Distance Vector Routing Protocols

Routing Protocols and Concepts

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Objectives

- The characteristics of distance vector routing protocols.
- The network discovery process of distance vector routing protocols using Routing Information Protocol (RIP).
- The processes to maintain accurate routing tables used by distance vector routing protocols.
- The conditions leading to a routing loop and explain the implications for router performance.
- Distance vector routing protocols are in use today

Distance Vector Routing Protocols

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- **Examples of Distance Vector routing protocols**:
  - Routing Information Protocol (RIP)
  - Interior Gateway Routing Protocol (IGRP)
    - obsolete
  - Enhanced Interior Gateway Routing Protocol (EIGRP)

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Distance Vector Routing Protocols

- Distance Vector Technology
  - **The Meaning of Distance Vector**:
    - A router using distance vector routing protocols knows 2 things:
      - Distance to final destination
      - Vector, or direction, traffic should be directed

Distance Vector Routing Protocols

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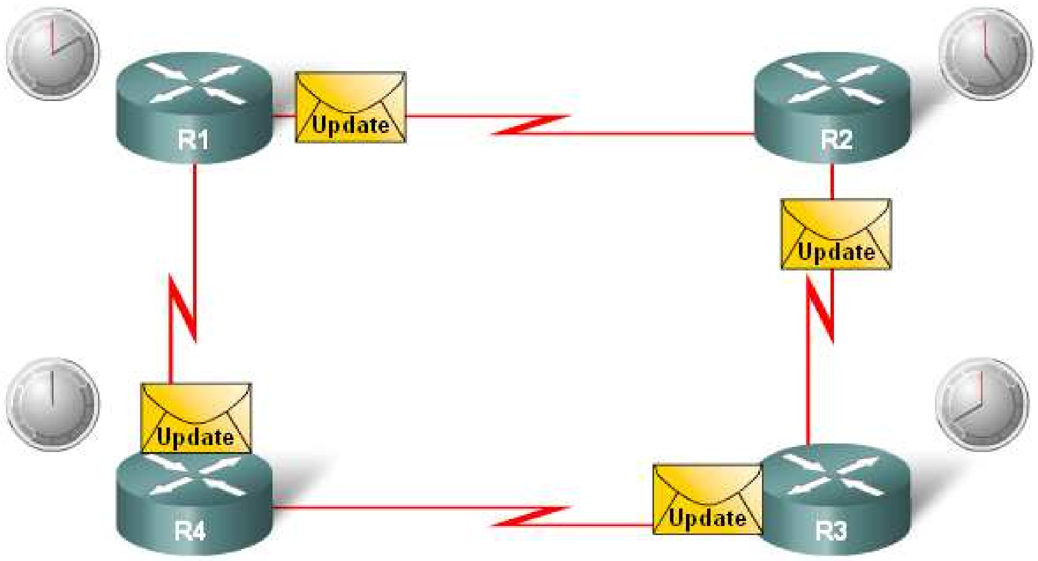
Characteristics of Distance Vector routing protocols:

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



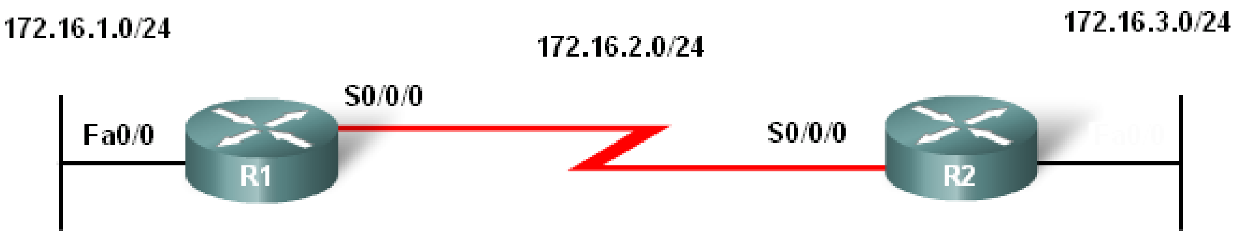
Distance Vector Routing Protocols

- **Routing Protocol Algorithm**:

