Module 2

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Enhanced Interior Gateway Routing Protocol (EIGPR)

part 1

Objectives

- Basic mechanisms of EIGRP
- Backward compatibility of IGRP and EIGRP
- EIGRP configuration
- EIGRP default-route
- EIGRP and load-balancing
- EIGRP authentication
- NTP services
- Summarization in EIGRP
- EIGRP stub
- EIGRP in NBMA

part 1

Enhanced IGRP

- Document ID: 16406

- Cisco proprietary protocol developed with SRI institute cooperation

- Distance-vector/Hybrid protocol with components:
  - diffuse computation
  - loop detection
  - reliable transfer using RTP
  - sending partial bounded updates

- The only one protocol that guarantee topology without routing loops if correctly configured

Enhanced IGRP

- EIGRP is modullar and protocol independend.
- Supports IPv4, IPv6, IPX, Appletalk.
- Classless, supports VLSM, automatic and manual summarization.
- In IPv4 networks uses:
  - multicast address 224.0.0.10
  - RTP using protocol number 88
- Administrative distances:
  - Internal (90) - External (170) - Discarding (5)

EIGRP key technologies

- **Neighbor discover/recovery**
  - **Every router builds its own neighbor table, in which router monitors directly connected neighbors and their reachability**
- **Reliable Transport Protocol (RTP)**
  - **Network protocol independend protocol with protocol ID: 88**
- **DUAL finite-state machine**
  - **Manage computation and diffuse calculation**
- **Protocol-dependent modules (PDMs)**
  - **PDM communicates with network protocols**

EIGRP terms

- **Successor**
  - next hop router to destination network
  - Path via successor is the shortest loop-free path
- **Feasible successor**
  - Potential next-hop router (backup successor)
  - Not shortest path to destination, but without loops
- **Feasible distance**
  - Currently known shortest path to destination
- **Reported distance, Advertised distance**
  - Neighbors distance to destination as reported by neighbor
- **Feasibility condition**
  - Condition, that guarantee loop-free topology via neighboring router to destination

$$RD_{FS} < FD_{S}$$

EIGRP terms

- **Neighbor table**
  - Router maintains information about neighbors
- **Topology table**
  - Topology table contain networks and destinations to that networks as reported by neighbors and locally evaluated (reported distance, feasible distance)
- **Passive state**
  - Successor to destination is known and next-hop to that network is usable.
- **Active state**
  - When for destination network does not exist successor and feasible successor

EIGRP terms

- **Diffusing algoritm**
  - Starts when router sends EIGRP query
  - Neighbor respond to query , or if do not know answer, will forward query to other neighboring routers

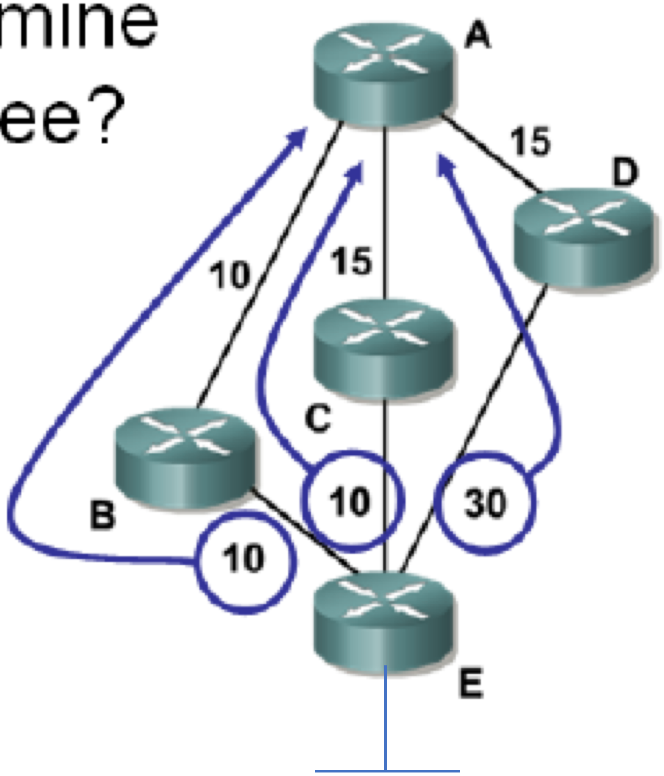
DUAL

- How does EIGRP determine which routes are loop-free?
  - Each of A's neighbors is reporting reachability to E:

