



Computer Networks

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Recap

- Network Architecture
- Network Models

Unit 3

Network Layer

Contents

Routing Protocols

- RIP
- OSPF
- BGP
- MPLS

RIP

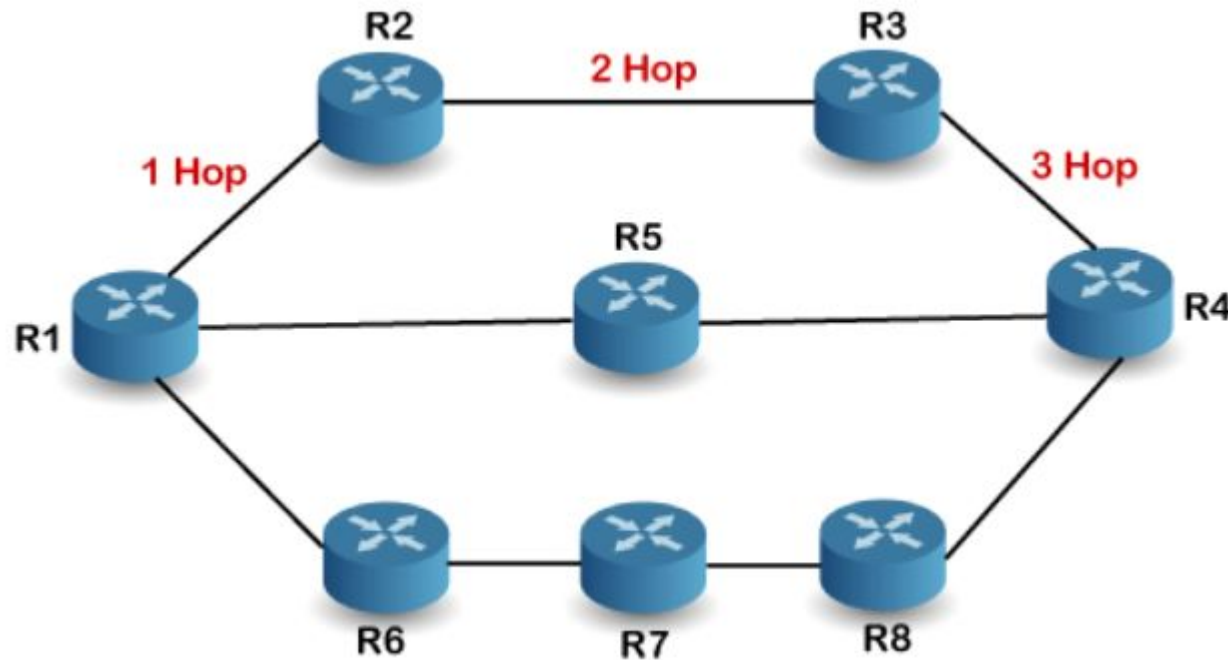
- The Routing Information Protocol (RIP) is an intradomain routing protocol used inside an autonomous system. It is based on distance vector routing.
- RIP implements distance vector routing directly with some considerations

Considerations:

1. In an autonomous system, we are dealing with routers and networks (links). The routers have routing tables; networks do not.
2. The destination in a routing table is a network, which means the first column defines a network address.
3. The metric used by RIP is very simple; the distance is defined as the number of links (networks) to reach the destination. For this reason, the metric in RIP is called a hop count.
4. Infinity is defined as 16, which means that any route in an autonomous system using RIP cannot have more than 15 hops.
5. The next-node column defines the address of the router to which the packet is to be sent to reach its destination.

