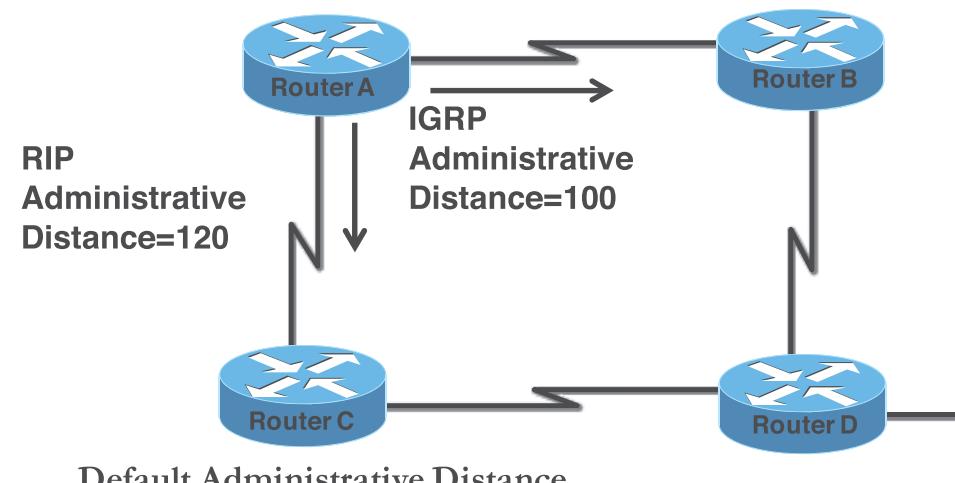




Administrative Distance



RIP
Administrative
Distance=120

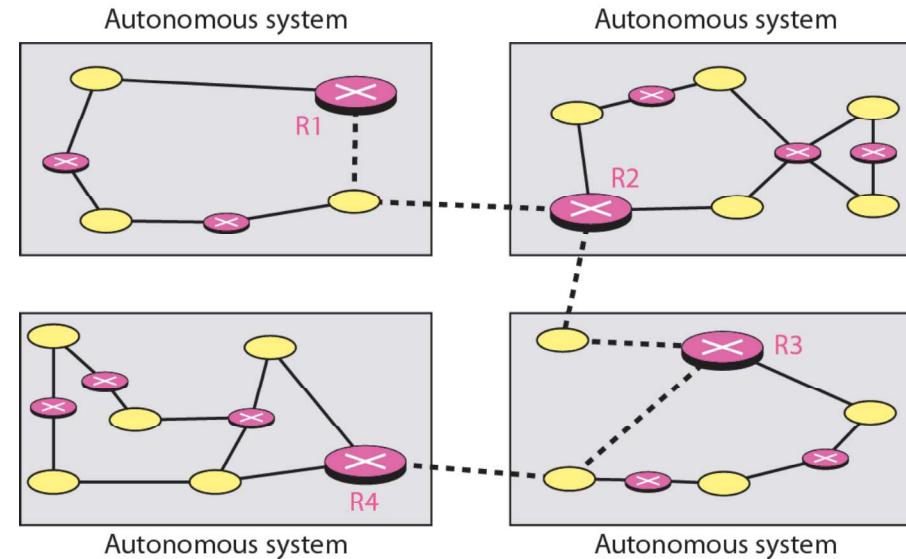
Default Administrative Distance
Directly Connected: 0
Static Route: 1
RIP: 120
IGRP: 100
EIGRP: 90
OSPF: 110



Autonomous System (AS)



SUT = 55545





Routing Protocols



Classful

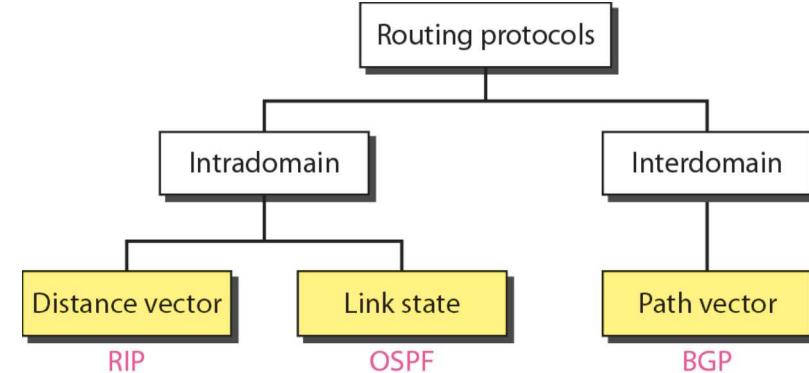
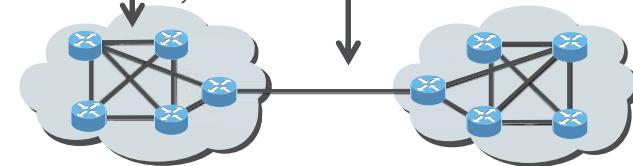
- RIPv1
- IGRP



Classless

- RIPv2
- EIGRP
- OSPF
- IS-IS

IIGPs: RIP, IGRP EGPs: BGP



Distance Vector

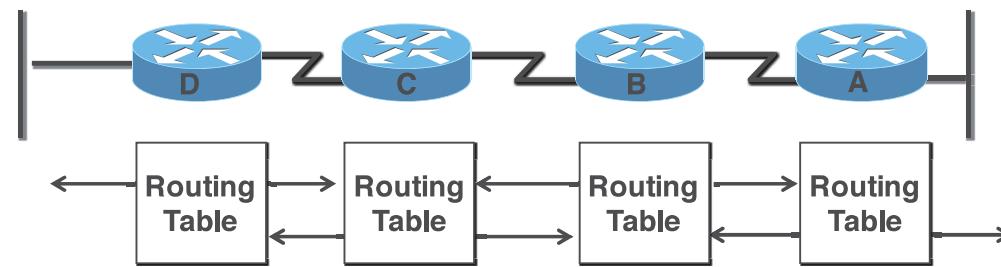


Distance = how long?



