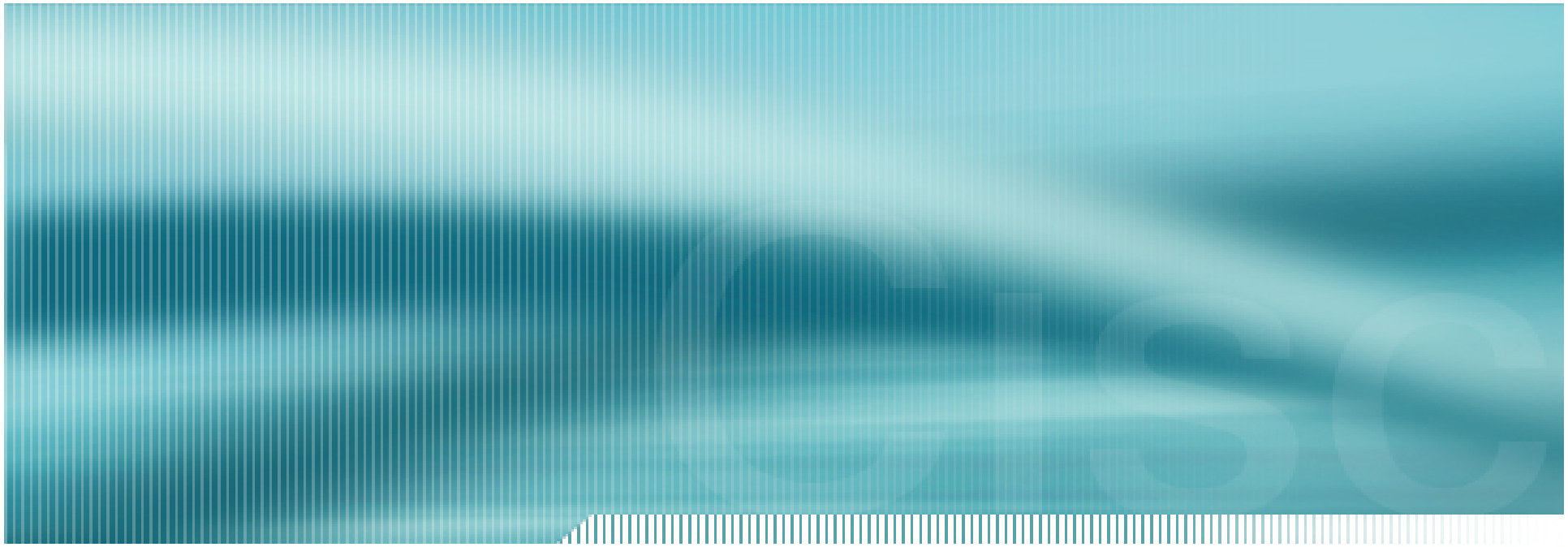


EIGRP - Enhanced Interior Gateway Routing Protocol

Philip Heimer

Halmstad University

Objectives

- EIGRP Overview
- EIGRP Operation
- Configuring EIGRP
- Verifying EIGRP

Introduction to EIGRP

- Improved IGRP, Cisco proprietary
- Hybrid
  - More like distance vector
  - Some link state ideas
- Scalable
- Support for CIDR and VLSM
- Multi-protocol support
  - PDMs (Protocol Dependent Modules)
- Rappid convergence with DUAL
- Partial, bounded updates

EIGRP Advantages

- **Rapid convergence - DUAL**
- **Efficient use of bandwidth – partial, bounded updates**
- **No periodic updates**
- **Support for VLSM and CIDR**
- **Multiple network-layer support - PDM**