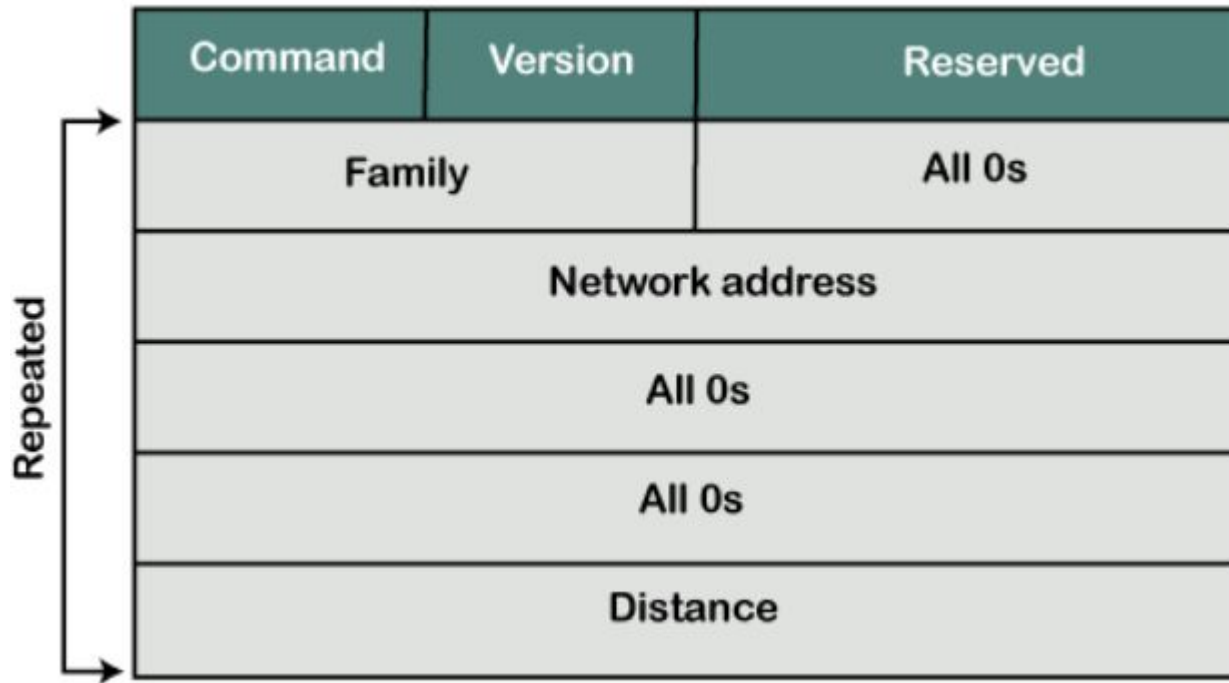
How is hop count determined?

When the router sends the packet to the network segment, then it is counted as a single hop. RIP can support maximum upto 15 hops, which means that the 16 routers can be configured in a RIP.



RIP Message Format

The message format is used to share information among different routers



Distance: The distance field specifies the hop count, i.e., the number of hops used to reach the destination.

Command: 8-bit field that is used for request or reply. The value of the request is 1, and the value of the reply is 2.

Version: which version of the protocol we are using. If version 1, then we put the 1 in this field.

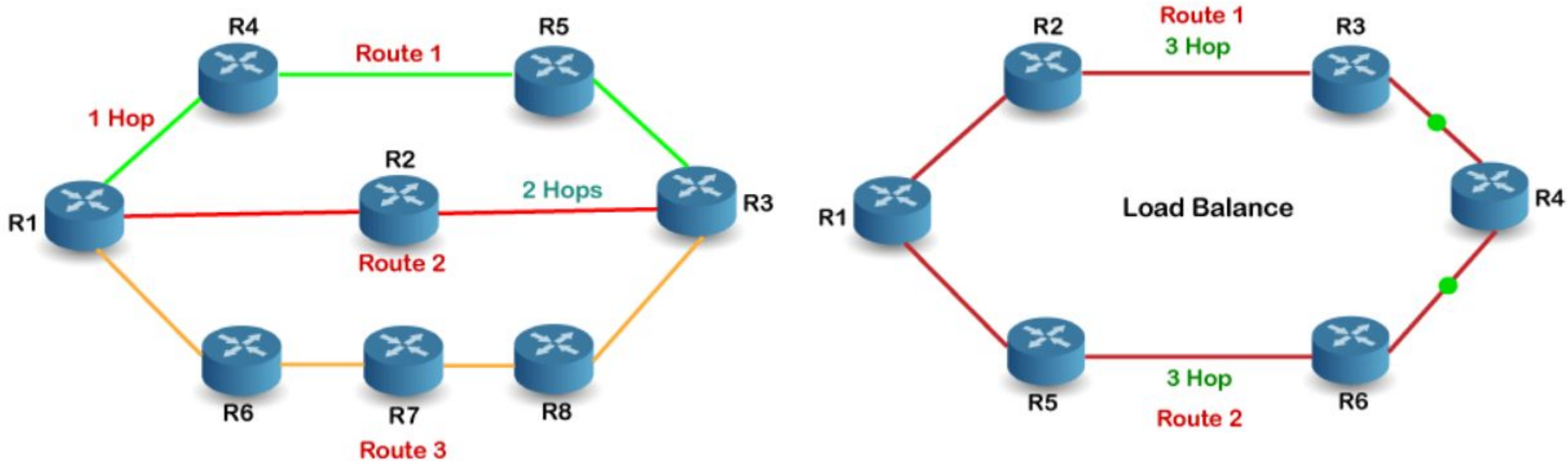
Reserved: This is a reserved field, so it is filled with zeroes.