Vector = in which direction?

- Broadcast all known hosts to its neighbor
- No one see big picture of the topology

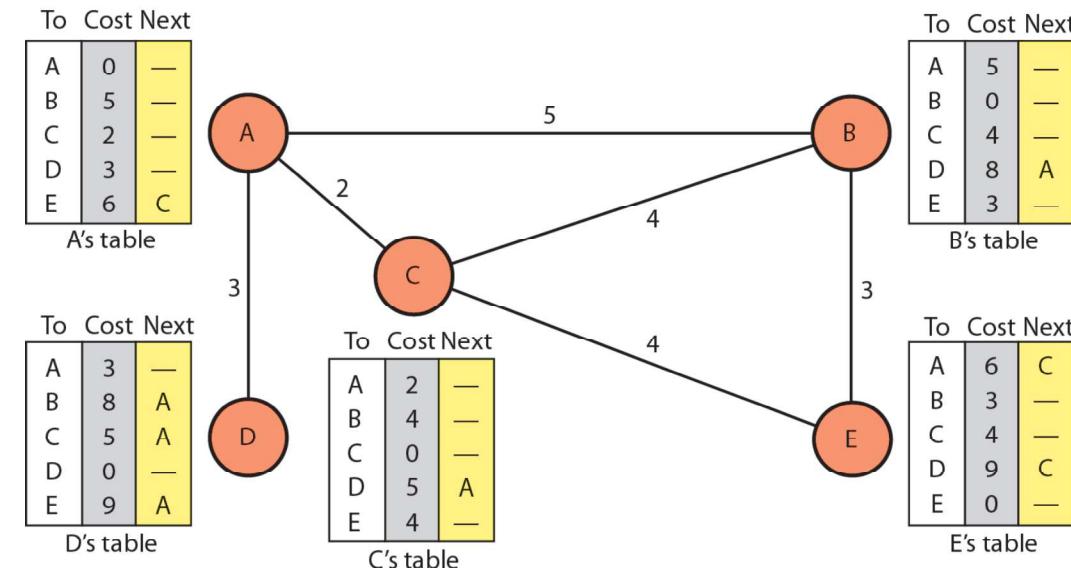




Distance Vector Routing Table



update: periodic (every 30s), trigger (when link down)