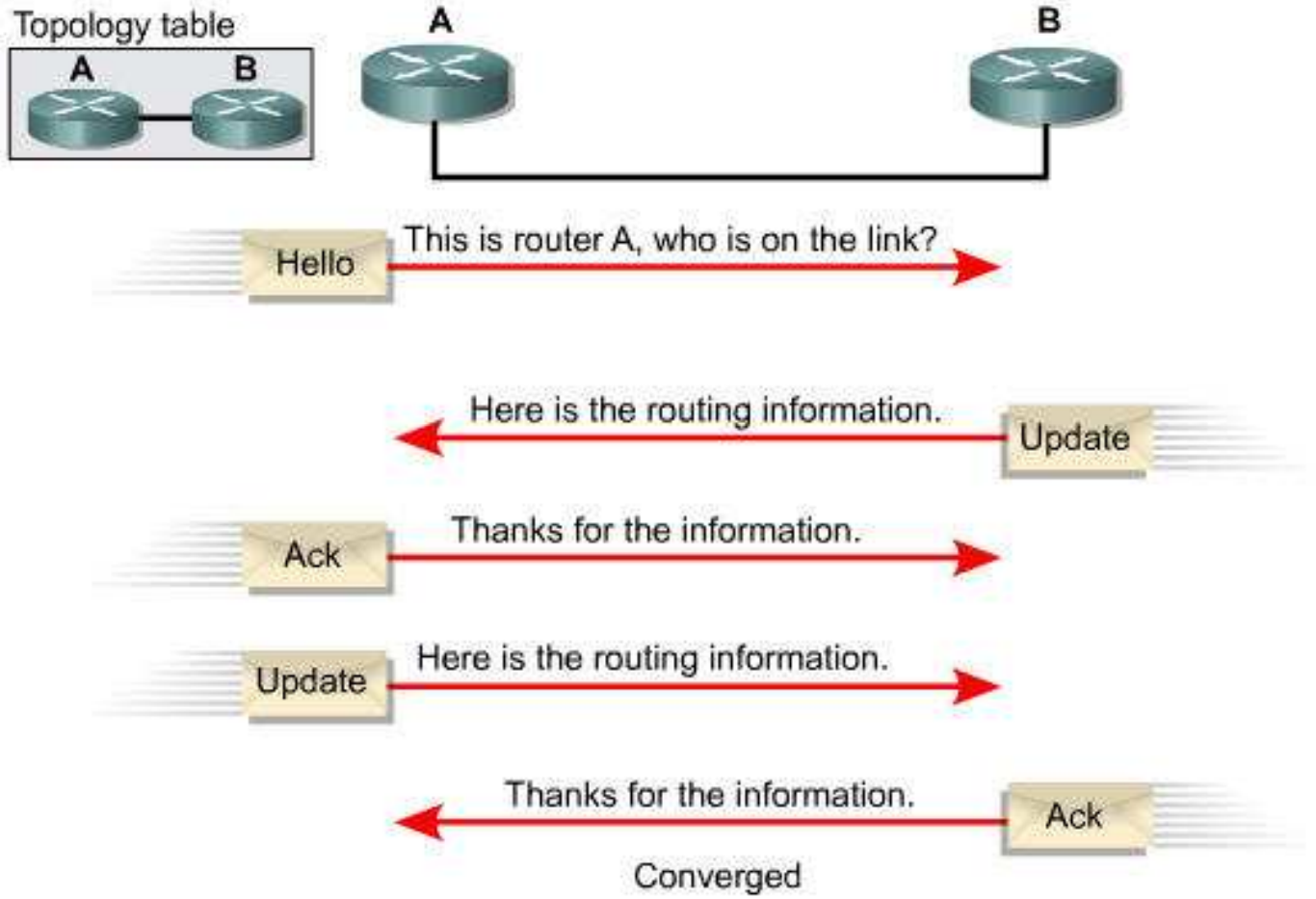
EIGRP Technologies

- Neighbor discovery and recovery
- Reliable Transport Protocol (RTP)
- DUAL Finite-State Machine (FSM)
- Protocol Dependent Modules (PDMs)
  - Support for IP, IPv6, IPX, Appletalk

Neighbor discovery and recovery

- Establish adjacencies with neighbor routers
  - Small hello packets
  - Every 5 seconds
- Neighbors as long as hello packets recieved
- By forming adjacencies:
  - Dynamically learn new routes
  - Identify routers that become unreachable (3 missing hello packets)
  - Rediscover routes

Neighbor Discovery and Recovery



Neighbor routers exchange their routing tables.

Reliable Transport Protocol - RTP

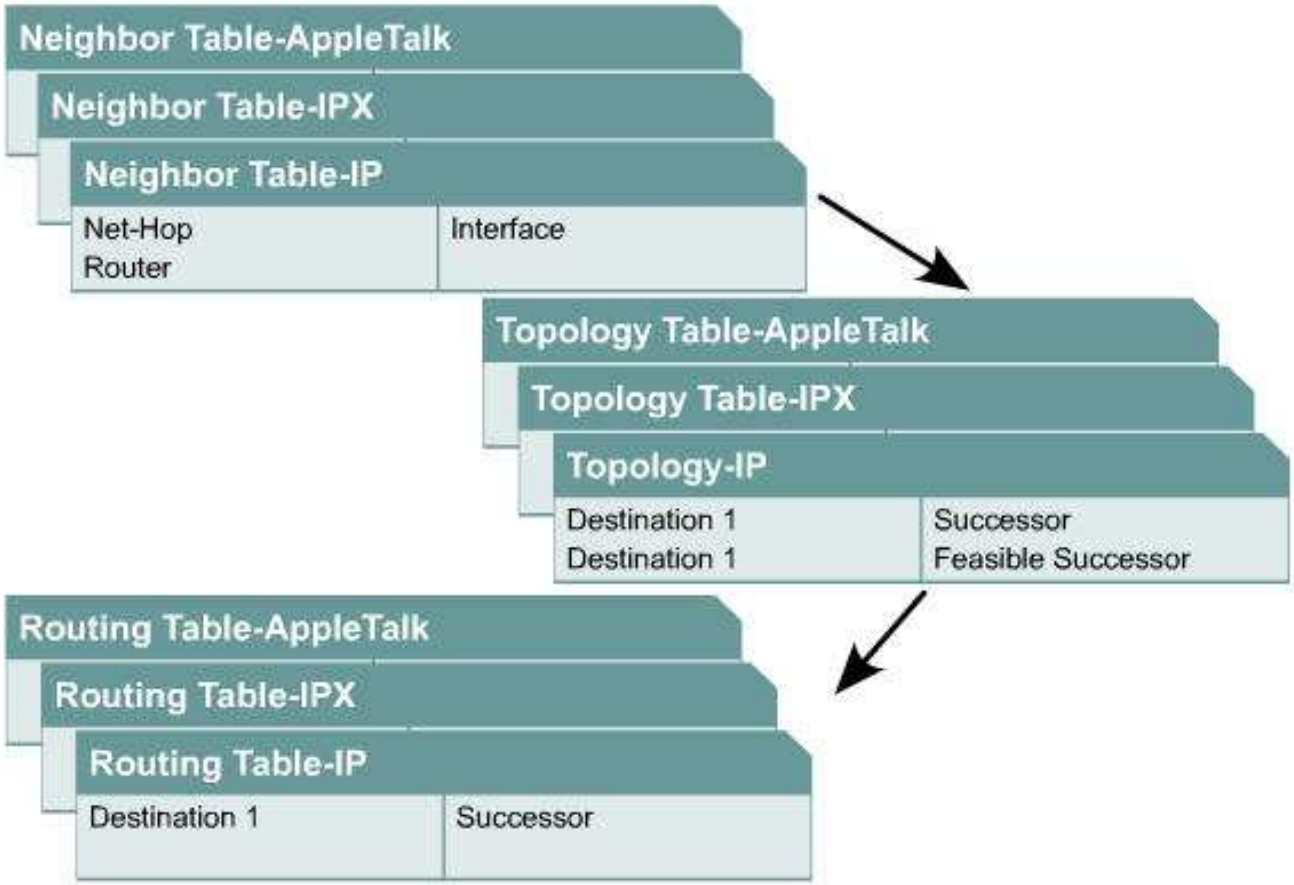
- Transport layer protocol
- EIGRP is protocol independent
  - Does not rely on TCP/IP to exchange routing information as RIP, IGRP and OSPF require
  - RTP guarantees ordered delivery of routing information
- Supports reliable and unreliable delivery
- Supports unicasting and multicasting

DUAL FSM

- The centerpiece of EIGRP is DUAL
  - Route calculation engine
  - Diffuse Update Algorithm Finite State Machine
  - Similar to Djikstra in OSPF or Bellman Ford in distance vector protocols
- Tracks all routes advertised by neighbors
  - Use the composite metric of each route to compare them
  - Stored in a neighbor table and topology table
- Guarantees that each path is loop-free
- Lowest cost paths are inserted by DUAL into the routing table

Protocol-dependent Modules

- **Each PDM is responsible for all functions related to its specific routed protocol**



