Chapter 9

by

Nazrulazhar Bahaman

nazrulazhar@utem.edu.my

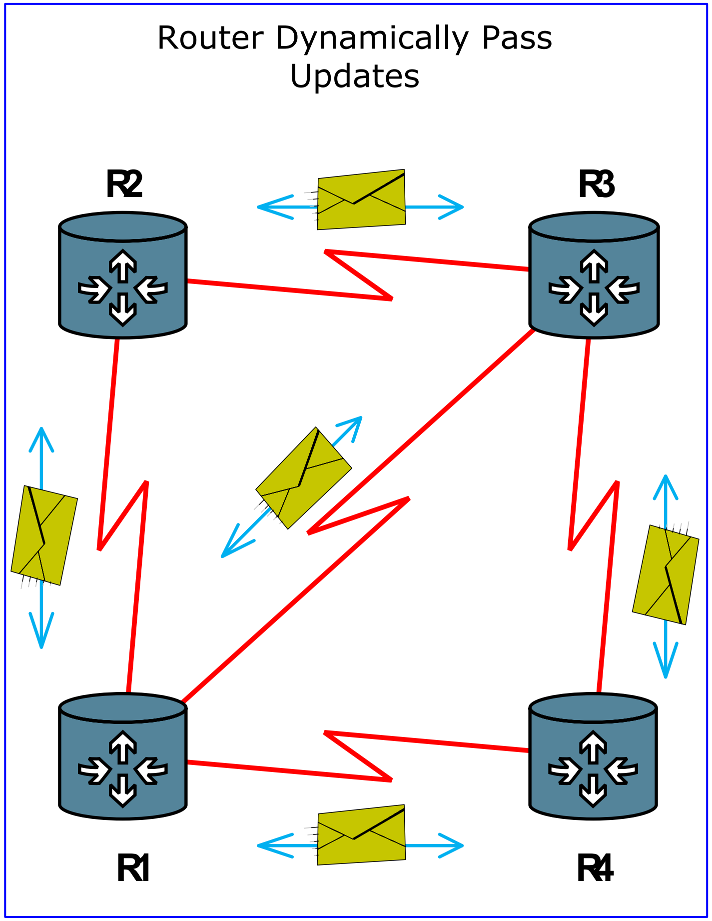
ROUTING PROTOCOL
DYNAMIC ROUTING

Objectives

- Describe the role of dynamic routing protocols.
- Identify several ways to classify routing protocols.
- Describe how Metrics are used by routing protocols
- Identify the Metric types used by dynamic routing protocols.
- Determine the Administrative Distance of a route
- Identify the different elements of the routing table

Introduction

- **Functions of Dynamic Routing Protocols**
  - Dynamically share information between routers.
  - Automatically update routing table when topology changes.
  - Determine best path to a destination

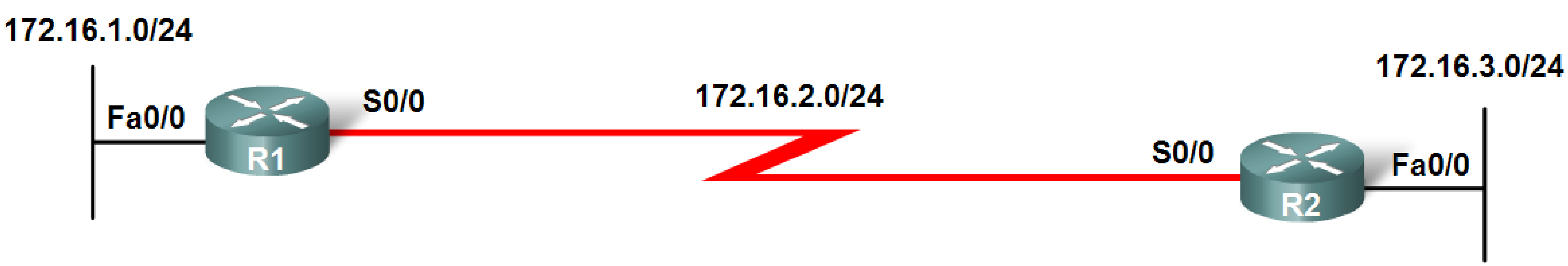


Introduction

- The purpose of a dynamic routing protocol is to:
  - Discover remote networks
  - Maintaining up-to-date routing information
  - Choosing the best path to destination networks
  - Ability to find a new best path if the current path is no longer available

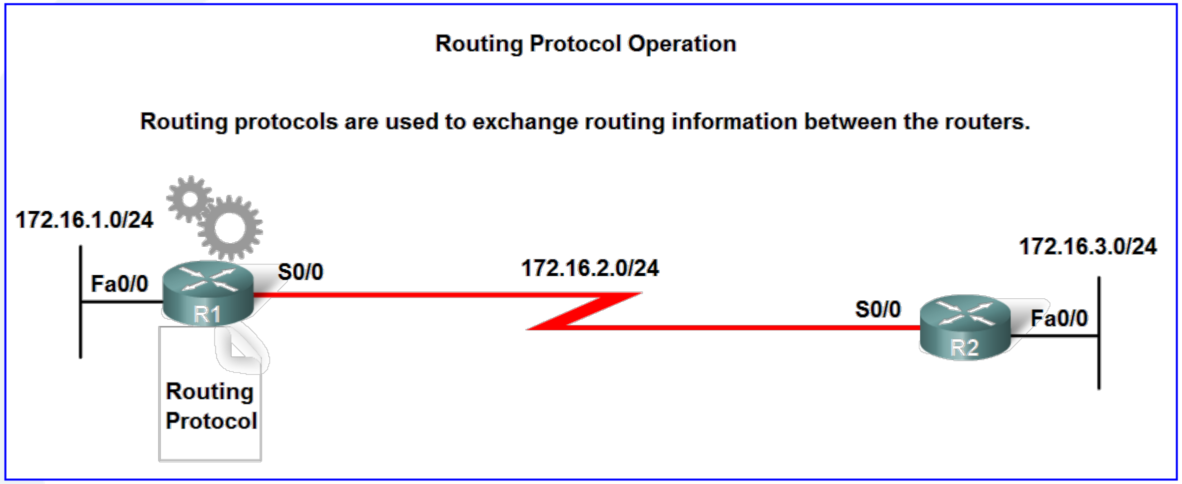
Routing Protocol Operation

Routing protocols are used to exchange routing information between the routers.



Introduction

- Components of a routing protocol
  - **Data Structures**
    - Tables or databases for their operations, kept in RAM
  - **Algorithm**
    - In the case of a routing protocol algorithms are used for facilitating routing information and best path determination
  - **Routing protocol messages**
    - These are messages for discovering neighbors and exchange of routing information



Introduction

Dynamic Routing vs Static Routing

	Dynamic routing	Static routing
Configuration Complexity	Generally independent of the network size	Increases with network size
Required administrator knowledge	Advanced knowledge required	No extra knowledge required
Topology changes	Automatically adapts to topology changes	Administrator intervention required
Scaling	Suitable for simple and complex topologies	Suitable for simple topologies
Security	Less secure	More secure
Resource usage	Uses CPU, memory, link bandwith	No extra resources needed
Predictability	Route depends on the current topology	Route to destination is always the same

Classifying Dynamic Routing Protocols

Classifying Dynamic Routing Protocols

- Dynamic routing protocols are grouped according to characteristics.
- Examples include:
  - RIP - Routing Information Protocol
  - IGRP - Interior Gateway Routing Protocol
  - EIGRP - Enhanced IGRP
  - OSPF - Open Shortest Path First
  - IS-IS - Intermediate System-to-Intermediate System
  - EGP – Exterior Gateway Protocol
  - BGP - Border Gateway Protocol

	Dynamic Routing				
	Interior Gateway				Exterior Gateway
	Distance Vector		Link State		Path Vector
IPv4 Classful	RIP	IGRP			EGP
IPv4 Classless	RIPv2	EIGRP	OSPFv2	IS-IS	BGPv4
IPv6	RIPng	EIGRP for IPv6	OSPFv3	IS-IS for IPv6	BGPv4 for IPv6

Classifying Routing Protocols

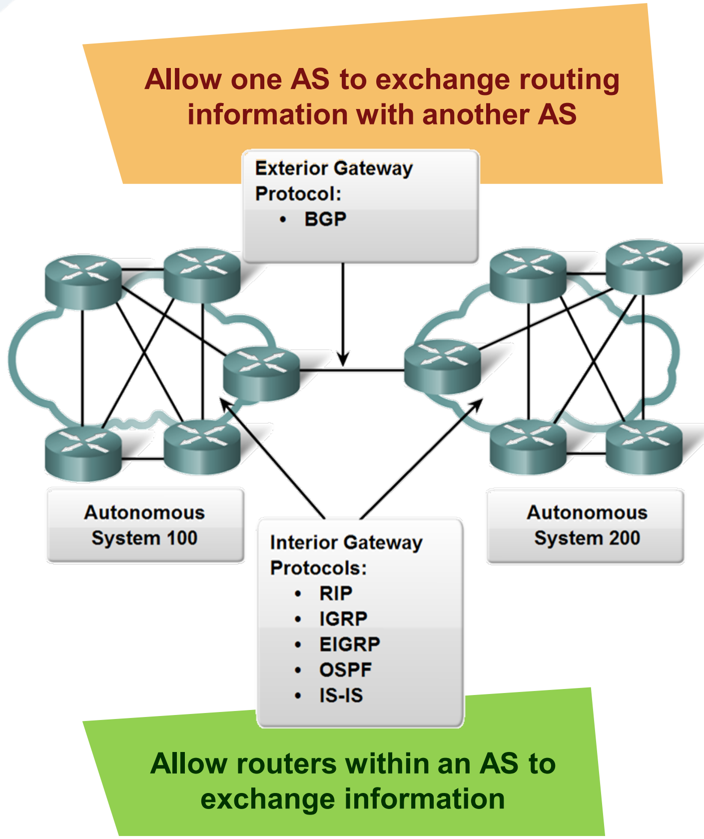
- Types of Dynamic routing protocols:
- **Interior Gateway Routing Protocols (IGP)**

  Used for routing inside an autonomous system & used to route within the individual networks themselves.

