Routing Protocol

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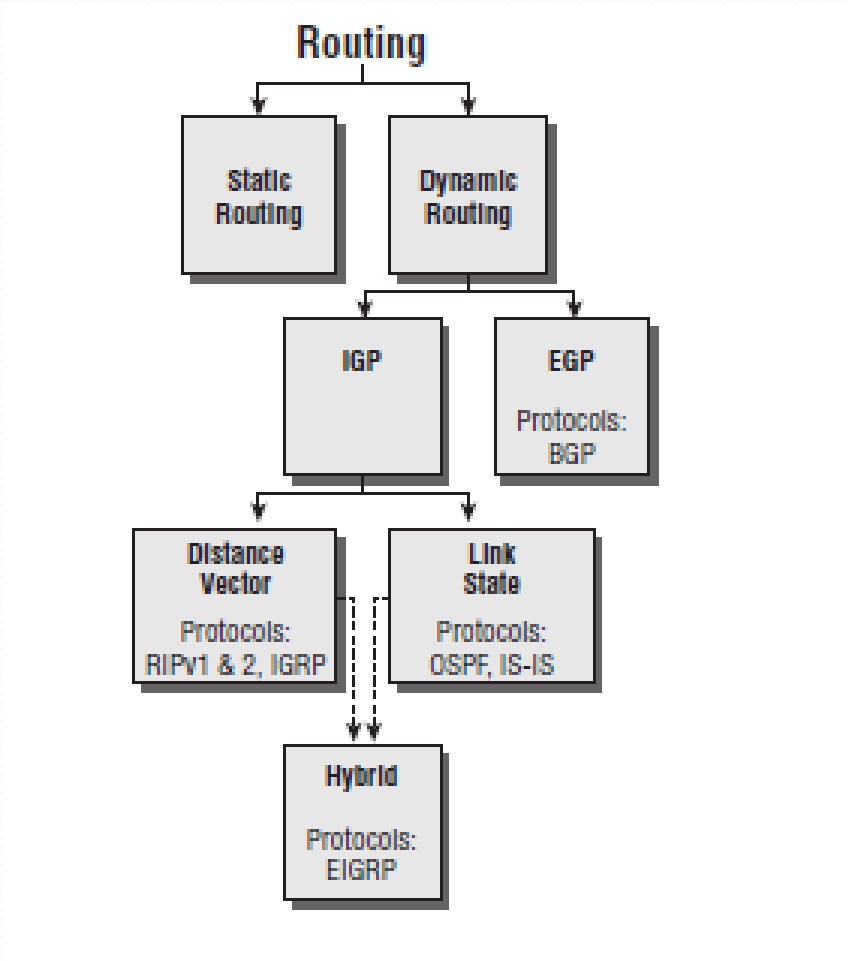
- Using dynamic routing is easier on you, the system administrator, than the labor-intensive, manually achieved, static routing method
- It'll cost you in terms of router CPU processes and bandwidth on the network links.
- A routing protocol defines the set of rules for communicates routing information → the router and its routing protocol need bandwidth to accomplish that.


Routing
Static Routing
Dynamic Routing
IGP
EGP
Protocols: BGP
Distance Vector
Protocols: RIPv1 & 2, IGRP
Link State
Protocols: OSPF, IS-IS
Hybrid
Protocols: EIGRP

Administrative Distances

- To rate the trustworthiness of routing information received on one router from its neighboring router
- 0 (most trusted) – 255 (“No traffic is allowed to be passed via this route.”)
- Remote network advertisement: the route with the lower AD is the one that will get placed in the routing table.

- Same AD, use routing metric like hop count
- Same AD and metric, then load balance
- To perform load balancing, a router will send packets down each link to test for the best one.

Default AD

Route Sources	**AD**
Connected Interface	0
Static	1
EIGRP	90
IGRP	100
OSPF	110
RIP	120
Unknown	255

- If a network is directly connected, the router will always use the interface connected to that network.
- Static routing will always be believed more.
- There is static routing, RIP and IGRP in a router, which one will be used ?
- Why do not turn on all routing protocol ?

Classes of Routing Protocol

- Distance vector
  - Use hop
  - RIP, RIPv2, IGRP (Cisco)
  - Send all routing table to its neighbor
- Link State
  - The router creates 3 separate tables
  - Directly attached neighbor, topology of entire network, routing table
  - Send update of their own link
  - OSPF, IS-IS
- Hybrid
  - Proprietary EIGRP from CISCO