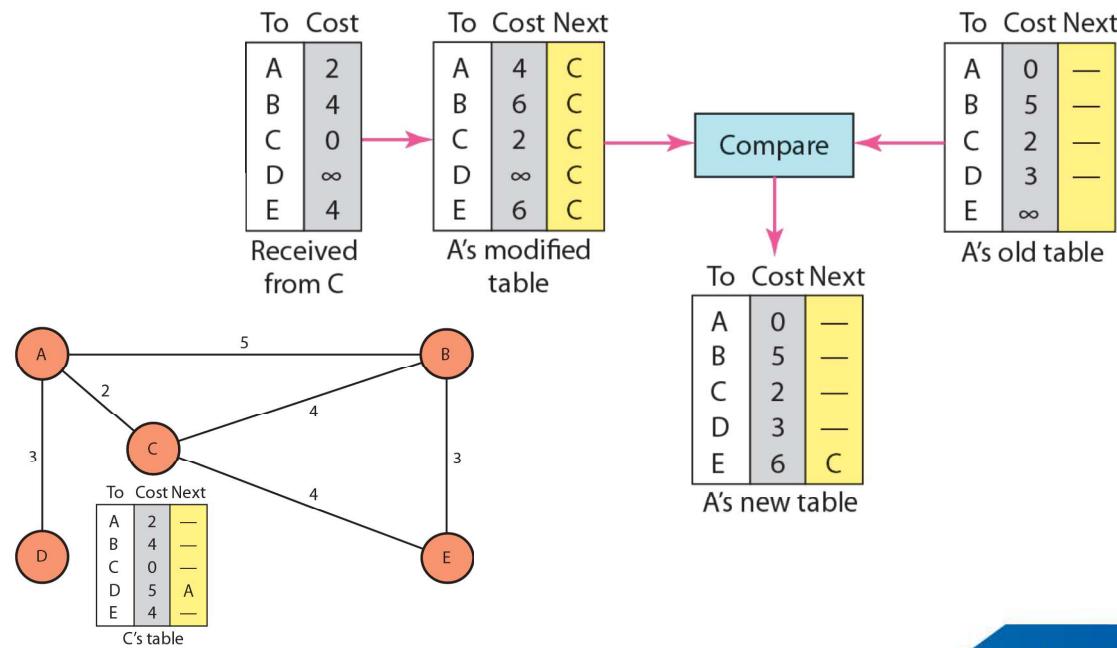




Distance Vector Routing Table

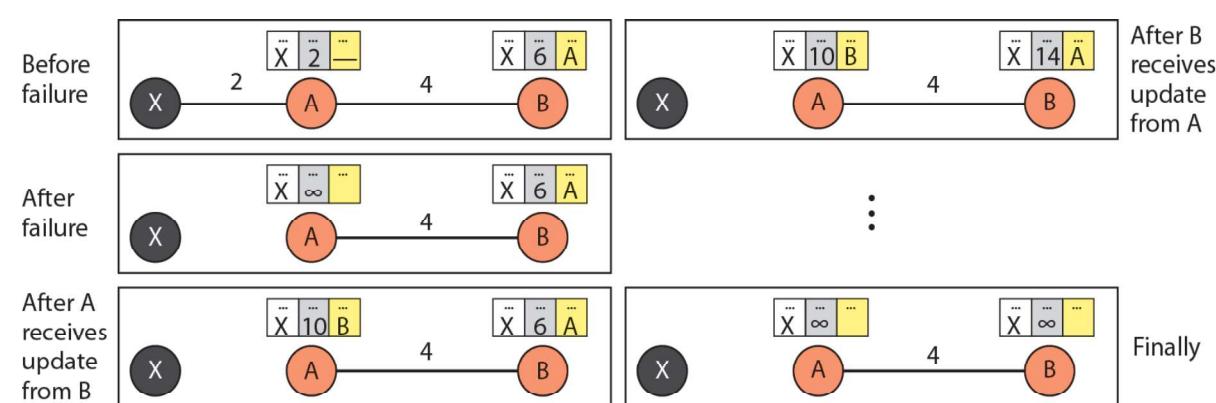


New A to X = C to X + A to C





Two Node Instability (Loop)

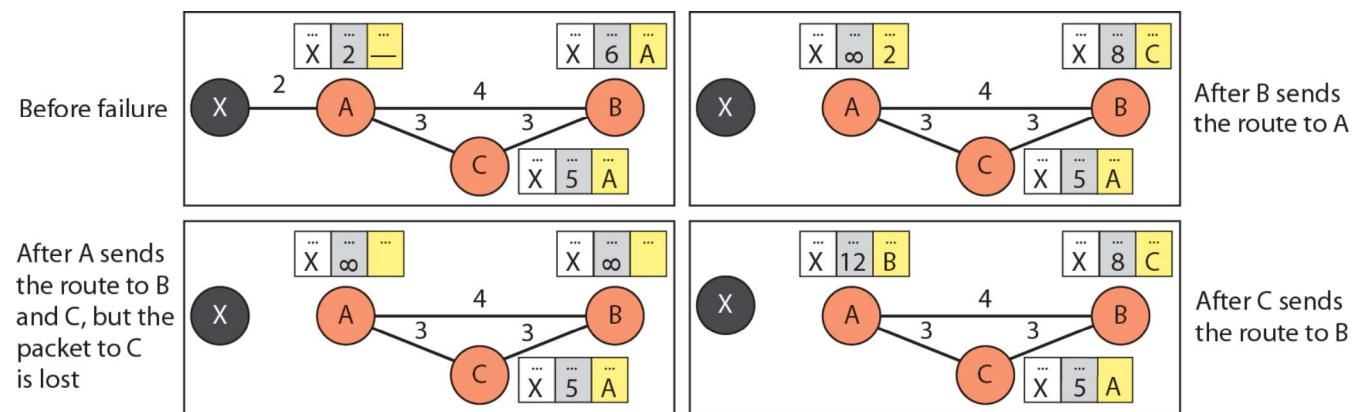


Solution

- **Defining Infinity:** define inf to 15 hop
- **Split horizon:** A won't send "via B" nodes to B
- **Split horizon with poison reverse:** A send "via B" to B with cost=inf



