

11. Routing Fundamentals & Static Routing

Routing Fundamentals

What is Routing?

Routing is the process that routers use to determine the best path for IP packets to travel through a network to reach their destination.

Key Points:

- **Routers** make routing decisions by consulting a **routing table**, which contains routes to known destinations.
 - When a router receives an IP packet, it refers to its routing table to determine the **next-hop** or the next destination for the packet.
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Types of Routing

There are two primary methods that routers use to learn and manage routes:

1. Dynamic Routing

- **Dynamic Routing Protocols** (e.g., OSPF, EIGRP, BGP) are used.
- Routers share routing information **automatically**, updating their routing tables as the network changes.
- **Advantages:**
 - Automatically adapts to network changes.
 - Scales well for larger, more complex networks.
- **Disadvantages:**
 - Requires more CPU, memory, and bandwidth.
 - Can take time to converge after network changes.

2. Static Routing

- Routes are manually configured by a network administrator.
 - Used in small or stable networks where paths rarely change.
 - **Advantages:**
 - Simple to configure.
 - Consumes no extra resources (e.g., bandwidth, CPU).
 - **Disadvantages:**
 - Does not adapt to network changes automatically.
 - Labor-intensive for larger networks.
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Routing Decision Process

A route tells the router one of three things:

1. **Next-Hop Routing:**
 - For destination X, forward the packet to next-hop Y.
2. **Directly Connected:**
 - If the destination is on a network directly connected to the router, send the packet to the destination directly.
3. **Local Delivery:**
 - If the destination is the router's own IP address, the router processes the packet itself (does not forward it).

Routers will choose the most specific matching route.

WAN and Routing

A **Wide Area Network (WAN)** spans a large geographical area, often connecting multiple smaller networks (LANs). Routers are crucial in WANs to manage traffic between geographically separated locations.

Visual Aids

1. **Routing Table Example:** `R1# show ip route`

The routing table contains the following for each route:

• **L - local**
→ A route to the actual IP address configured on the interface. (with a /32 netmask)

• **C - connected**
→ A route to the network the interface is connected to. (with the actual netmask configured on the interface)

- **Destination:** The network or device to reach.
 - **Next-Hop:** The next device (or interface) to forward the packet to.
 - **Metric:** A value that indicates the cost of the route (lower is better).
 - **Interface:** The router's interface used to send the packet.
2. **Routing in a WAN:**
 - Routers within the WAN maintain routes to other routers and networks.
 - Dynamic routing protocols are often used in large WANs to handle complex topologies.
- **WAN Diagram:** Visualizes routers and their connections across a large geographical area.

- **Routing Table Visualization:** Explains how routers reference routes for decision-making.
- **Next-Hop Example:** Shows how packets are forwarded step-by-step in a network.

Key Takeaways



Summary

- Routers store information about destinations they know in their **routing table**.
 - When they receive packets, they look in the routing table to find the best route to forward the packet.
- Each **route** in the routing table is an instruction:
 - To reach destinations in network X, send the packet to **next-hop** Y (the next router in the path to the destination).
 - If the destination is directly connected (**Connected** route) send the packet directly to the destination.
 - If the destination is your own IP address (**Local** route), receive the packet for yourself.

*We will look at how **next-hops** work in the next video on **static routes**.
- When you configure an IP address on an interface and enable the interface, two routes are automatically added to the routing table:
 - Connected** route (code **C** in the routing table): A route to the network connected to the interface.
 - ie. if the interface's IP is **192.168.1.1/24**, the route will be to **192.168.1.0/24**.
 - Tells the router: "To send a packet to a destination in this network, send it out of the interface specified in the route".
 - Local** route (code **L** in the routing table): A route to the exact IP address configured on the interface.
 - ie. if the interface's IP is **192.168.1.1/24**, the route will be to **192.168.1.1/32**.
 - Tells the router: "Packets to this destination are for you. You should receive them for yourself (not forward them)".
- A route **matches** a destination if the packet's destination IP address is part of the network specified in the route.
 - ie. a packet to **192.168.1.60** is matched by a route to **192.168.1.0/24**, but not by a route to **192.168.0.0/24**.
- If a router receives a packet and it doesn't have a route that matches the packet's destination, it will **drop** the packet.
 - This is different than switches, which **flood** frames if they don't have a MAC table entry for the destination.
- If a router receives a packet and it has multiple routes that match the packet's destination, it will use the **most specific matching route** to forward the packet.
 - **Most specific matching route** = the matching route with the longest prefix length.
 - This is different than switches, which look for an **exact** match in the MAC address table to forward frames.

- Routing ensures efficient delivery of IP packets across networks.
- **Static routing** is simple but inflexible; **dynamic routing** adapts but requires more resources.
- Routers play a pivotal role in WANs, ensuring connectivity over vast geographical areas.

Static Routing

Review

Switches vs. Routers

- **Switches:** Operate within a **Local Area Network (LAN)** to forward traffic between devices on the same network.
 - **Routers:** Operate **between LANs**, forwarding traffic to destinations across different networks.
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WAN (Wide Area Network)

- A WAN is a network that spans large geographic areas, connecting multiple LANs.
 - Routers enable communication between networks across a WAN.
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Static Routing Overview

Static routing involves manually configuring routes on routers. This type of routing is used in small, stable networks or in specific parts of larger networks.

Key Characteristics:

1. **Manually Configured:** A network administrator specifies the route to a destination.
2. **Simple and Resource-Efficient:** No additional CPU or bandwidth is required.
3. **Inflexible:** Routes do not adapt to network changes automatically.

Why Use Static Routing?

- It provides greater control over routing decisions.
 - It is efficient for predictable, small, or simple network topologies.
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Static Route Configuration

Basic Syntax:

```
ip route <destination-network> <subnet-mask> <next-hop-IP>
```

Parameters Explained:

1. **destination-network:** The network you want to route packets to.
 2. **subnet-mask:** The subnet mask for the destination network.
 3. **next-hop-IP:** The IP address of the next router in the path to the destination.
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Static Route with Exit Interface

Another way to configure static routing is by specifying the **exit-interface** instead of the next-hop IP address.

Syntax:

```
ip route <destination-network> <subnet-mask> <exit-interface>
```

Example:

```
ip route 192.168.2.0 255.255.255.0 Serial0/0/0
```

- In this example, packets destined for **192.168.2.0/24** are sent out the router's **Serial0/0/0** interface.
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Default Routes

A **default route** is used when no other route matches the destination of a packet. It serves as a "catch-all" route.

Syntax:

```
ip route 0.0.0.0 0.0.0.0 <next-hop-IP>
```

Key Points:

- **0.0.0.0/0** represents any network address.
 - The router forwards packets that do not match any specific routes to the default route's next hop.
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1. **Static Route Configuration:**
 - Displays examples of static route syntax and implementation.
 2. **Static Route with Exit-Interface:**
 - Demonstrates the alternative method of specifying an interface instead of the next-hop IP.
 3. **Default Route:**
 - Highlights the importance of the default route for packets without a specific destination.
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Key Takeaways

- **Static routes** are manually configured and suitable for small or stable networks.
- Using the **exit interface** in static routing reduces dependency on the next-hop IP address but can have limitations in complex topologies.
- A **default route** is essential for handling traffic with unknown destinations, especially when connecting to external networks like the internet.