  -Defined as a procedure for accomplishing a certain task

Purpose of Routing Algorithms

1. Send and Receive Updates
2. Calculate best path; install routes
3. Detect and react to topology changes



Network	Interface	Hope
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	Hope
172.16.3.0/24	Fa0/0	0
172.16.2.0/24	S0/0/0	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
  - Scalability
  - Resource usage
  - Implementation & maintenance

Distance Vector Routing Protocols

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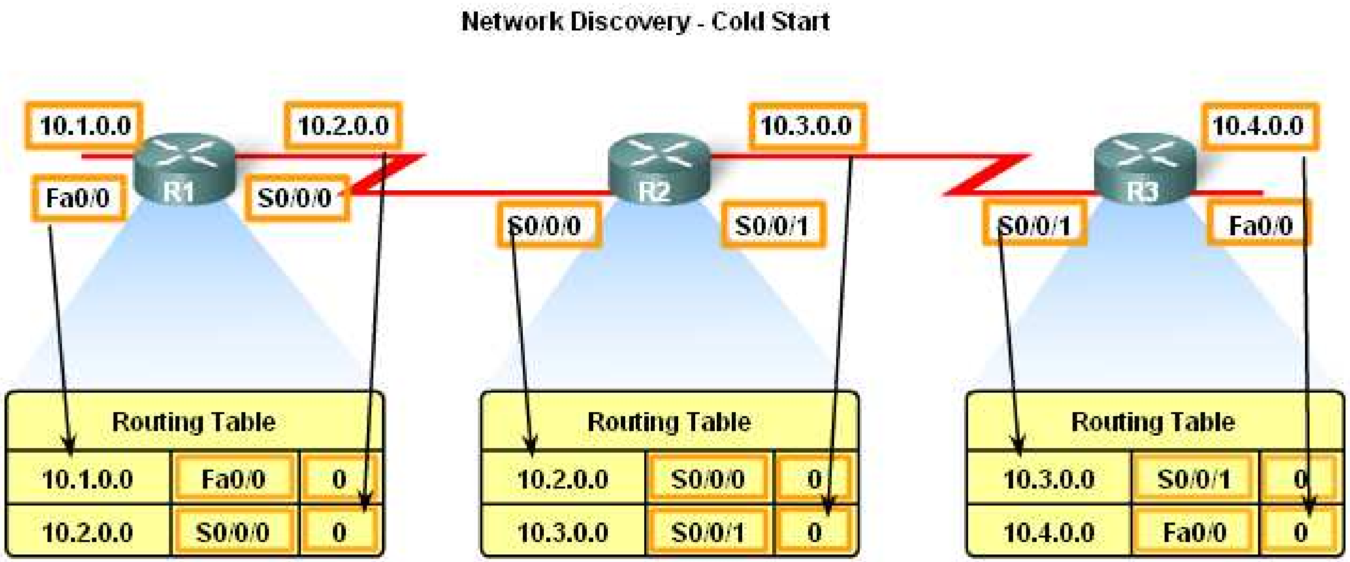
Advantages & Disadvantages of Distance Vector Routing Protocols

Advantages:	Disadvantages:
Simple implementation and maintenance. The level of knowledge required to deploy and later maintain a network with distance vector protocol is not high.	**Slow convergence.** The use of periodic updates can cause slower convergence. Even if some advanced techniques are used, like triggered updates which are discussed later, the overall convergence is still slower compared to link state routing protocols.
Low resource requirements. Distance vector protocols typically do not need large amounts of memory to store the information. Nor do they require a powerful CPU. Depending of the network size and the IP addressing implemented they also typically do not require a high level of link bandwidth to send routing updates. However, this can become an issue if you deploy a distance vector protocol in a large network.	**Limited scalability.** Slow convergence may limit the size of the network because larger networks require more time to propagate routing information.
	Routing loops. Routing loops can occur when inconsistent routing tables are not updated due to slow convergence in a changing network.