Three Node Instability

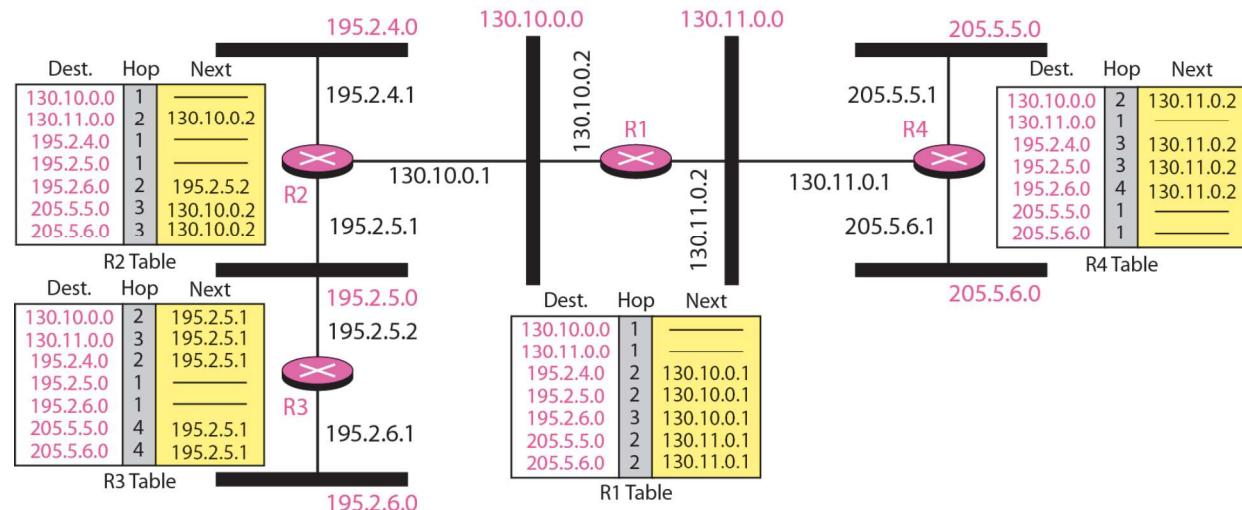




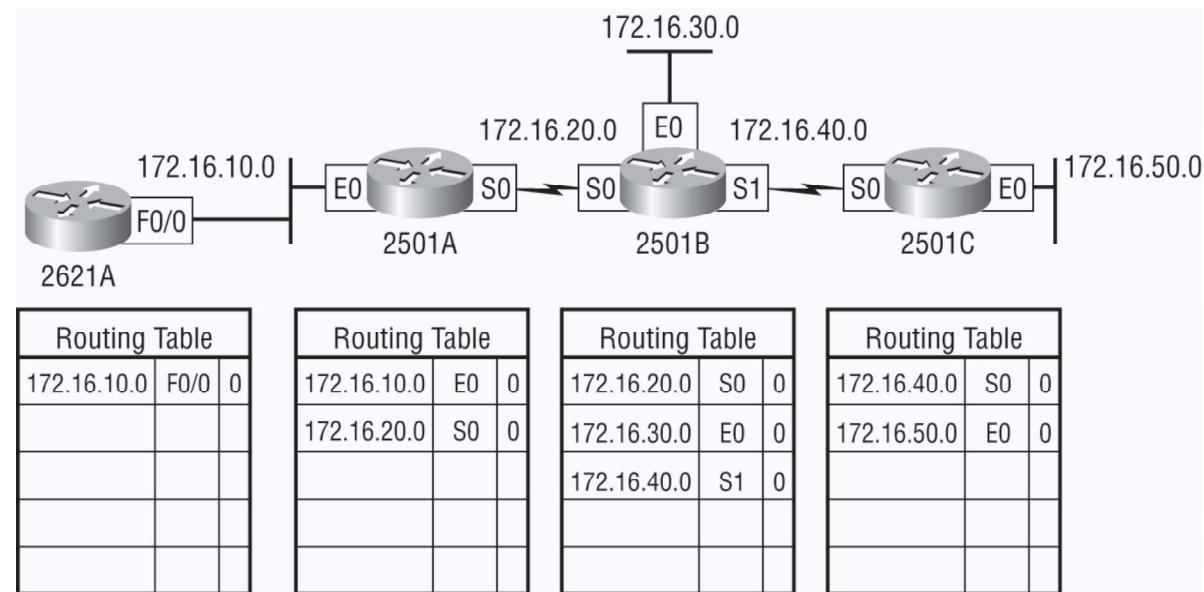
Distance Vector Protocol



RIP: Routing Information Protocol

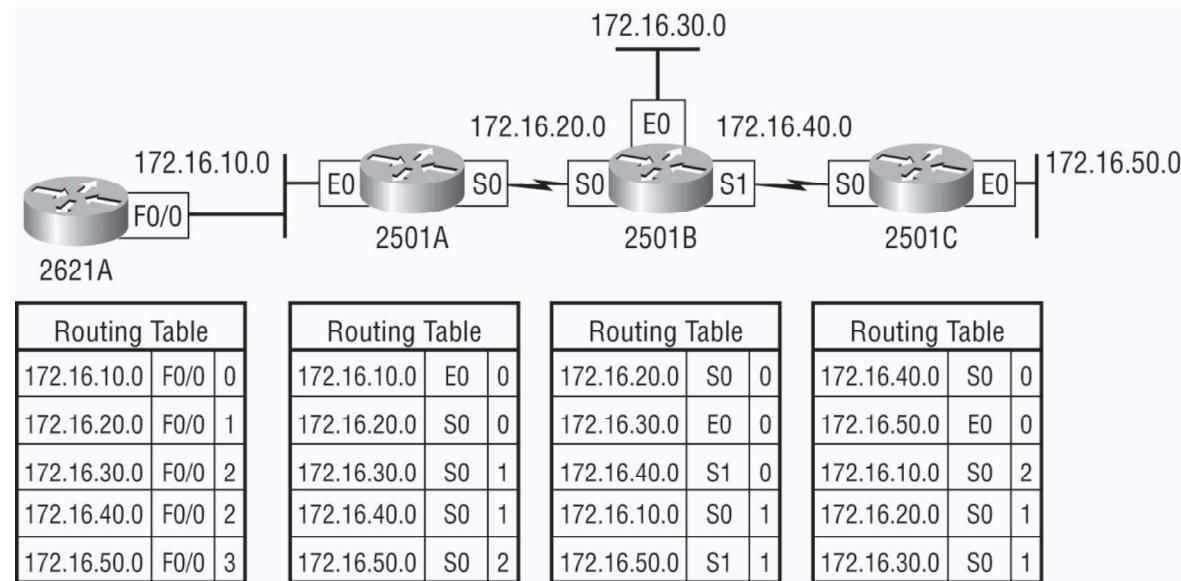


Initializing RIP





RIP after converged





Configure the RIP



- Router(config)#**router rip**
- Router(config-router)#**network <network addr>**
 - e.g., Router(config-router)#**network 192.168.10.0**
 - [optional] If RIPv2 then Router(config-router)#**version 2**
- Router(config-router)#**^z**

