator ID	Optional, Non-transitive	Identifies Route Reflector. Not used in path selection.
Weight	Optional, not communicated to peers	Administrative Cisco attribute. Prefer highest.

BGP Path Selection

Order	Attribute	Preference	Description
0	Synchronised	True	Use only routes that meet the synchronisation requirement
1	Weight	Highest	Administrative override
2	Local Preference	Highest	Used internally to pick path out of AS
3	Self Originated	True	Used to prefer paths originated on this router
4	AS-Path	Shortest	Minimise AS-hops
5	Origin	i<?	Prefer stability
6	MED	Lowest	Used external to come in
7	External	EBGP<IBGP	External path preferred over internal path
8	IGP Cost	Lowest	Look for more information
9	EBGP Peering	Oldest	Prefer stability
10	RID	Lowest	Chose lowest BGP router ID

BGP Databases

- Neighbor table:
  - List of BGP neighbors
- BGP table (forwarding database):
  - List of all networks learned from each neighbor
  - Can contain multiple paths to destination networks
  - Contains BGP attributes for each path
- IP routing table:
  - List of best paths to destination networks

BGP States

When establishing a BGP session, BGP goes through the following steps:

- Idle: Router is searching routing table to see if a route exists to reach the neighbor.
- Connect: Router found a route to the neighbor and has completed the three-way TCP handshake.
- Open sent: Open message sent, with the parameters for the BGP session.
- Open confirm: Router received agreement on the parameters for establishing session.
  - Alternatively, router goes into Active state if no response to open message
- Established: Peering is established; routing begins.

•In Cisco IOS Software Release 12.4, you use the **debug ip bgp ipv4 unicast** to view BGP events. Earlier Cisco IOS releases use **debug ip bgp events**.

BGP Peering

```
RouterA# show ip bgp summary
BGP router identifier 10.1.1.1, local AS number 65001
BGP table version is 124, main routing table version 124
9 network entries using 1053 bytes of memory
22 path entries using 1144 bytes of memory
12/5 BGP path/bestpath attribute entries using 1488 bytes of memory
6 BGP AS-PATH entries using 144 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3829 total bytes of memory
BGP activity 58/49 prefixes, 72/50 paths, scan interval 60 secs

Neighbor      V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd

10.1.0.2      4 65001      11      11      124    0    0 00:02:28        8
172.31.1.3    4 64998      21      18      124    0    0 00:01:13        6
172.31.11.4   4 64999      11      10      124    0    0 00:01:11        6
```

•Note that the *state* column is blank, which indicates that BGP is *established* between neighbours.

•If there is an entry in the state column, there is a problem with the neighbour relationship.

BGP Active State Troubleshooting

- Active: The router has sent out an open packet and is waiting for a response.
- The state may cycle between *active* and *idle*. The neighbor may not know how to get back to this router because of the following reasons:
  1. Neighbor does not have a route to the source IP address of the BGP open packet generated by this router
  2. Neighbor peering with the wrong address
  3. Neighbor does not have a **`neighbor`** statement for this router
  4. AS number mis-configuration

BGP Neighbors

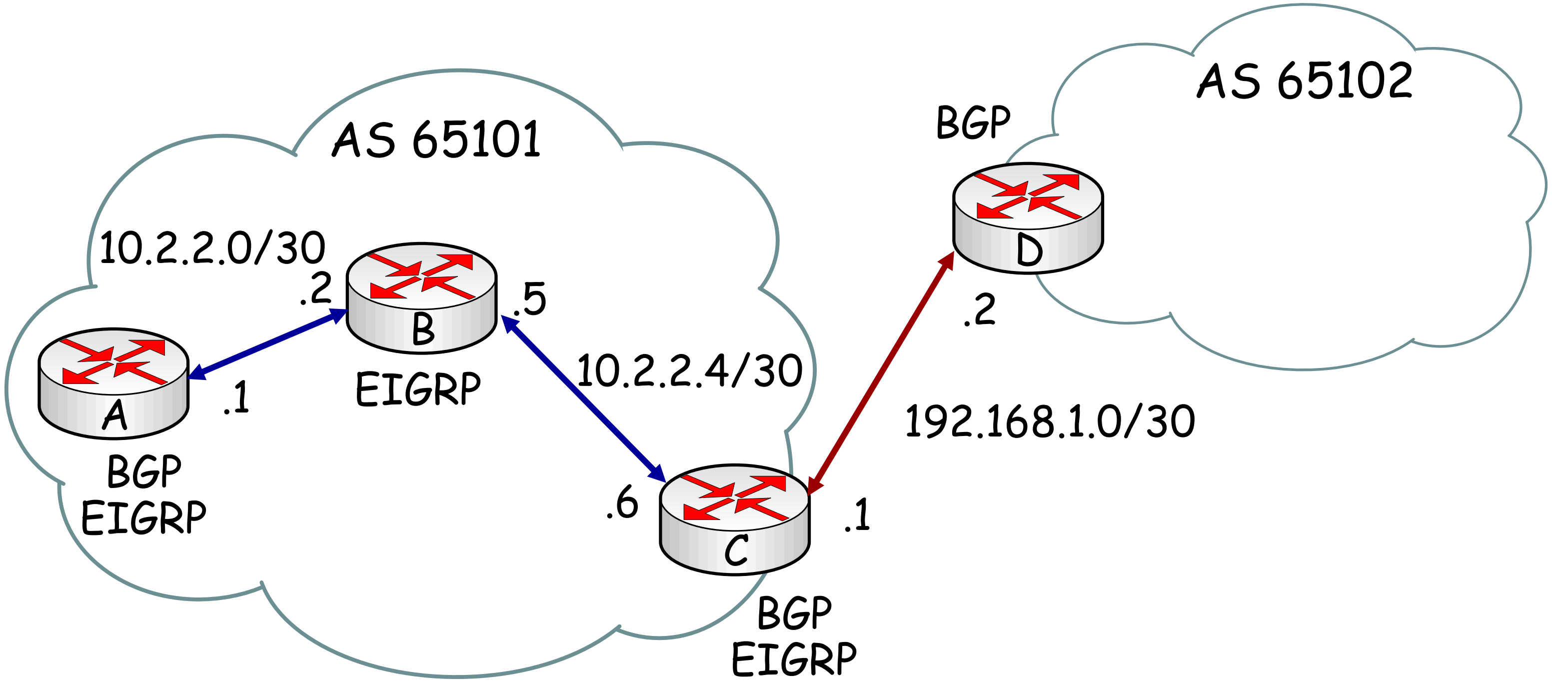
```
RouterA#sh ip bgp neighbors
BGP neighbor is 172.31.1.3,  remote AS 64998, external link
  BGP version 4, remote router ID 172.31.2.3
  BGP state = Established, up for 00:19:10
  Last read 00:00:10, last write 00:00:10, hold time is 180,
keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent         Rcvd
    Opens:                  7            7
    Notifications:          0            0
    Updates:               13           38
<output omitted>
```