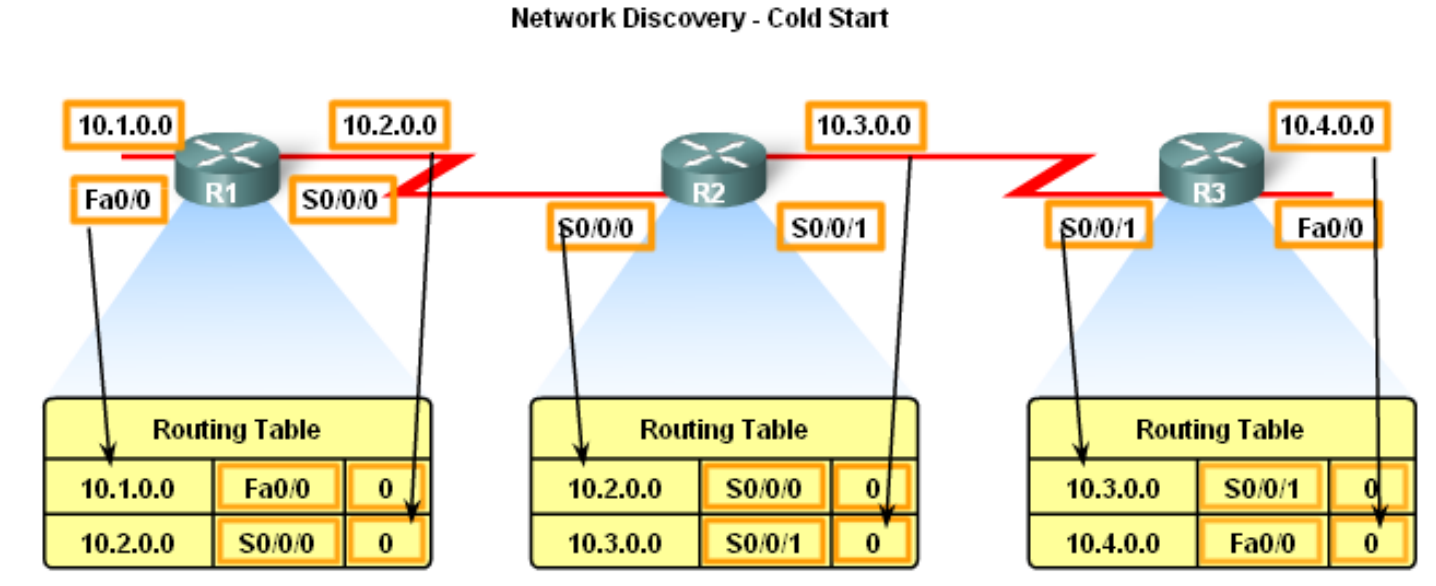
Distance Vector

- RIP
- Passes complete routing-table contents to neighboring routers, combine with their own routing tables
- *Routing by rumor*
- Same distance, use *round robin load balancing*

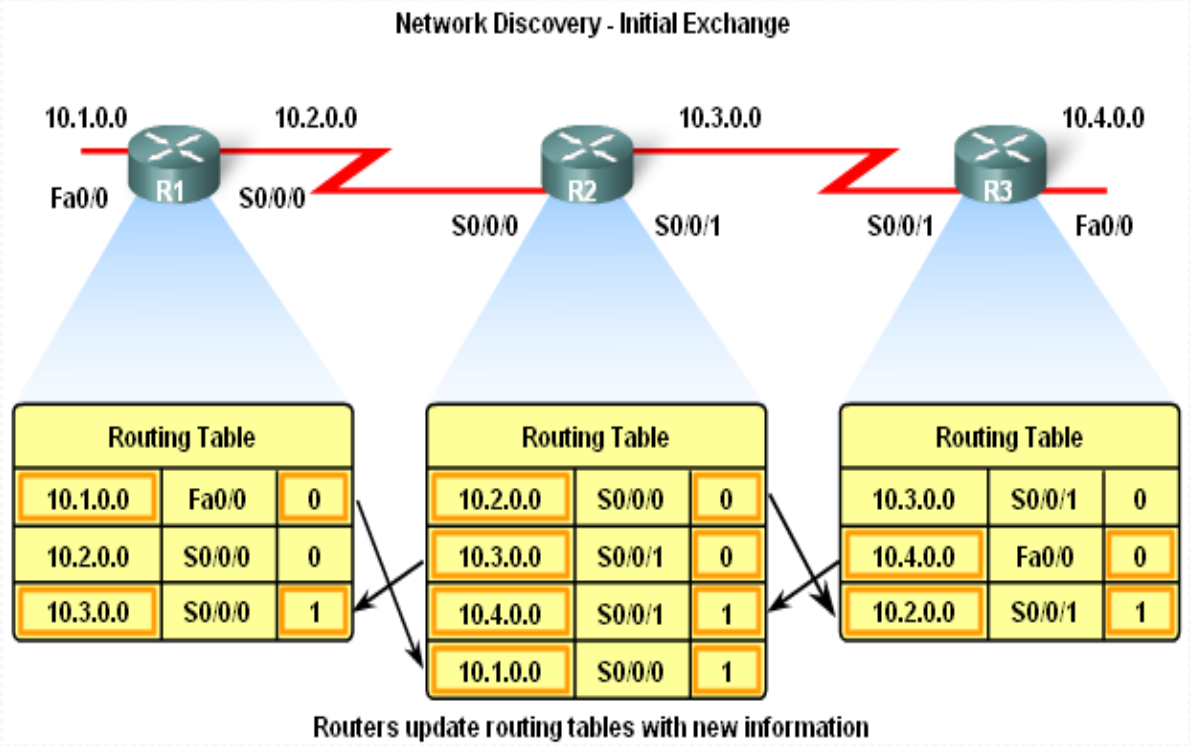
Advantages & Disadvantages of Distance Vector Routing Protocols

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.