- Router#**sh ip route**
 - **R 191.168.50.0 [120/2] via 192.168.10.2, 00:00:23, Serial 0/0**
 - **R is RIP, [120/2]** is Admin distance = 120, hop count =2



Discontiguous Networks

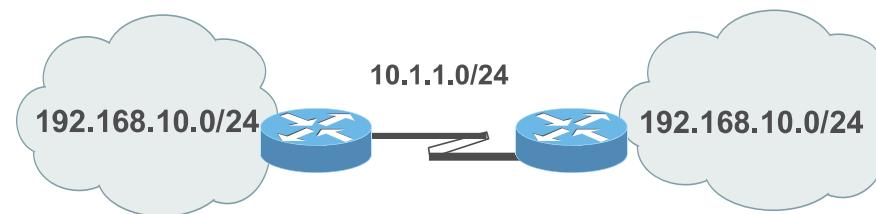


RIP, IGRP does not support

- They support only classful
- No subnet mask broadcasting



RIPv2, OSPF, EIGRP support





Passive Interface



Prevent update in an unwanted interface

- Router(config)# router rip
- Router(config-router)# passive-interface serial 0



This allows a router to receive route updates on an interface,
but not send updates via that interface



IGRP - Interior Gateway Routing Protocol



- ✓ Cisco proprietary (Cisco devices only)
- ✓ IGRP uses metrics e.g., bandwidth, MTU, reliability, hop count (max 255)
 - RIP - uses hop count
 - Requires AS number
- Router(config)# `router igrp 10` ← where 10 is AS number (1-65535)
- Router(config-router)# `network 192.168.10.0`
- Router#`sh ip router`
 - I 192.168.50.0 [100/170420] via 192.168.20.2, serial0/o
 - I is IGRP, 100 is Administrative distance, 170420 is metric (lower is better)

Debugging



- Router# show ip route [display routing table]
- Router# show protocols [display routed protocols]
- Router# show ip protocols [display routing protocols]
- Router# debug ip rip [display rip update]
- Router# debug igrp events
- Router# debug igrp transactions





Enhanced IGRP (EIGRP)



Diffused update algorithm (DUAL)

- fast convergence, loop free, require low bandwidth



Support multiple network protocols



Maximum 6 routes to other networks (default=4)



Maximum 255 hop counts (default=100)



EIGRP for IP

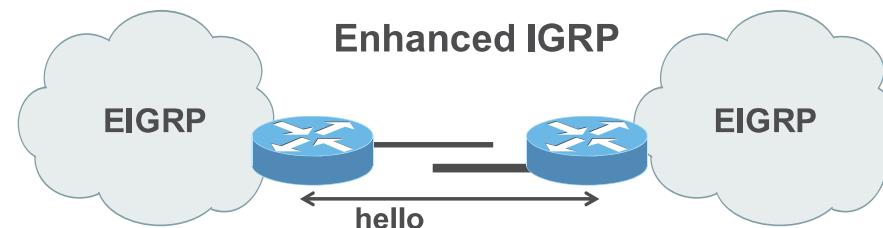


update when something has been changed

- multicast 224.0.0.10



send hello messages to neighbors every 5 seconds



EIGRP Tables



Neighbor Table—IP	
Next Hop Router	Interface



Topology Table—IP	
Destination 1	Successor
Destination 1	Feasible Successor



Routing Table—IP	
Destination 1	Successor



EIGRP Tables



Neighbor table, Topology table

- keep in RAM
- hello/update packets



EIGRP uses Successor route for sending data to dest.

- keep in Topology table and Routing table
- has a back up route called feasible successor route
- Router# `show ip eigrp topology`

Route selection



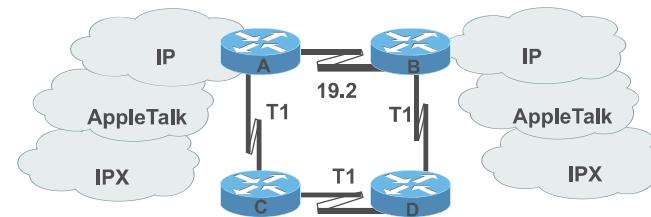
Use several metrics to select the best routes

- e.g., bandwidth, delay, load, reliability



Load balancing of 6 different cost routes

- Router(config)#**router eigrp <AS>**
- Router(config-router)#**maximum-paths <1-6>**

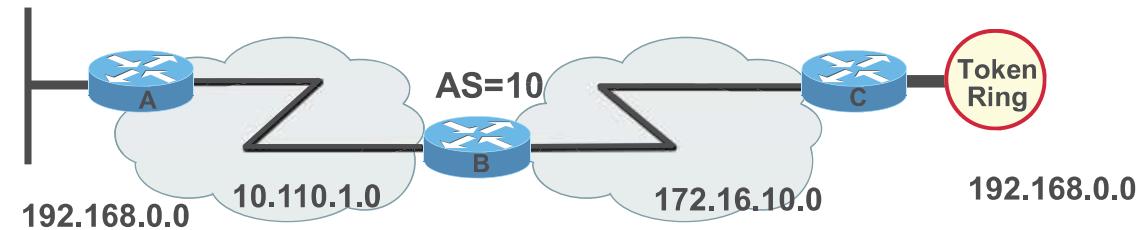




Configure EIGRP



- RouterB(config)# router eigrp 10
- RouterB(config)# network 10.0.0.0
- RouterB(config)# network 172.16.0.0