EIGRP Packet Types

- **Hello**
- **Acknowledgment**
- **Update**
- **Query**
- **Reply**

EIGRP Packet Types

- **Hello packets**
  - **5-second hello interval by default**
  - **60-second hello interval (links < T1 1.54 Mb)**
  - **Hold-time defaults to 3x the hello interval**
  - **EIGRP does not require same hello/hold intervals for all routers**
  - **Multicasts to 224.0.0.10**

EIGRP Packet Types

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

EIGRP Packet Types

- **Acknowledgement packets**
  - **Reply to any EIGRP packet that requires reliable delivery**
  - **Hello packet without any data**
  - **unicast**
- **Update packets**
  - **Routing information to known destinations**
  - **Always transmitted reliable**
  - **Only the information that is changed**

EIGRP Packet Types

- **Query packet**
  - **When router needs info from one ore more neighbors**
  - **Multicast 224.0.0.10**
- **Reply packet**
  - **Response to query**
  - **unicast**

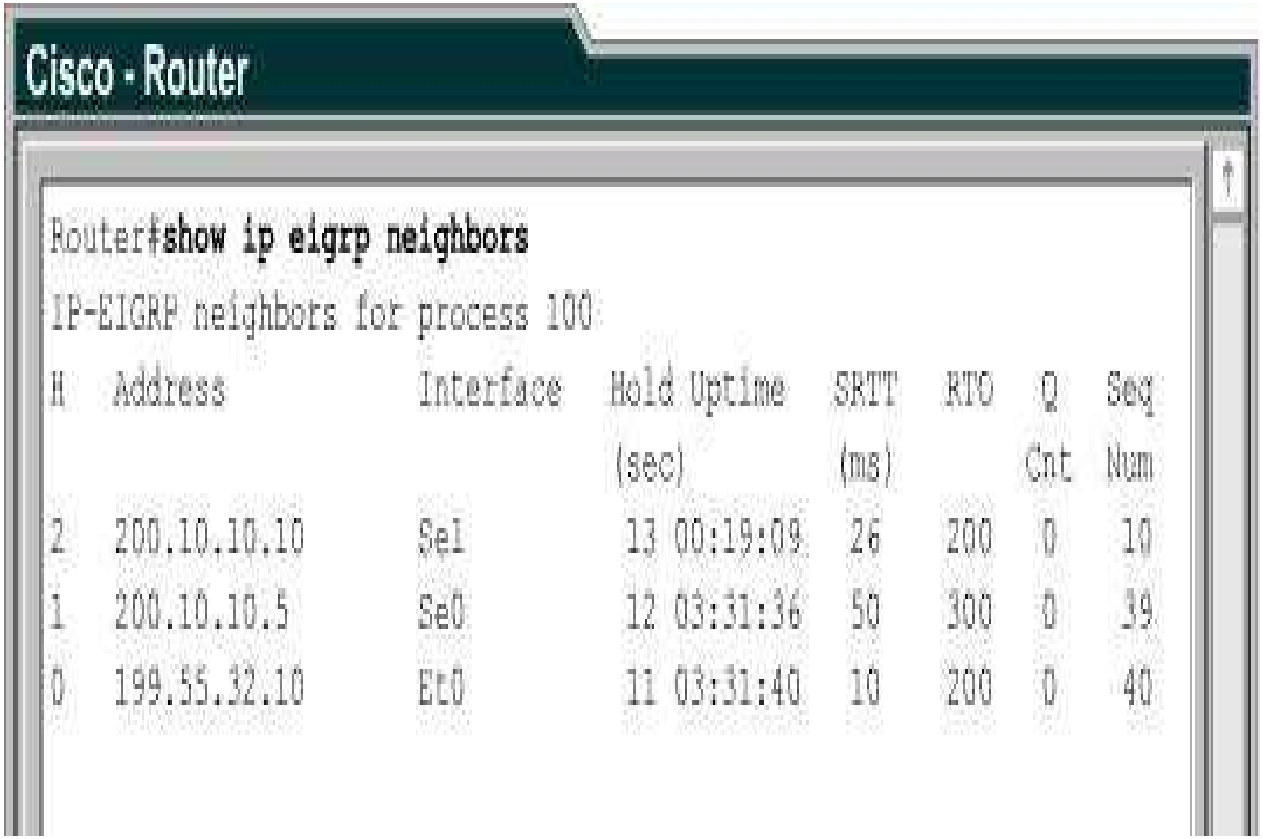
EIGRP Tables

- **Neighbor table**
- **Topology table**
- **Routing table**

EIGRP Neighbor Table

- **Lists adjacent routers discovered by hello protocol**
- **Comparable by the adjacency database used by OSPF**
- **Separate neighbor table for each PDM**
- **Show ip eigrp neighbors**