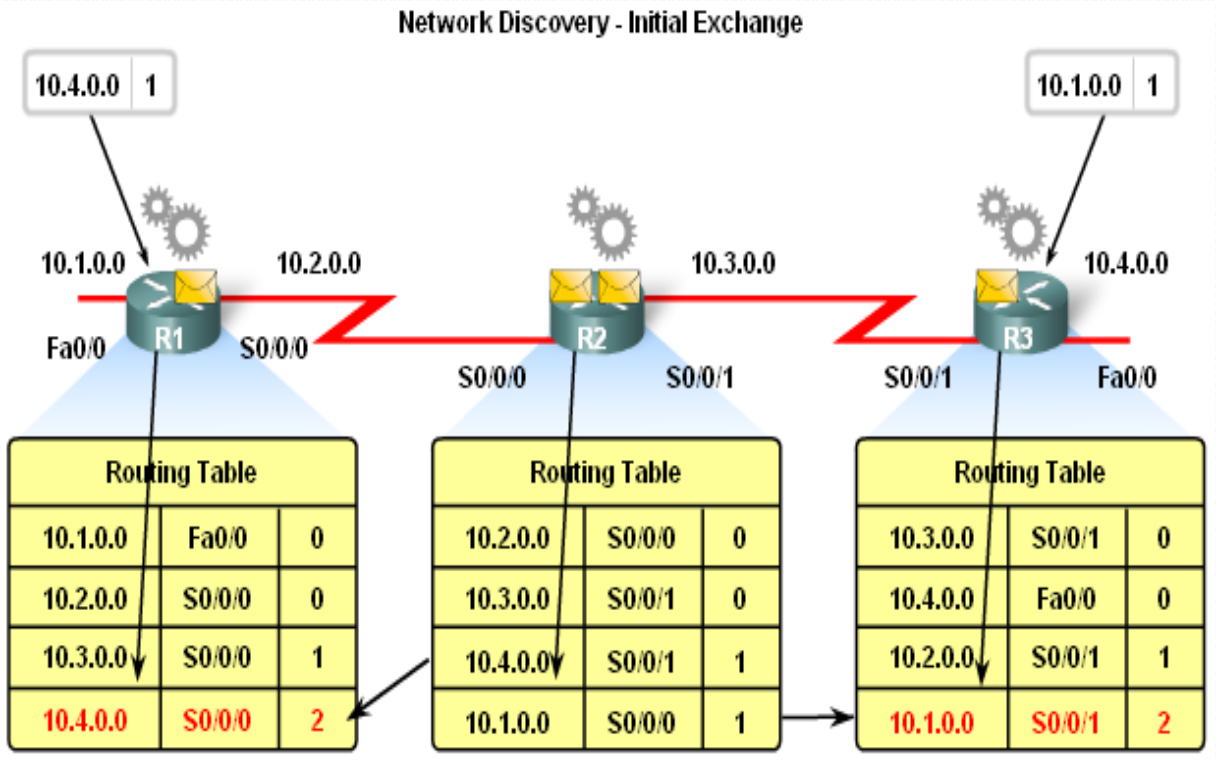
- **Initial network discovery**
  - Directly connected networks are initially placed in routing table



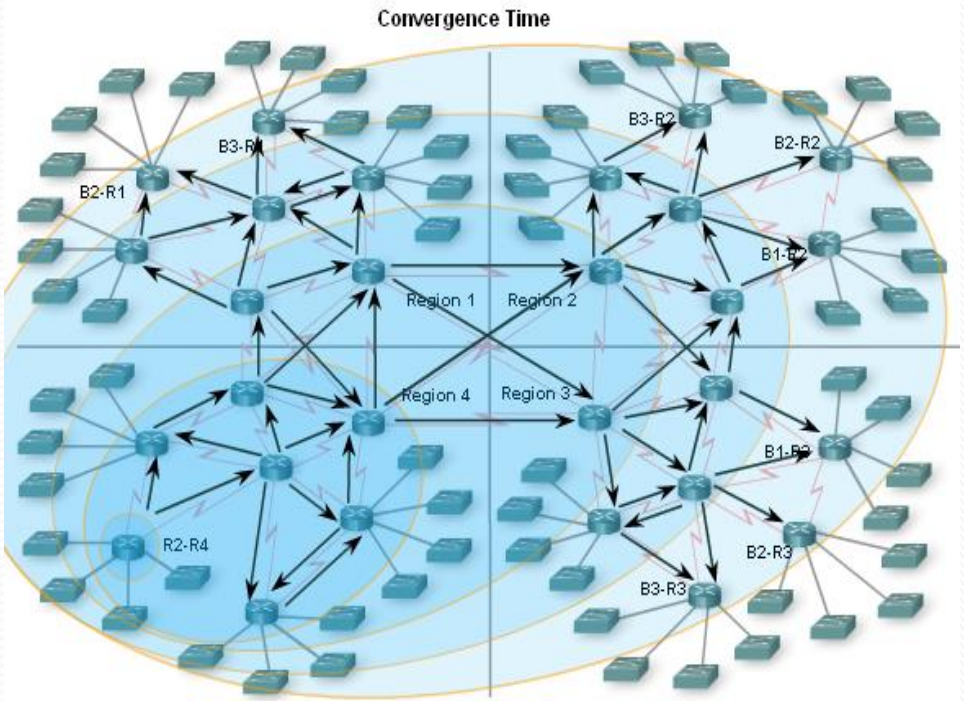
- **Initial Exchange** of Routing Information
  - Routers will exchange routing information