    B with a cost of 10

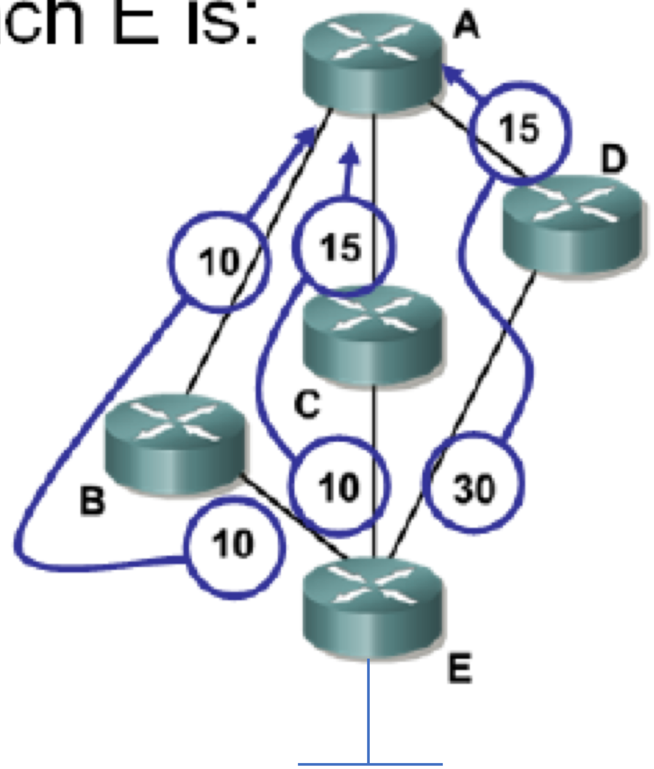
    C with a cost of 10

    D with a cost of 30
  - These three costs are called the reported distance (RD); the distance each neighbor is reporting to a given destination



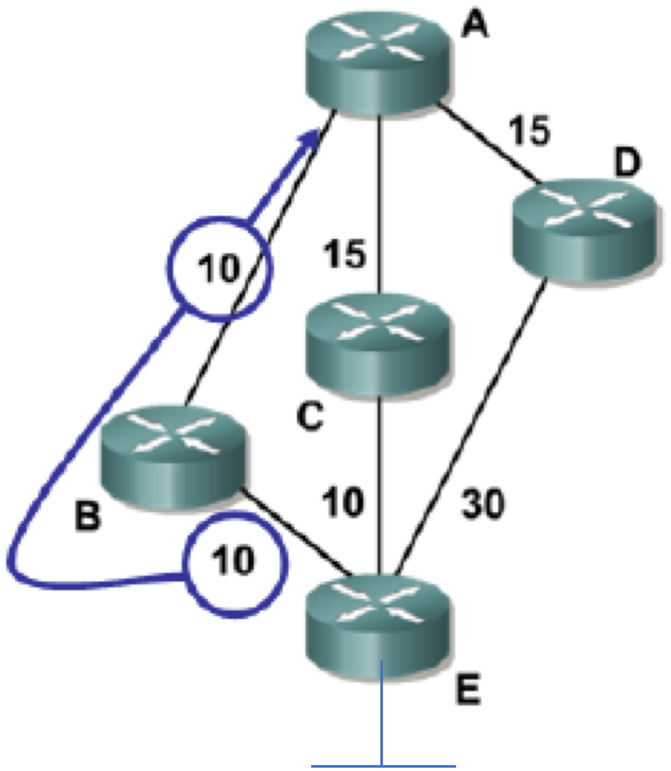
DUAL

- At A, the total cost to reach E is:
  - 20 through B
  - 25 through C
  - 45 through D
- The best of these three
paths is the path
through B, with a
cost of 20



DUAL

- A uses the FD and the RD to determine which paths are loop-free
- The best path (FD) is used as a benchmark; all paths with RDs lower than the FD cannot contain loops
- The algorithm may mark some loop-free paths as loops
- However, it is guaranteed never to mark a looped path as loop-free

