Routing Concepts

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Agenda

Static Routes

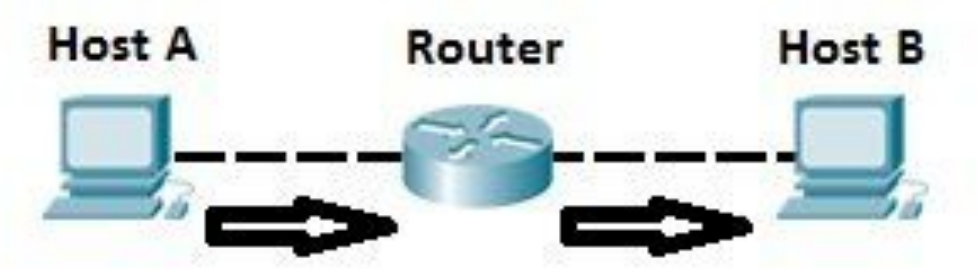
RIP v2 (Router Information Protocol)

What is IP routing?

IP routing is the process of sending packets from a host on one network to another host on a different remote network. This process is usually done by routers.

Routers examine the destination IP address of a packet , determine the next-hop address, and forward the packet. Routers use **routing tables** to determine the next hop address to which the packet should be forwarded.

Consider the following example of **IP routing**:



Host A wants to communicate with host B, but host B is on another network.

Host A is configured to send all packets destined for remote networks to router R1.

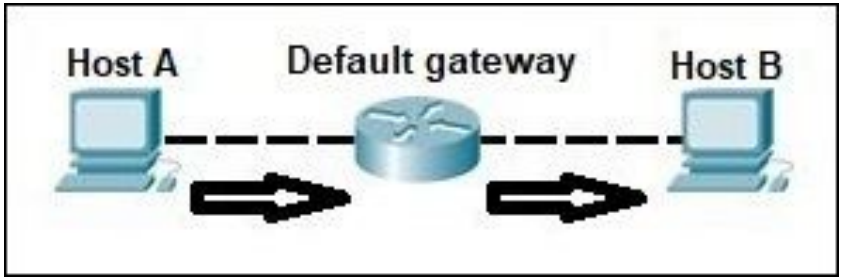
Router R1 receives the packets, **examines the destination IP address and forwards the packet to the outgoing interface associated with the destination network**.

Default gateway

A **default gateway** is a **router that hosts use to communicate with other hosts on remote networks**.

A default gateway is used when a host doesn't have a route entry for the specific remote network and doesn't know how to reach that network. Hosts can be configured to send all packets destined to remote networks to the default gateway, which has a route to reach that network.

The following example explains the concept of a default gateway more thoroughly.



Routing table

Each router maintains a routing table and stores it in RAM. A routing table is used by routers to determine the path to the destination network. Each routing table consists of the following entries:

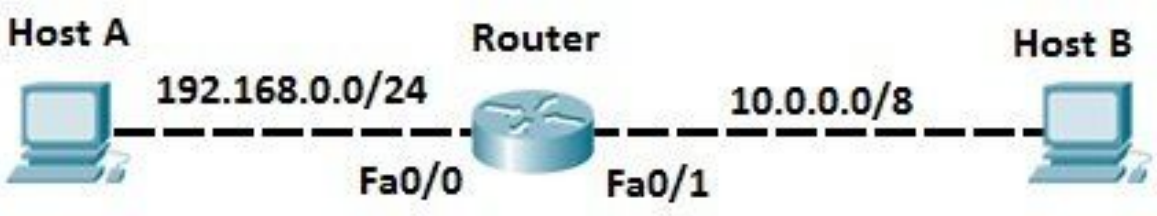
- **Network destination and subnet mask** – specifies a range of IP addresses.
- **Remote router** – IP address of the router used to reach that network.
- **Outgoing interface** – outgoing interface the packet should go out to reach the destination network.

There are three different methods for populating a routing table:

- directly connected subnets [C]
- using static routing [S]
- using dynamic routing [RIP, OSPF, EIGRP]

Example

Consider the following example. Host A wants to communicate with host B, but host B is on another network. Host A is configured to send all packets destined for remote networks to the router. The router receives the packets, checks the routing table to see if it has an entry for the destination address. If it does, the router forwards the packet out the appropriate interface port. If the router doesn’t find the entry, it discards the packet.