- **Router convergence** is reached when routing tables in the network contain the same network information

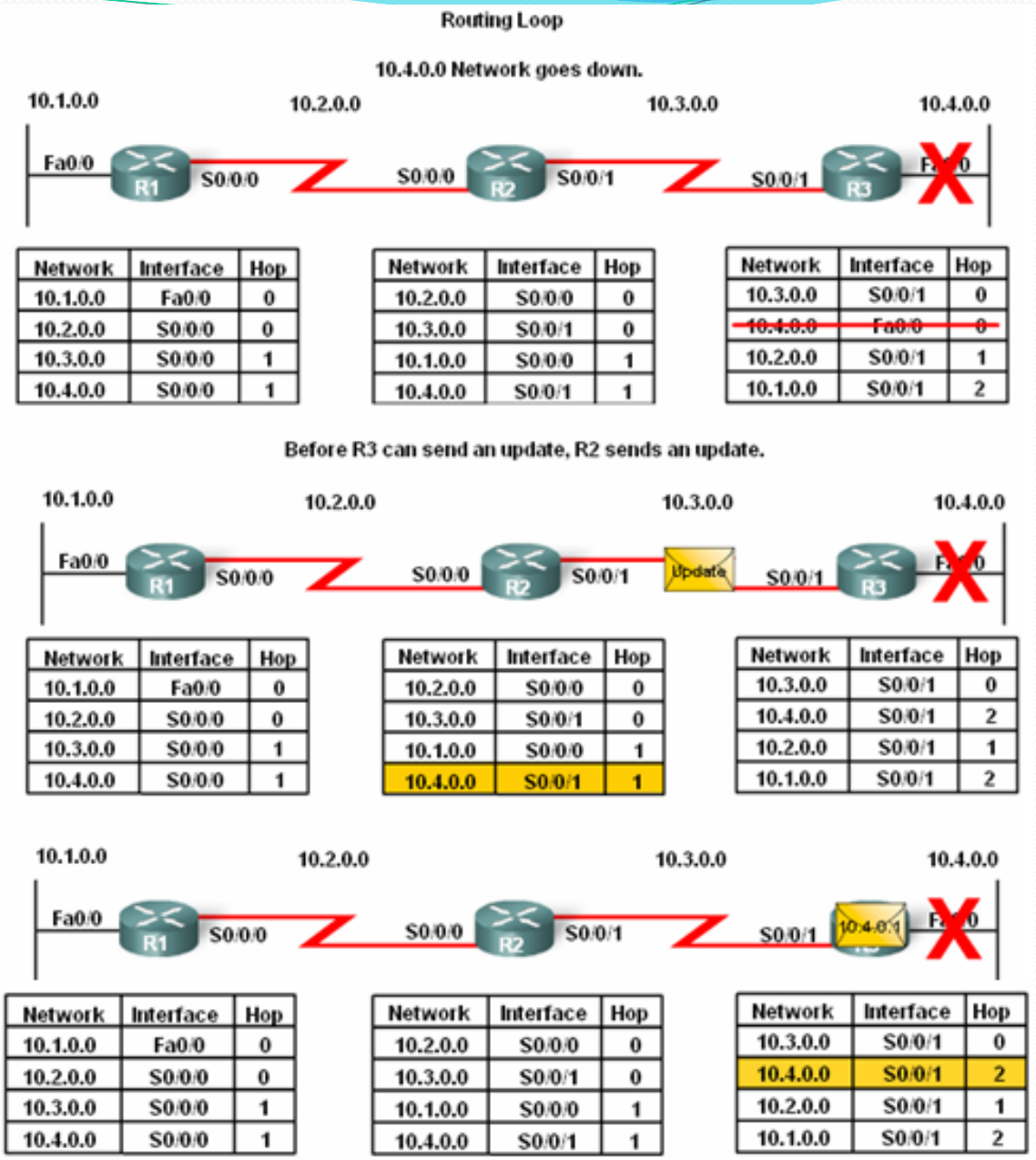


- **Convergence must be reached** before a network is considered completely operable
- Speed of achieving convergence consists of 2 interdependent categories
  - -Speed of broadcasting routing information
  - -Speed of calculating routes