EIGRP Neighbor Table



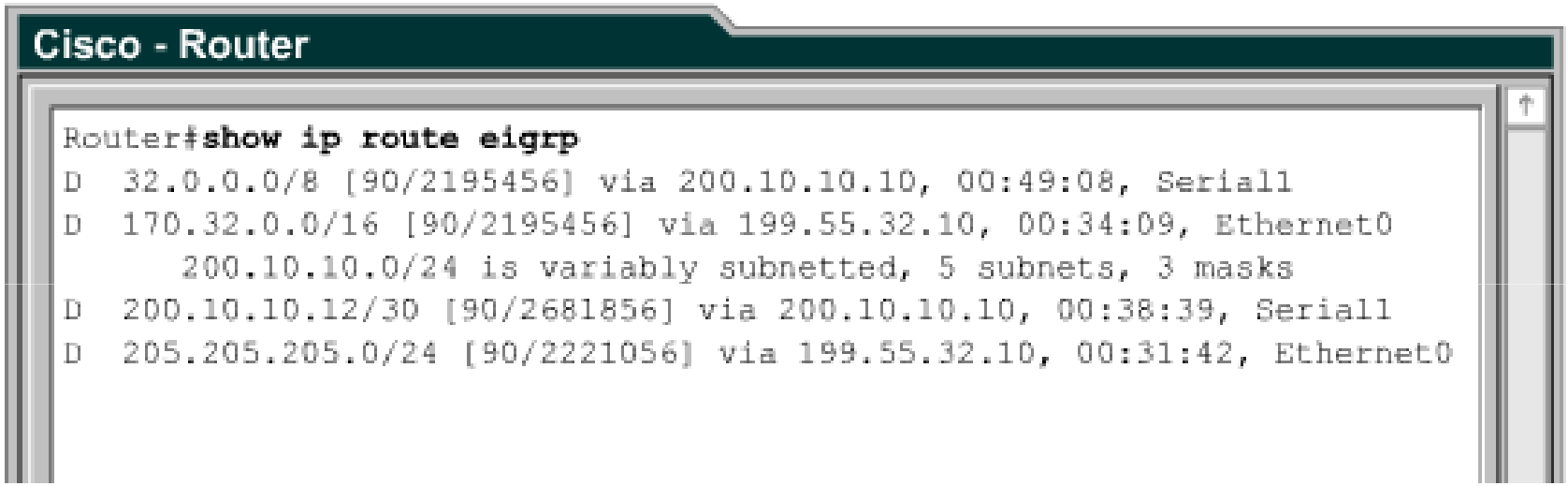
EIGRP Topology Table

- One for each configured network protocol
- Store information of all routes learned
- Calculates distances and vectors to all reachable destinations
- DUAL operates on the topology table
- Show ip eigrp topology

EIGRP Routing Table

- **Chooses the best routes to a destination from the topology table**
  - **successor**
- **Successor placed in routing table**
- **Show ip route**

EIGRP Routing Table



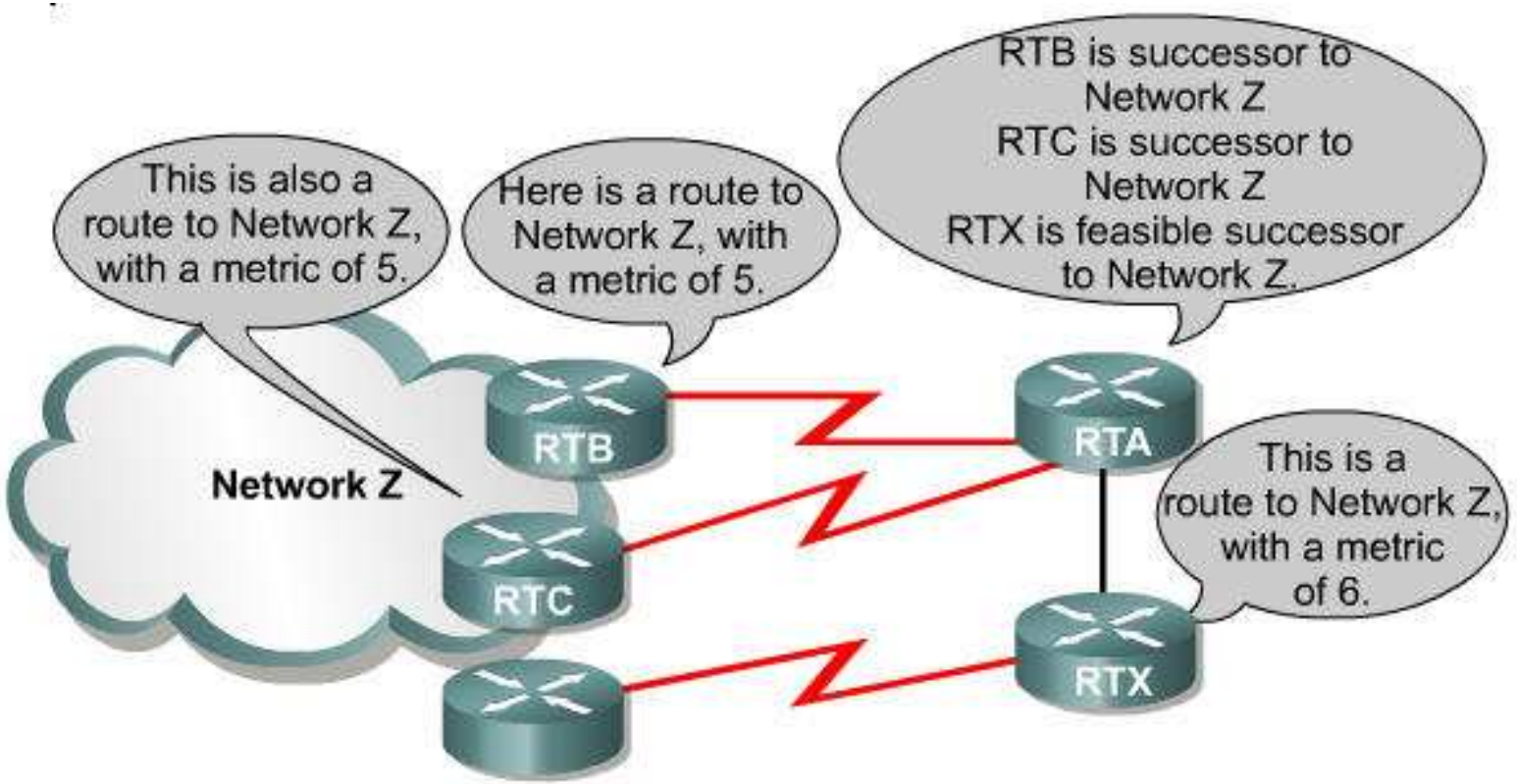
EIGRP Operation

- Adjacent routers form peer relationships with neighbors
  - Neighbor table
- Exchanging routing information
  - Topology table
- Use topology table
  - Cost metrics
- Run DUAL to populate routing table