Demonstration

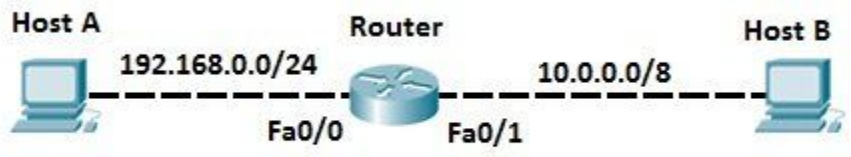
```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E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

C    10.0.0.0/8 is directly connected, FastEthernet0/1
C    192.168.0.0/24 is directly connected, FastEthernet0/0
Router#
```

Connected, static & dynamic routes

Connected routes

Subnets directly connected to a router's interface are added to the router's routing table. Interface has to have an IP address configured and both interface status codes must be in the **up and up** state. A router will be able to route all packets destined for all hosts in subnets directly connected to its active interfaces.

Consider the following example. The router has two active interfaces, Fa0/0 and Fa0/1. Each interface has been configured with an IP address and is currently in the up-up state, so the router adds these subnets to its routing table.



Types of routing protocols

There are two types of routing protocols:

1. Distance vector (RIP, IGRP)

2. Link state (OSPF, IS-IS)

```
Router#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
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Gateway of last resort is not set

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Router#
Router#
```

Dynamic routes

A router can learn dynamic routes if a routing protocol is enabled. A routing protocol is used by routers to exchange routing information with each other. Every router in the network can then use information to build its routing table. A routing protocol can dynamically choose a different route if a link goes down, so this type of routing is fault-tolerant. Also, unlike with static routing, there is no need to manually configure every route on every router, which greatly reduces the administrative overhead. You only need to define which routes will be advertised on a router that connect directly to the corresponding subnets – routing protocols take care of the rest.

The disadvantage of dynamic routing is that it increases memory and CPU usage on a router, because every router has to process received routing information and calculate its routing table.

To better understand the advantages that dynamic routing protocols bring, consider the following example:

The following table lists the administrative distance default values:

Routing Protocol	Administrative Distance
Directly connected	0
Static route	1
Internal EIGRP	90
OSPF	110
RIP	120
External EIGRP	170
Unknown	255

The following table lists the parameters that various routing protocols use to calculate the metric:

Routing Protocol	Metric
RIP	hop count
EIGRP	bandwidth, delay
OSPF	cost

Routing Protocols

Routing protocols

Dynamic routes are routes learned via routing protocols. Routing protocols are configured on routers with the purpose of **exchanging routing information**. There are many benefits of using routing protocols in your network, such as:

- unlike static routing, you don’t need to manually configure every route on each router in the network. You just need to configure the networks to be advertised on a router directly connected to them.
- if a link fails and the network topology changes, routers can advertise that some routes have failed and pick a new route to that network.

Distance vector protocols

Distance vector routing protocols use distance to determine the best path to a remote network. The distance is something like the number of hops (routers) to the destination network.

Distance vector protocols usually send the complete routing table to each neighbor (a neighbor is directly connected router that runs the same routing protocol).

Distance vector protocols also use more bandwidth because they send complete routing table, while the link state protocols send specific updates only when topology changes occur.

RIP and EIGRP are examples of distance vector routing protocols.

Link State Routing Protocols

Link state routing protocols are the second type of routing protocols.

Link state protocols **don’t advertise the entire routing table**. Instead, they advertise information about a network toplogy (directly connected links, neighboring routers...). Link state routing protocols converge much faster than distance vector routing protocols, support classless routing, send updates using multicast addresses and use triggered routing updates.

They also require more router CPU and memory usage than distance-vector routing protocols and can be harder to configure.

Each router running a link state routing protocol creates three different tables:

- **neighbor table** – the table of neighboring routers running the same link state routing protocol.
- **topology table** – the table that stores the topology of the entire network.
- **routing table** – the table that stores the best routes.

