Routing

Course Code: CSC 3116 Course Title: Computer Networks

Dept. of Computer Science
Faculty of Science and Technology

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Lecture Outline

1. Introduction
2. Static routing vs dynamic routing
3. Dynamic routing
4. Routing information protocol (RIP)

Introduction

❖ Routing

➢ routing is the act of forwarding network packets from a source network to a destination networks by a router based on its routing table [2].

CODE	NETWORK, MASK	AD/METRIC	NEXT HOP	INTERFACE
O	10.0.0.0 /8	110/20	200.1.1.1	S0
O	172.16.0.0 /16	110/15	200.1.1.1	S0
O	192.168.1.0 /24	110/20	200.2.2.2	S1
C	210.1.1.4 /30	0/0	Directly connected	E0

Fig. A simplified routing table [2]

Introduction

- How is the routing table created?
  - Static routing
    - If it is done manually by inputting information for each destination network by a network engineer,
    - Suitable for very small network
  - Dynamic routing
    - If the table is created and modified automatically depending on the network condition by a routing protocol
    - Dynamic routing can be deployed on small to large size network.

Dynamic Routing

Features

- Facilitates the exchange of routing information between routers
- Allow routers to dynamically learn information about remote networks and automatically add this information to their own routing tables
- Determines the best path to each network

Dynamic Routing….

Ways to classify routing protocols

- Interior Gateway Protocols or Exterior Gateway protocols
- Distance vector or Link state

Dynamic Routing….

IGP

- IGP
  - Routing inside an autonomous system (AS), where, AS is a collection of network under a common administrator
  - Example
    - Routing Information Protocol (RIP) version 1
    - Interior Gateway Routing Protocol (IGRP)
    - Enhanced IGRP (EIGRP)
    - Open Shortest Path First (OSPF)
    - Intermediate System (IS)-IS

Dynamic Routing….

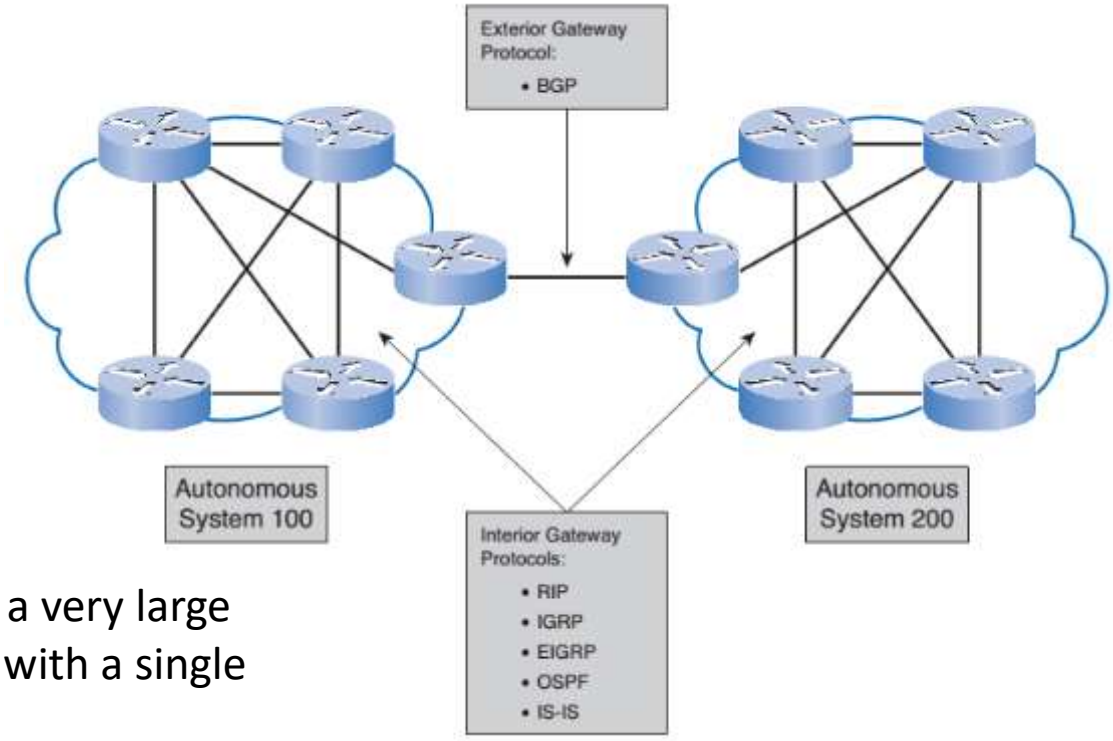
EGP

- EGP
  - Routing between autonomous systems(AS)
  - Example
    - Border Gateway Protocol (BGP)

Dynamic Routing....