Network Discovery

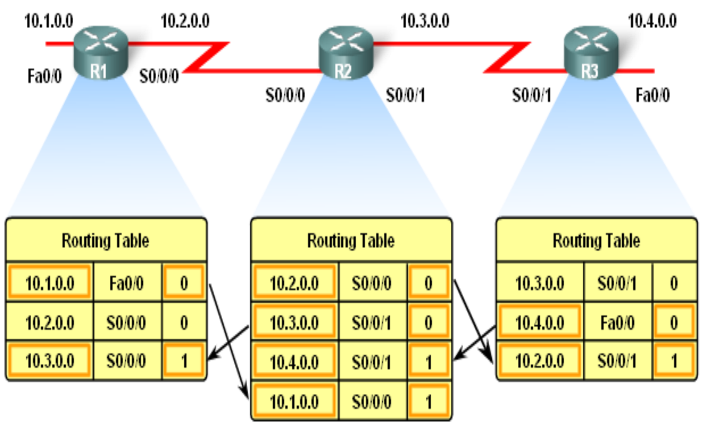
- **Router initial start up** (Cold Starts)
  - -**Initial network discovery**
    - Directly connected networks are initially placed in routing table



Network Discovery

- **Initial Exchange** of Routing Information
  - If a routing protocol is configured then routers will exchange routing information
- Routing updates received from other routers
  - -Router checks update for new information
    - If there is new information:
    - Metric is updated
    - New information is stored in routing table

Network Discovery - Initial Exchange



Routers update routing tables with new information

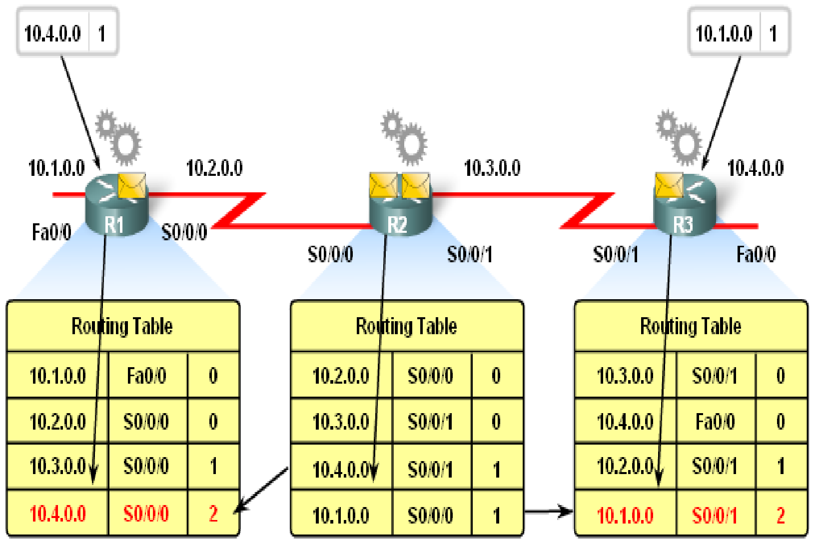
Network Discovery

- **Exchange of Routing Information**
  - **Router convergence** is reached when

    -All routing tables in the network contain the same network information
  - Routers continue to exchange routing information

    -If no new information is found then Convergence is reached

Network Discovery - Initial Exchange

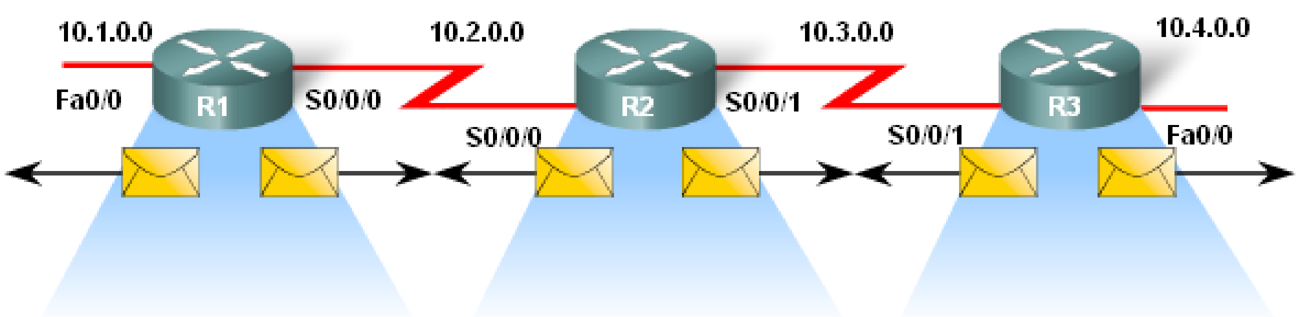


Routing Table Maintenance

- **Periodic Updates**: RIPv1 & RIPv2

  These are time intervals in which a router sends out its entire routing table.