EIGRP Terminology

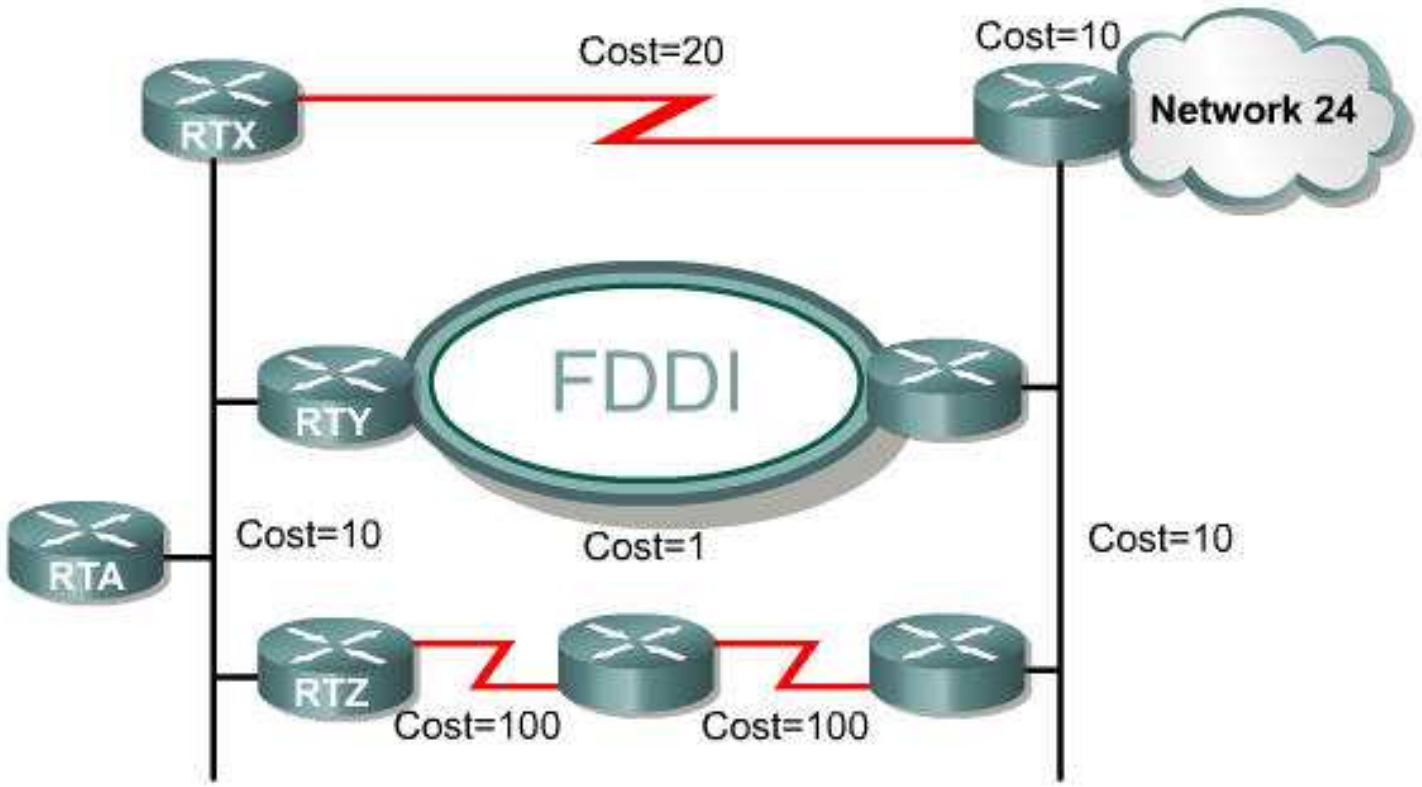
- **In Topology table**
  - **Successor**
    - **Neighbor router for least cost path**
    - **Kept in routing table**
  - **Feasible successor**
    - **Neighbor that offers loop free alternative path**
    - **Kept in topology table**
  - **Feasible distance**
    - **Lowest cost to destination**
  - **Advertised distance**
    - **Neighbors advertised distance to destination**
  - **Active state**
    - **Looking for alternative route**
  - **Passive state**
    - **Stable route**

EIGRP Successors and Feasible Successors



By identifying feasible successors, EIGRP routers can immediately install alternate routes if a successor fails.

Convergence using EIGRP



RTA can reach network 24 via three different routers, but RTY is used as the successor because it provides the lowest cost path.

DUAL

Neighbor	Feasible Distance to Net 24	Reported Distance to Net 24
RTY	31	21
RTZ	230	220
RTX	40	30

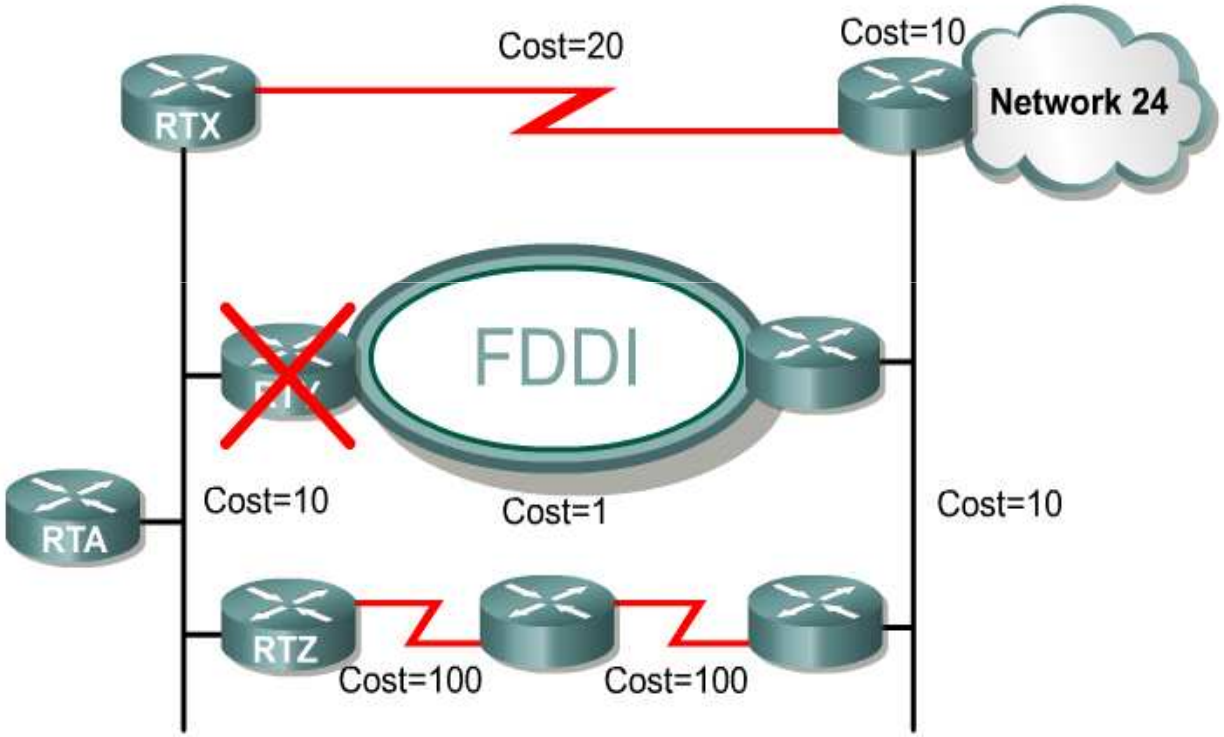
RTY is successor with a computed cost (feasible distance) of 31.