Family: It is a 16-bit field. As we are using the TCP/IP family, so we put 2 value in this field.

Network Address: It is defined as 14 bytes field. If IPv4, then we use 4 bytes, and the other 10 bytes are all zeroes.

How does the RIP work?

In fig 2: RIP will send the data to both the routes simultaneously. This way, it manages the load balancing, and data reach the destination a bit faster.



How RIP updates its Routing table

The following timers are used to update the routing table:

RIP update timer : 30 sec : The routers configured with RIP send their updates to all the neighboring routers every 30 seconds.

RIP Invalid timer : 180 sec

If the router is disconnected from the network or some link goes down, then the neighbor router will wait for 180 seconds to take the update. If it does not receive the update within 180 seconds, then it will mark the particular route as not reachable.

RIP Flush timer : 240 sec

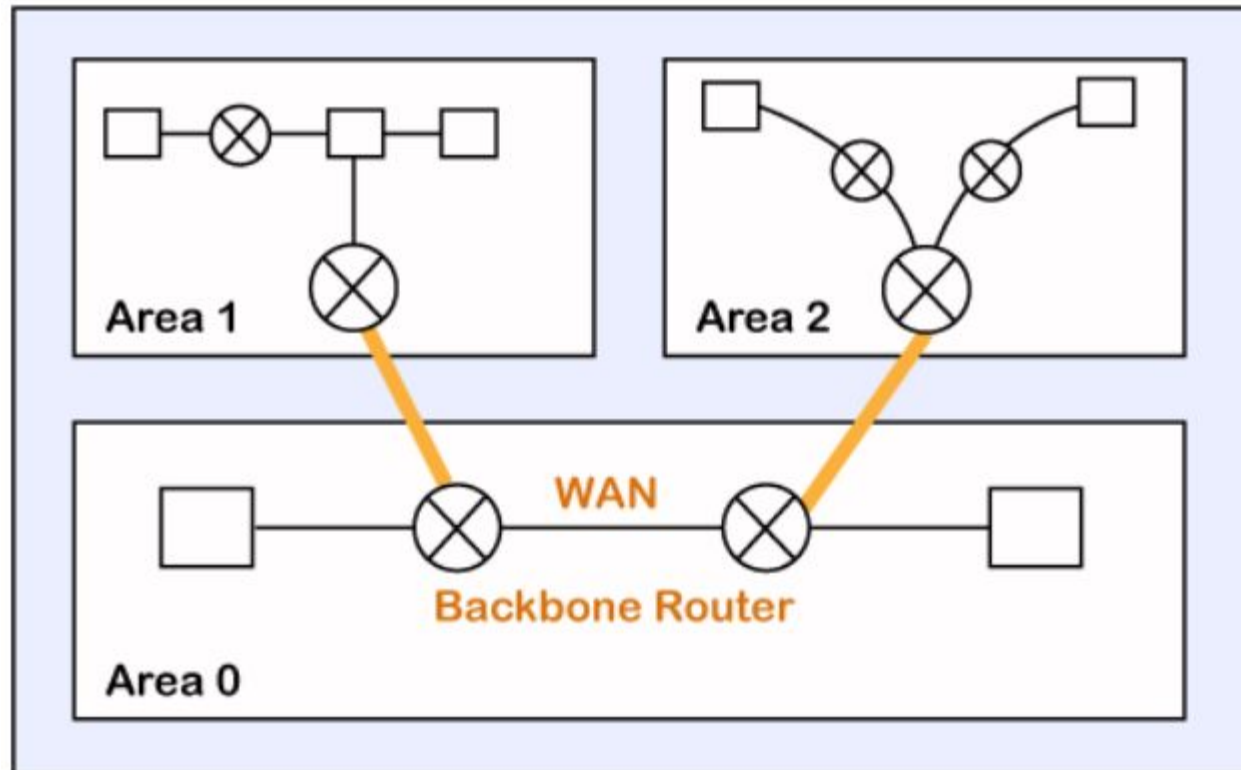
4 min, if the router does not receive the update within 240 seconds then the neighbor route will remove that particular route from the routing table which is a very slow process as 4 minutes is a long time to wait.