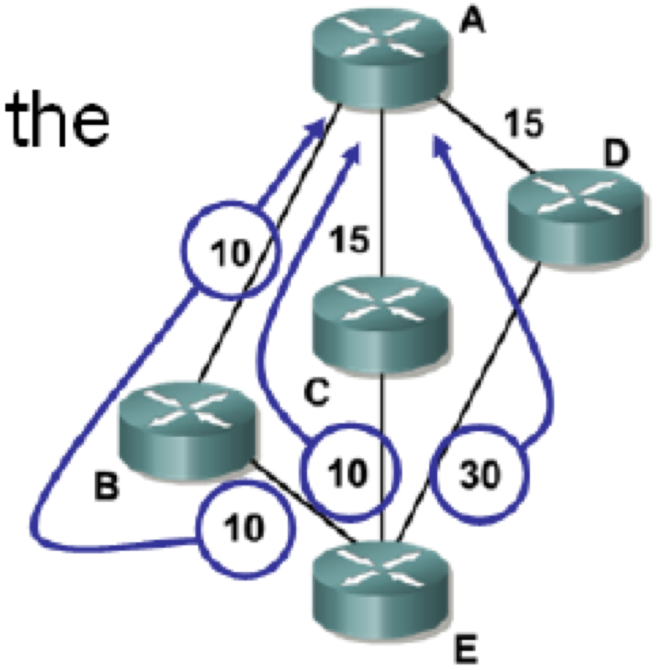


DUAL

- At A:
  - The path through B is the best path (FD), at 20

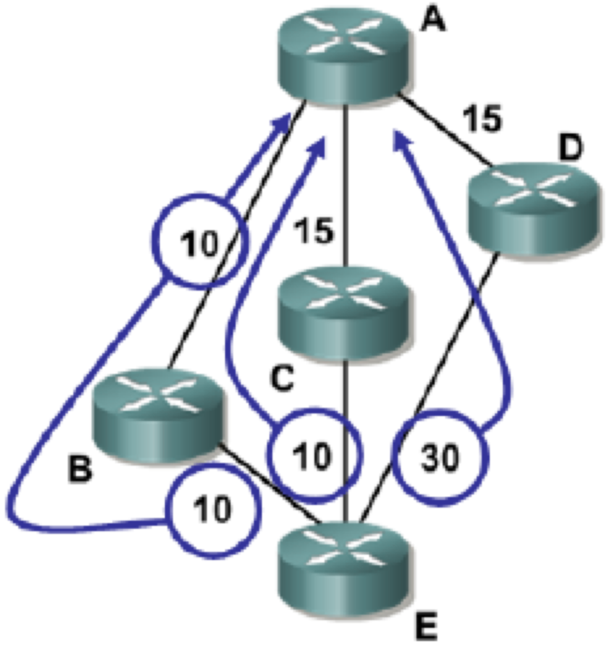
C can reach E with a cost of 10; 10 (RD) is less than 20 (FD), so this path is loop-free.

D can reach E with a cost of 30; 30 (RD) is not less than 20 (FD), so EIGRP assumes this path is a loop.

