GOVT. GRADUATE COLLEGE
Sheikhupura

NAME : IMRAN ALI

ROLL NO : 110855

SEMESTER : THIRD

DEPARTMENT : INFORMATION TECHNOLOGY

TOPIC : ROUTER DECISIONS

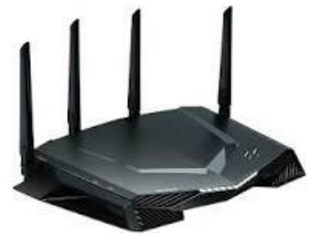
SUBMITTED TO : MISS SAHRISH KHAN

ROUTER

DEFINATION:

A router is a networking device that forwards data packets between computer networks. Routers are essential in directing internet traffic by determining the best paths for data to travel across interconnected networks. They connect devices within a network (e.g., within a home or office) and allow communication with other networks, such as the internet.

IMAGE



Types of Routers

1. **Wireless Router**

- Connects to a modem and provides wireless internet access to devices within range. It commonly supports Wi-Fi connectivity and often includes features for network security and control.

2. **Wired Router**

- Uses Ethernet cables to connect directly to devices within a local network. Wired routers are typically more secure and can offer faster and more stable connections, often used in business or industrial settings.

3. **Core Router**

- Designed to operate within the backbone or core of a network, primarily used by Internet Service Providers (ISPs) or large organizations. Core routers handle large amounts of data and direct traffic efficiently across complex, large-scale networks.

4. **Edge Router**

- Sits at the edge of a network and connects it to external networks, like the internet. Edge routers are responsible for managing data entering and leaving the network and providing security through firewall settings.

5. **Virtual Router**

- A software-based router that performs routing functions without requiring dedicated hardware. Virtual routers are commonly used in virtualized environments or data centers where network resources are managed in software.

6. **Branch Router**

- Found in remote or branch offices, these routers connect branch networks to the central office or main data center. Branch routers typically support advanced security and connectivity options for secure data transmission over wide-area networks (WANs).

7. **Distribution Router**

- Used in larger networks to connect multiple routers or different subnetworks. Distribution routers aggregate data from multiple networks and route it toward the core network.

Each type of router is specialized to manage different network requirements based on data volume, security needs, and connectivity preferences.

PURPOSE:

The main purpose of a router is to direct data packets between networks and ensure efficient and secure communication across them. Routers serve multiple roles in networking:

1**. Data Packet Routing**

- Routers determine the best path for data packets to reach their destination by analyzing IP addresses, network topology, and routing protocols. This is essential for fast, reliable data transmission.

2. **Network Segmentation**

- Routers segment networks by dividing them into smaller subnetworks, which helps manage traffic, reduce congestion, and increase security by controlling how devices communicate across different parts of a network.

3**. Internet Access**

- Routers connect local networks to the internet by linking with an Internet Service Provider (ISP). They act as the gateway between the internal network (e.g., a home or office) and external networks like the internet.

4. **Network Address Translation (NAT)**

- Routers perform NAT to translate private IP addresses within a local network to a single public IP address. NAT allows multiple devices on a local network to share a single public IP, enhancing security and conserving IP addresses.

5. **Firewall and Security Management**

- Many routers include firewall features to protect networks from unauthorized access. By filtering incoming and outgoing data, routers help block unwanted traffic and prevent security threats, such as malware and hacking attempts.

6. **Traffic Prioritization and Quality of Service (QoS)**

- Routers can prioritize certain types of traffic (e.g., video calls, gaming, or streaming) over others to ensure a smooth user experience. This is particularly useful for applications sensitive to delays or interruptions.

7. **Connecting Different Network Types**

- Routers can connect different types of networks, such as local area networks (LANs) and wide area networks (WANs), allowing seamless communication and data sharing between devices across various locations.

By serving as the central traffic manager, routers play a crucial role in network efficiency, security, and connectivity, making them fundamental components in modern network infrastructures.

HOW ROUTER TAKE ROUTING DECISIONS ?

Routers make routing decisions by analyzing the destination IP address of incoming data packets and consulting their routing tables to determine the best path. These decisions involve several steps and rely on various protocols and algorithms. Here’s how a router decides where to send a packet:

1. **Routing Table Lookup**

- Each router has a **routing table**, a database that contains information on possible network paths and directions for forwarding data. The routing table includes information on the next hop (the next router or device to send the packet to), the destination network, and metrics like the cost or distance to reach each destination.

- When a data packet arrives, the router reads the packet’s destination IP address and consults its routing table to find the most suitable route.

2**. Routing Algorithms**

- Routers use algorithms to calculate the best path for each packet, based on factors like speed, distance, and network reliability. Common routing algorithms include:

Distance-Vector Routing: Routers exchange information with neighboring routers and update their routing tables based on the shortest path or minimum "hop count" (number of routers passed) to reach a destination.

Link-State Routing: Routers build a complete view of the network by exchanging link-state advertisements with all routers in the network. Each router uses this data to create a map and calculate the shortest path using algorithms like Dijkstra's algorithm.

Path-Vector Protocols: Primarily used in larger networks (e.g., between ISPs), path-vector protocols like Border Gateway Protocol (BGP) keep track of the path taken by each route, allowing routers to avoid loops and optimize routes across different networks.

3. **Routing Protocols**

- Routers communicate with each other using **routing protocols**, which help them share information and update routing tables dynamically. Common routing protocols include:

-RIP (Routing Information Protocol): A distance-vector protocol that chooses routes based on the number of hops; suited for smaller networks.

