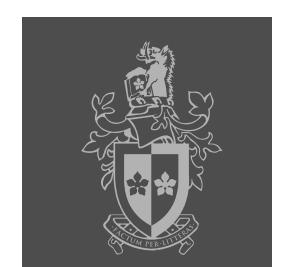


CENTRE FOR
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ARCHITECTURES

TNE20002/TNE70003

Topic 4. EIGRP



## **Outline**



#### 4.1 EIGRP Overview

- Characteristics
- Data Structures & Messages
- Authentication

#### 4.2 EIGRP Configuration

- Autonomous System Number & Wildcard Mask
- Configure EIGRP with IPv4
- Neighbor Table & Routing Table entry

## 4.3 DUAL Concepts

- Diffusing Update Algorithm
- EIGRP Topology Table
- Composite Metric

### 4.4 EIGRP Recovery

- Recovery using Feasible Successor
- Recovery using Query Reply packets



# **EIGRP Summary**



#### **EIGRP Characteristics**

Enhanced Interior-Gateway Routing Protocol
Classless Distance Vector Protocol
Cisco Proprietary
EIGRP replaced IGRP
RFC 7868 - released to IETF
as open standard.

Characteristics and Features	IGRP	EIGRP
Metric	Both use a composite metric consisting of bandwidth and delay. Reliability and load can also be included in the metric calculation.	
Updates Forwarded to Address	255.255.255.255	224.0.0.10
Supports VLSM	X	✓
Supports CIDR	X	J
Supports Summarization	X	<b>√</b>
Supports Authentication	Χ	<b>/</b>

Administrative Distance (5 summary), (90 Internal), (170 external)

Diffusing Update ALgorithm (DUAL) used to calculate the cost to a destination network

Metric bandwidth, delay, reliability, load

Establishes Neighbor Adjacencies. Hello keepalive mechanism

Reliable Transport Protocol (RTP) used to provide delivery of EIGRP packets to neighbors.

Partial Updates Bounded triggered updates

Maintains a topology table - maintains all the routes received from neighbors (not only the best paths) in a topology table.

Rapid convergence – because it maintains alternate routes.

Route summarization

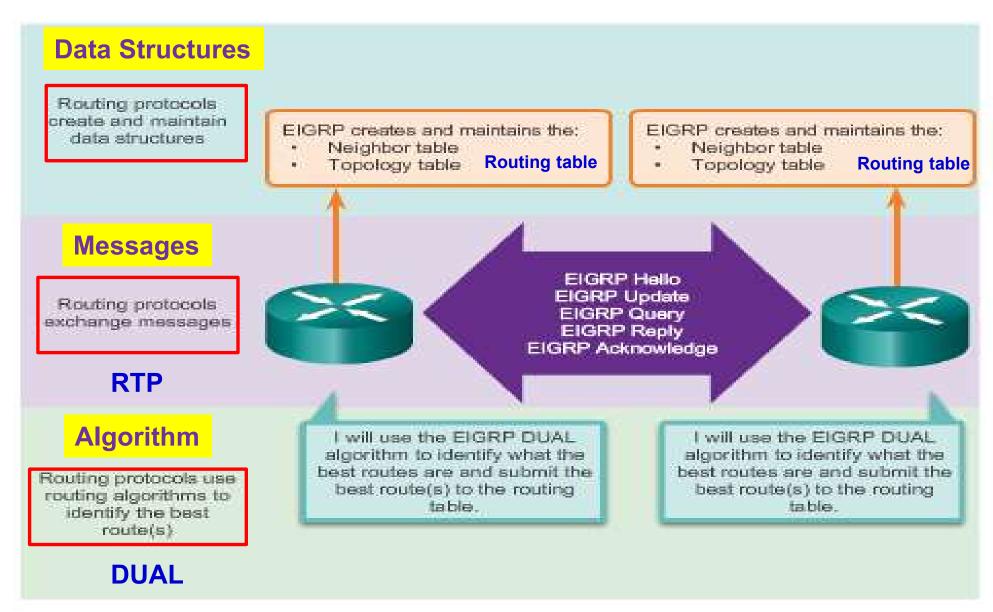
Load Balancing - supports Equal and Unequal load balancing

**Authentication** 



# Components of Routing Protocol: EIGRP







#### **EIGRP Data Structures**: Three Tables



#### **EIGRP Neighbor Table**

Next-Hop Router Interface

List of directly connected routers with which a router has an adjacency

To view neighbor table # show ip eigrp neighbors

#### **EIGRP Topology Table**

Destination FD via Each Neighbor

List of all routes learned from each neighbor

To view topology table # show ip eigrp topology

#### **EIGRP Routing Table**

Destination

Least Cost Route FD List of all **least cost routes** from **Topology** Table
To view routing table
# show ip route



Packet Type	Description
Hello	Used to discover other EIGRP routers in the network.
Acknowledgement	Used to acknowledge the receipt of any EIGRP packet.
Update	Convey routing information to known destinations.
Query	Used to request specific information from a neighbor router
Reply	Used to respond to a query.