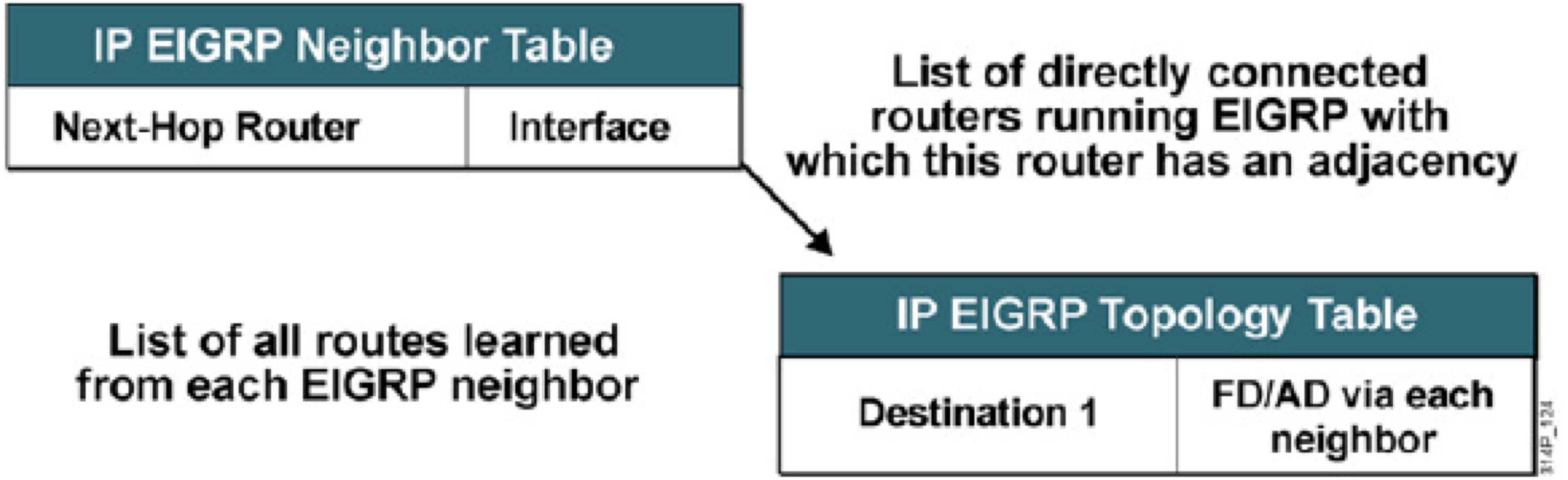


DUAL

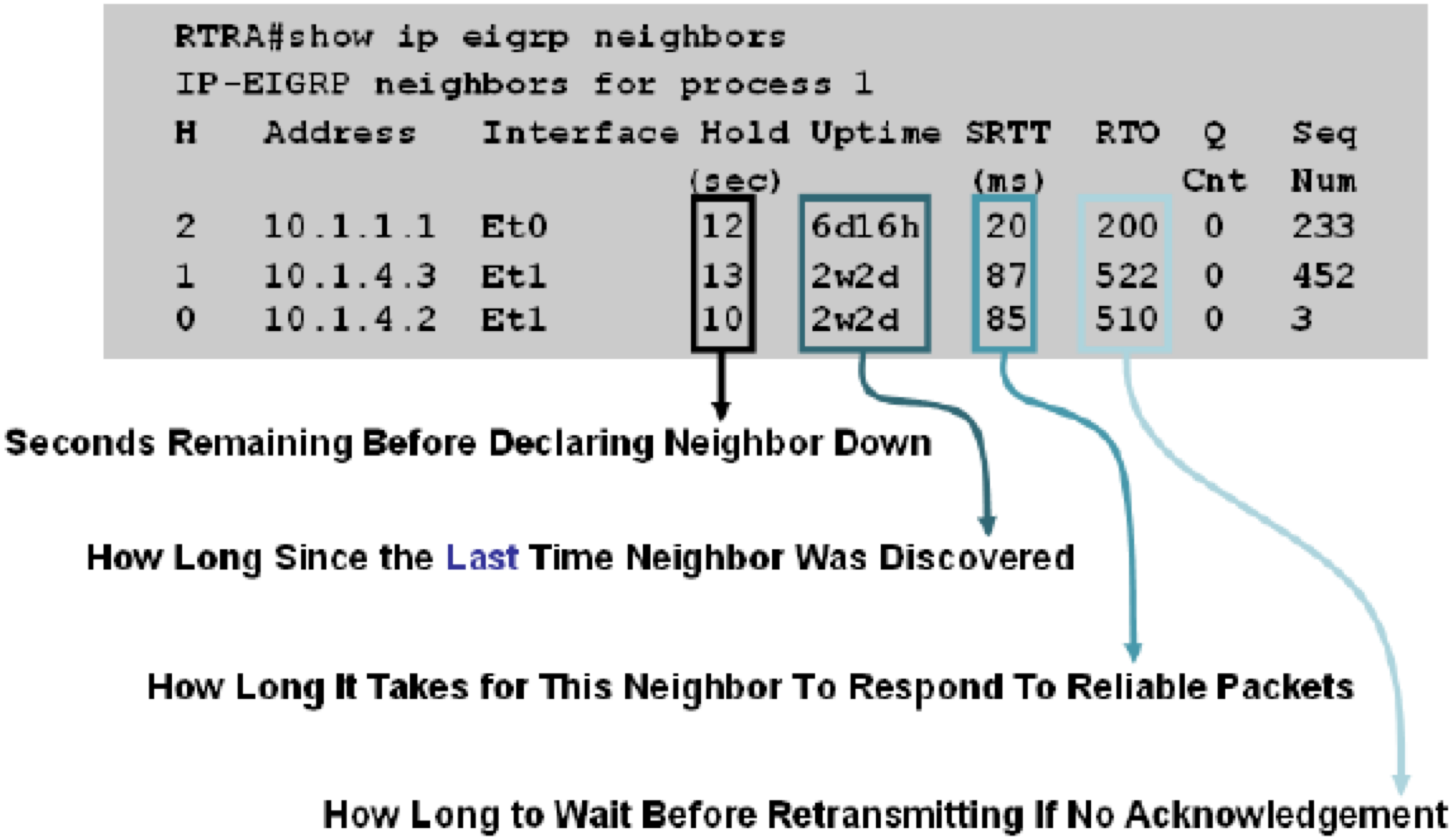
- Feasible distance
  - –In passive state, can be only decremented
  - –Incrementing of FD represents diffuse calculation
  - –Feasible distance is historically shortest path to destination
(history starts and ends by changing to passive state)
  - –Feasibility condition:
If my neighbor is closer to destination that I ever was, he can't be
on loop path.