  Examples: RIP, EIGRP, OSPF
- **Exterior Routing Protocols (EGP)**

  Used for routing between autonomous systems

  Example: EGP, BGPv4



* ***Autonomous System*** *is a network or group of networks identified and administered as a single entity.*

Classifying Dynamic Routing Protocols

- Classful routing protocols

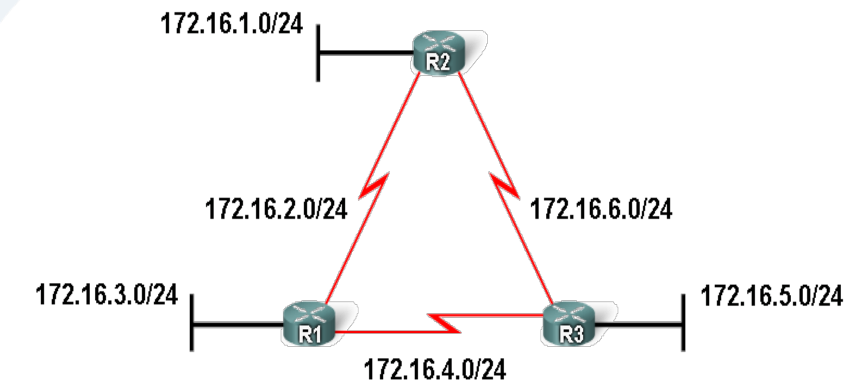
  Do NOT send subnet mask in routing updates

- Classless routing protocols

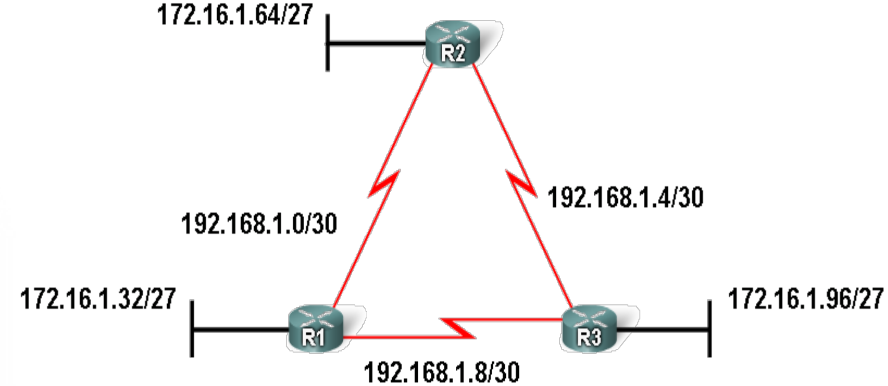
  Do send subnet mask in routing updates.

Dynamic Routing					
	Interior Gateway				Exterior Gateway
	Distance Vector		Link State		Path Vector
IPv4 Classful	RIP	IGRP			EGP
IPv4 Classless	RIPv2	EIGRP	OSPFv2	IS-IS	BGPv4
IPv6	RIPng	EIGRP for IPv6	OSPFv3	IS-IS for IPv6	BGPv4 for IPv6

Classful vs. Classless Routing



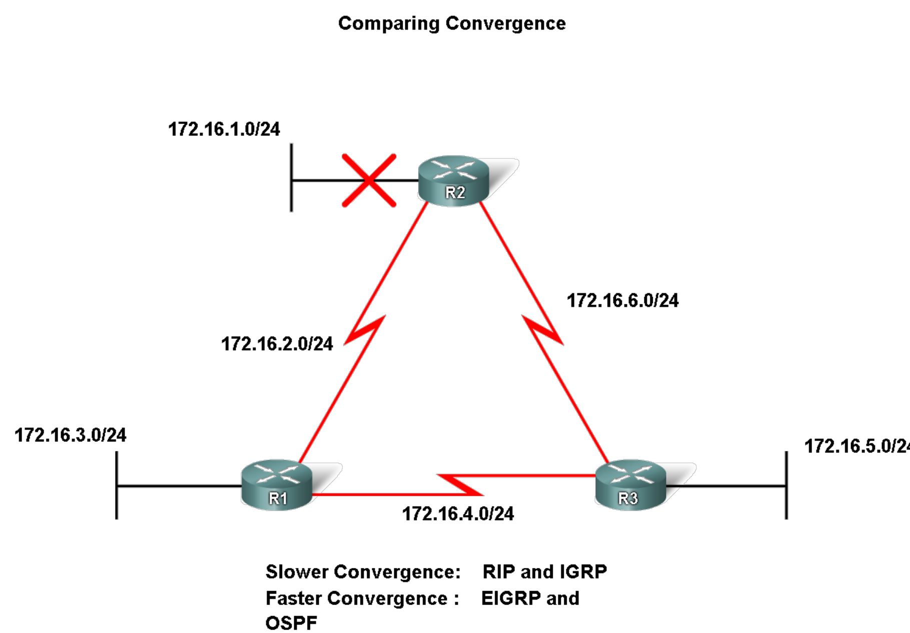
Classful: Subnet mask is the same throughout the topology



Classless: Subnet mask can vary in the topology

Classifying Dynamic Routing Protocols

- Convergence is defined as when all routers' routing tables are at a state of consistency
  - all routers have complete and accurate information about the network
- Convergence must be reached before a network is considered completely operable
- The routers must:
  - Share routing information.
  - Calculate the best path to a destination.
  - Update their routing tables.



Classifying Routing Protocols

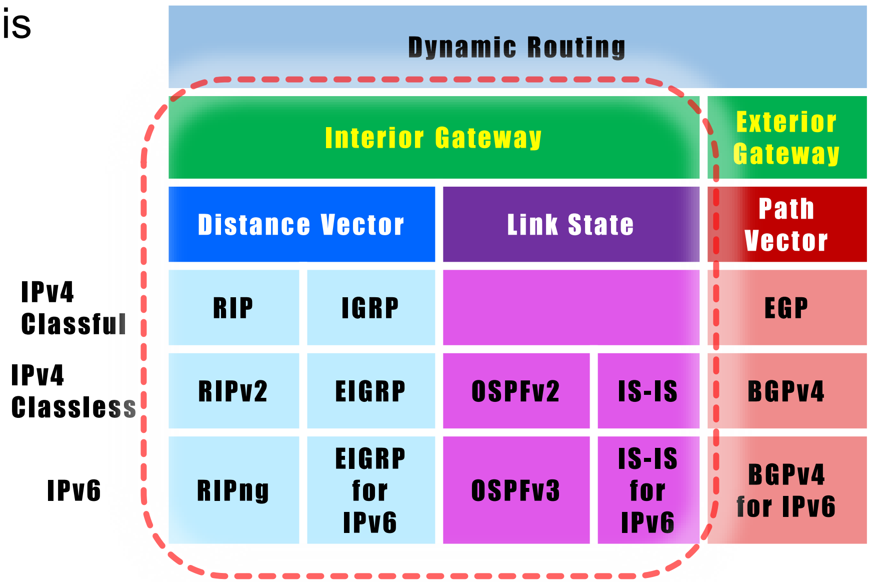
Types of IGP

Distance vector

- routes are advertised as vectors of distance & direction.
- incomplete view of network topology.
- Generally, periodic updates.

Link State

- complete view of network topology is created.
- updates are not periodic



Distance Vector Routing Protocols

Distance Vector Routing Protocols

Examples of Distance Vector routing protocols:

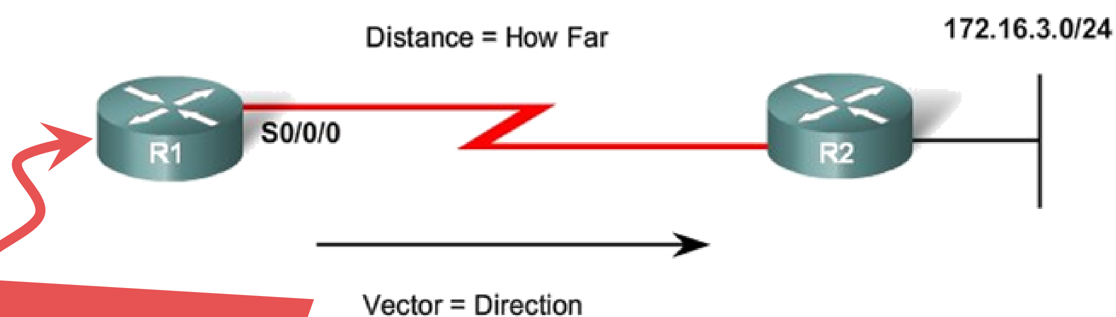
- Routing Information Protocol version 2(RIPv2)
  - Routing Information Protocol (RIP)
- Enhanced Interior Gateway Routing Protocol (EIGRP)
  - Interior Gateway Routing Protocol (IGRP)

	Dynamic Routing				
	Interior Gateway				Exterior Gateway
	Distance Vector		Link State		Path Vector
IPv4 Classful	RIP	IGRP			EGP
IPv4 Classless	RIPv2	EIGRP	OSPFv2	IS-IS	BGPv4
IPv6	RIPng	EIGRP for IPv6	OSPFv3	IS-IS for IPv6	BGPv4 for IPv6