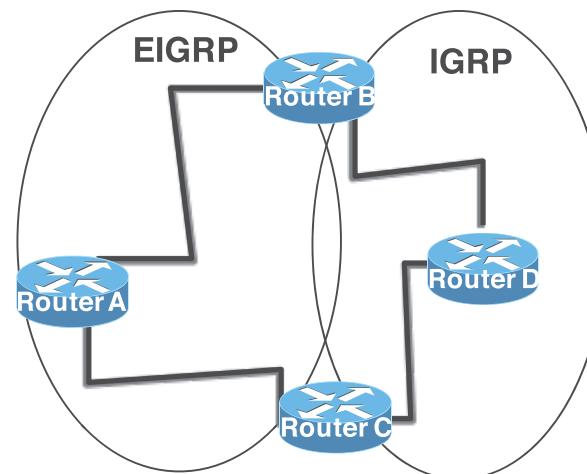


Redistribution



Automatically protocol conversion

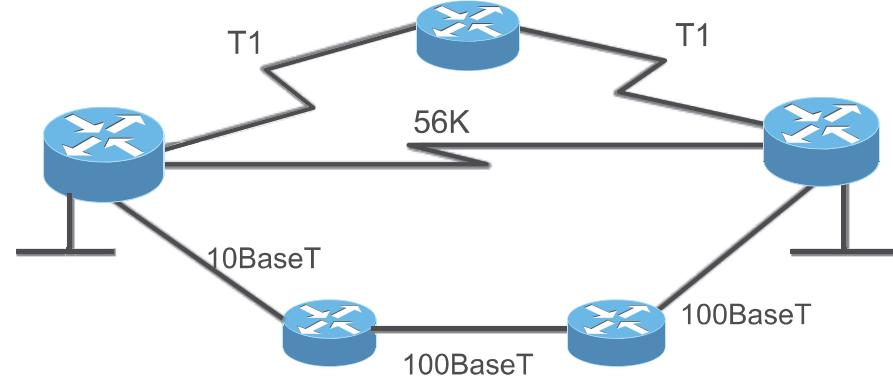
- e.g., EIGRP and IGRP with the same AS number



Route Path



RIP vs. EIGRP, which route will they take?





Checking EIGRP configuration



Display neighbor/topology/routing tables

- Router#**show ip eigrp neighbors**
- Router#**show ip eigrp topology**
- Router#**show ip route eigrp**



Display parameters and status

- Router#**show ip protocols**



Display packets

- Router#**show ip eigrp traffic**

```
R1#show ip eigrp traffic
IP-EIGRP Traffic Statistics for AS 100
Hello sent/received: 26296/13151
Updates sent/received: 13/13
Queries sent/received: 1/2
Replies sent/received: 2/2
ACKs sent/received: 11/5
Input queue high water mark 2, 0 drops
SIA-Queries sent/received: 0/0
SIA-Replies sent/received: 0/0
Hello Process ID: 172
PDM Process ID: 171
R1#
```

Show IP Route



D - DUAL (EIGRP) [90/40514560]

- 90=administrative distance, 40514560 = cost

```
R1#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route
Gateway of last resort is not set

D    172.17.0.0/16 [90/40514560] via 192.168.1.102, 00:00:01, Serial1/0
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
      D    172.16.0.0/16 is a summary, 00:00:03, 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, Serial1/0
      D    192.168.1.0/24 is a summary, 00:00:03, Null0
R1#
```



OSPF – Open Shortest Path First



Open (standard), Shortest Path First (algorithm)



Link State Protocol

- See overall topology, find the shortest path
- only update when something has been changed
- can be used within or between AS
- support only IP (not support Apple Talk, IPX)