Classification

Autonomous systems



An autonomous system (AS) is a very large network or group of networks with a single routing policy.

Dynamic Routing....

Distance vector routing

- A router communicates with its neighbors only for populating its routing table
- *Distance vector* means that routes are advertised as *vectors* of distance and direction
- Distance is defined in terms of a metric such as hop count, and direction is simply the next hop router or exit interface.
- Bellman-Ford algorithm is used for the best-path route determination.
- Some distance vector protocols periodically send complete routing tables to all connected neighbors.
- In large networks, these routing updates can become enormous, causing significant traffic on the links.
- Example

  RIP, EIGRP

Dynamic Routing….

Link state routing

- A router configured with a *linkstate* routing protocol can create a "complete view," or topology, of the network by gathering information from all the other routers.
- A router communicates with all other routers of the network
- Only send update (partial) when there is any change in the network topology
- Example

  OSPF

Dynamic Routing....

Administrative Distance

- The term *trustworthiness* is commonly used when defining administrative distance.
- Administrative distance (AD) defines the preference of a routing source.
- Administrative distance is an integer value from 0 to 255.
- The lower the value, the more preferred the route source.
- An administrative distance of 0 is the most preferred.
- Only a directly connected network has an administrative distance of 0, which cannot be changed.

Dynamic Routing....

Administrative distance

Route Source	AD
Connected	0
Static	1
EIGRP summary route	5
External BGP	20
Internal EIGRP	90
IGRP	100
OSPF	110
IS-IS	115
RIP	120
External EIGRP	170
Internal BGP	200

RIP

Features

- Distance vector routing protocol
- Hop count is used as the metric for path selection.
- If the hop count for a network is greater than 15, RIP cannot supply a route to that network.
- Routing updates are broadcast or multicast every 30 seconds, by default.
- If for some reason, an update for a particular route is not received within a period of 180 seconds then that specific route is declared as invalid and the router which identified that, informs all its neighbors about this invalid route.
- Has two versions: RIPv1 & RIPv2

RIP

RIP v1-vs-RIPv2

- **Uses Classless addressing**

  RIPv1 uses classful addressing, RIPv2 uses VLSM

- **Multicasting vs Broadcasting**

  Version 1 of RIP uses broadcasting (to 255.255.255.255) to send RIP messages to every neighbor. In this way, all the routers on the network receive the packets, as well as the hosts. RIP version 2, on the other hand, uses the all-router multicast address (224.0.0.9) to send the RIP messages only to RIP routers in the network.

- **Updates**

  RIPv2 sends and receives version 2 updates only. RIPv1 sends version 1 updates and receives both 1 and 2, however version 2 information is ignored.