Distance Vector Routing Protocols

The Meaning of Distance Vector

- Routers using distance-vector protocol
  - using 2 methods:
    - Distance to final destination.
    - Vector in which router or exit interface a traffic should be forwarded.
  - do not have knowledge of the entire path to a destination network

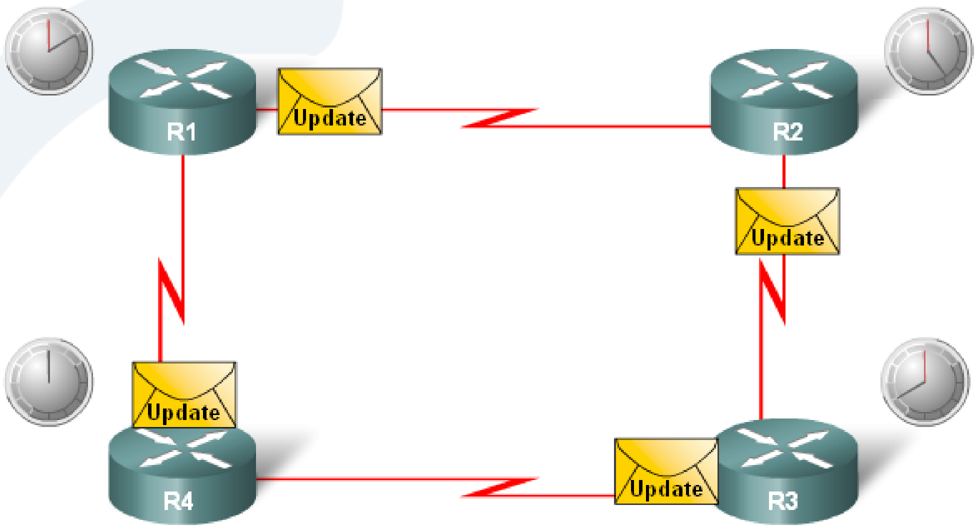


Network 172.16.3.0/24:
- **Distance - is 1 hop away ()**
- **Vector - through interface s0/0/0**

Distance Vector Routing Protocols

Characteristics of Distance Vector routing protocols:

- Periodic updates
- Neighbors
- Broadcast updates
- Entire routing table is included with routing update



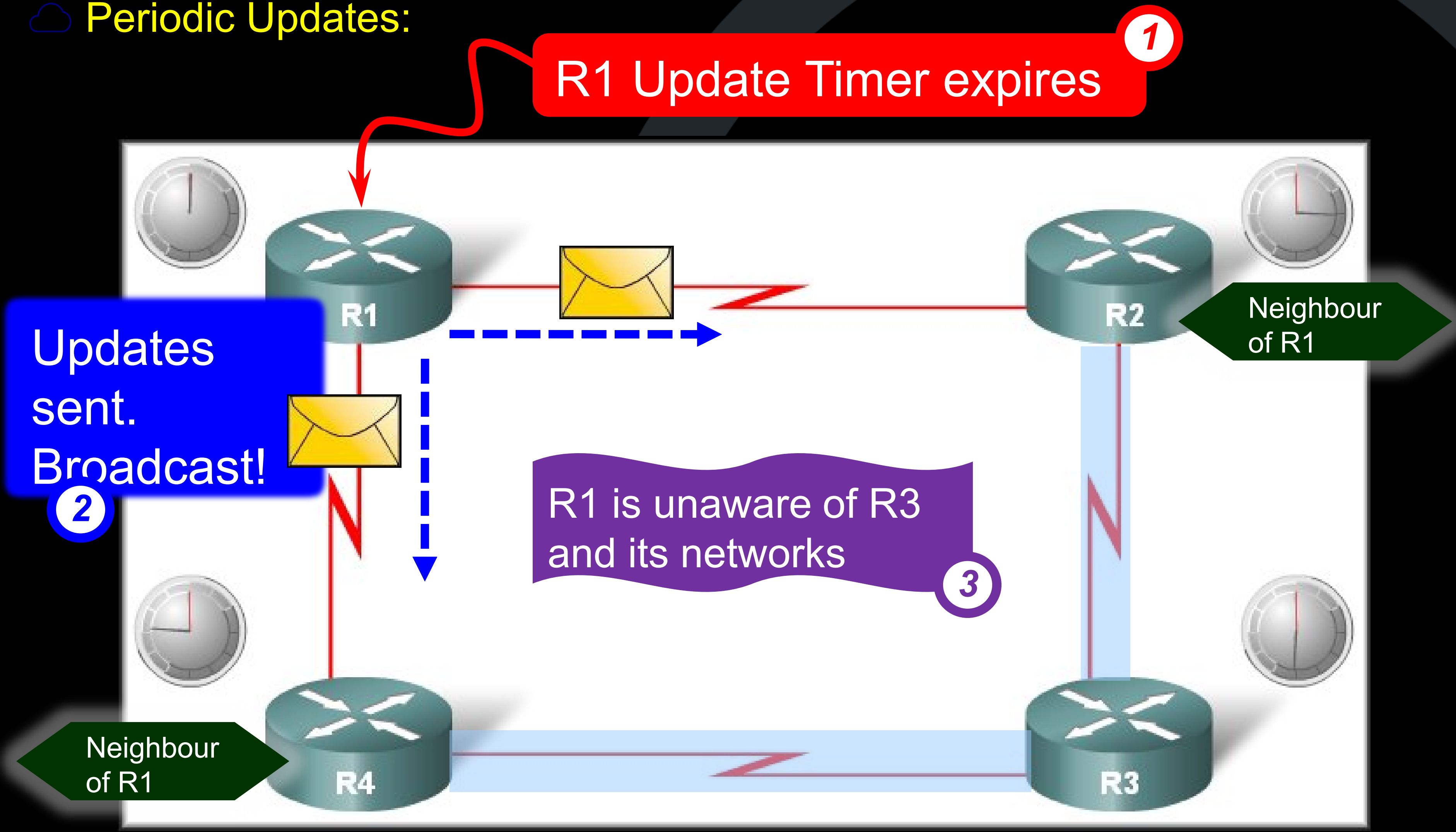
Distance Vector Routing Protocols

Operation of Distance Vector

- **Periodic Updates:**
  - Some distance vector routing protocols periodically broadcast the entire routing table to each of its neighbors (RIP – every 30 seconds).
    - Inefficient: Updates consume bandwidth and router CPU resources.
    - Periodic updates are always sent even there have been no changes for weeks or months.
  - Router is only aware of the:
    - Network addresses of its own interfaces.
    - Network addresses the neighbors running the same routing protocol.

Operation of Distance Vector

- Periodic Updates:



Distance Vector Routing Protocols

Routing Protocol Algorithm

- The algorithm used by a particular routing protocol is responsible for building and maintaining the router's routing table.
  - Mechanism for sending and receiving routing information.
  - Mechanism for calculating the best paths and installing routes in the routing table.
  - Mechanism for detecting and reacting to topology changes.

Step 0 : Initialize

$d(s) := 0;\ d(v) := +\infty\ \ \forall v \in V \setminus \{s\};\ \pi(v) := v\ \ \forall v \in V;\ Q := V;\ i := 1$

Step 1 : Select the node

If Q=0, then go to step 3, else select the node v from the head of Q

Step 2 :Search the Path (let v be the initial point)

If $d(u) > d(v)+l((v, u))$ for all path(v,u), then $d(u) = d(v) + l((v, u))$, $\pi(u) = v$ $\rightarrow$ Step 1

Step 3:judgement

$i \leftarrow i+1$

If $i < n$, then $Q \leftarrow V$ and go to step 1,

else check whether triangle inequality* is satisfied or not on all paths.

If any paths "A" not satisfied the triangle inequality, there is the negatively circuit including the path "A".

* Triangle inequality

Let X be linear space,

$\| u+v \| \leq \| u \| + \| v \|$ for $u,v \in X$

Routing Protocol Algorithms

Calculate Best Path and Install Route

Periodic Update

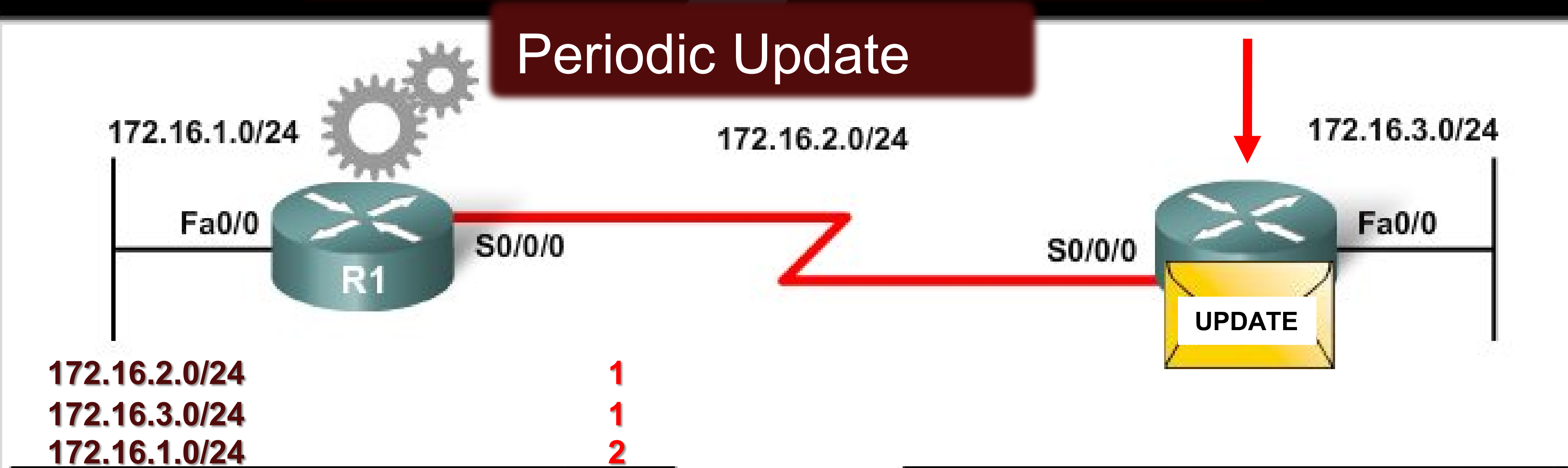
Network	Interface	Hop
172.16.1.0/24	Fa0/0	0
172.16.2.0/24	S0/0/0	0