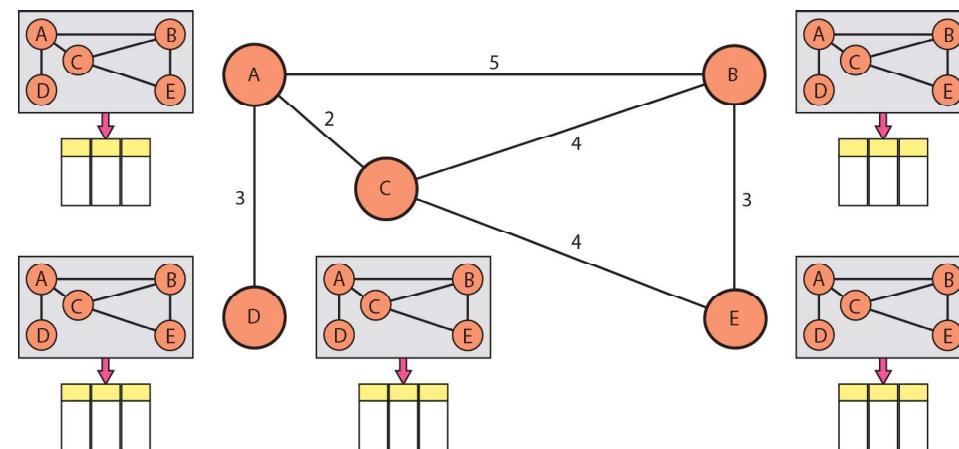


Link Stage Routing



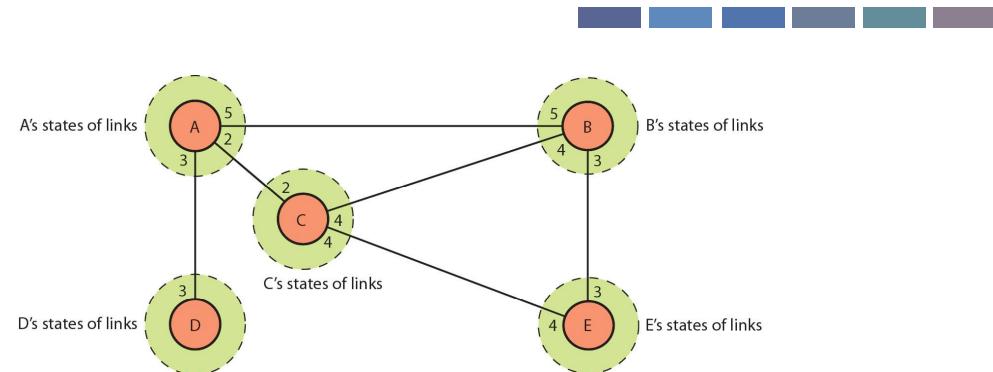
Everyone know overall topology

- Routing of each node is different





Link Stage Routing

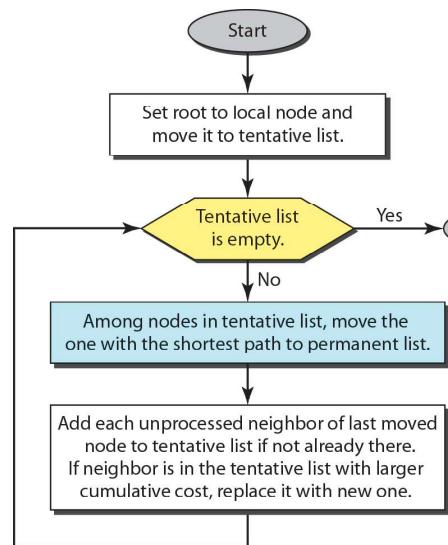


Routing table creation process

- Each node know state of each connected link
 - Create link state packet (LSP)
- Each node broadcast (flooding) LSP to every nodes.
- Create shortest path to every node using Dijkstra's algorithm
- Create routing table from the shortest path

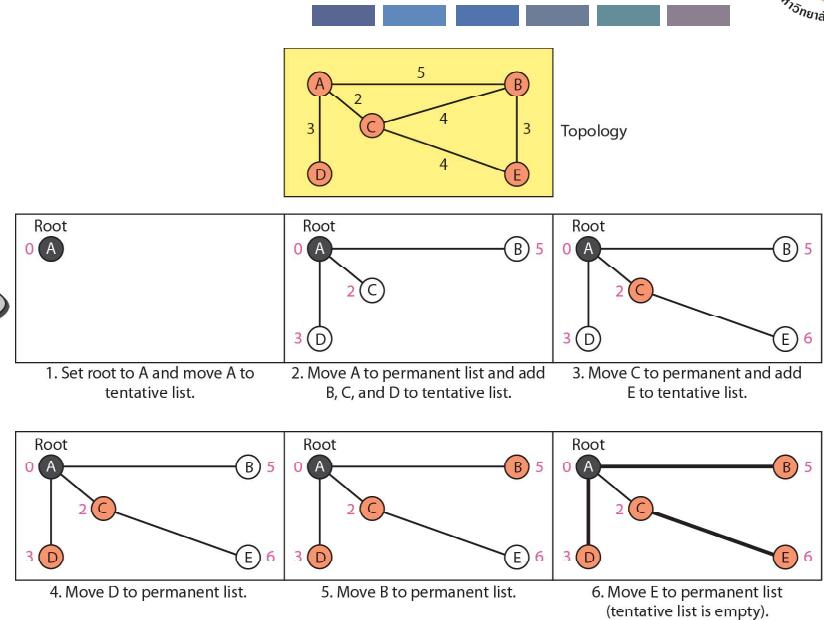


Dijkstra's Algorithm



```

1. P = [ ], T = [A(0)]
2. P = [A(0)], T = [B(5), C(2), D(3)]
3. P = [A(0), C(2)], T = [B(5), D(3), E(6)]
4. P = [A(0), C(2), D(3)], T = [B(5), E(6)]
5. P = [A(0), C(2), D(3), B(5)], T = [E(6)]
6. P = [A(0), C(2), D(3), B(5), E(6)], T = []
    
```