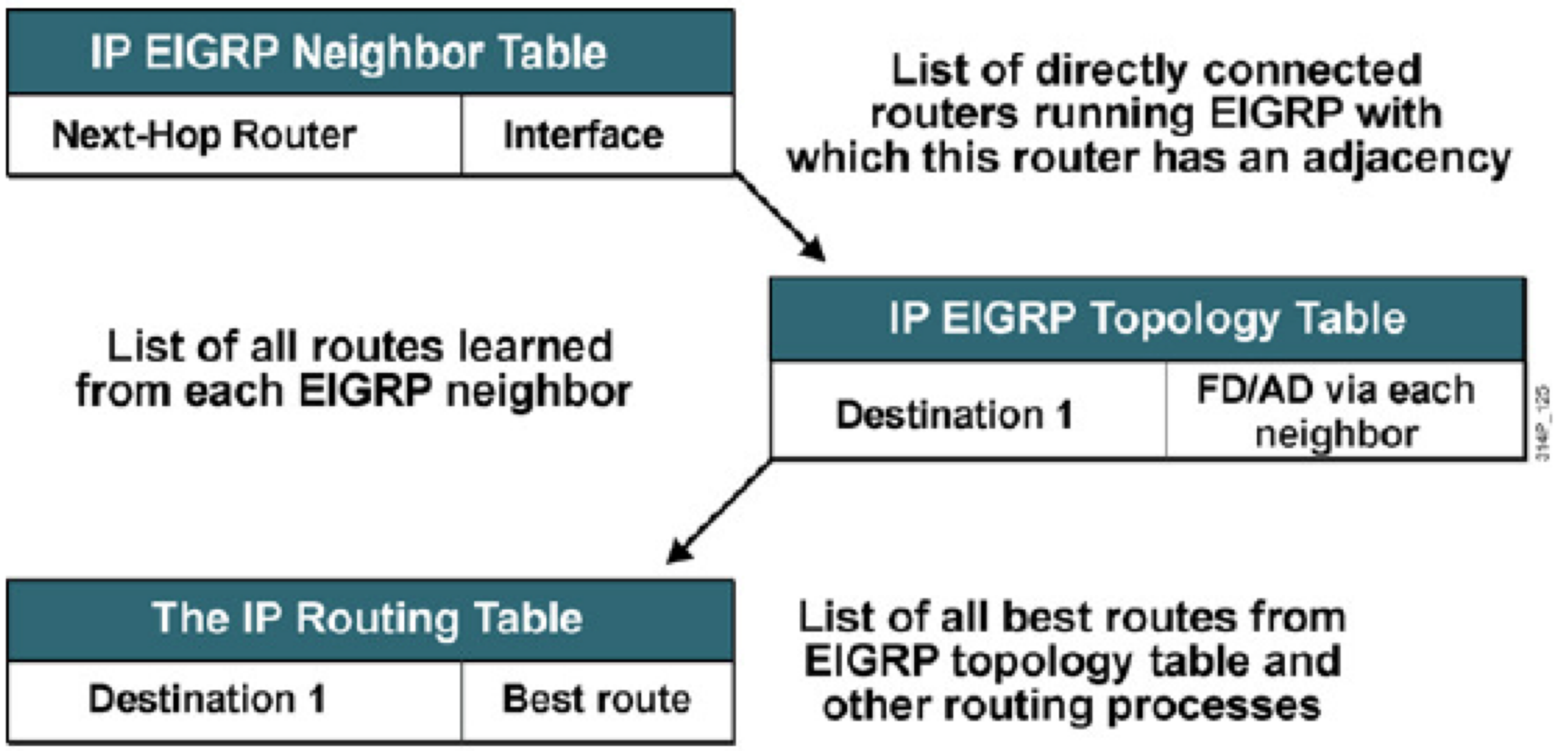
EIGRP topology table



EIGRP neighbor table



EIGRP IP routing table



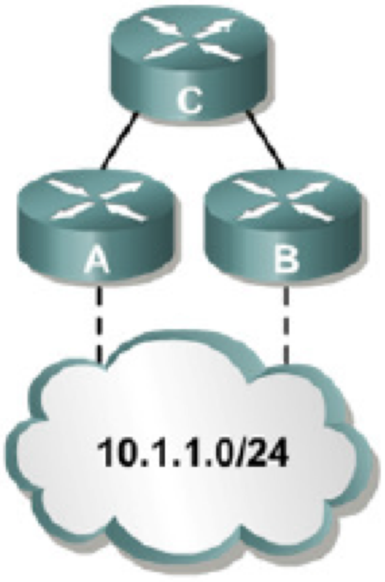
EIGRP tables

Router C's tables:

IP EIGRP Neighbor Table	
Next-Hop Router	Interface
Router A Router B	Ethernet 0 Ethernet 1

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

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



EIGRP packet types

- **Hello: Establish neighbor relationships.**
  - 224.0.0.10, without acknowledgement
  - Sent every 5 seconds on highspeed interfaces
  - Sent every 60 seconds on multipoint interfaces slower than T1 (1544 Kbps)