172.16.1.0/24 1
172.16.2.0/24 1

Network	Interface	Hop
172.16.2.0/24	S0/0/0	0
172.16.3.0/24	Fa0/0	0

Routing Protocol Algorithms

Calculate Best Path and Install Route

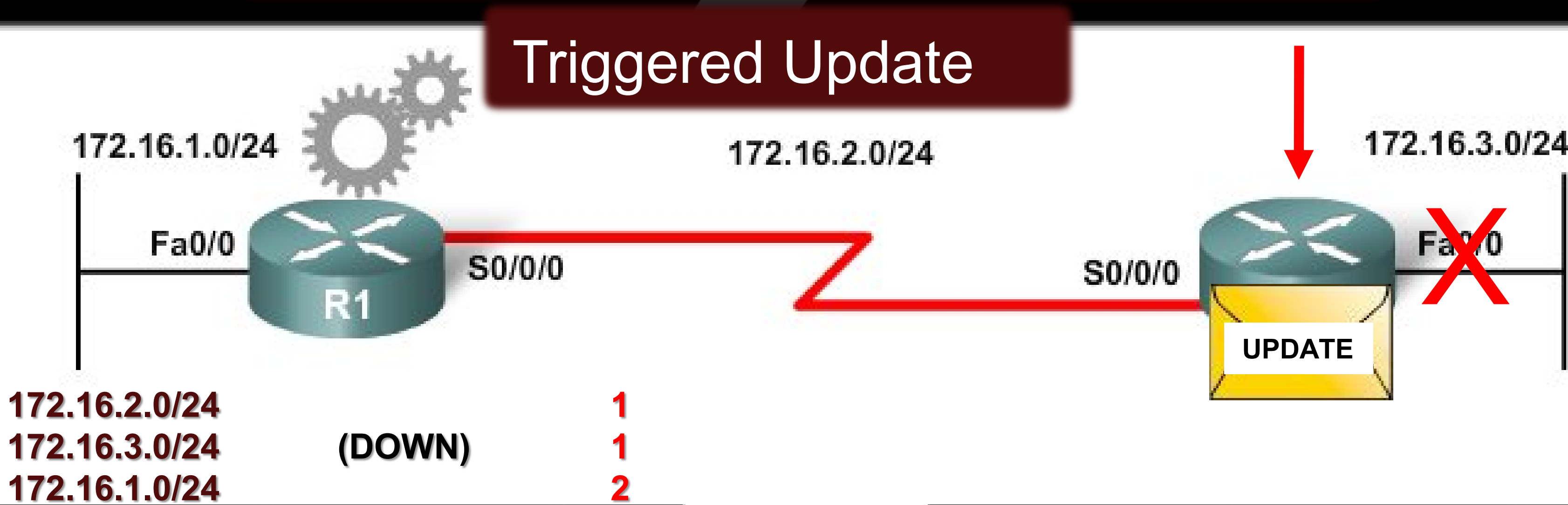


Network	Interface	Hop
172.16.1.0/24	Fa0/0	0
172.16.2.0/24	S0/0/0	0

Network	Interface	Hop
172.16.2.0/24	S0/0/0	0
172.16.3.0/24	Fa0/0	0
172.16.1.0/24	S0/0/0	1

Routing Protocol Algorithms

Detect and React to Topology Changes



Network	Interface	Hop
172.16.1.0/24	Fa0/0	0
172.16.2.0/24	S0/0/0	0
~~172.16.3.0/24~~	~~S0/0/0~~	~~1~~

Network	Interface	Hop
172.16.2.0/24	S0/0/0	0
~~172.16.3.0/24~~	~~Fa0/0~~	~~0~~
172.16.1.0/24	S0/0/0	1

Distance Vector Routing Protocols

Routing Protocol Characteristics

- Criteria used to compare routing protocols includes
  - Time to convergence:
    - Faster the better.
  - Scalability:
    - How large a network the routing protocol can handle.
  - Classless or Classful:
    - Support VLSM and CIDR.
  - Resource usage:
    - Routing protocol usage of RAM, CPU utilization, and link bandwidth utilization.
  - Implementation and maintenance:
    - Level of knowledge of a network administrator.

Distance Vector Routing Protocols

- Routing Information Protocol (RIPv2):
  - Metric: Hop count.
  - A hop count greater than 15 means that the network is unreachable.
  - Periodic routing updates.
    - Entire routing table is broadcast every 30 seconds.

- Enhanced Interior Gateway Routing Protocol (EIGRP):
  - Cisco proprietary.
  - Composite metric: Bandwidth, delay, reliability and load.
  - It uses Diffusing Update Algorithm (DUAL) to calculate the shortest path.
  - No periodic updates.
    - Multicast updates only on a change in topology.

Distance Vector Routing Protocols

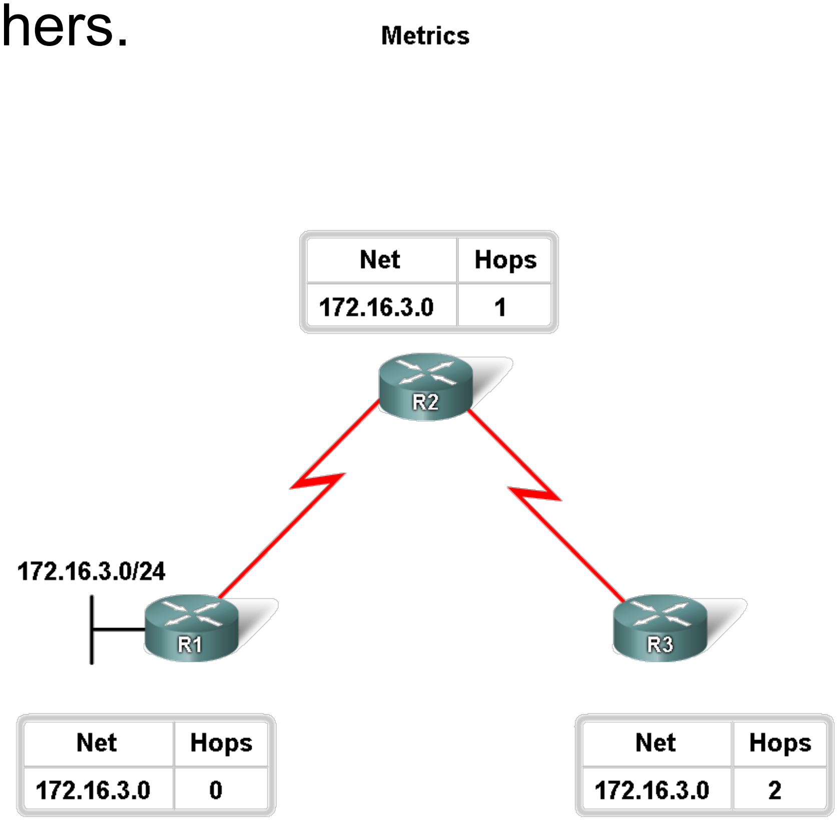
- Comparing Routing Protocol Features

Distance Vector Routing Protocols			
Feature	RIPv1	RIPv2	EIGRP
Speed of Convergence	Slow	Slow	Fast
Scalability	Small	Small	Large
Supports VLSM	No	Yes	Yes
Resource Usage	Low	Low	Medium
Implementation	Simple	Simple	Complex

Routing Protocols Metrics

Routing Protocols Metrics

- **Metric**
  - A value used by a routing protocol to determine which routes are better than others.
  - Types of Metric
    - Bandwidth
    - Cost
    - Hop count
    - Latency
    - Load
    - Reliability



Routing Protocols Metrics

Metrics used in IP routing protocols

- Hop count
  - Hop count is the number of routers (number of hops) from the source router through which data must pass to reach the destination network
- Bandwidth
  - The total capacity of each network link to carry traffic between different networks in the internetwork.
- Cost
  - A parameter roughly proportional to the actual cost in RMs of using each network link. Some wide area network (WAN) links might have more latency but cost much less.