OSPF (Open Shortest Path First): A link-state protocol that calculates the shortest path within a large network, suitable for complex internal networks.

BGP (Border Gateway Protocol): A path-vector protocol used to manage routing between large networks on the internet, focusing on policy-based decisions and avoiding routing loops.

4. **Metric Evaluation**

-Routers evaluate different paths based on metrics such as:

Hop Count: The number of routers a packet must pass through.

Bandwidth: Available capacity on a given path, favoring higher bandwidth routes for faster transmission.

Latency: Time delay on a path, with lower latency routes prioritized for time-sensitive data.

Reliability: Network stability or error rates, with more reliable paths preferred.

Cost: A configurable metric that may reflect operational cost or path preference (often used in commercial networks).

5. **Load Balancing and Traffic Optimization**

- In some networks, routers use **load balancing** to distribute traffic evenly across multiple paths, avoiding congestion and improving network efficiency. This process ensures that no single path is overwhelmed and can be dynamically adjusted based on network conditions.

6**.Forwarding the Packet**

- Once the router identifies the best path, it forwards the packet to the next device or router (known as the **next hop**), continuing this process until the packet reaches its final destination. If the router is connected to the destination network directly, it forwards the packet to the specific device on that network.

Through these steps, routers ensure data reaches the correct destination quickly and efficiently, adapting to network changes and optimizing for speed, reliability, and security.

ALGORITHM OF ROUTER DECISIONS

Routers use various **routing algorithms** to make decisions, depending on the routing protocol they implement and the network's size and complexity. Here's a breakdown of the main algorithms routers use:

1. **Distance-Vector Algorithm**

- **How It Works**: Each router calculates the best path to each destination based on the distance (usually measured by hop count, delay, or another metric) and shares this information with its neighboring routers.

Algorithm Example: Bellman-Ford Algorithm

- Each router maintains a routing table with information on the distance to each network. It updates this table based on information from neighbors, calculating the shortest path to each destination iteratively. It chooses the path with the lowest distance (fewest hops).

Protocols That Use It:

RIP (Routing Information Protocol): Uses hop count as the metric, with a maximum hop count of 15 to prevent routing loops. RIP is suitable for small networks but has limited scalability and convergence speed.

EIGRP (Enhanced Interior Gateway Routing Protocol): Combines distance-vector and link-state characteristics. EIGRP considers multiple metrics (bandwidth, delay, reliability) for more sophisticated path selection and is faster than RIP.

2. **Link-State Algorithm**

How It Works: Each router has a complete map of the network and uses this map to compute the shortest path to each destination. Routers exchange link-state information with all routers in the network, enabling them to independently calculate the best route.

Algorithm Example: Dijkstra's Shortest Path First (SPF) Algorithm

- Dijkstra's algorithm computes the shortest path tree from a given starting point (the router) to all possible destinations by evaluating the cumulative cost of each path. Routers build a map of the network and independently calculate the shortest path based on the least cost.

Protocols That Use It:

OSPF (Open Shortest Path First): A widely used link-state protocol that divides large networks into hierarchical areas to reduce routing table size and improve efficiency. OSPF uses Dijkstra's algorithm to compute the shortest path.

IS-IS (Intermediate System to Intermediate System): Similar to OSPF but often used in large ISP networks. It also uses Dijkstra's algorithm for shortest-path calculation.

3. **Path-Vector Algorithm**

How It Works: Rather than calculating distance or link-state information, path-vector algorithms track the entire path (list of ASes) a packet takes to reach its destination. Each router maintains a path-vector that includes the AS path for each destination. This helps avoid routing loops in inter-domain routing.

Algorithm Example: Path-Vector Algorithm

- In the path-vector approach, each router advertises its reachable networks along with the path (sequence of ASes) taken. Routers then select the path that aligns with policies and avoids routing loops.

Protocols That Use It:

BGP (Border Gateway Protocol): The primary protocol for inter-domain routing on the internet. BGP uses the path-vector algorithm to make policy-based routing decisions, selecting paths based on AS path length, policy, and preference rather than simply shortest distance.

4**. Hybrid Routing Algorithms**

How They Work: Hybrid routing algorithms combine features of distance-vector and link-state algorithms to balance scalability, speed, and accuracy. They use distance-vector methods for basic path calculations but add link-state-like features to improve convergence and prevent loops.

Algorithm Example:

DUAL (Diffusing Update Algorithm)

- Used by Cisco's EIGRP, DUAL ensures a loop-free, fast convergence by using a distance-vector approach combined with additional topology information. DUAL allows EIGRP to quickly recalculate routes when network changes occur without requiring a complete routing update.

Protocols That Use It:

EIGRP (Enhanced Interior Gateway Routing Protocol): EIGRP uses the DUAL algorithm to provide efficient routing with features like faster convergence and reduced bandwidth consumption compared to standard distance-vector protocols.

Routing Decision-Making Process

Each of these algorithms supports routers in making routing decisions in the following ways:

1. **Metric Evaluation**: Each protocol and algorithm calculates a metric based on factors like hop count, bandwidth, delay, or reliability.

2. **Shortest Path Computation**: Algorithms like Dijkstra's and Bellman-Ford identify the shortest or least-cost path to each destination.

3**. Routing Table Updates**: Routers update routing tables based on received information and calculated paths. Routing table changes are shared with neighbors or throughout the network.

4**. Forwarding Decision**: After calculating the best route, the router forwards packets to the next hop on the selected path.

These algorithms allow routers to choose efficient, reliable, and loop-free paths, adapting to changes in network topology and managing traffic effectively**.**