#### **EIGRP Hello Packet**

- Used to discover EIGRP neighbors.
- Used to form and maintain EIGRP neighbor adjacencies
- Router creates a neighbor table.
- Sent as IPv4 or IPv6 multicasts.
  - IPv4 layer 3 multicast address 224.0.0.10
  - IPv6 layer 3 multicast address FF02::A.
- Hello Interval default, send Hello every 5 seconds
- Hold timer
  - by default set to three times the Hello interval.
  - If have not received Hello from neighbor within 15 secs, declare neighbor unreachable.
- Unreliable Delivery requires no response from recipient

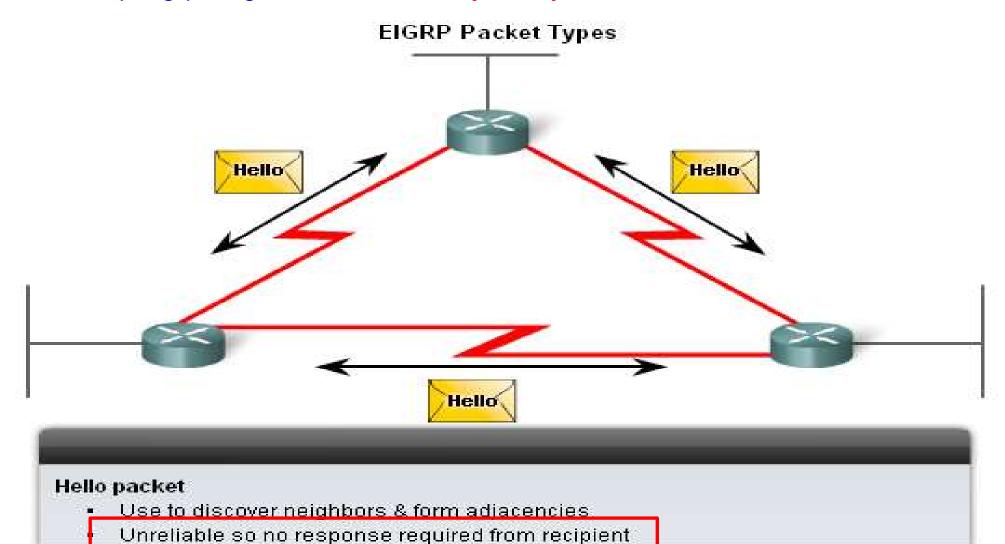




#### **EIGRP Hello Packet**

Used to discover and form adjacencies with neighbors

show ip eigrp neighbors – verifies adjacency has been established





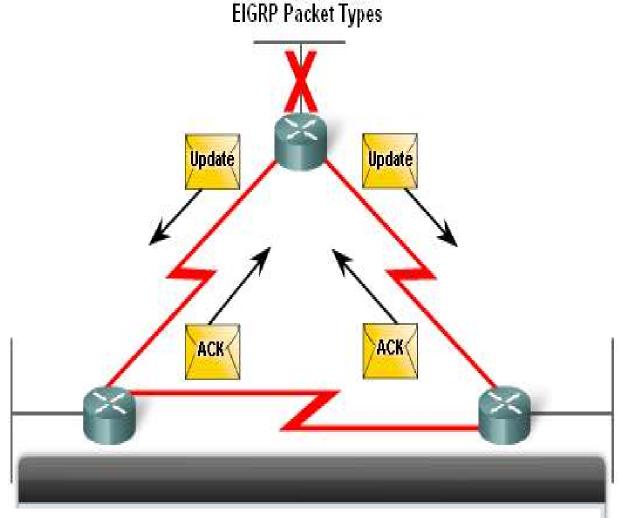


#### **Update packets**

- Used to propagate routing information
- Sent initially to exchange topology information
- or
- Sent after change
- Reliable Delivery