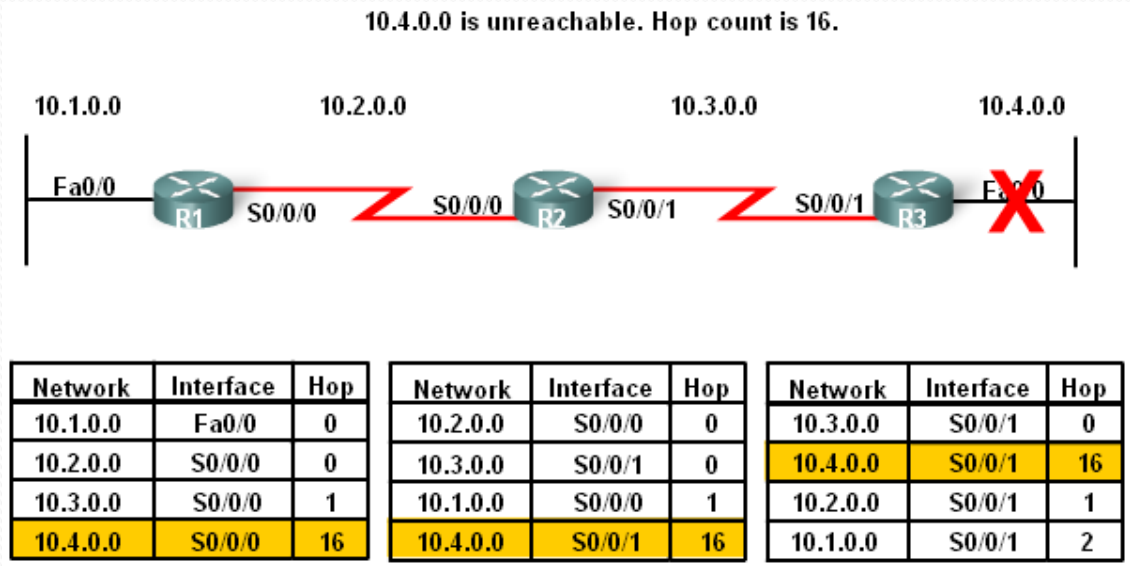
Routing Loops

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



Routing Loops

- 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



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

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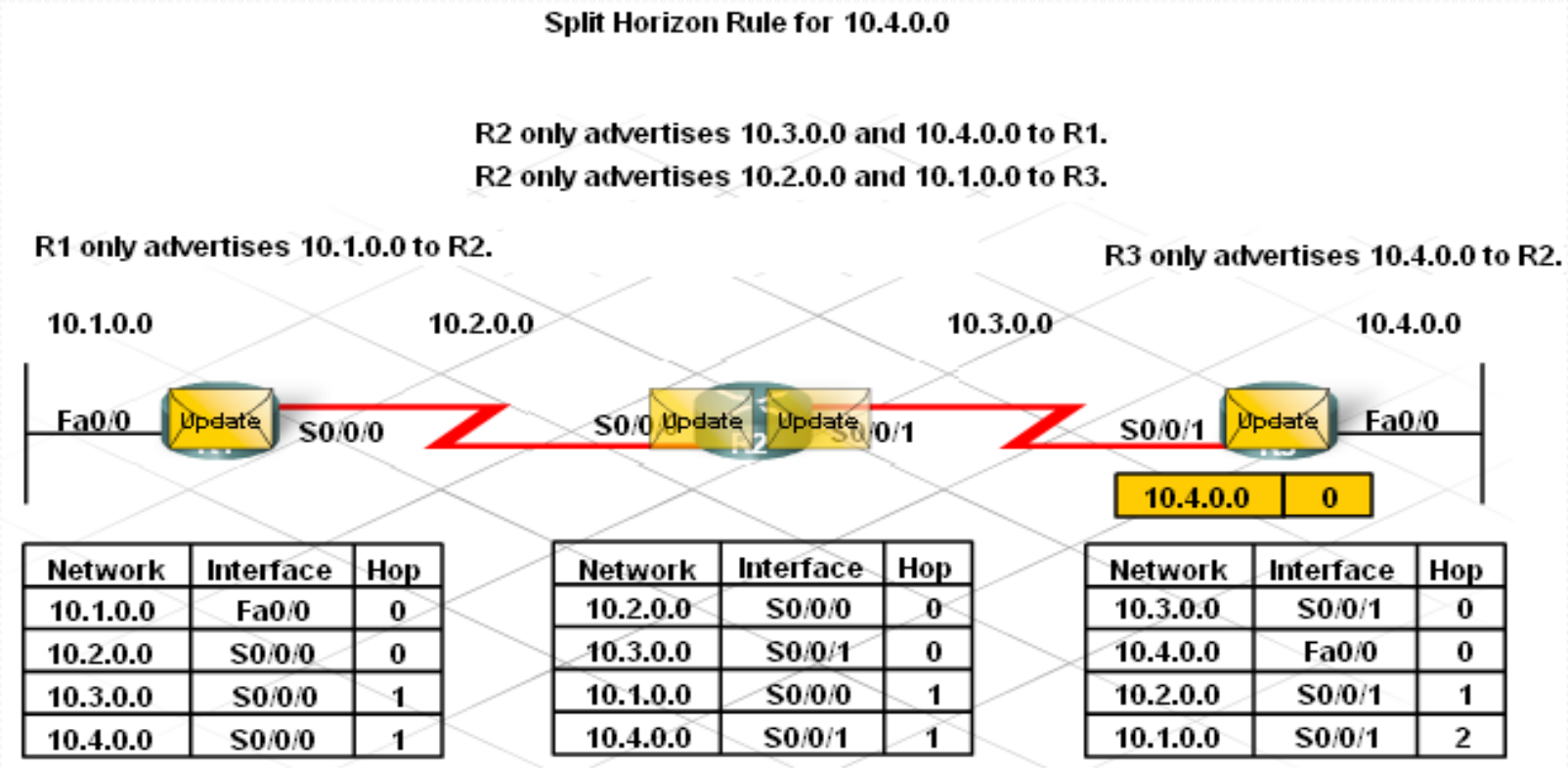
10.3.0.0	S0/0/1	0
10.4.0.0	S0/0/1	16
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