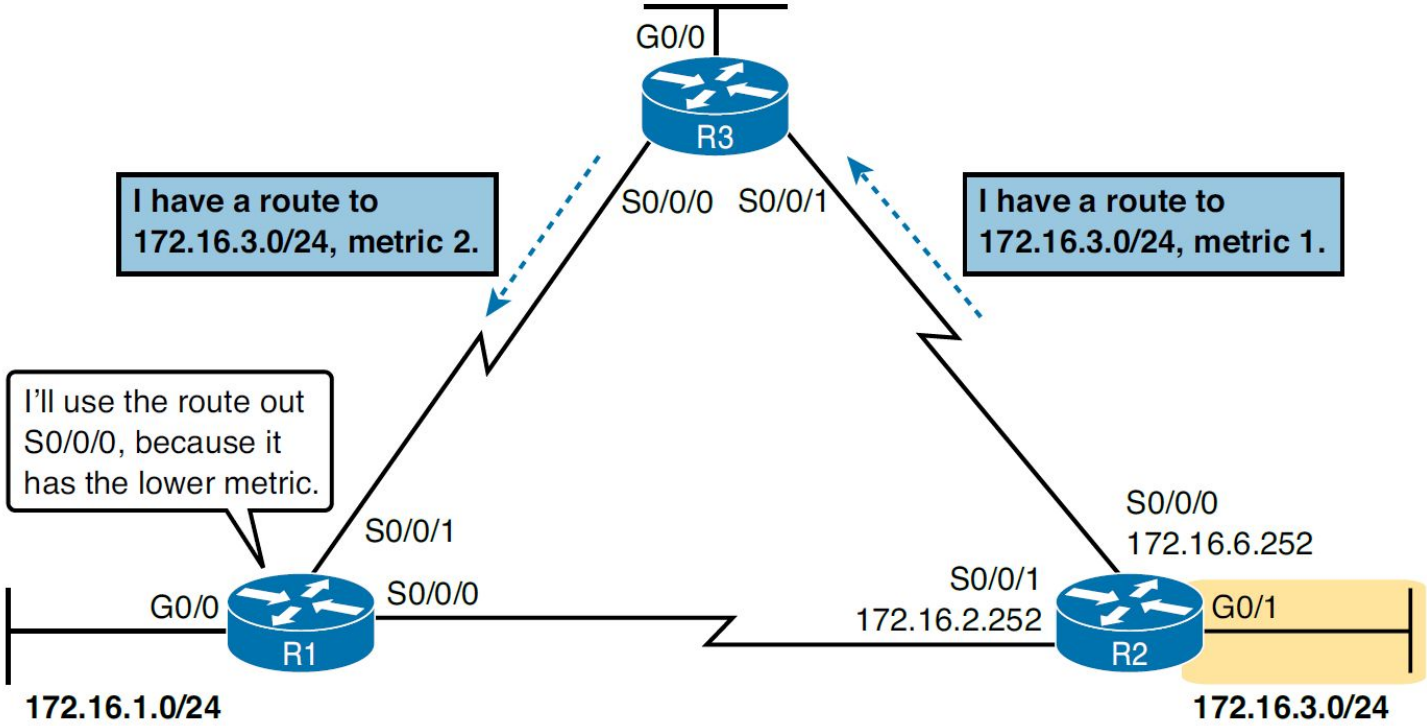
RIP (Routing Information Protocol)

Routing Information Protocol

Routing Information Protocol (RIP) is a protocol that **routers can use to exchange network topology information**. It is characterized as an interior gateway protocol, and is typically used in small to medium-sized networks.

A router running **RIP sends the contents of its routing table to each of its adjacent routers** every 30 seconds. When a route is removed from the routing table, it is flagged as unusable by the receiving routers after 180 seconds, and removed from their tables after an additional 120 seconds.

tion 3).



R1 IP Routing Table

Subnet	Out Int.	Next-Hop	Metric
172.16.3.0	**S0/0/0**	**172.16.2.252**	**1**

Figure 17-1 *Three of the Four Basic Functions of Routing Protocols*