Periodic Updates



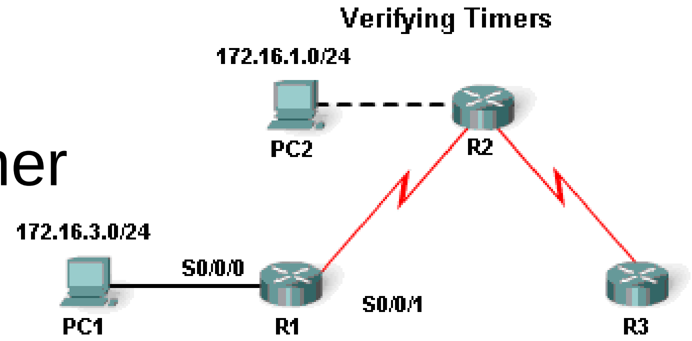
Routing Table		
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Routing Table		
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	1
10.1.0.0	S0/0/0	1

Routing Table		
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Table Maintenance

- **RIP uses 4 timers**
  - Update timer
  - Invalid timer
  - Holddown timer
  - Flush timer



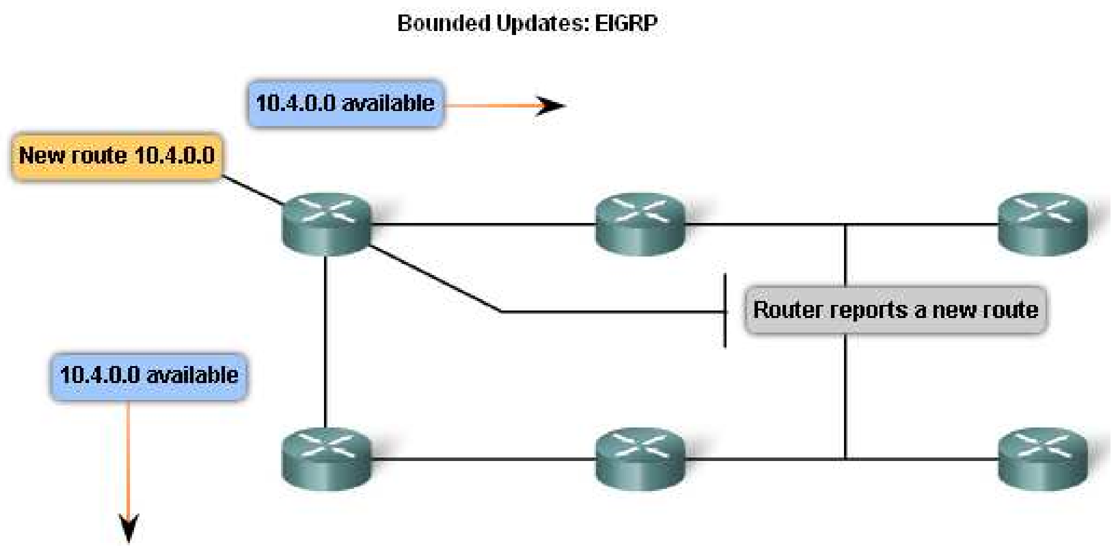

```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       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
R       172.16.1.0 [120/1] via 172.16.2.2, 00:00:18, Serial0/0/0
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
R    192.168.1.0/24 [120/1] via 192.168.3.1, 00:00:27, Serial0/0/1
                    [120/1] via 172.16.2.2, 00:00:18, Serial0/0/0
C    192.168.3.0/24 is directly connected, Serial0/0/1
R1#
```

Routing Table Maintenance

- **Bounded Updates: EIGRP**
- EIRPG routing updates are
  - -Partial updates
  - -Triggered by topology changes
  - -Bounded
  - -Non periodic