Routing Loops

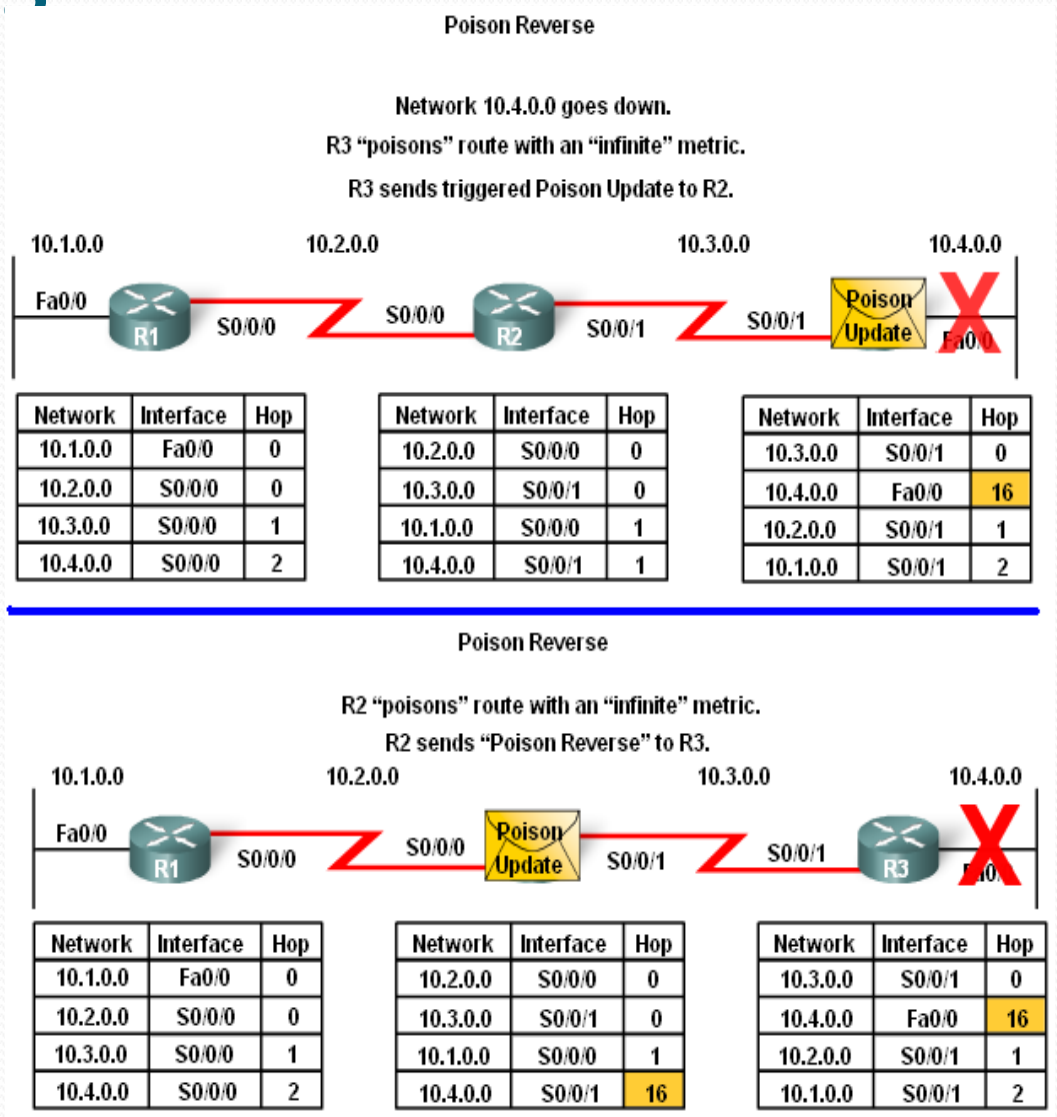
- The **Split Horizon Rule** is used to prevent routing loops
- **Split Horizon rule**: A router should not advertise a network through the interface from which the update came.



