### **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.

### **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.

### **Routing Decision Process**

A route tells the router one of three things:

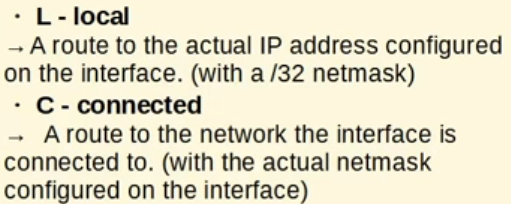
1. **Next-Hop Routing:**
   * For destination X, forward the packet to next-hop Y.
2. **Directly Connected:**
   * If the destination is on a network directly connected to the router, send the packet to the destination directly.
3. **Local Delivery:**
   * If the destination is the router’s own IP address, 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:  
   
   * **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.

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* **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**

* 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.

### **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.

### **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.

### **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.

### **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.

### **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.

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.

### **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.