Routing Table Maintenance

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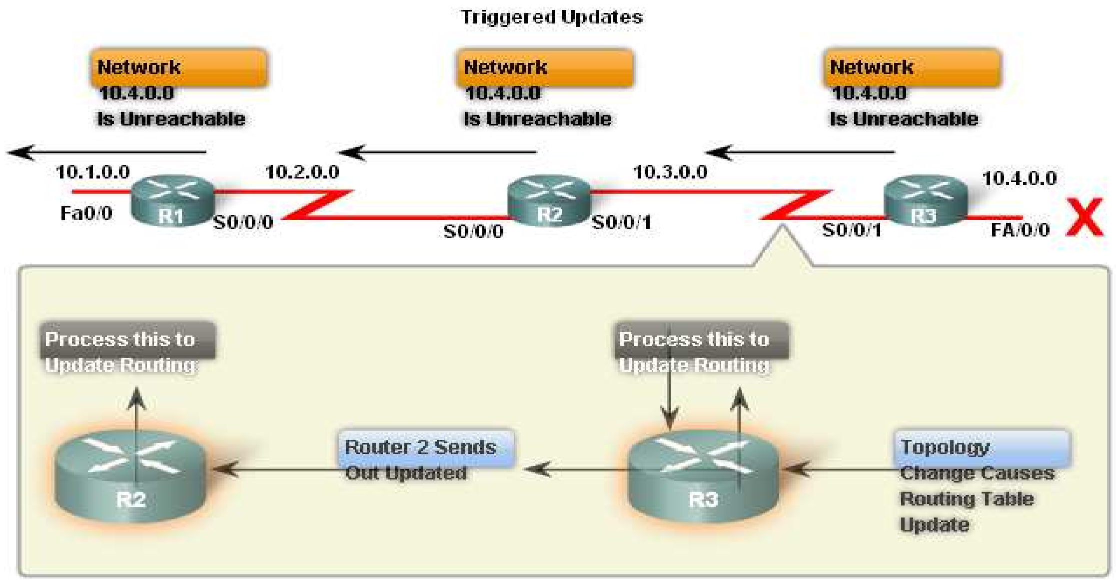
- **Triggered Updates**
  - Conditions in which triggered updates are sent

    -Interface changes state

    -Route becomes unreachable

    -Route is placed in routing table



Routing Loops

- **Routing loops** are
  - A condition in which a packet is continuously transmitted within a series of routers without ever reaching its destination.

Routing Loops

Routing Loop

10.4.0.0 Network goes down.

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	1

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
~~10.4.0.0~~	~~Fa0/0~~	~~0~~
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Before R3 can send an update, R2 sends an update.

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	1

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	2
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	1

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	2
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

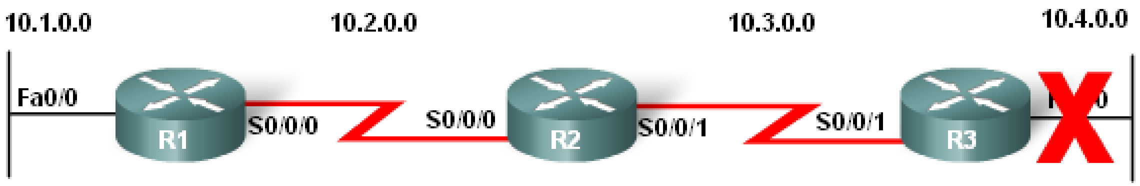
- **Routing loops** may be caused by:
  - -Incorrectly configured static routes
  - -Incorrectly configured route redistribution
  - -Slow convergence
  - -Incorrectly configured discard routes
- **Routing loops** can create the following issues
  - -Excess use of bandwidth
  - -CPU resources may be strained
  - -Network convergence is degraded
  - -Routing updates may be lost or not processed in a timely manner

Routing Loops

- **Count to Infinity**
  - This is a routing loop whereby packets bounce infinitely around a network.

Count to Infinity

Each round of updates continues to increase hop count.



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	24

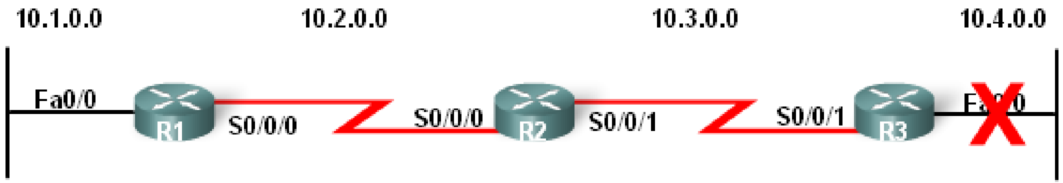
Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	23

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	22
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- Setting a maximum
- **Distance Vector routing protocols** set a specified metric value to indicate infinity
- Once a router "counts to infinity" it marks the route as unreachable

10.4.0.0 is unreachable. Hop count is 16.