Routing Protocols Metrics

Metrics used in IP routing protocols

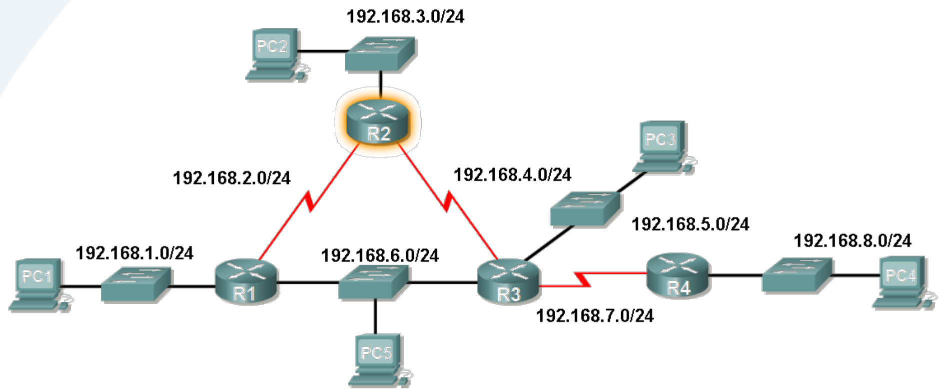
- Latency
  - The time interval needed to route a packet through the router or over a specific path through the internetwork. Latency can be increased by delays due to such factors as port congestion on the router, heavy router load, bandwidth utilization of links between networks, and physical distance between networks.
- Load
  - Generally, the number of packets being processed per second by the router or its CPU utilization. If the load on a router becomes high, the router can advise other routers to recalculate routing tables in order to divert traffic around it
- Reliability
  - The relative amount of anticipated downtime for a given link between two networks.

Routing Protocols Metrics

The Metric Field in the Routing Table

- **Metric** used for each routing protocol
  - RIP - hop count
  - IGRP & EIGRP - Bandwidth (used by default), Delay (used by default), Load, Reliability
  - IS-IS & OSPF – Cost, Bandwidth (Cisco's implementation)

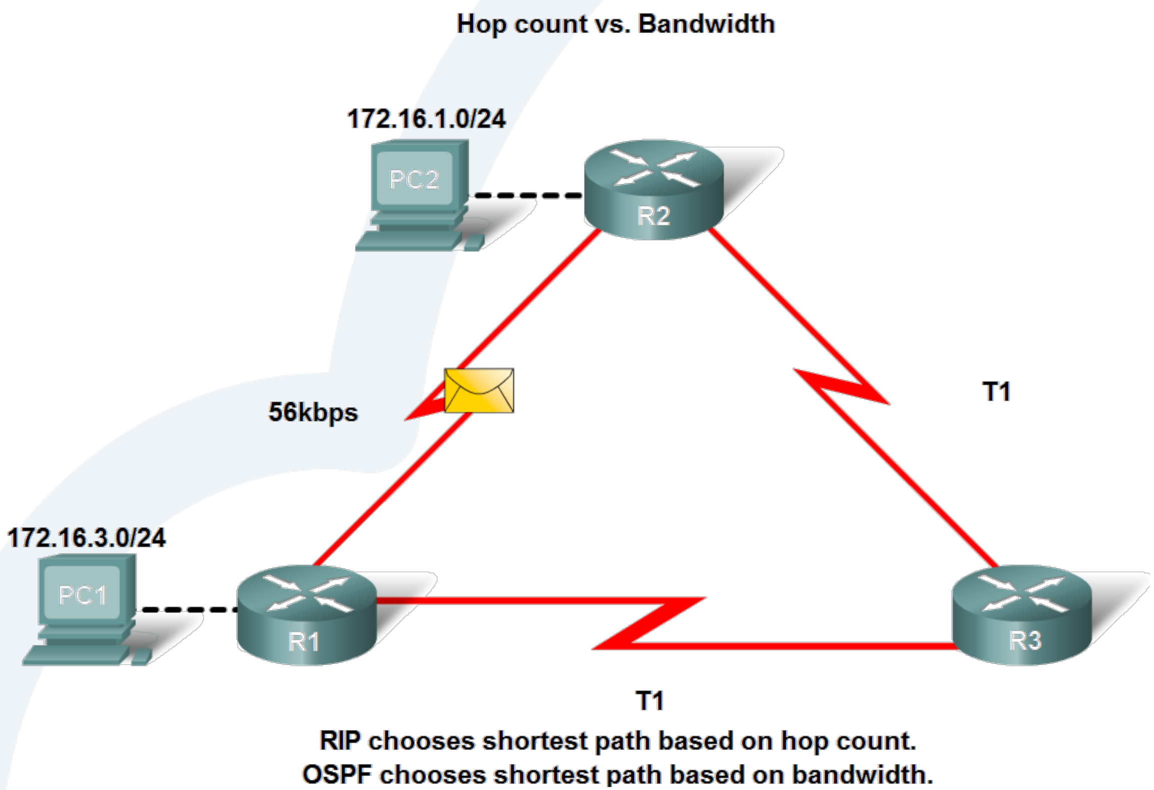
Metric in the Routing Table




```
R2#show ip route
<output omitted>

Gateway of last resort is not set

R    192.168.1.0/24 [120/1] via 192.168.2.1, 00:00:24, Serial0/0
C    192.168.2.0/24 is directly connected, Serial0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
C    192.168.4.0/24 is directly connected, Serial0/1
R    192.168.5.0/24 [120/1] via 192.168.4.1, 00:00:26, Serial0/1
R    192.168.6.0/24 [120/1] via 192.168.2.1, 00:00:24, Serial0/0
                    [120/1] via 192.168.4.1, 00:00:26, Serial0/1
R    192.168.7.0/24 [120/1] via 192.168.4.1, 00:00:26, Serial0/1
R    192.168.8.0/24 [120/2] via 192.168.4.1, 00:00:26, Serial0/1
```

It is 2 hops from R2 to 192.168.8.0/24

Routing Protocols Metrics

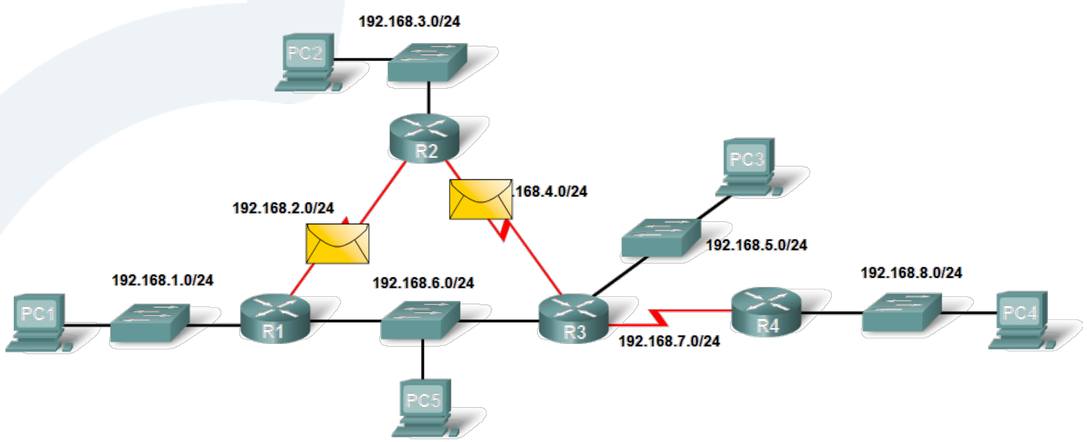


Routing Protocols Metrics

Load balancing

- This is the ability of a router to distribute packets among multiple same cost paths

Load Balancing Across Equal Cost Paths



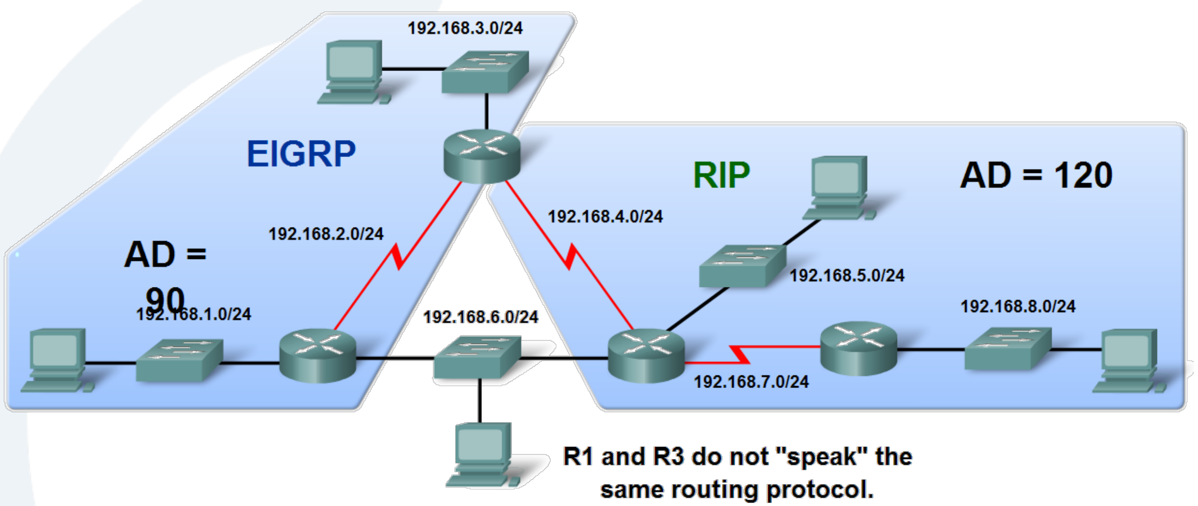

```
R2#show ip route
<output omitted>

R    192.168.6.0/24 [120/1] via 192.168.2.1, 00:00:24, Serial0/0/0
                    [120/1] via 192.168.4.1, 00:00:26, Serial0/0/1
```

Administrative Distance (AD)

Administrative Distance of a Route

- **Purpose of a metric**
  - It's a calculated value used to determine the best path to a destination
- **Purpose of Administrative Distance**
  - It's a numeric value that specifies the preference of a particular route