“31” is the Feasible Distance (FD).

RTX is a feasible successor because its RD is less than the FD.

RTZ is not a feasible successor because it’s RD (230) > RTY’s FD (31) and thus may be routed through RTY (loop ?)

DUAL



With the successor down, RTA will try to use a feasible successor to reach Network 24.

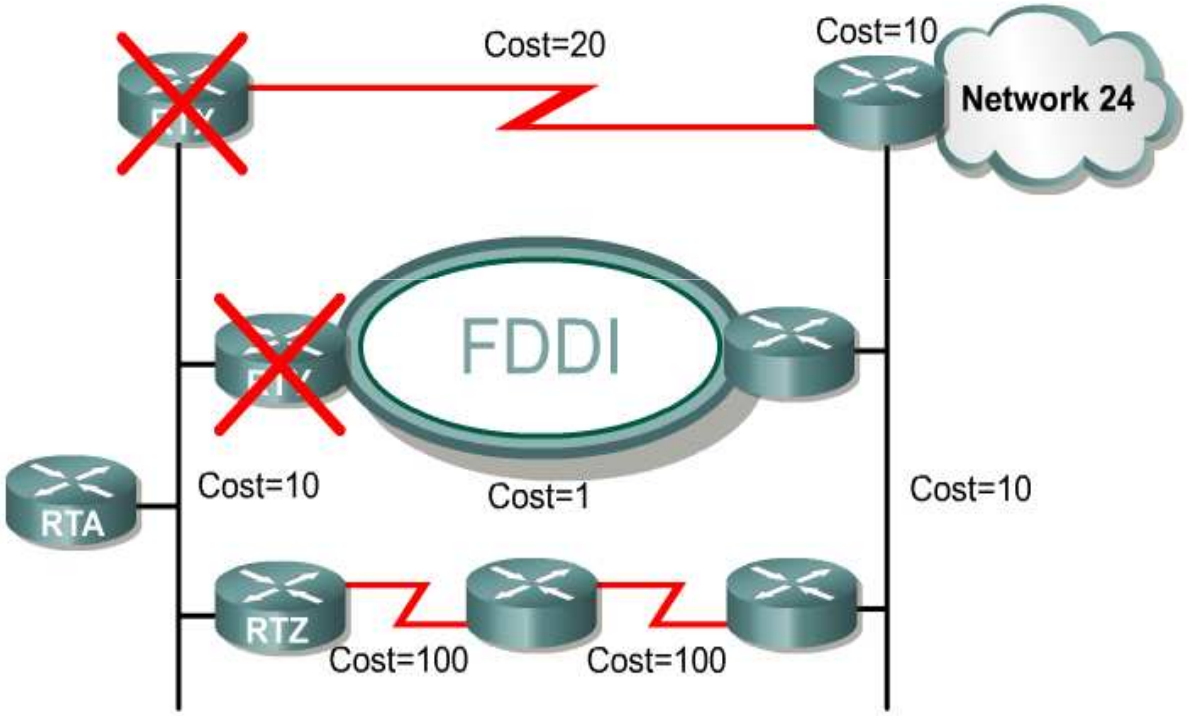
DUAL

Neighbor	FD to Net 24	Reported Distance to Net 24
RTY	31	21
RTZ	230	220
RTX	40	30

Since RTX is a feasible successor, it is installed in the routing table immediately (no re-computation).

It's RD (30) is less than the FD (31).

DUAL



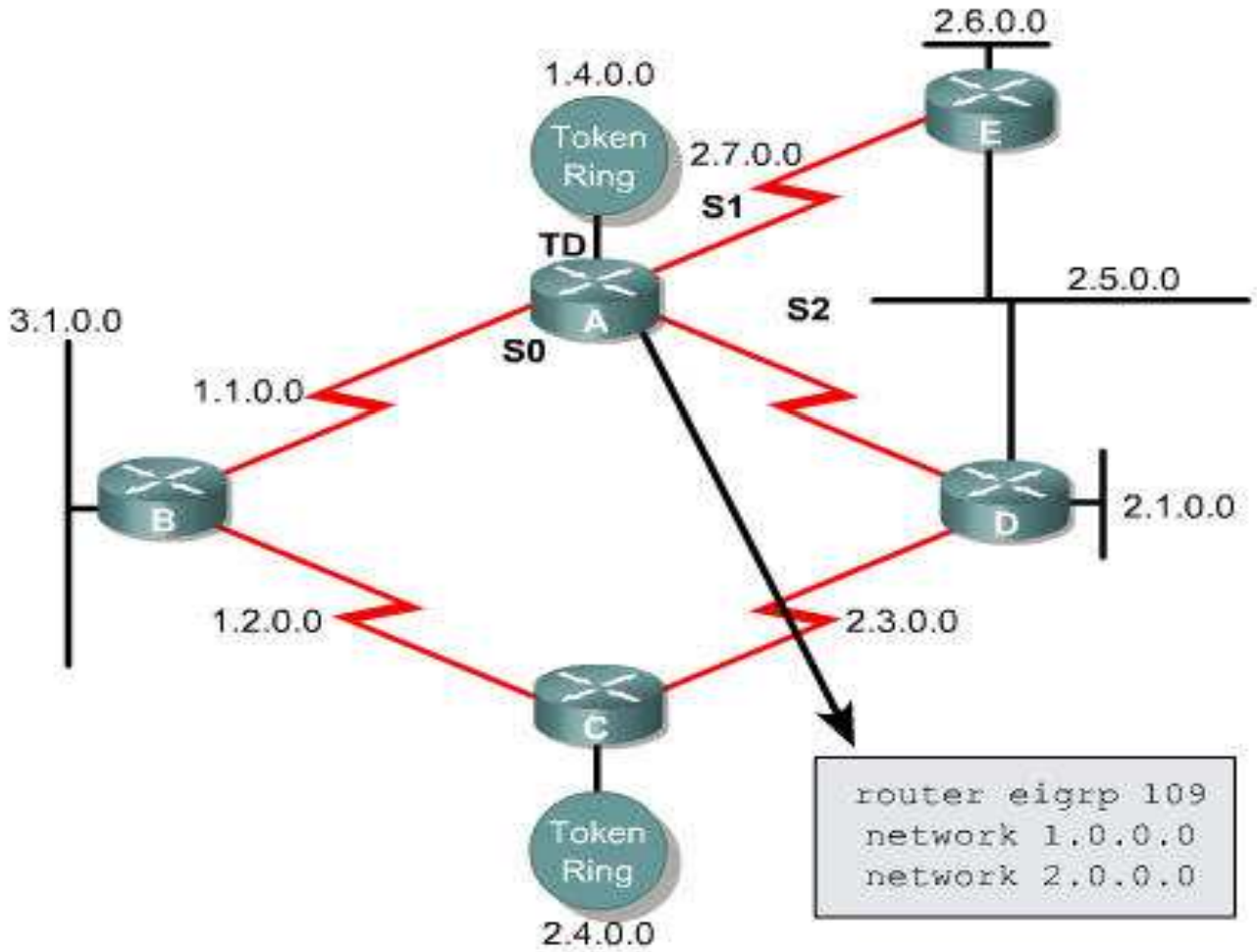
With no routers advertising costs below the FD, RTA places Network 24 in the active state and queries neighbors for alternate routes.