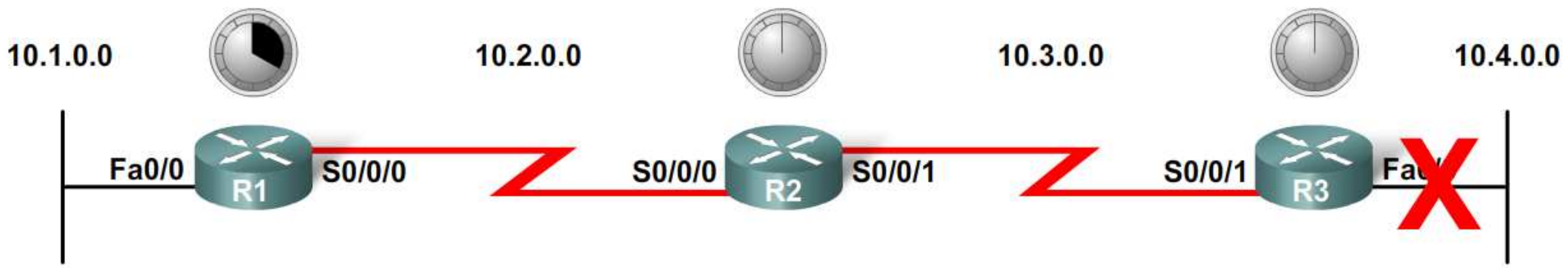
Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	16

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	16

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	16
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- **Preventing loops with holddown timers**
  - -Holddown timers allow a router to not accept any changes to a route for a specified period of time.
  - -Point of using holddown timers
    - Allows routing updates to propagate through network with the most current information.



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- The **Split Horizon Rule** is used to prevent routing loops
- **Split Horizon rule**:

  A router should not advertise a network through the interface from which the update came.

Split Horizon Rule for 10.4.0.0

R2 only advertises 10.3.0.0 and 10.4.0.0 to R1.
R2 only advertises 10.2.0.0 and 10.1.0.0 to R3.

R1 only advertises 10.1.0.0 to R2.

R3 only advertises 10.4.0.0 to R2.

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	1

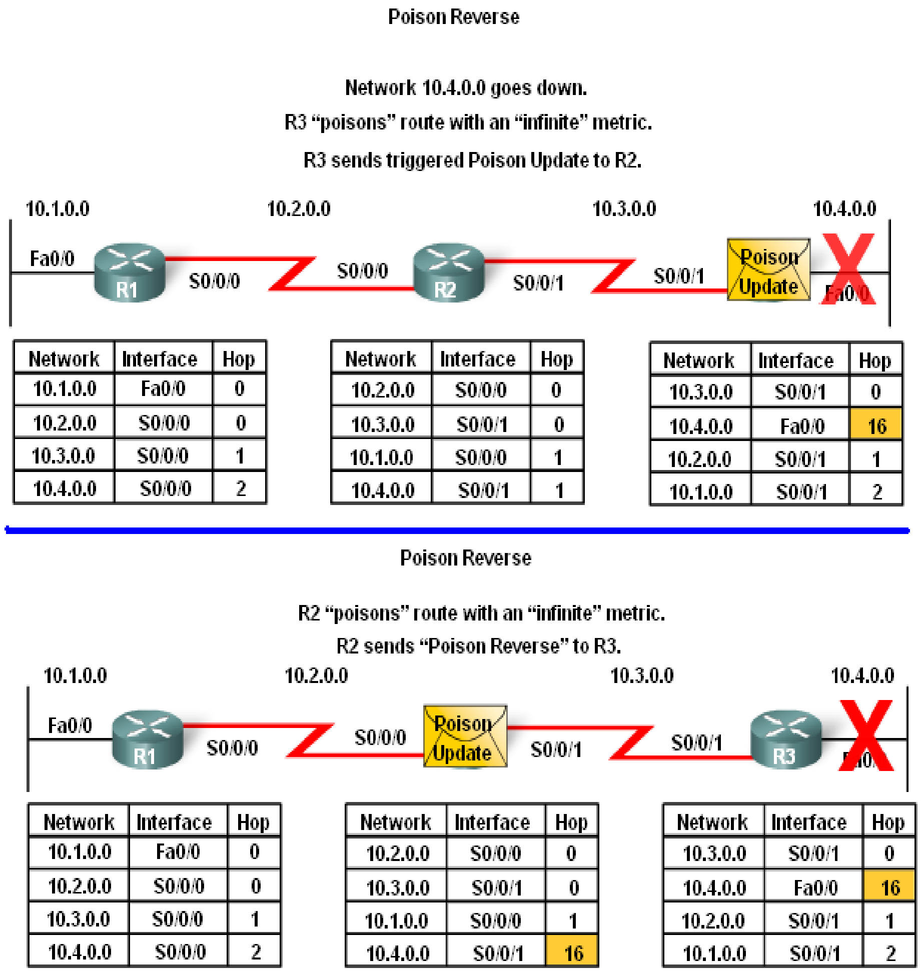
Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- **Split horizon with poison reverse**