- **Update: Send routing updates**
  - Unicast or multicast
  - Acknowledgements

- **Query: Ask neighbors about routing information**
  - Usually multicast with acknowledgements

- **Reply: Respond to query about routing information**
- **ACK: Acknowledge a reliable packet**

EIGRP metric

- Composite metric and has same metric components as IGRP:
  - Bandwidth
  - Delay
  - Reliability
  - Loading
  - MTU

- EIGRP metric is IGRP metric multiplied by 256

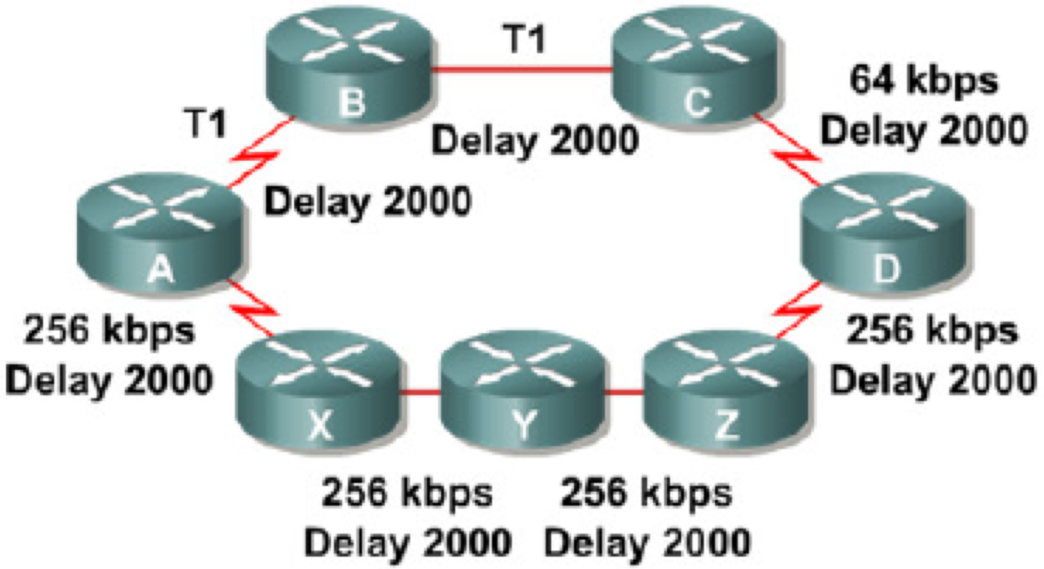
EIGRP matric calculation

- By **default**, EIGRP metric:
  - Metric = bandwidth (slowest link) + delay (sum of delays)

- **Delay** = sum of the delays in the path, in tens of microseconds, multiplied by 256.

- **Bandwidth** = [10 / (minimum bandwidth link along the path, in kilobits per second)] * 256
- Formula with default K values (K1 = 1, K2 = 0, K3 = 1, K4 = 0, K5 = 0):
  - Metric = [K1 * BW + ((K2 * BW) / (256 – load)) + K3 * delay]
- If K5 not equal to 0:
  - Metric = Metric * [K5 / (reliability + K4)]

Metrics calculation example



A → B → C → D	**Least bandwidth 64 kbps**	**Total delay 6,000**
A → X → Y → Z → D	**Least bandwidth 256 kbps**	**Total delay 8,000**

- Delay is the sum of all the delays of the links along the paths:
  Delay = [delay in tens of microseconds] x 256
- BW is the lowest bandwidth of the links along the paths:
  BW = [10,000,000 / (bandwidth in kbps)] x 256

EIGRP configuration

Router(config)#

```
router eigrp autonomous-system-number
```

- Defines EIGRP as the IP routing protocol.
- All routers in the internetwork that must exchange EIGRP routing updates must have the same autonomous system number.

Router(config-router)#

```
network network-number [wildcard-mask]
```

- **Identifies attached networks participating in EIGRP.**
- **The** *wildcard-mask* **is an inverse mask used to determine how to interpret the address. The mask has wildcard bits, where 0 is a match and 1 is "don't care."**