DUAL

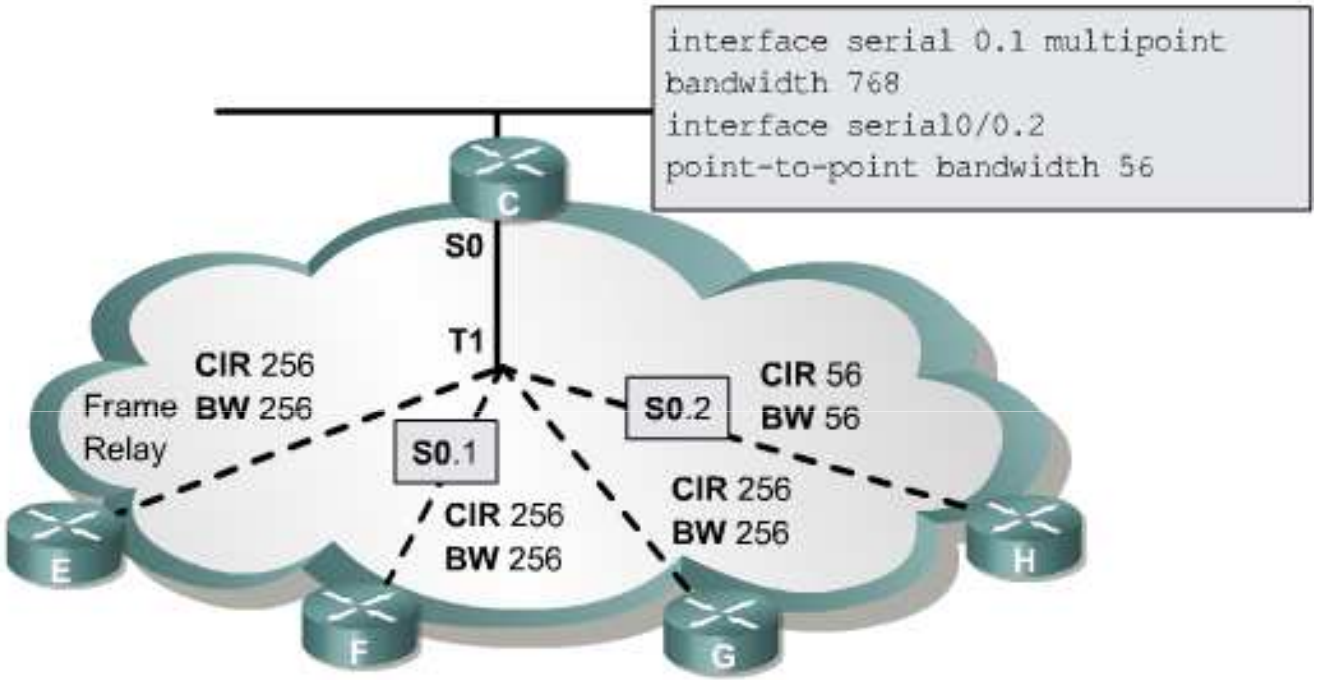
Neighbor	Computed Cost to Net 24	Reported Distance to Net 24
RTY	31	21
RTZ	230	220
RTX	40	30

RTZ is not a feasible successor. It's RD (220) is greater than the FD (31) for Net 24. Before this route can be installed, the route to net 24 must be placed in the ***active state*** and recomputed.