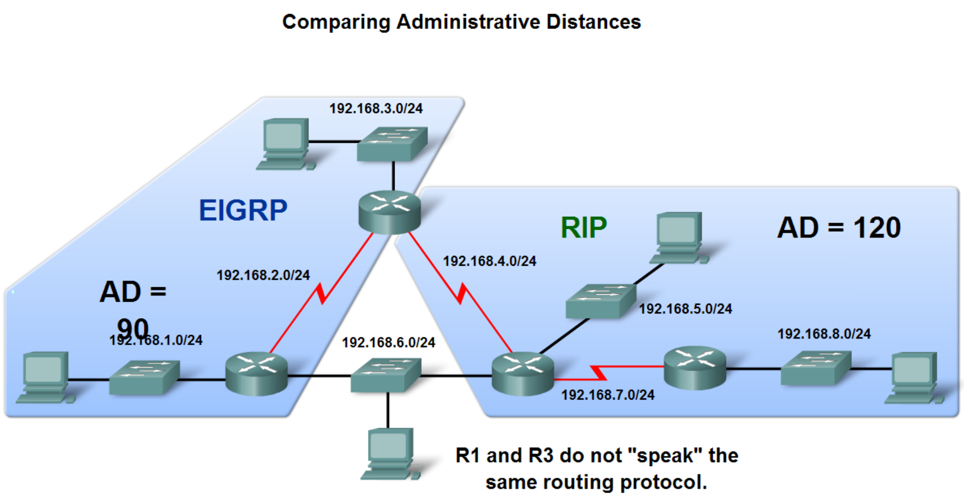
Comparing Administrative Distances



Administrative Distance of a Route

Identifying the Administrative Distance (AD) in a routing table

- It is the first number in the brackets in the routing table




```
R2#show ip route
<output omitted>

Gateway of last resort is not set

D    192.168.1.0/24 [90/2172416] via 192.168.2.1, 00:00:24, Serial0/0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
C    192.168.4.0/24 is directly connected, Serial0/0/1
R    192.168.5.0/24 [120/1] via 192.168.4.1, 00:00:08, Serial0/0/1
D    192.168.6.0/24 [90/2172416] via 192.168.2.1, 00:00:24, Serial0/0/0
R    192.168.7.0/24 [120/1] via 192.168.4.1, 00:00:08, Serial0/0/1
R    192.168.8.0/24 [120/2] via 192.168.4.1, 00:00:08, Serial0/0/1
```

```
R2#show ip rip database
192.168.3.0/24    directly connected, FastEthernet0/0
192.168.4.0/24    directly connected, Serial0/0/1
192.168.5.0/24
    [1] via 192.168.4.1, Serial0/0/1
192.168.6.0/24
    [1] via 192.168.4.1, Serial0/0/1
192.168.7.0/24
    [1] via 192.168.4.1, Serial0/0/1
192.168.8.0/24
    [2] via 192.168.4.1, Serial0/0/1
```

Administrative Distance of a Route

- **Dynamic Routing Protocols**

Default Administrative Distances

Route source	Default AD
Connected interface	0
Static	1
EIGRP summary route	5
eBGP	20
EIGRP (Internal)	90
IGRP	100
OSPF	110
IS - IS	115
RIP	120
EIGRP (External)	170
iBGP	200
Unknown	255

Administrative Distance of a Route

- **Directly connected routes**
  - Have a default **AD of 0**
- **Static Routes**
  - Have a default **AD of 1**

```
R2#show ip route 172.16.3.0
Routing entry for 172.16.3.0/24
Known via "static", distance 1, metric 0 (connected)
  Routing Descriptor Blocks:
  * directly connected, via Serial0/0/0
      Route metric is 0, traffic share count is 1
```

Administrative Distance of a Route

- **Directly connected routes**
  - Immediately appear in the routing table as soon as the interface is configured

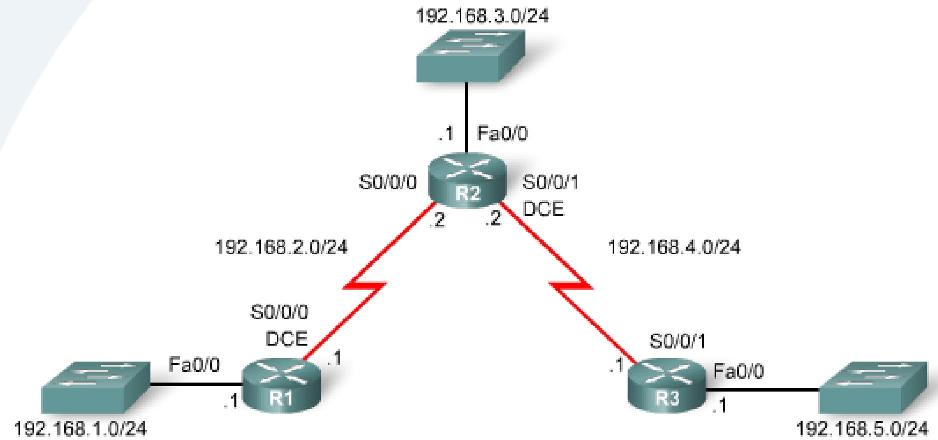
```
R2#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, 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

     172.16.0.0/24 is subnetted, 3 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0/0
S       172.16.3.0 is directly connected, Serial0/0/0
C    192.168.1.0/24 is directly connected, Serial0/0/1
S    192.168.2.0/24 [1/0] via 192.168.1.1
```

RIP

Basic RIPv1 Configuration

- A typical topology suitable for use by RIPv1 includes:
  - Three router set up
  - No PCs attached to LANs
  - Use of 5 different IP subnets

RIP Topology: Scenario A



Addressing Table: Scenario A

Device	Inferface	IP Address	Subnet Mask
R1	Fa0/0	192.168.1.1	255.255.255.0
	S0/0/0	192.168.2.1	255.255.255.0
R2	Fa0/0	192.168.3.1	255.255.255.0
	S0/0/0	192.168.2.2	255.255.255.0
	S0/0/1	192.168.4.2	255.255.255.0
R3	Fa0/0	192.168.5.1	255.255.255.0
	S0/0/1	192.168.4.1	255.255.255.0

Basic RIPv1 Configuration

Router RIP Command

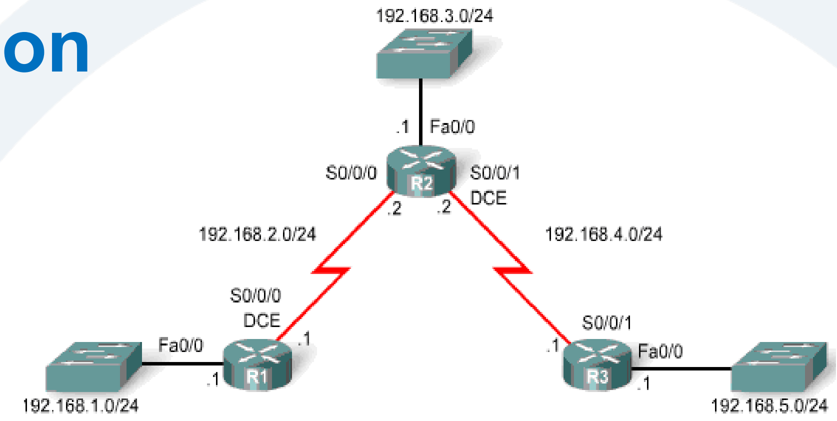
- To enable RIP enter:
  - *router rip* at the global configuration prompt
  - Prompt will look like **R1(config-router)#**

```
R1#conf t
Enter configuration commands, one per line. End with CTRL/Z.
R1(config)#router ?
  bgp        Border Gateway Protocol (BGP)
  egp        Exterior Gateway Protocol (EGP)
  eigrp      Enhanced Interior Gateway Protocol (EIRGP)
  igrp       Interior Gateway Routing Protocol (IGRP)
  isis       ISO IS-IS
  iso-igrp   IGRP for OSI networks
  mobile     Mobile routes
  odr        On Demand stub Routes
  ospf       Open Shortest Path First (OSPF)
  rip        Routing Information Protocol (RIP)

R1(config)#router rip
R1(config-router)#
```

Basic RIPv1 Configuration

Specifying Networks

- Use the **`network`** command to:
  - Enable RIP on all interfaces that belong to this network
  - Advertise this network in RIP updates sent to other routers every 30 seconds




```
R1(config)#router rip
R1(config-router)#network 192.168.1.0
R1(config-router)#network 192.168.2.0
```