#### **ACK** packets

 Dataless Hello packets used to acknowledge receipt of update



#### **Update Packet**

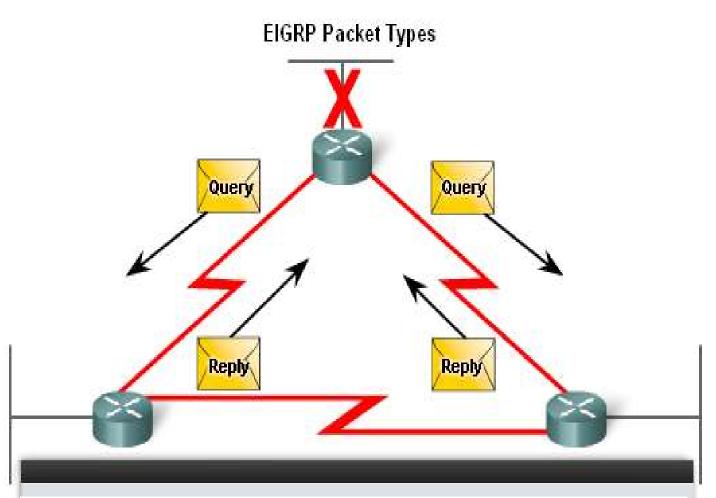
- Used to propagate routing information, after a change
- Acknowledged (ACK) by receiving router, reliable delivery





#### **Query & Reply packets**

- Used to request alternate path information from neighbors
- Both Query and Reply packets require acknowledgement
- Query packets can be
- Multicast or unicast
- Reply packets always
- unicast



#### **Query Packet**

- Used by DUAL when searching for networks
- Reply packet sent in response to Query



#### **EIGRP** Authentication

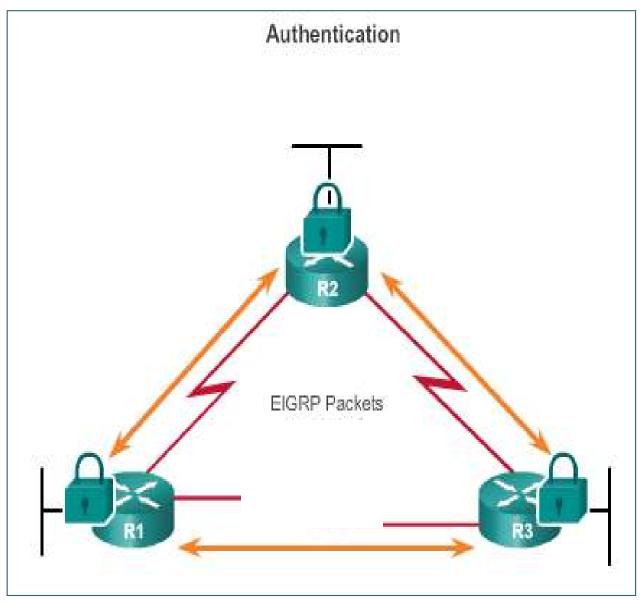


#### **EIGRP Authentication**

EIGRP can be configured to authenticate routing information.

 Ensures routers only accept updates from routers that have been configured with the correct authentication information.

- Default NO authentication
- EIGRP routing updates are not encrypted



# Topic 4.2



## 4.2 EIGRP Configuration

- Autonomous System Number & Wildcard Mask
- Configure EIGRP with IPv4
- Neighbor Table & Routing Table entry



# EIGRP – Autonomous System Number

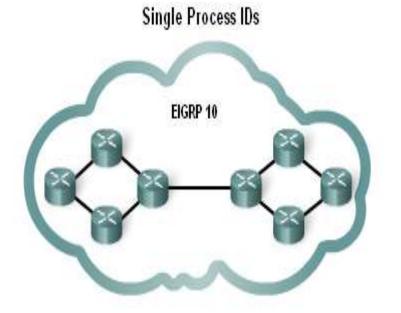


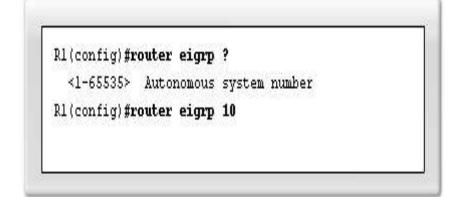
# EIGRP Autonomous System Number

#### Two functions

- Acts as a Process ID representing an instance of the routing protocol running on a router
- Acts as Group ID Only routers using the same AS number can exchange updates with each other

To configure EIGRP with IPv4
Use command
Syntax #
Router(config) #router eigrp AS-#