Routing Loops

- **Split horizon with poison reverse**

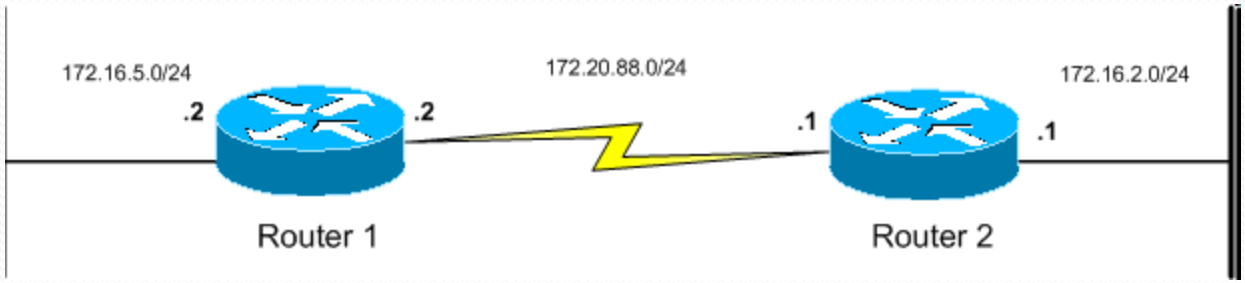
  The rule states that once a router learns of an unreachable route through an interface, advertise it as unreachable back through the same interface



RIP & RIPV2

RIPv1	RIPv2
Distance vector	Distance vector
Maximum hop count of 15	Maximum hop count of 15
Classful	Classless
Broadcast based	Uses Multicast 224.0.0.9
No support for VLSM	Supports VLSM networks
No authentication	Allows for MD5 authentication
No support for discontiguous networks	Supports discontiguous networks

Discontiguous Network



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

Link State Routing

- Link-state protocols also fall into the classless category of routing protocols
- the subnet-mask information must be carried with the routing update
- link-state protocols learn and maintain much more information about the internetwork than distance-vector routing protocols do.

- routing protocols maintain two additional tables with more detailed information, with the first of these being the neighbor table.
- Other two: topology of entire network, routing table
- Once all of that raw data is shared and each one of the routers has the data in its topology table, then the routing protocol runs the Shortest Path First (SPF) algorithm to compare it all and determine the best paths to each of the destination networks.

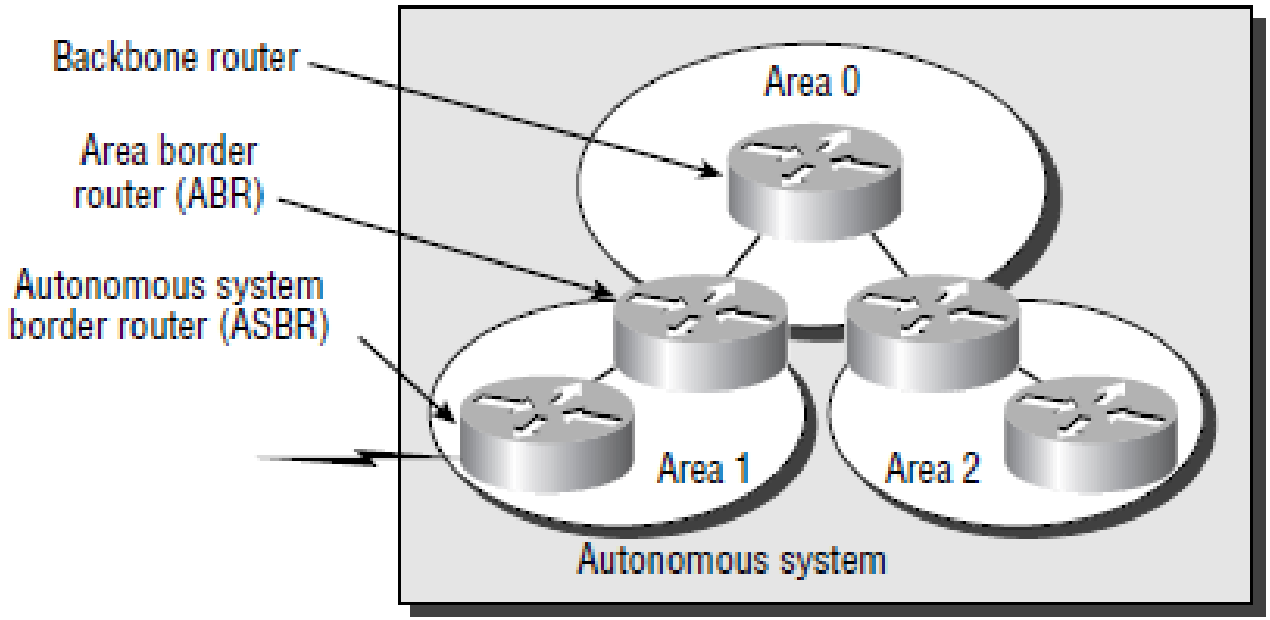
OSPF

- An open standard
- Using the *Dijkstra algorithm*
- First, a shortest-path tree is constructed, and then the routing table is populated with the resulting best paths
- Support IP and IPv6

Characteristic	OSPF	RIPv2	RIPv1
Type of protocol	Link state	Distance vector	Distance vector
Classless support	Yes	Yes	No
VLSM support	Yes	Yes	No
Auto-summarization	No	Yes	Yes
Manual summarization	Yes	No	No