Configuring EIGRP for IP Networks

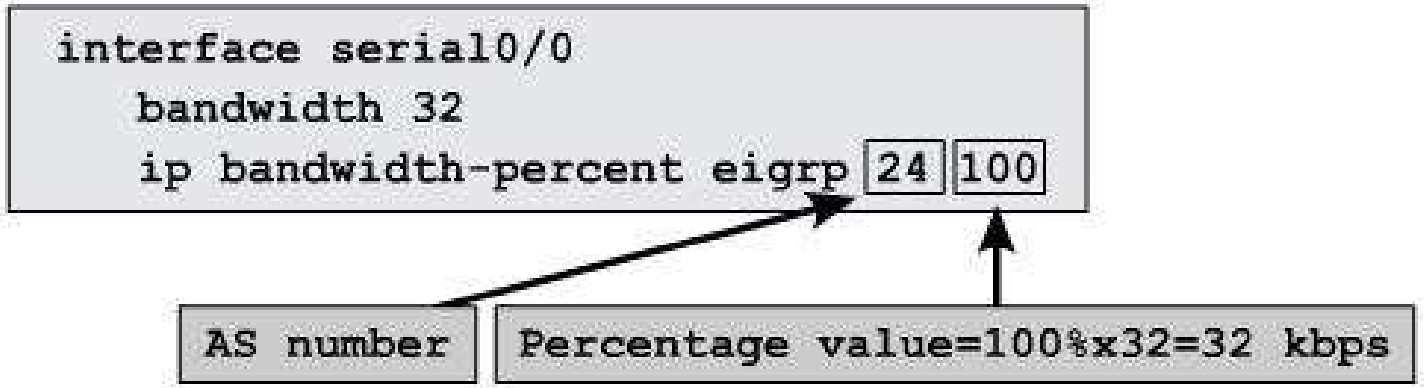


EIGRP and the `bandwidth` Command



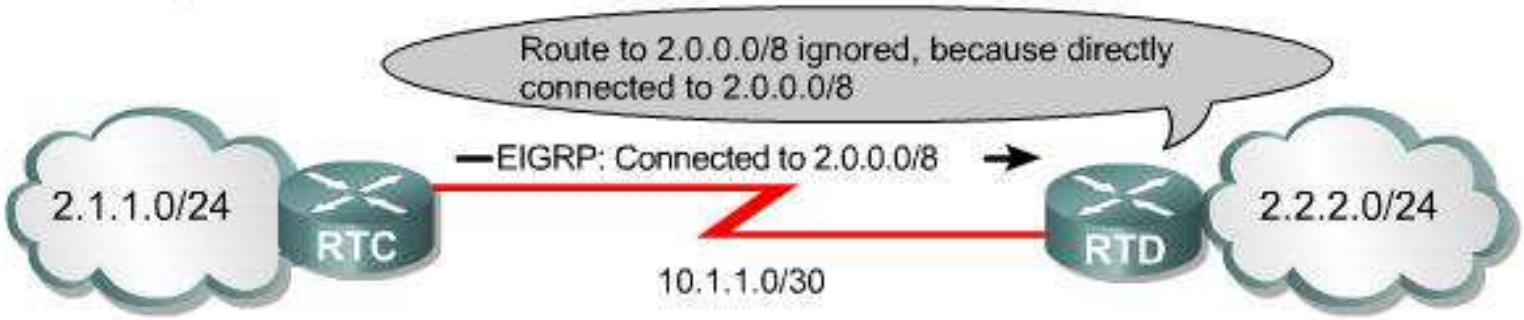
- Configure lowest CIR VCs as point-to-point, specify BW=CIR
- Configure highest CIR VCs as multipoint, combine CIRs

Using the `ip bandwidth-percent` command

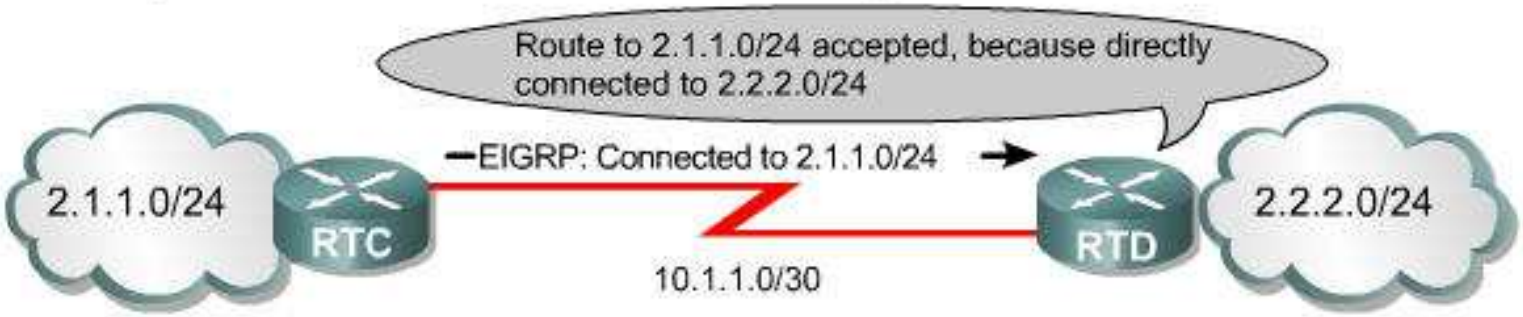


EIGRP Automatically Summarizes Based on Class

Discontiguous Networks with Autosummarization

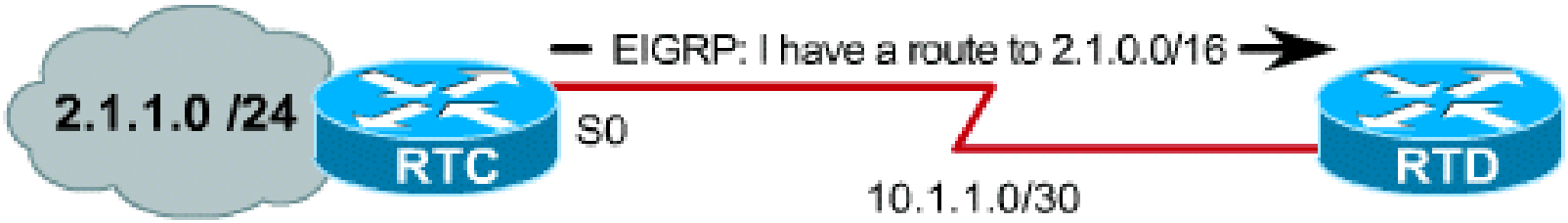


Discontiguous Networks with `no auto-summary`



Auto-summarization prevents routers from learning about discontiguous subnets. With summarization turned off, EIGRP routers will advertise subnets.

Manual summarisation



RTC(config)#**router eigrp 2446**
RTC(config-router)#**no auto-summary**
RTC(config-router)#**exit**
RTC(config)#**interface serial0**
RTC(config-if)#**ip summary-address eigrp 2446 2.1.0.0 255.255.0.0**

EIGRP summary addresses can be manually configured on a per-interface basis.

Verifying EIGRP Operation

Command	Description
show ip eigrp neighbors [type number] **[details]**	Displays EIGRP neighbor table. Use the type and number options to specify an interface. The details keyword expands the output.
show ip eigrp interfaces [type number] [as-number] **[details]**	Shows EIGRP information for each interface. The optional keywords limit the output to a specific interface or AS. The details keyword expands the output.
show ip eigrp topology [**as-number** | [[**ip-address**] mask]]	Displays all feasible successors in the EIGRP topology table. Optional keywords can filter output based on AS number or specific network address.
show ip eigrp topology [**active** | **pending** | **zero-successors**	Depending on which keyword is used, displays all routes in the topology table that are either active, pending, or without successors.
show ip eigrp topology all-links	Displays all routes, not just feasible successors, in the EIGRP topology.
show ip eigrp traffic [as-number]	Displays the number of EIGRP packets sent and recieved. Command output can be filtered by including an optional AS number.

Command	Description
debug eigrp fsm	This command helps in observing EIGRP feasible successor activity and to determine whether route updates are being installed and deleted by the routing process.
debug eigrp packet	The output of the command shows transmission and receipt of EIGRP packets. These packet types may be hello, update, request, query, or reply packets. The sequence and acknowledgment numbers by the EIGRP reliable transport algorithm are shown in the output.