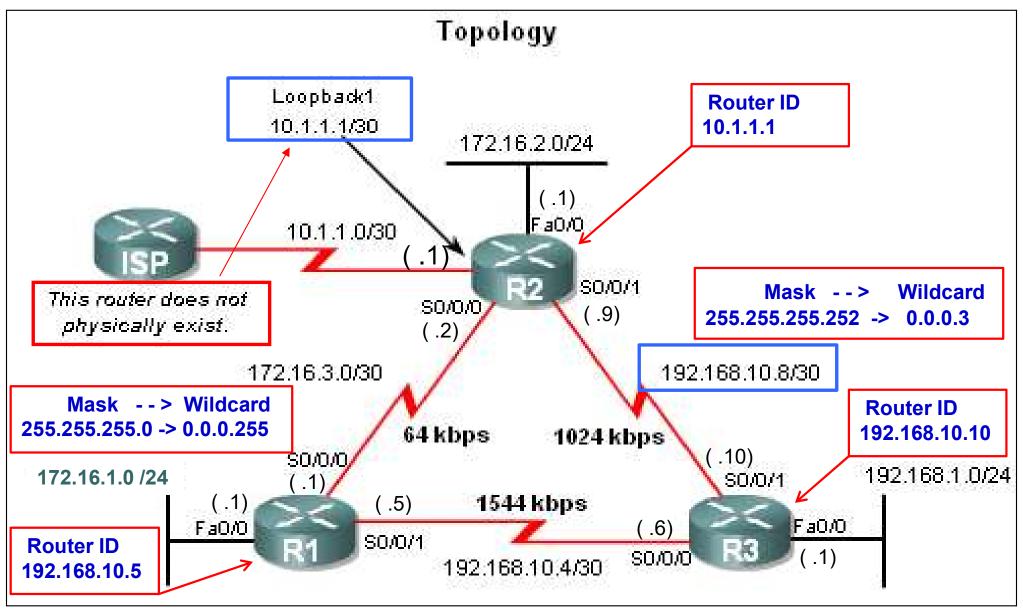








#### **Topology Diagram**





Syntax # network network-number [wildcard-mask]

#### Wildcard Mask

Specifies a subnet or range of subnet network addresses

wildcard mask is the inverse of the subnet mask

Subtract SNM from 255.255.255.255

```
R1(config) #router eigrp 1
R1(config-router) #network 172.16.0.0
R1(config-router) #network 192.168.10.0
```

Enables EIGRP interfaces subnet 172.16.1.0 /24 & subnet 172.16.3.0 /30

Enables EIGRP interfaces subnet 192.168.10.0 /30

```
R2(config) #router eigrp 1
R2(config-router) #network 172.16.0.0
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 172.16.
```

SNM 255.255.255.252 --> 0.0.0.3

%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 172.16.3 (Serial0/0/0) is up: new adjacency R2(config-router)#network 192.168.10.8 0.0.0.3

```
R3(config) #router eigrp 1  
R3(config-router) #network 192.168.10.0  
R1, R2 and R3 are in Autonomous System 1

R0(config-router) #network 192.168.10.0  
R1, R2 and R3 are in Autonomous System 1

R1, R2 and R3 are in Autonomous System 1

R1, R2 and R3 are in Autonomous System 1

R1, R2 and R3 are in Autonomous System 1
```

%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.10.9 (Serial0/0/1) is up: new adjacency R3(config-router)#network 192.168.1.0





#### Passive Interface

```
R3(config) # router eigrp 1
R3(config-router) # passive-interface gigabitethernet 0/0
```

Syntax #

Router (config-router) # passive-interface type number [default]

#### Passive interfaces

Passive interfaces prevent

EIGRP updates out a specified interface

```
R3# show ip protocols
*** IP Routing is NSF aware ***
Routing Protocol is "eigrp 1"
<output omitted>
Routing for Networks:
   192.168.1.0
   192.168.10.4/30
    192.168.10.8/30
Passive Interface(s):
  GigabitEthernet0/0
Routing Information Sources:
    Gateway
                    Distance
                                   Last Update
   192.168.10.5
                                   01:37:57
    192.168.10.9
                                   01:37:57
 Distance: internal 90 external 170
```