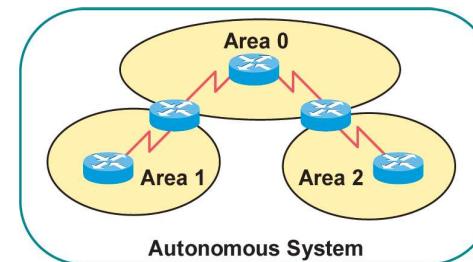


Node	Cost	Next Router
A	0	—
B	5	—
C	2	—
D	3	—
E	6	C

OSPF Hierarchy



Divide areas in AS to reduce traffic



Backbone routers = routers located in area 0

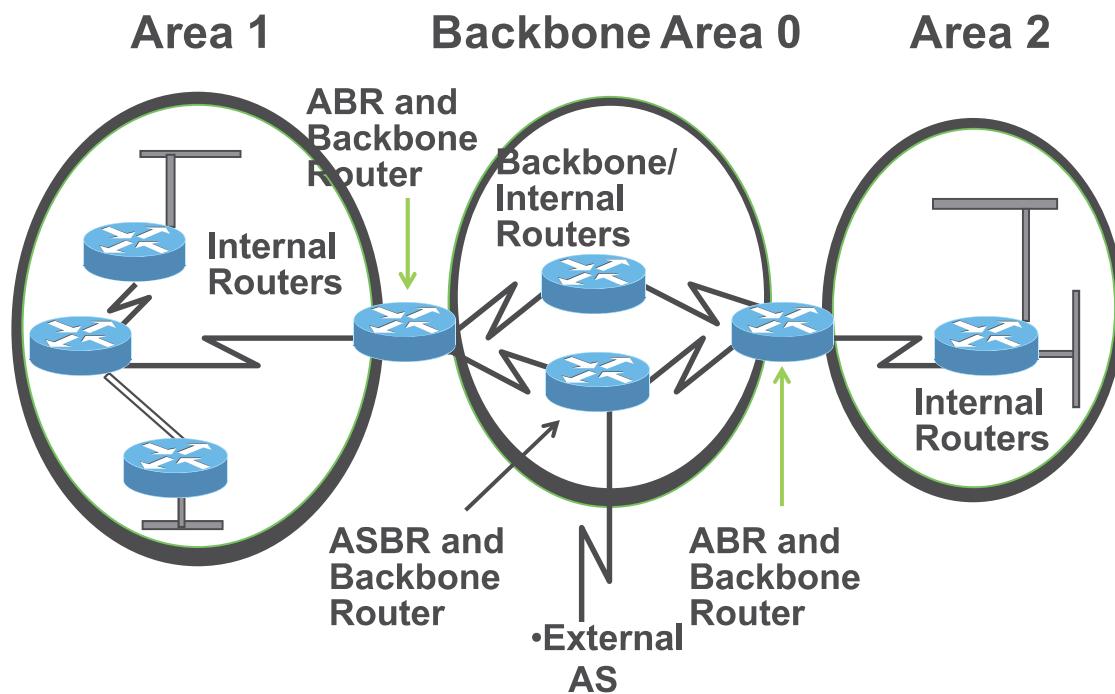


Area border routers (ABR) = router located between areas



Autonomous system border routers (ASBR) = router located between AS

Classes of OSPF Router





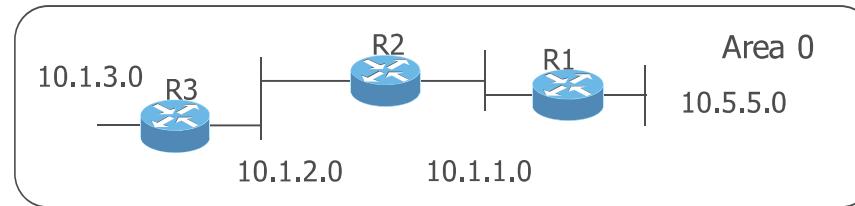
Configure OSPF in Area



R(config)# router ospf <process-ID>



R(config)# network <address> <wildcard mask> area <area-ID>



hostname R3	hostname R2	hostname R1
router ospf 10 network 10.1.2.3 0.0.0.0 area 0 network 10.1.3.1 0.0.0.0 area 0	router ospf 20 network 10.0.0.0 0.255.255.255 area 0	router ospf 30 network 10.1.0.0 0.0.255.255 area 0 network 10.5.5.1 0.0.0.0 area 0

Wildcard Mask



0.0.0.0 = match all octets



0.0.0.255 = match only the first 3 octets

- 192.168.10.128/26
 - 0.0.0.63
 - Wildcard = Block size -1



Checking OSPF Configuration



- Router# `show ip protocol`
- Router# `show ip route`
- Router# `show ip ospf interface`
- Router# `show ip ospf neighbor`
- Router# `show ip ospf database`

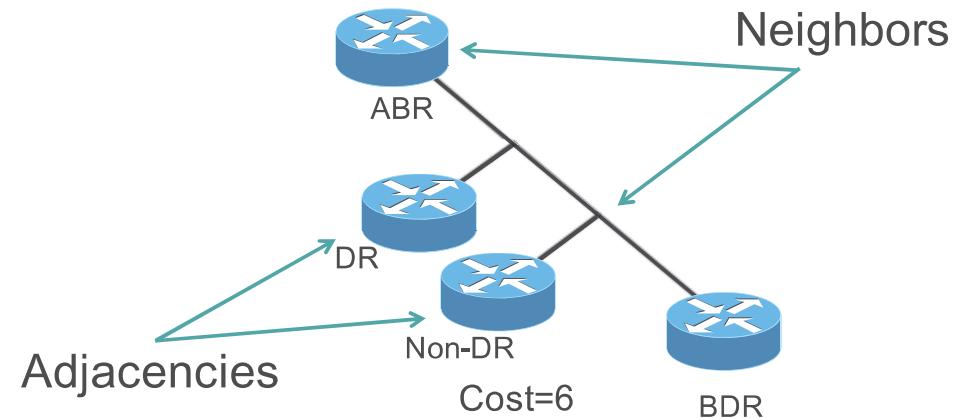


OSPF Neighbor / Adjacency



OSPF send hello packet with multicast 224.0.0.5

- to find adjacency / neighbor





DR and BDR Selection



- ✓ Designated Router (DR) for broadcast
- ✓ Each device has different Router ID (RID)
 - Default: The highest IP value in the device
- ✓ Each machine compare RID in hello packet
 - The highest RID = Designated router (DR)
 - The second highest RID = Backup DR (BDR)



Digital Arts & Science
DIGITECH