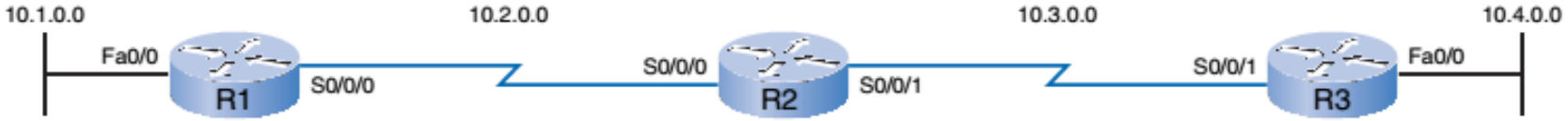
- **Authentication**

  RIPv2 ensure authentication, while RIPv1 does not

RIP

Routing table update

Cold Start



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0

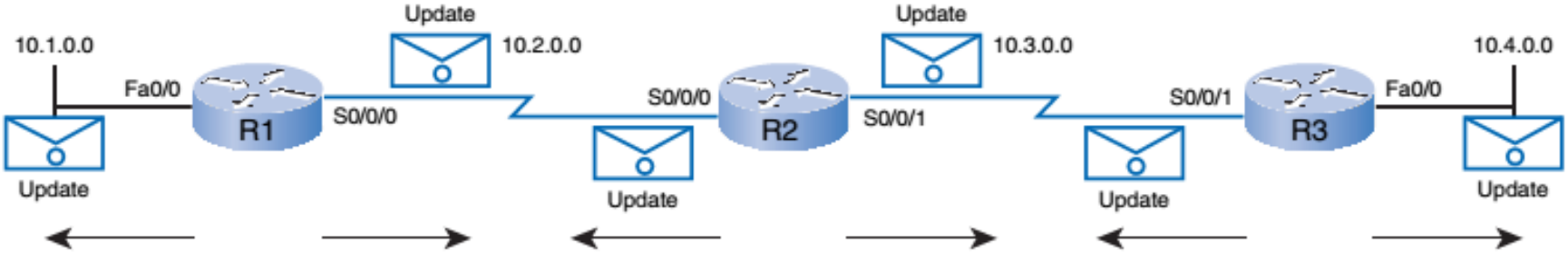
Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0

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

Topic Heading..

Routing table update

❖Initial Exchange of Information



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0

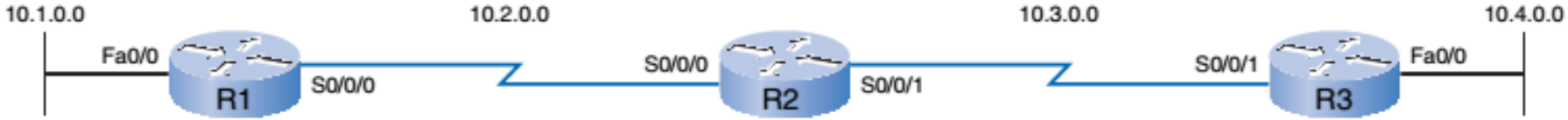
Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0

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

Topic Heading..

Routing table update

❖Table Updating



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

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

Topic Heading..

Routing table update

❖Next Update

No New 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

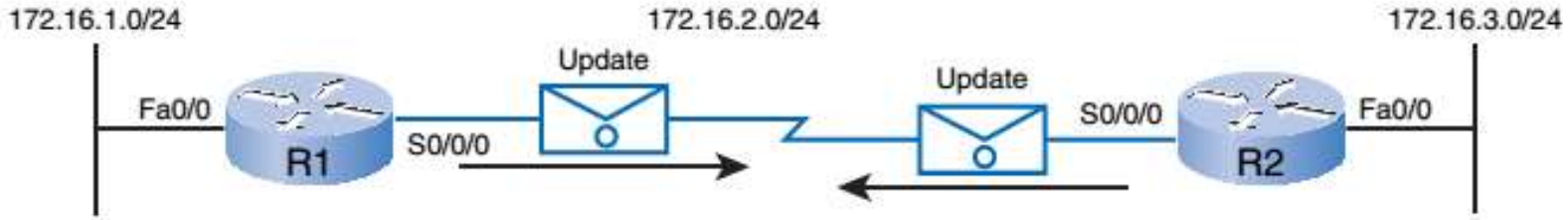
Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

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

R1 and R3 now have complete routing tables.

Topic Heading..