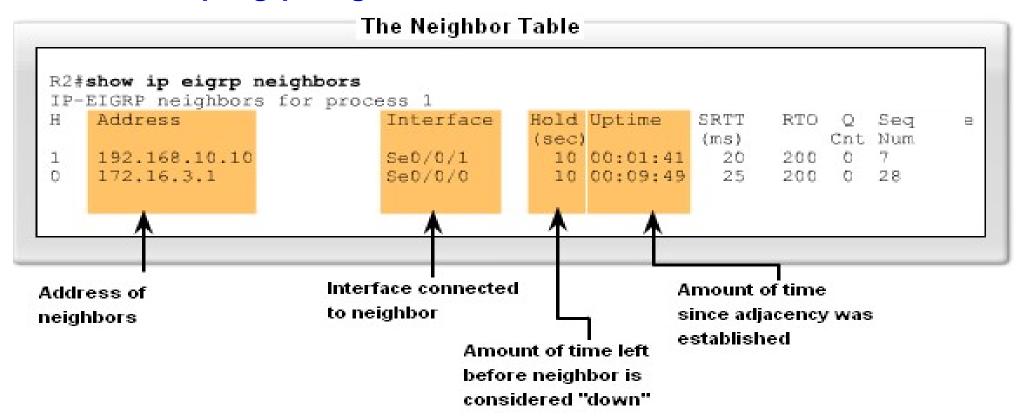
Default option sets all router interfaces to passive Prevents neighbor relationships from being established Routing updates from a neighbor are ignored



# **EIGRP Neighbor Table**



- EIGRP routers must establish adjacencies with their neighbors before any updates can be sent or received
- First check to see what routers have established communication
  - show ip eigrp neighbors



To see when last update was received on each interface

show ip protocols





#### Route Table

Router # show ip route D route source EIGRP

#### Successor

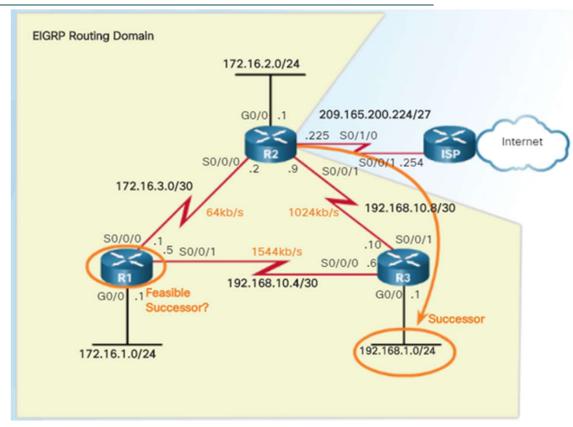
A successor is neighboring router with the least-cost route to the destination network.

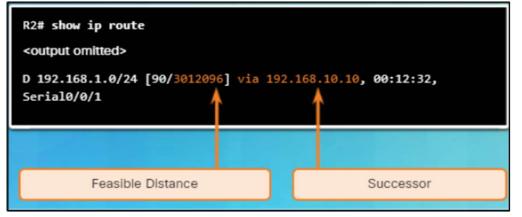
The successor IP address is shown right after "via".

FD is lowest calculated metric to reach the destination network.

FD is second number inside the brackets.

Also known as the "metric" for the route.







# Topic 4.3



## 4.3 DUAL Concepts

- Diffusing Update Algorithm
- EIGRP Topology Table
- Composite Metric

# **DUAL Concepts**



#### **DUAL Concepts**

EIGRP uses Diffusing Update Algorithm DUAL as its routing algorithm.

DUAL guarantees loop free paths and backup routes.

EIGRP uses composite metric

incl. Bandwidth , Delay & optional (Reliability and Load)

Routers use DUAL to calculate the best routes to each destination,

Routers update Routing Table with best routes.

Store all destinations advertised by neighbors including loopfree backup routes in EIGRP Topology Table metric & next-hop router + other parameters reported by neighbors.

