

Day 12 (Life of a Packet)

Overview

When data travels across a network, it moves through several layers, each with its own addressing and encapsulation rules. A packet's journey involves interaction between different devices (hosts, switches, and routers) and their respective protocols.

Key Concepts

1. **MAC (Media Access Control) Address:**
 - Unique to each device's network interface.
 - Used for communication within the same network or broadcast domain.
 2. **IP (Internet Protocol) Address:**
 - Identifies devices at the network layer.
 - Used to communicate across different networks.
 3. **Headers:**
 - **TCP Header:** Contains source and destination IP addresses.
 - **Ethernet Header:** Contains destination and source MAC addresses.
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Key Header Sequence

1. **TCP Header:**
 - **Source IP Address** precedes **Destination IP Address**.
 2. **Ethernet Header:**
 - **Destination MAC Address** precedes **Source MAC Address**.
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Packet Journey

1. **Host Sends Data:**
 - The host encapsulates data with headers (TCP, IP, and Ethernet).
 - The source IP and destination IP remain unchanged throughout the journey.
 - The source MAC and destination MAC are updated at each hop.
2. **Switching Within a LAN:**
 - The switch uses the **destination MAC address** in the Ethernet header to forward the packet to the appropriate device or port.
3. **Routing Across Networks:**
 - When a packet reaches a router, the **Ethernet header** is stripped and replaced with a new one.
 - The **destination MAC** is updated to the next-hop router or destination device.

- The **source MAC** becomes the router's outgoing interface.
 - 4. **Reaching the Destination Host:**
 - The final router forwards the packet with the destination MAC address set to the target host's MAC.
 - The destination host processes the packet using the IP layer.
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MAC vs. IP Addresses in Transit

- **IP Addresses (Source and Destination):**
 - Do **not** change during the journey, ensuring end-to-end delivery.
 - **MAC Addresses (Source and Destination):**
 - Change at every hop as the packet moves through routers and switches.
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Illustration of the Journey

1. **Source Host:**
 - Creates a packet with:
 - Source IP: Host A
 - Destination IP: Host B
 - Source MAC: Host A's MAC
 - Destination MAC: Default Gateway's MAC
 2. **Switch:**
 - Forwards the packet based on the destination MAC.
 3. **Router (First Hop):**
 - Strips the Ethernet header and replaces it with:
 - Source MAC: Router's outgoing interface.
 - Destination MAC: Next-hop router's MAC.
 4. **Intermediate Routers:**
 - Repeat the process until the packet reaches the destination network.
 5. **Destination Router:**
 - Updates the Ethernet header:
 - Source MAC: Router's outgoing interface.
 - Destination MAC: Target host's MAC.
 6. **Destination Host:**
 - Processes the packet and responds back with its own MAC as the source.
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Key Takeaways

1. **IP Addresses:** Remain constant throughout the journey, enabling end-to-end communication.
2. **MAC Addresses:** Change at every hop, enabling local delivery within a network segment.

3. **Encapsulation and Decapsulation:** Essential processes at each hop for addressing and forwarding.