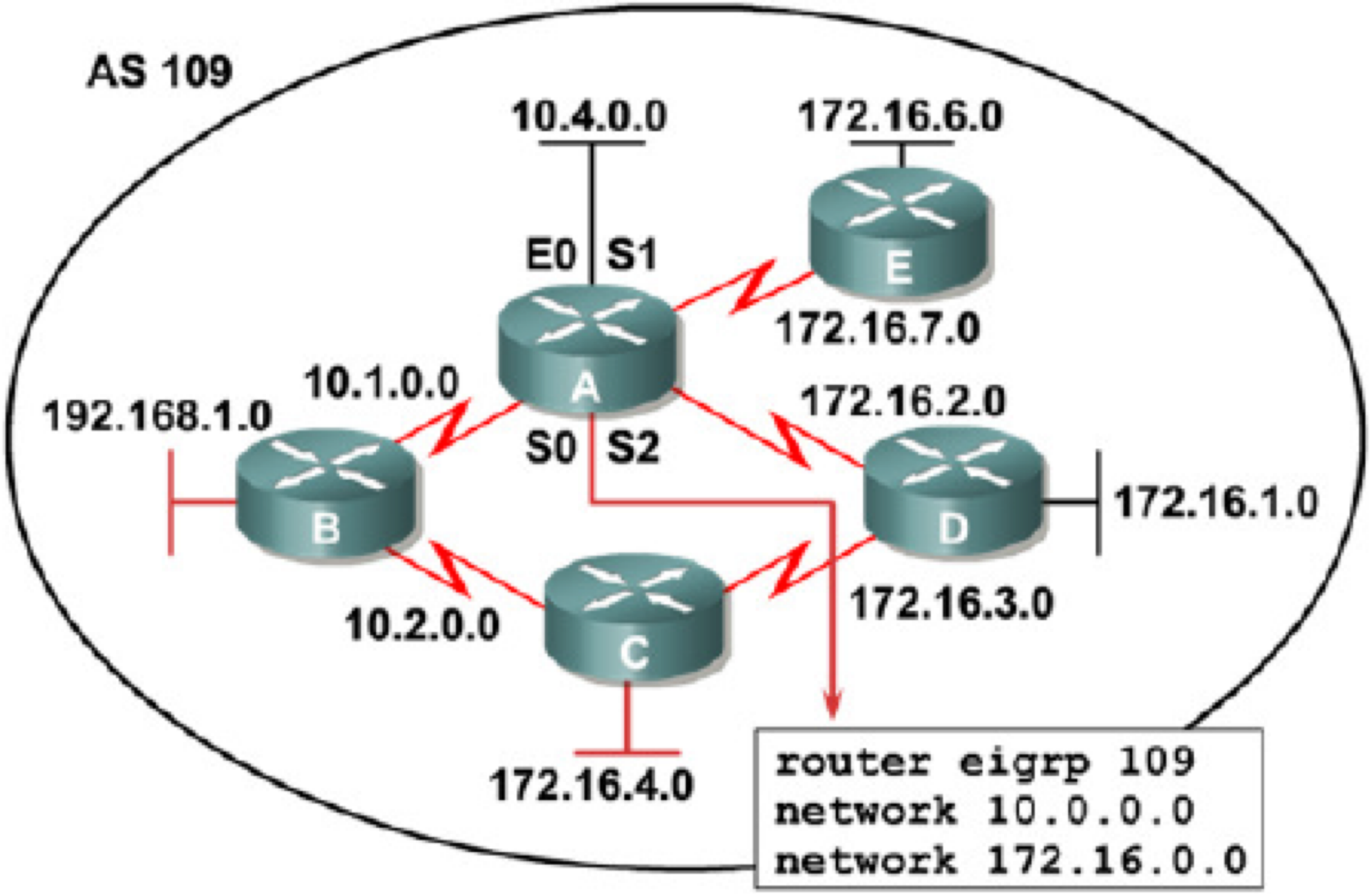
EIGRP configuration

```
Router(config-if)#
bandwidth kilobits
```

- Defines the interface's bandwidth for the purposes of sending routing update traffic.

- By default, EIGRP is allowed to use 50% of bandwidth for routing purposes.

EIGRP configuration for IP



Network 192.168.1.0 is not configured on router A, because it is not directly connected to router A.

EIGRP configuration (example)

Classful configuration example:

```
routerA(config)#router eigrp 109
routerA(config-router)#network 10.1.0.0
routerA(config-router)#network 10.4.0.0
routerA(config-router)#network 172.16.7.0
routerA(config-router)#network 172.16.2.0
```

Classless configuration example:

```
routerA(config)#router eigrp 109
routerA(config-router)#network 10.1.0.0 0.0.255.255
routerA(config-router)#network 10.4.0.0 0.0.255.255
routerA(config-router)#network 172.16.2.0 0.0.0.255
routerA(config-router)#network 172.16.7.0 0.0.0.255
```

EIGRP and default route

EIGRP can send default route in two different ways:

- As destination 0.0.0.0/0
- As network with gateway of last resort flag

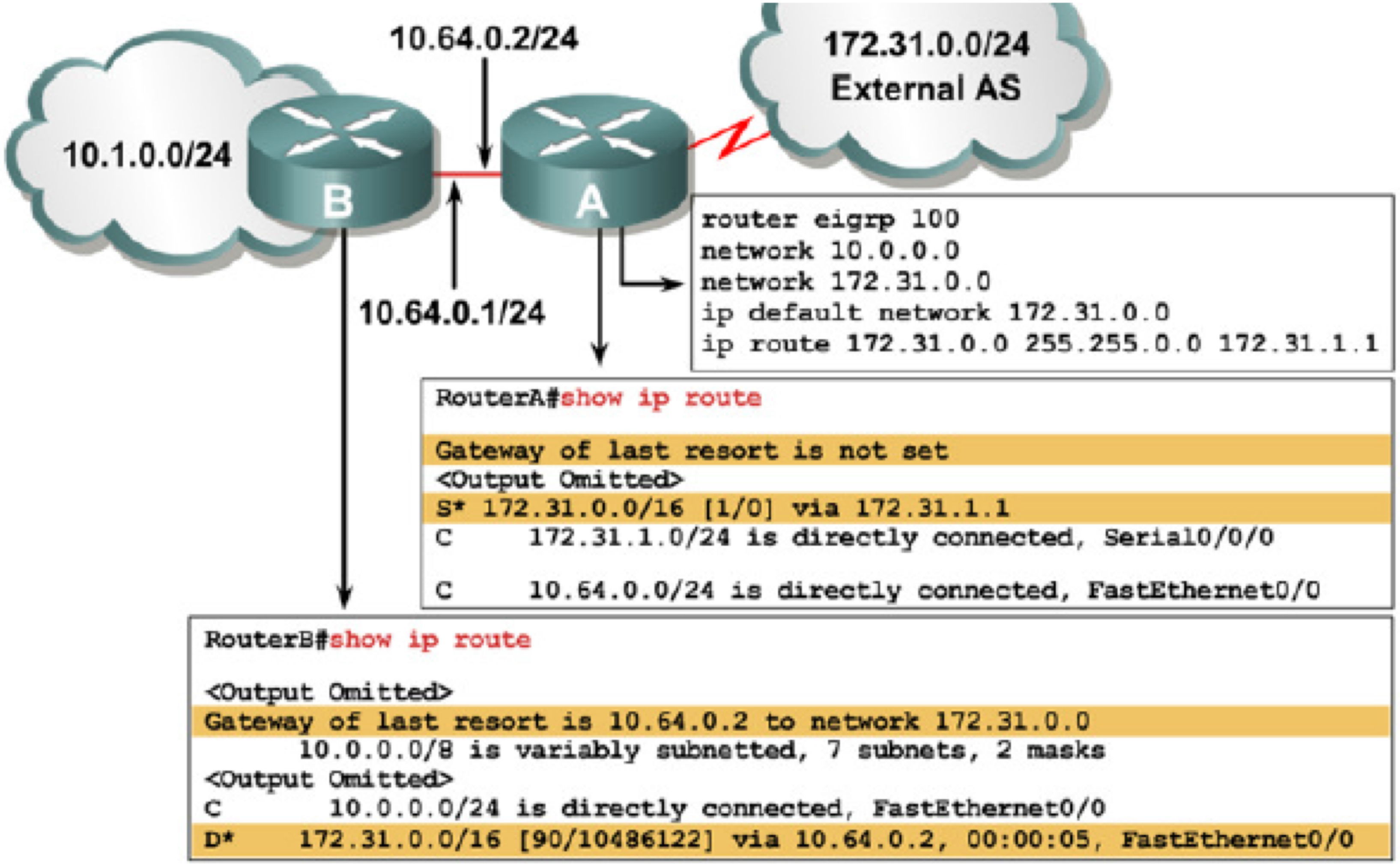
Advertising 0.0.0.0/0:

- default route needs to be in routing table at first
- possible to advertise via redistribution

Network with gateway flag:

- flag can be set by “ip default-network” command

Ip default-network command



EIGRP Load-balancing

- Every dynamic routing protocol supports equal-cost load balancing.
- EIGRP is the only one that supports unequal-cost proportional load-balancing.
- Variance – defines multiplier of the best metric that is still acceptable for load-balancing on loop-free paths.

EIGRP Load-balancing

- Load-balancing can be provided with or without CEF

With CEF:

```
Router(config)# ip cef
Router(config)# interface FastEthernet 0/0
Router(config-if)# ip load-sharing {per-packet | per-destination}
```

Without CEF:

```
Router(config)# no ip cef
Router(config)# interface FastEthernet 0/0
Router(config-if)# no ip route-cache
```

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