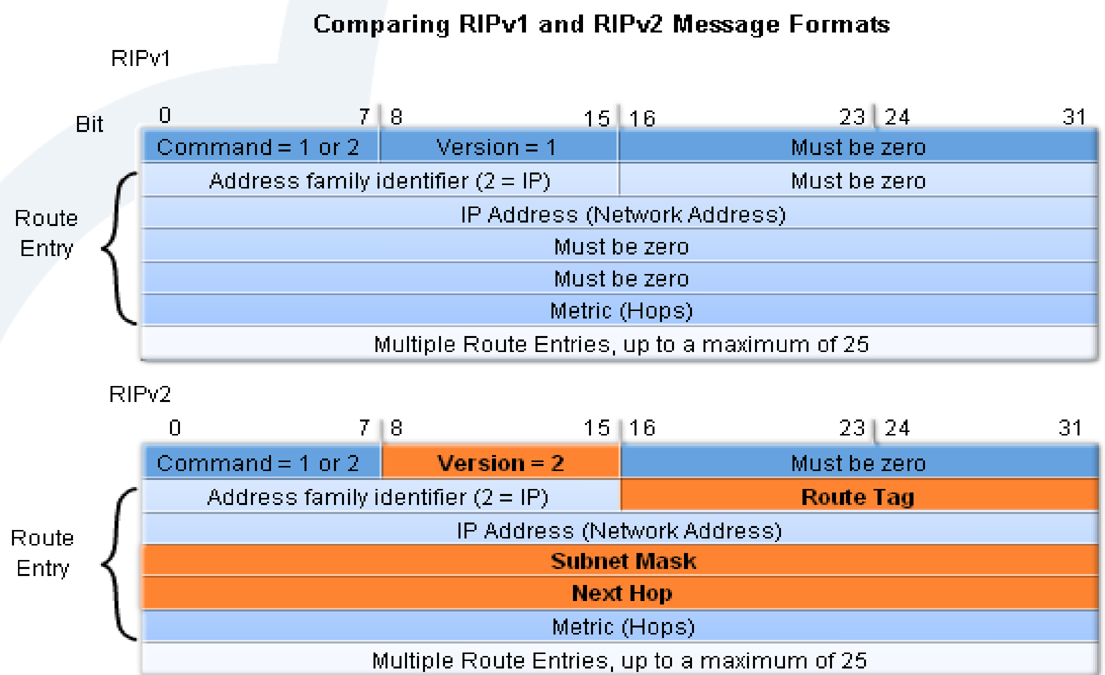
```
R2(config)#router rip
R2(config-router)#network 192.168.2.0
R2(config-router)#network 192.168.3.0
R2(config-router)#network 192.168.4.0
```

```
R3(config)#router rip
R3(config-router)#network 192.168.4.0
R3(config-router)#network 192.168.5.0
```

Configuring RIPv2

Comparing RIPv1 & RIPv2 Message Formats

- RIPv2 Message format is similar to RIPv1 but has 2 extensions
  - 1st extension is the subnet mask field
  - 2nd extension is the addition of next hop address

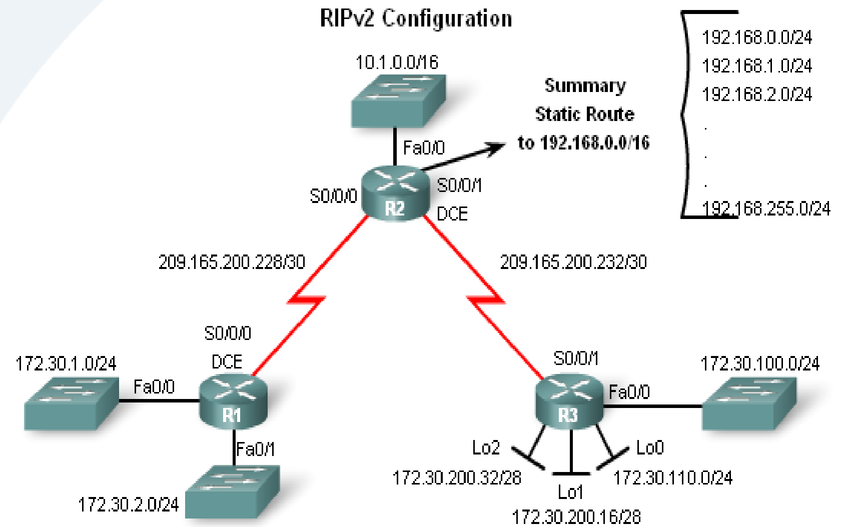


Configuring RIPv2

- Enabling and Verifying RIPv2
- Configuring RIP on a Cisco router
    - By default it is running RIPv1

Configuring RIPv2

- Configuring RIPv2 on a Cisco router
  - Requires using the *version 2* command
  - RIPv2 ignores RIPv1 updates
- To verify RIPv2 is configured use the *show ip protocols* command




```
R1(config)#router rip
R1(config-router)#version 2
```

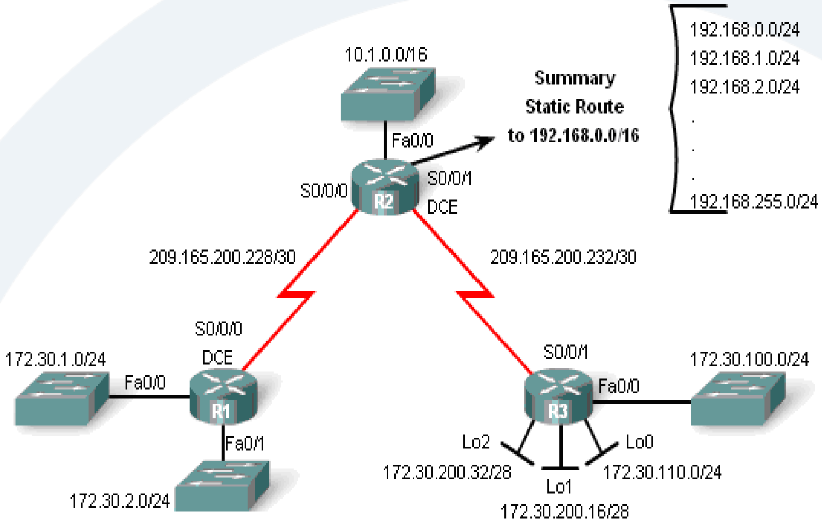
```
R2(config)#router rip
R2(config-router)#version 2
```

```
R3(config)#router rip
R3(config-router)#version 2
```

R2 After RIPv2 Configuration: RIPv2 ignores RIPv1 updates

```
R2#show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 1 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Redistributing: static, rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    Serial0/0/0           2     2
    Serial0/0/1           2     2
  Automatic network summarization is in effect
  Routing for Networks:
    10.0.0.0
    209.165.200.0
  Passive Interface(s):
    FastEthernet0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    209.165.200.234      120      00:00:03
    209.165.200.230      120      00:00:17
  Distance: (default is 120)
```

Configuring RIPv2



Auto-Summary & RIPv2

- RIPv2 will automatically summarize routes at major network boundaries and can also summarize routes with a subnet mask that is smaller than the classful subnet mask

R1 now has supernet.

```
R1#show ip route

Gateway of last resort is not set

     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.2.0 is directly connected, Loopback0
C       172.30.1.0 is directly connected, FastEthernet0/0
     209.165.200.0/30 is subnetted, 2 subnets
R       209.165.200.232 [120/1] via 209.165.200.229, 00:00:04, Serial0/0/0
C       209.165.200.228 is directly connected, Serial0/0/0
R    10.0.0.0/8 [120/1] via 209.165.200.229, 00:00:04, Serial0/0/0
R    192.168.0.0/16 [120/1] via 209.165.200.229, 00:00:04, Serial0/0/0
```

R1 still sending summary route but now with subnet mask /16.

```
R1#debug ip rip
RIP protocol debugging is on
R1#
RIP: sending v2 update to 224.0.0.9 via Serial0/0/0 (209.165.200.230)
RIP: build update entries
        172.30.0.0/16 via 0.0.0.0, metric 1, tag 0
R1#
<output omitted for brevity>
RIP: received v2 update from 209.165.200.229 on Serial0/0/0
     10.0.0.0/8 via 0.0.0.0 in 1 hops
     192.168.0.0/16 via 0.0.0.0 in 1 hops
     209.165.200.232/30 via 0.0.0.0 in 1 hops
<output omitted for brevity>
```

show ip protocols command verifies auto summarization.

```
R1#show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 20 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Redistributing: rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    FastEthernet0/0       2     2
    FastEthernet0/1       2     2
    Serial0/1/0           2     2
  Automatic network summarization is in effect
  Maximum path: 4
```

Supernets are now included in RIPv2 updates.

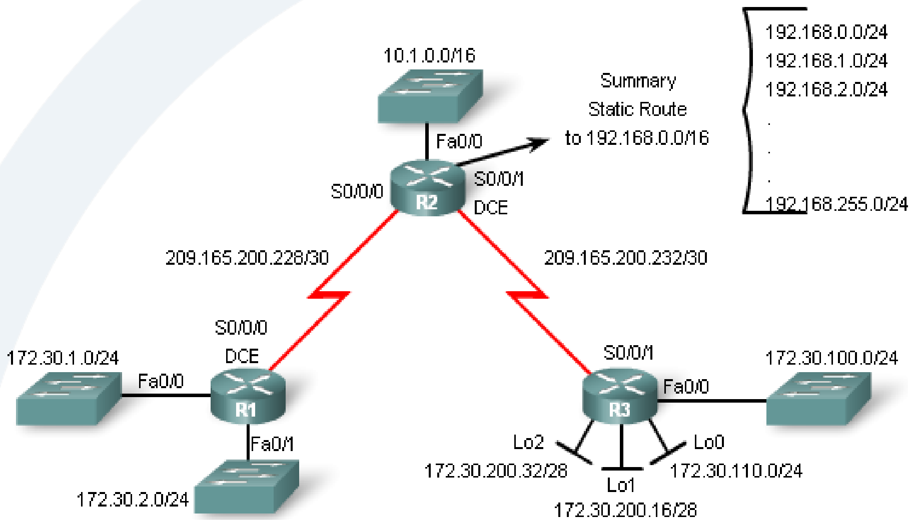
```
R1#debug ip rip
RIP protocol debugging is on
R1#
RIP: sending v2 update to 224.0.0.9 via Serial0/1/0 (209.165.200.230)
RIP: build update entries
        172.30.0.0/16 via 0.0.0.0, metric 1, tag 0
R1#
<output omitted for brevity>
RIP: received v2 update from 209.165.200.229 on Serial0/1/0
     10.0.0.0/8 via 0.0.0.0 in 1 hops
     192.168.0.0/16 via 0.0.0.0 in 1 hops
     209.165.200.232/30 via 0.0.0.0 in 1 hops
<output omitted for brevity>
```