BGP Table

```
RouterA# show ip bgp
BGP table version is 14, local router ID is 172.31.11.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal, r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network          Next Hop            Metric LocPrf Weight Path
*> 10.1.0.0/24      0.0.0.0                  0         32768 i
* i                 10.1.0.2                 0    100      0 i
*> 10.1.1.0/24      0.0.0.0                  0         32768 i
*>i10.1.2.0/24      10.1.0.2                 0    100      0 i
*> 10.97.97.0/24    172.31.1.3                             0 64998 64997 i
*                   172.31.11.4                            0 64999 64997 i
* i                 172.31.11.4              0    100      0 64999 64997 i
*> 10.254.0.0/24    172.31.1.3               0             0 64998 i
*                   172.31.11.4                            0 64999 64998 i
* i                 172.31.1.3               0    100      0 64998 i
r> 172.31.1.0/24    172.31.1.3               0             0 64998 i
r                   172.31.11.4                            0 64999 64998 i
r i                 172.31.1.3               0    100      0 64998 i
*> 172.31.2.0/24    172.31.1.3               0             0 64998 i
<output omitted>
```

Displays networks from lowest to highest.

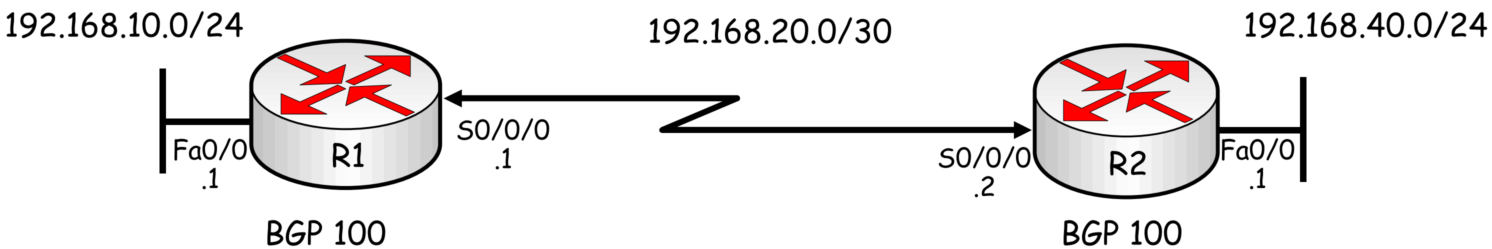
Injecting Routing Information into BGP




```
RouterC(config)# router bgp 65101
RouterC(config-router)# neighbor 10.2.2.1 remote-as 65101
RouterC(config-router)# neighbor 192.168.1.2 remote-as 65102
RouterC(config-router)# network 10.2.2.4 mask 255.255.255.252
RouterC(config-router)# network 10.2.2.0 mask 255.255.255.252
```

- At least one subnet of the specified major network *must be present in the IP routing table* to allow BGP to start announcing the classful network as a BGP route

Monitoring BGP



- The following debug commands can be used to observe the transmission and reception of BGP packets and the exchange of routing information:
- **debug ip bgp :** provides real-time information about BGP events, such as the establishment of a peering relationship.
- **debug ip bgp updates:** shows real-time information about BGP updates sent and received by a BGP router.
- The output of this debug can be limited to a specific neighbor and specific prefixes by use of extra options:

  R1#debug ip bgp ip-address updates 10

  R1(config)#access-list 10 permit host 192.168.20.2
- If no restrictions are imposed by use of the access-list option, this command can generate a large amount of output and affect the router's *performance*.

Chapter 5 – Maintaining & Troubleshooting Routing Solutions Objectives

- Describe EIGRP operation & troubleshooting techniques.
- Describe OSPF operation & troubleshooting techniques.
- Describe BGP operation & troubleshooting techniques.
- Describe route redistribution operation & troubleshooting techniques.

Any Questions?