#### **DUAL Terminology**

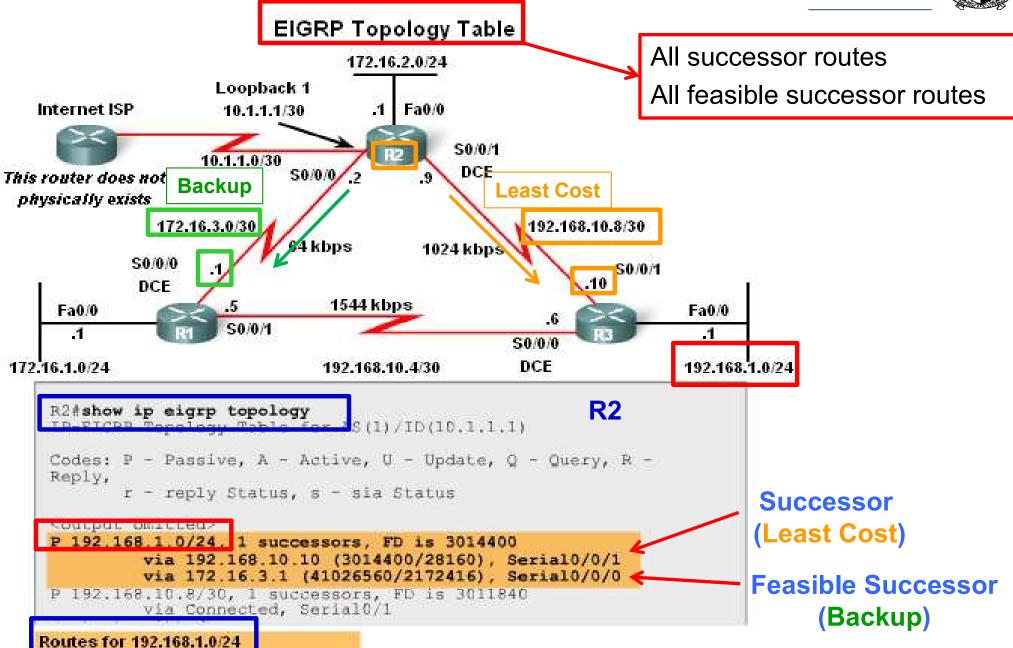
DUAL uses several terms to describe parameters seen in the EIGRP Topology Table.

Term	Description	
Successor	<ul> <li>Is a neighboring router that is used for packet forwarding and is the least-cost route to the destination network.</li> <li>The IP address of a successor is shown in a routing table entry right after the word "via".</li> </ul>	
Feasible Successors (FS)	These are the "Backup paths" that are a loop-free.  Must comply to a feasibility condition.	
Reported Distance (RD)	<ul> <li>Also called "advertised distance", this is the reported metric from the neighbor advertising the route.</li> <li>If the RD metric is less than the FD, then the next-hop router is downstream and there is no loop.</li> </ul>	
Feasible Distance (FD)	<ul> <li>This is the actual metric of a route from the current router.</li> <li>Is the lowest calculated metric to reach the destination network.</li> <li>FD is the metric listed in the routing table entry as the second number inside the brackets.</li> </ul>	