  The rule states that once a router learns of an unreachable route through an interface, advertise it as unreachable back through the same interface



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	16
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	16

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	16
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

- **IP & TTL**
  - **Purpose of the TTL field**
    - The TTL field is found in an IP header and is used to prevent packets from endlessly traveling on a network
- **How the TTL field works**
  - TTL field contains a numeric value
  - The numeric value is decreased by one by every router on the route to the destination. If numeric value reaches 0 then Packet is discarded.

Routing Protocols Today

- **Factors used to determine whether to use RIP or EIGRP include**
  - -Network size
  - -Compatibility between models of routers
  - -Administrative knowledge

Distance Vector Routing Protocols Compared

	Ripv1	Ripv2	IGRP	EIGRP
Speed of Convergance	Slow	Slow	Slow	Fast
Scalability – size of network	Small	Small	Small	Large
Use of VLSM	No	Yes	No	Yes
Resource usage	Low	Low	Low	Medium
Implementation and maintenance	Simple	Simple	Simple	Complex

Routing Protocols Today

- **RIP**
  - **Features of RIP:**
    - Supports split horizon & split horizon with poison reverse
    - Capable of load balancing
    - Easy to configure
    - Works in a multi vendor router environment

Routing Protocols Today

- **EIGRP**
  - **Features of EIGRP:**
    - Triggered updates
    - EIGRP hello protocol used to establish neighbor adjacencies
    - Supports VLSM & route summarization
    - Use of topology table to maintain all routes
    - Classless distance vector routing protocol
    - Cisco proprietary protocol

Summary

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- **Characteristics of Distance Vector routing protocols**
  - Periodic updates
  - RIP routing updates include the entire routing table
  - Neighbors are defined as routers that share a link and are configured to use the same protocol
- **The network discovery process for D.V. routing protocol**
  - Directly connected routes are placed in routing table 1st
  - If a routing protocol is configured then
    - Routers will exchange routing information
  - Convergence is reached when all network routers have the
  - same network information

Summary

- **D.V. routing protocols maintains routing tables by**
  – RIP sending out periodic updates
  – RIP using 4 different timers to ensure information is accurate and convergence is achieved in a timely manner
  – EIGRP sending out triggered updates
- **D.V. routing protocols may be prone to routing loops**
  – routing loops are a condition in which packets continuously traverse a network
  – Mechanisms used to minimize routing loops include defining maximum hop count, holddown timers, split horizon, route poisoning and triggered updates

Summary

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- **Conditions that can lead to routing loops include**
  - Incorrectly configured static routes
  - Incorrectly configured route redistribution
  - Slow convergence
  - Incorrectly configured discard routes
- **How routing loops can impact network performance includes:**
  - Excess use of bandwidth
  - CPU resources may be strained
  - Network convergence is degraded
  - Routing updates may be lost or not processed

Summary

- **Routing Information Protocol (RIP)**
  - A distance vector protocol that has 2 versions
  - RIPv1 – a classful routing protocol
  - RIPv2 - a classless routing protocol
- **Enhanced Interior Gateway Routing Protocol (EIGRP)**
  - A distance vector routing protocols that has some features of link state routing protocols
  - A Cisco proprietary routing protocol