Configuring RIPv2

Disabling Auto-Summary in RIPv2

- To disable automatic summarization issue the *no auto-summary* command

No Automatic Summarization




```
R1(config)#router rip
R1(config-router)#no auto-summary
R1(config-router)#end
R1#show ip protocols
Routing Protocol is "rip"
<output omitted for brevity>
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    FastEthernet0/0       2     2
    FastEthernet0/1       2     2
    Serial0/1/0           2     2
  Automatic network summarization is not in effect
  <output omitted for brevity>
```

```
R2(config)#router rip
R2(config-router)# no auto-summary
```

```
R3(config)#router rip
R3(config-router)#no auto-summary
```

Configuring RIPv2

Verifying RIPv2 Updates

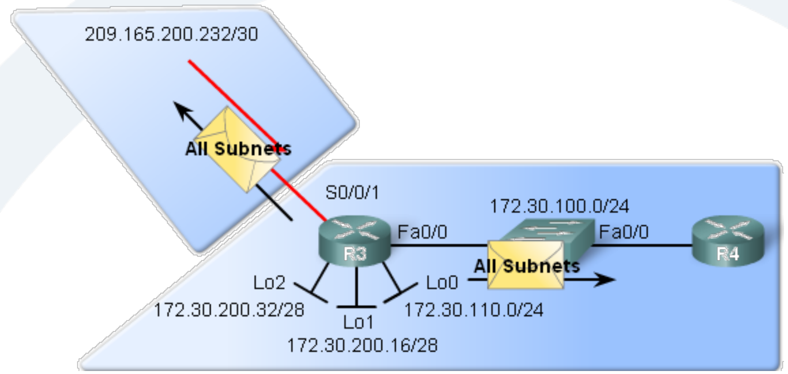
- When using RIPv2 with automatic summarization turned off
  - Each subnet and mask has its own specific entry, along with the exit interface and next-hop address to reach that subnet.
- To verify information being sent by RIPv2 use the
  - debug ip rip command

VLSM & CIDR

RIPv2 and VLSM

- Networks using a VLSM IP addressing scheme
  - Use classless routing protocols (i.e. RIPv2) to disseminate network addresses and their subnet masks

R3 Debug Output



R3 Debug Output

```
R3#debug ip rip
RIP protocol debugging is on
R3#
RIP: received v2 update from 209.165.200.233 on Serial0/0/1
     10.1.0.0/16 via 0.0.0.0 in 1 hops
     172.30.1.0/24 via 0.0.0.0 in 2 hops
     172.30.2.0/24 via 0.0.0.0 in 2 hops
     192.168.0.0/16 via 0.0.0.0 in 1 hops
     209.165.200.228/30 via 0.0.0.0 in 1 hops
R3#
RIP: sending v2 update to 224.0.0.9 via FastEthernet0/0 (172.30.100.1)
RIP: build update entries
        10.1.0.0/16 via 0.0.0.0, metric 2, tag 0
        172.30.1.0/24 via 0.0.0.0, metric 3, tag 0
        172.30.2.0/24 via 0.0.0.0, metric 3, tag 0
        172.30.110.0/24 via 0.0.0.0, metric 1, tag 0
        172.30.200.16/28 via 0.0.0.0, metric 1, tag 0
        172.30.200.32/28 via 0.0.0.0, metric 1, tag 0
        192.168.0.0/16 via 0.0.0.0, metric 2, tag 0
        209.165.200.228/30 via 0.0.0.0, metric 2, tag 0
        209.165.200.232/30 via 0.0.0.0, metric 1, tag 0
RIP: sending v2 update to 224.0.0.9 via Serial0/0/1 (209.165.200.234)
RIP: build update entries
        172.30.100.0/24 via 0.0.0.0, metric 1, tag 0
        172.30.110.0/24 via 0.0.0.0, metric 1, tag 0
        172.30.200.16/28 via 0.0.0.0, metric 1, tag 0
        172.30.200.32/28 via 0.0.0.0, metric 1, tag 0
```

RIPv2 supports VLSM

VLSM & CIDR

- CIDR uses Supernetting

  Supernetting is a bunch of contiguous classful networks that is addressed as a single network.

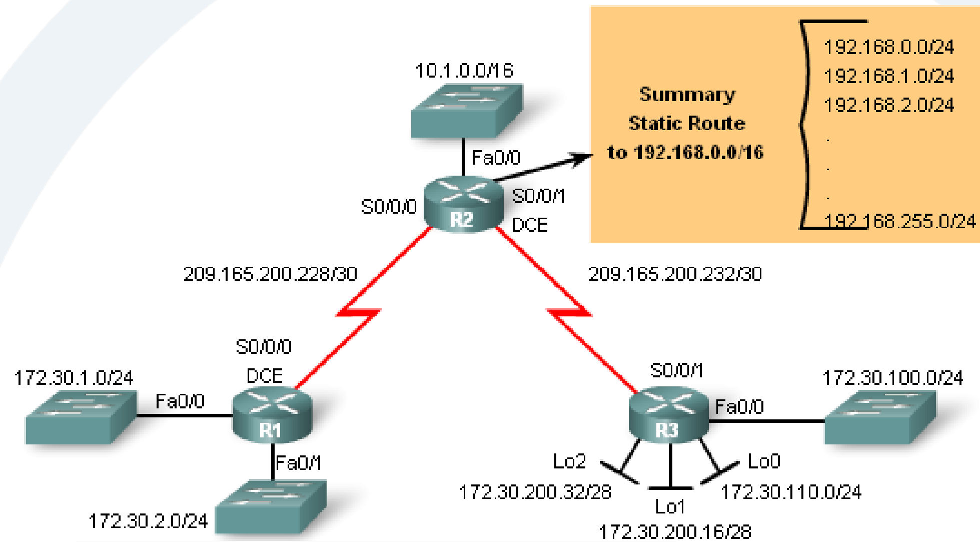
VLSM & CIDR

- To **verify** that **supernets** are being sent and received use the following commands

  show ip route

  debug ip rip

RIPv2 and CIDR



RIPv2 and CIDR

```
R2(config)#router rip
R2(config-router)#redistribute static
R2(config-router)#network 10.0.0.0
R2(config-router)#network 209.165.200.0
R2(config-router)#exit
R2(config)#ip route 192.168.0.0 255.255.0.0 null0
```

192.168.0.0/16 is a Supernet.

```
R2#debug ip rip
RIP protocol debugging is on
R2#
RIP: sending v2 update to 224.0.0.9 via Serial0/0/0 (209.165.200.229)
RIP: build update entries
       10.1.0.0/16 via 0.0.0.0, metric 1, tag 0
       172.30.100.0/24 via 0.0.0.0, metric 2, tag 0
       172.30.110.0/24 via 0.0.0.0, metric 2, tag 0
       172.30.200.16/28 via 0.0.0.0, metric 2, tag 0
       172.30.200.32/28 via 0.0.0.0, metric 2, tag 0
       192.168.0.0/16 via 0.0.0.0, metric 1, tag 0
       209.165.200.232/30 via 0.0.0.0, metric 1, tag 0
```

Supernet is sent by R2.

Verifying & Troubleshooting RIPv2

- **Basic Troubleshooting** steps
  - Check the status of all links
  - Check cabling
  - Check IP address & subnet mask configuration
  - Remove any unneeded configuration commands

- Commands used to verify proper operation of RIPv2
  - `show ip interfaces brief`
  - `show ip protocols`
  - `debug ip rip`
  - `show ip route`

Verifying & Troubleshooting RIPv2

- Common RIPv2 Issues
- When trouble shooting RIPv2 examine the following issues:
  - **Version**

    Check to make sure you are using version 2
  - **Network statements**

    Network statements may be incorrectly typed or missing
  - **Automatic summarization**

    If summarized routes are not needed then disable automatic summarization

Verifying & Troubleshooting RIPv2

- Reasons why it's good to authenticate routing information
  - Prevent the possibility of accepting invalid routing updates
  - Contents of routing updates are encrypted
- Types of routing protocols that can use authentication

  -RIPv2

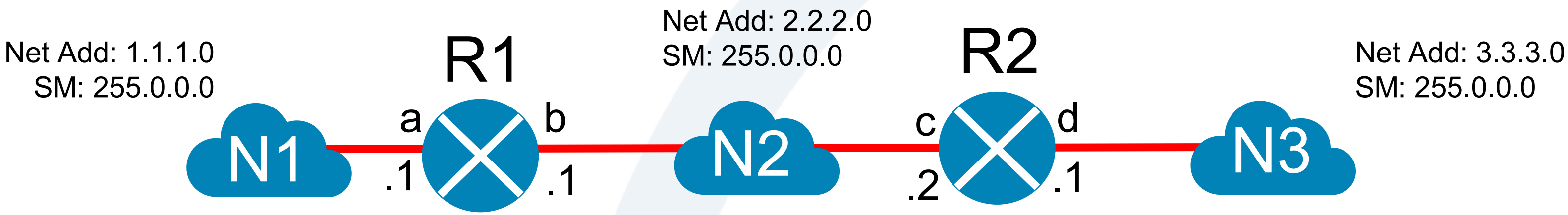
  -EIGRP

  -OSPF

  -IS-IS

  -BGP

Static and Dynamic Routing Configuration



- Static Routing
  - Which network to reach by the router
  - Next hop as gateway
  - Ex. (R1 to reach N3) →
    - ip route <N3 address> <N3 subnet mask> <next hop address>
    - Ip route 3.3.3.0 255.0.0.0 2.2.2.1

- Dynamic (RIPv2)
  - What network(s) attach to the router
  - Ex. (R1)
    - router rip
      network 1.1.1.0
      network 2.2.2.0

THE END