Another Example

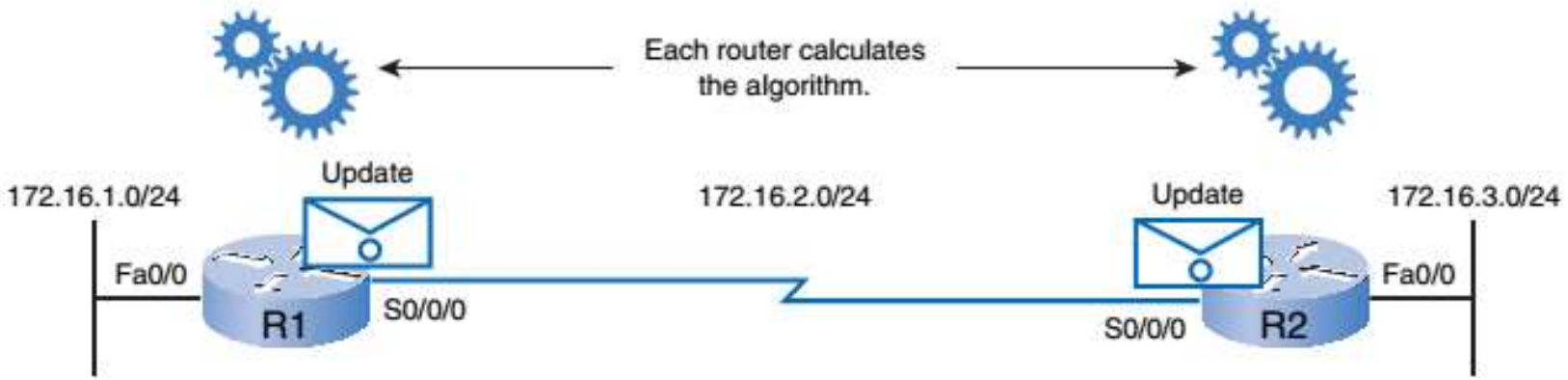


Network	Interface	Hop
172.16.1.0/24	Fa0/0	0
172.16.2.0/24	S0/0/0	0

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

Topic Heading..

New route



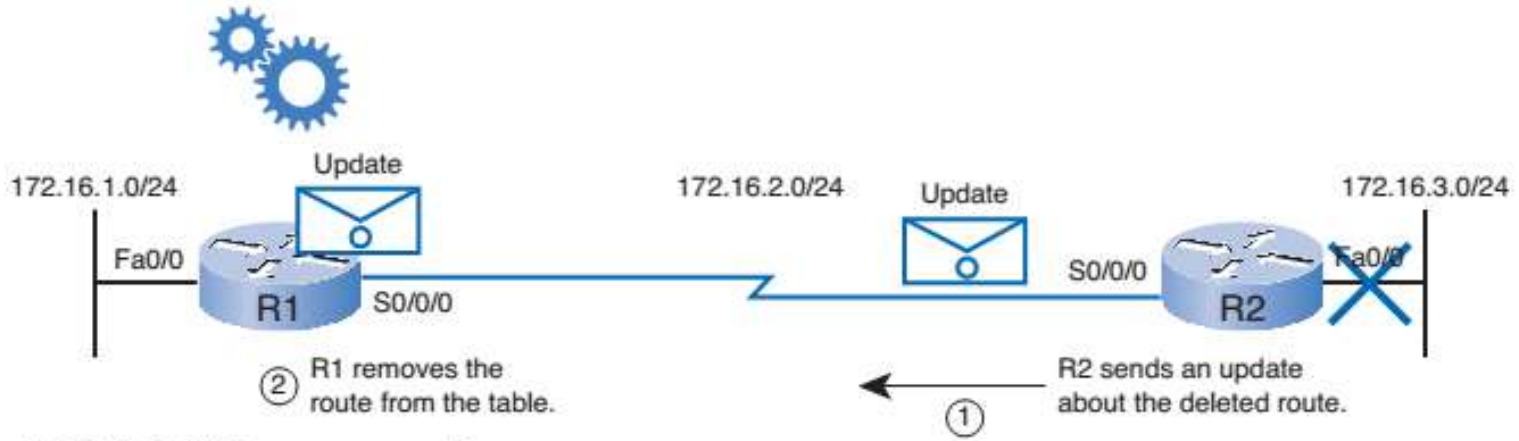
Network	Interface	Hop
172.16.1.0/24	Fa0/0	0
172.16.2.0/24	S0/0/0	0
172.16.3.0/24	S0/0/0	1

New routes are installed.

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

Topic Heading..

Removing a route



172.16.3.0/24 Down

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

References

[1] R. Graziani and A. Johnson, *Routing Protocols and Concepts*, 2nd ed., Cisco Systems, Inc., USA, 2008, pp. 148-173.

[2] J. Macfarlane, *Network Routing Basics*, Wiley Publications. Inc., 2006, USA, pp. 70-104.

Books

1. Official Cert Guide CCNA 200-301 , vol. 1, *W. Odom*, Cisco Press, First Edition, 2019, USA.

2. CCNA Routing and Switching, *T. Lammle*, John Wily & Sons, Second Edition, 2016, USA.