# **EIGRP** Topology Table

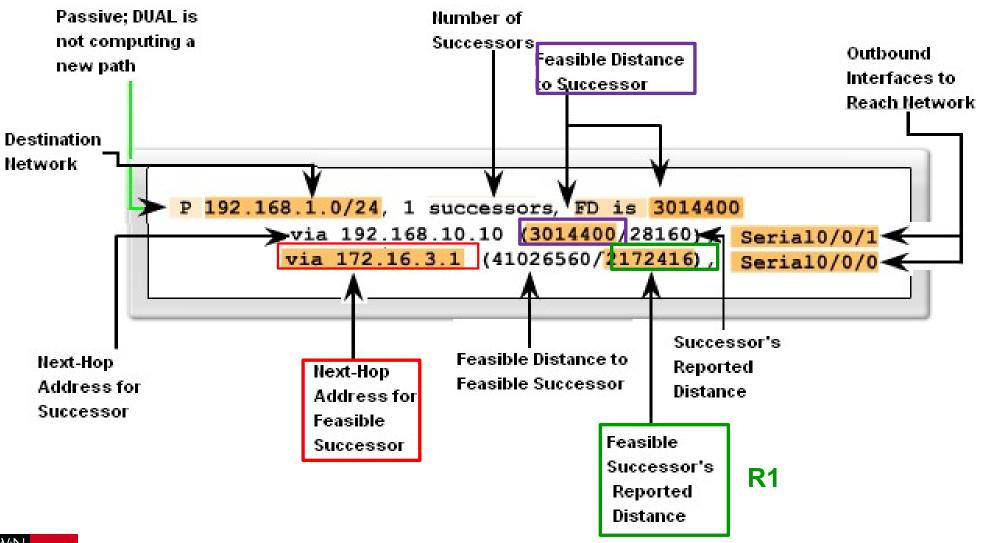




# EIGRP Topology Table R2 - - > 192.168.1.0 /24



Table Entry for 192.168.1.0/24



# **DUAL Concepts**



#### **EIGRP Composite Metric**

EIGRP uses composite metric formula incl. Bandwidth, Delay & optional ( Reliability and Load )

```
Default Composite Formula:

metric = [K1*bandwidth + K3*delay] * 256

Complete Composite Formula:

metric = [K1*bandwidth + (K2*bandwidth) / (256 - load) + K3*delay] * [K5 / (reliability + K4)]

(Not used if "K" values are 0)

Note: This is a conditional formula. If K5 = 0, the last term is replaced by 1 and the formula becomes: Metric = [K1*bandwidth + (K2*bandwidth) / (256-load) + K3*delay] * 256
```

```
Sample Calculation using
Bandwidth = 1,024 kbps
Composite Delays = 20,100 microseconds
```

```
Metric = [(10,000,000 / 1,024 \text{ kbps}) + (20,100 / 10)] times 256 Metric = [(9,765) + (2,010)] times 256 Metric = 3,014,400
```



# **EIGRP Composite Metric**



#### **EIGRP Metric**

#### **Bandwidth**

- Most serial interfaces use a default bandwidth value of 1.544Mbps (T1)
- Can be modified using the bandwidth command for each interface
- Is a logical value that does not change the link's physical bandwidth only the value used in routing protocol calculations

# **EIGRP Metric Signal Delay**

- The measure of time it takes for a packet to traverse a route
- Value based on the link type

#### **Delay Values in Microseconds**

Media	Delay
100M ATM	2ىر 100
Fast Ethernet	2ىر 100
FDDI	کبر 100
1HSSI	عب 20,000 ps
16M Token Ring	630 µട
Ethernet	2μ 1,000
T1 (Serial Default)	20,000 μS
512K	20,000 يع
DSO	20,000 µS
56K	20,000 μS