OSPF

- The OSPF stands for Open Shortest Path First.
- It is based on a link-state routing algorithm in which each router contains the information of every domain, and based on this information, it determines the shortest path
- LSA (Link State Advertisements) : contain information about every router, subnet, and other networking information. Once the LSAs have been flooded, the OSPF stores the information in a link-state database known as LSDB. The main goal is to have the same information about every router in an LSDBs.

OSPF Areas

OSPF divides the autonomous systems into areas where the area is a collection of networks, hosts, and routers. Like internet service providers divide the internet into a different autonomous system for easy management and OSPF further divides the autonomous systems into Areas.



OSPF Areas

Routers that exist inside the area flood the area with routing information

In Area, the special router also exists. The special routers are those that are present at the border of an area, and these special routers are known as Area Border Routers. This router summarizes the information about an area and shares the information with other areas.

All the areas inside an autonomous system are connected to the backbone routers, and these backbone routers are part of a primary area. The role of a primary area is to provide communication between different areas.

How does OSPF work?

Step 1: The first step is to become OSPF neighbors. The two connecting routers running OSPF on the same link creates a neighbor relationship.

Step 2: The second step is to exchange database information. After becoming the neighbors, the two routers exchange the LSDB information with each other.

Step 3: The third step is to choose the best route. Once the LSDB information has been exchanged with each other, the router chooses the best route to be added to a routing table based on the calculation of SPF.

Types of links in OSPF

Point-to-point link: The point-to-point link directly connects the two routers without any host or router in between.

Transient link: When several routers are attached in a network, they are known as a transient link. The transient link has two different implementations:

Unrealistic topology: When all the routers are connected to each other, it is known as an unrealistic topology.

Realistic topology: When some designated router exists in a network then it is known as a realistic topology. Here designated router is a router to which all the routers are connected. All the packets sent by the routers will be passed through the designated router.

Stub link: It is a network that is connected to the single router. Data enters to the network through the single router and leaves the network through the same router.

Virtual link: If the link between the two routers is broken, the administration creates the virtual path between the routers, and that path could be a long one also.

OSPF Message Format

Version(8)	Type(8)	Message (16)
Source IP address		
Area Identification		
Chcek sum		Auth.Type
Authentication (32)		

Authentication type: There are two types of authentication, i.e., 0 and 1. 0 for none that specifies no authentication is available and 1 means for pwd that specifies the password-based auth

Version: It is an 8-bit field that specifies the OSPF protocol version.

Type: It is an 8-bit field. It specifies the type of the OSPF packet.

Message: It is a 16-bit field that defines the total length of the message, including the header. Therefore, the total length is equal to the sum of the length of the message and header.

Source IP address: It defines the address from which the packets are sent. It is a sending routing IP address.

Area identification: It defines the area within which the routing takes place.

Checksum: It is used for error correction and error detection.

Authentication: contains the actual value of the authentication data.

OSPF Packets

1. Hello : to create a neighborhood relationship and check the neighbor's reachability
2. Database Description : describe topological database contents
3. Link state request: requesting the pieces of the neighbor's database which are more up to date
4. Link state update: flooding of link state advertisements is implemented by these packets.
5. Link state Acknowledgment: the reliability of flooding link state advertisement

OSPF States

1. Down: If the device is in a down state, it has not received the HELLO packet. Here, down does not mean that the device is physically down; it means that the OSPF process has not been started yet.
2. Init: It means that the device has received the HELLO packet from the other router.
3. 2WAY: Both the routers have received the HELLO packet from the other router, and the connection gets established between the routers.
4. Exstart: Once the exchange between the routers get started, both the routers move to the Exstart state. In this state, master and slave are selected based on the router's id. The master controls the sequence of numbers, and starts the exchange process.
5. Exchange: Both the routers send a list of LSAs to each other that contain a database description.
6. Loading: On the loading state, the LSR, LSU, and LSA are exchanged.
7. Full: Once the exchange of the LSAs is completed, the routers move to the full state.