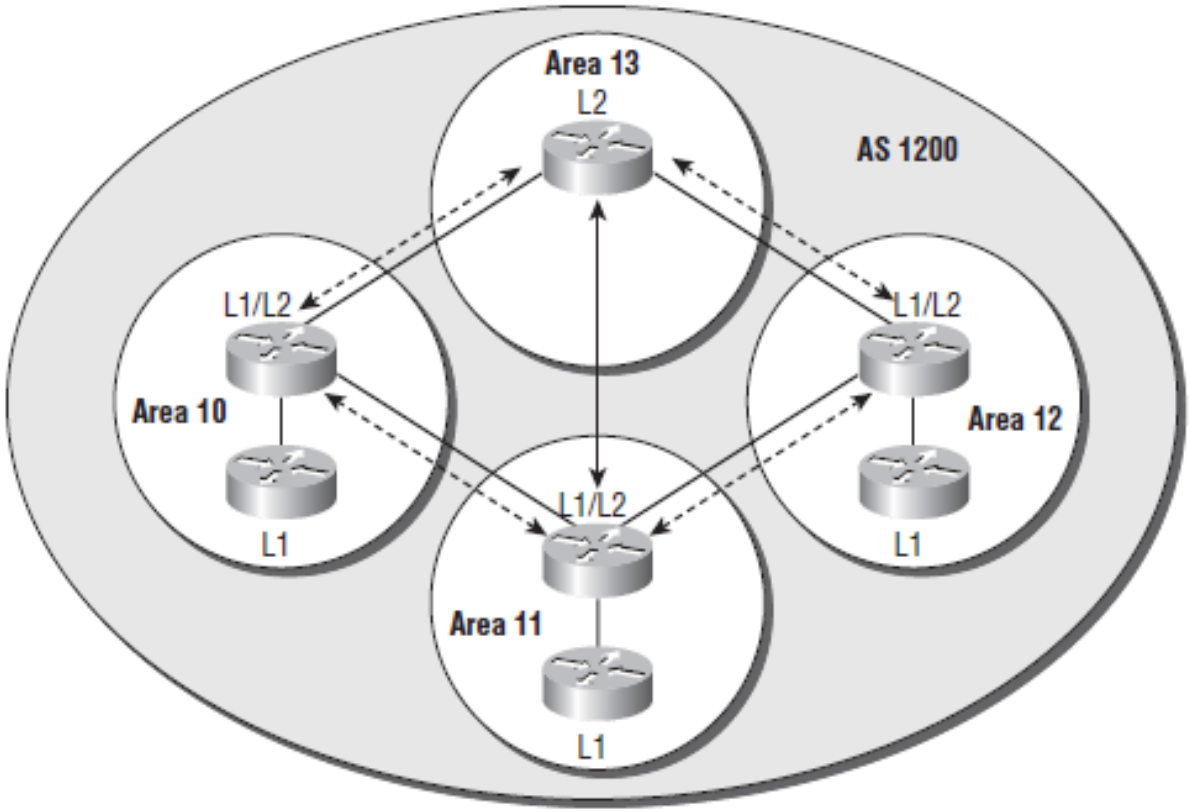
Discontiguous support	Yes	Yes	No
Route propagation	Multicast on change	Periodic multicast	Periodic broadcast
Path metric	Bandwidth	Hops	Hops
Hop-count limit	None	15	15
Convergence	Fast	Slow	Slow
Peer authentication	Yes	Yes	No
Hierarchical network	Yes (using areas)	No (flat only)	No (flat only)
Updates	Event triggered	Route table updates	Route table updates
Route computation	Dijkstra	Bellman-Ford	Bellman-Ford

- OSPF has many features beyond the few listed
- OSPF is supposed to be designed in a hierarchical fashion
- Separate the larger internetwork into smaller internetworks called *areas*.



Intermediate System to Intermediate System (IS-IS)

- A link-state routing protocol
- It operates by reliably flooding topology information throughout a network of routers
- Each router then independently builds a picture of the network's topology, just like OSPF does.
- Packets or datagrams are forwarded based on the best topological path through the network to the destination.


Area 13
L2
AS 1200
L1/L2
L1/L2
Area 10
Area 12
L1
L1
L1/L2
Area 11
L1

- The difference between IS-IS and OSPF is that IS-IS only uses Connectionless Network Service (CLNS) to provide connectionless delivery of data packets between routers.
- OSPF uses IP to communicate between routers instead.
- An advantage to having CLNS around is that it can easily send information about multiple routed protocols (IP and IPv6), OSPF must maintain a completely different routing database for IP and IPv6, respectively, for it to be able to send updates for both protocols.

- even though it's not as common, IS-IS, although comparable to OSPF, is actually preferred by ISPs because of its ability to run IP and IPv6 without creating a separate database for each protocol like OSPF does.
- That single feature makes it more efficient in very large networks.

Readings

- eBook : “CompTIA Network+ Deluxe Study Guide” Todd Lammle, Wiley Publishing Inc. 2009.
- eBook : "TCP/IP Tutorial and Technical Overview“ seventh edition. Adolfo Rodriguez, John Gatrell, John Karas, Roland Peschke. IBM Redbook, 2001.