# Topic 4.4



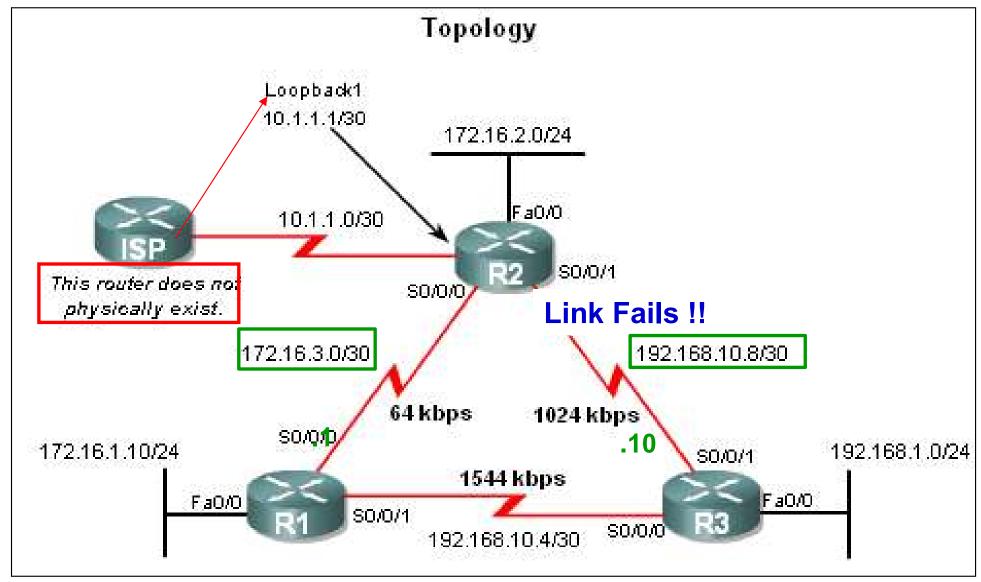
## 4.4 EIGRP Recovery

- Recovery using Feasible Successor
- Recovery using Query Reply packets

## **EIGRP – Link Fails**



### **EIGRP** Recovery using Feasible Successor



# Link Fails - EIGRP Update

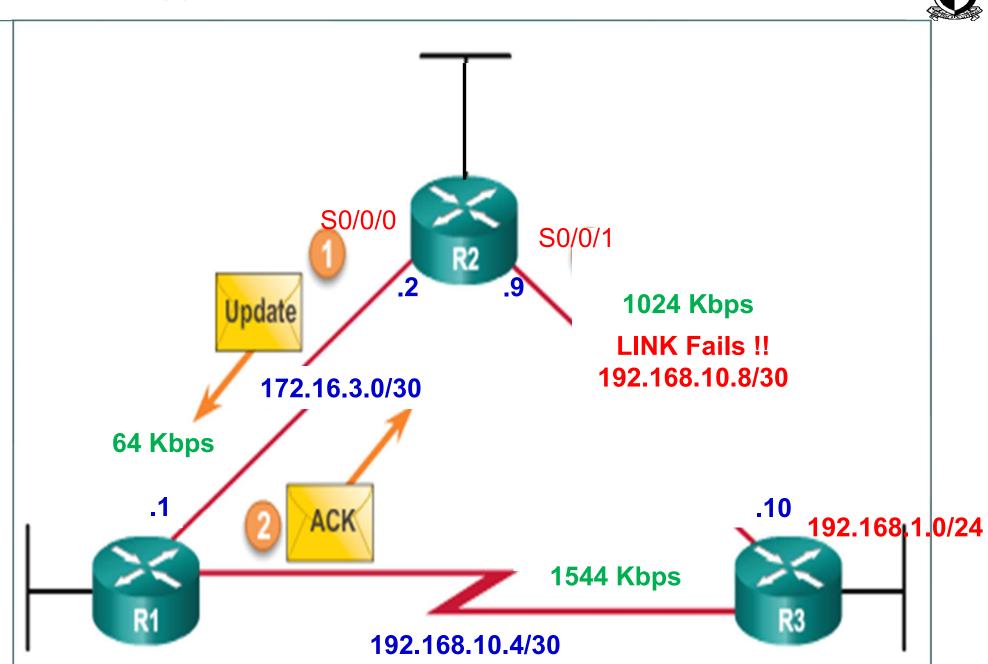


#### Link Failure triggers Partial Update

- A link failure will trigger an update
- It is a Partial update, includes only the route information that has changed

   the whole routing table is NOT sent
- Router 2 checks if there is a Feasible Successor
   Feasible Successor instantly becomes the Successor route.
- Router 2 sends out an update packet for that path because of the new EIGRP path metrics.
- Downstream routers run their own DUAL for any impacted prefixes to account for the new EIGRP metrics

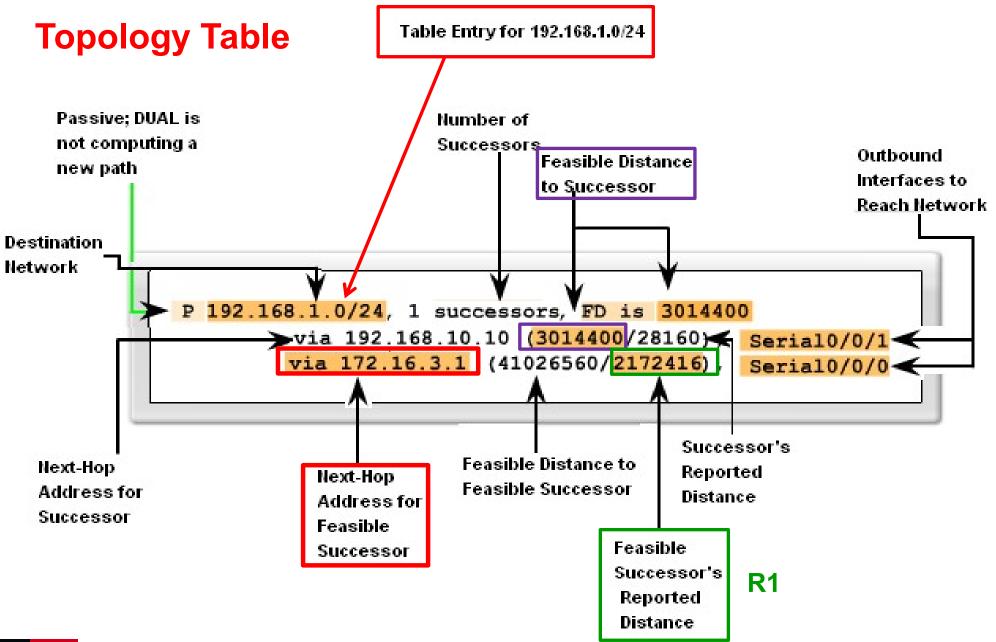
# Link Fails: Triggered Update, R2 tells R1 that a Link has failed





# EIGRP - R2 Checks for Feasible Successor (Backup) to 192.168.1.0





#### **EIGRP**



#### Recovery using Query and Replies

If no Feasible Successor R2
Queries
Neighbor or neighbors for New route

#### **Query & Reply messages**

- Used to request alternate path information from neighbors
- Both Query and Reply packets require acknowledgement
- Query packets can be
- Multicast or unicast
- Reply packets always unicast

# EIGRP – If no Feasible Successor, R2 sends Query to Neighbor R1 for new route