BGP

- Border Gateway Protocol : Is an interdomain routing protocol, and it uses the path-vector routing. It is a gateway protocol that is used to exchange routing information among the autonomous system on the internet.

BGP Autonomous System

- An autonomous system is a collection of networks that comes under the single common administrative domain or a collection of routers under the single administrative domain.
- Within the same autonomous system or same organization, we generally use IGP (Interior Gateway Protocol) protocols like RIP, IGRP, EIGRP, OSPF.
- Suppose we want to communicate between two autonomous systems. In that case, we use EGP (Exterior Gateway Protocols).
- The protocol that is running on the internet or used to communicate between two different autonomous number systems is known as BGP (Border Gateway Protocol).
- The BGP is the only protocol that is used to exchange the routes between two different autonomous number systems. Internet service providers use the BGP protocol to control all the routing information.



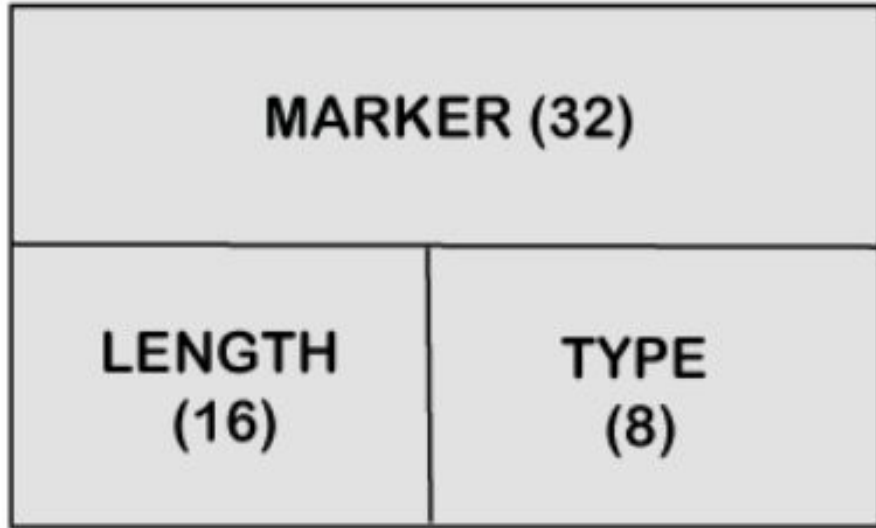
BGP Features

- Open standard
- Exterior Gateway Protocol
- InterAS-domain routing
- Supports internet
- Classless :It is a classless protocol.
- Incremental and trigger updates
- Path vector protocol
- Configure neighborhood relationship
- Application layer protocol
- Metric
- Administrative distance

Types of Packets

- Open : create neighborhood
- Update: withdraw previous destination
- KeepAlive: Exchange regularly
- Notification: Error, close connection

BGP Message Format



Marker: It is a 32-bit field which is used for the authentication purpose.

Length: It is a 16-bit field that defines the total length of the message, including the header.

Type: It is an 8-bit field that defines the type of the packet.

MPLS

- Multi Protocol Label Switching : is an IP packet routing technique that routes IP packet through paths via labels instead of looking at complex routing tables of routers. This feature helps in increasing the delivery rate of IP packets.

MPLS Message Format



Label – This field is 20 bit long and can take value b/w 0 & 220 – 1.

Exp – They are 3 bits long and used for Quality of Service(QoS).

Bottom of stack (S) – It is of size 1 bit. MPLS labels are stacked one over other. If there is only one label remained in MPLS header, then its value is 1 otherwise 0.

Time to Live (TTL) – It is 8 bit long and its value is decreased by one at each hop to prevent packet to get stuck in network.

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Thank you