Applied Industrial Internet of Things

Configuration of Address Resolution Protocol (ARP)

Using Cisco Packet Tracer

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1. Introduction

The Industrial Internet of Things (IIoT) involves connecting industrial equipment and devices to networks to improve efficiency, monitoring, and automation. One fundamental networking protocol used in IIoT environments is the Address Resolution Protocol (ARP). ARP plays a crucial role in enabling communication between devices within a local network by resolving IP addresses to MAC addresses.

This project aims to construct a simple Local Area Network (LAN) using Cisco Packet Tracer and demonstrate how ARP works to facilitate device communication at the data link layer.

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2. Aim

To design and simulate a LAN environment using Cisco Packet Tracer, and understand the concept and operation of ARP by observing how IP addresses are resolved to MAC addresses within the network.

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3. Problem Statement

In a LAN, devices communicate using MAC addresses at the data link layer. However, most communication and routing use IP addresses. Therefore, there is a need for a protocol that maps IP addresses to MAC addresses. ARP fulfills this function. The challenge is to demonstrate and understand this process practically by creating a LAN and capturing ARP requests and replies.

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4. Scope of the Solution

- Design a basic LAN using PCs and switches.
- Assign IP addresses to devices in the same subnet.
- Enable communication between devices via ARP.
- Use Cisco Packet Tracer to simulate network traffic and analyze ARP packet flow.
- Gain insights into ARP operation applicable to IIoT network environments.

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5. Required Components

- **Software:** Cisco Packet Tracer (version 8.0 or above recommended)
- **Hardware (simulated):**
    - 3 PCs (virtual devices in Packet Tracer)
    - 8-port Ethernet switch (Cisco Packet Tracer device)
    - Ethernet cables (virtual connections)
- **Additional Tools:** Screen capture software for recording demo

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6. Network Design and Configuration

6.1 Network Topology

- Three PCs connected to an 8-port switch using copper straight-through cables.
- All devices reside in the same IP subnet (192.168.1.0/24).

6.2 IP Configuration

Device	IP Address	Subnet Mask	Default Gateway
PC0	192.168.1.10	255.255.255.0	None
PC1	192.168.1.11	255.255.255.0	None
PC2	192.168.1.12	255.255.255.0	None

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7. Procedure

1. **Open Cisco Packet Tracer** and create a new workspace.
2. **Place 3 PCs and 1 switch** on the workspace.
3. **Connect PCs to the switch** using copper straight-through cables.
4. **Assign IP addresses** to each PC as per the table above.
5. **Test connectivity:**
    - Open Command Prompt on PC0.
    - Ping PC1 (`ping 192.168.1.11`).
6. **Observe ARP behavior:**
    - Open simulation mode in Packet Tracer.
    - Filter packets by ARP protocol.
    - Send ping again and watch ARP Request and ARP Reply packets.

7. **Check ARP cache:**
    - On PC0, open command prompt.
    - Enter `arp -a` to view the IP-to-MAC address mappings.

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8. Observations and Results

- PCs successfully communicated after ARP resolved the destination MAC addresses.
- ARP Request packets were broadcasted by the source device to ask "Who has IP 192.168.1.x?"
- The device with the matching IP replied with its MAC address via ARP Reply.
- The sender updated its ARP cache with the resolved IP-to-MAC address pair.
- Subsequent communication used MAC addresses directly without repeating ARP requests.
- This process demonstrated the dynamic mapping essential for efficient network communication.

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9. Conclusion

This project successfully demonstrated the operation and importance of the Address Resolution Protocol within a simple LAN. Using Cisco Packet Tracer, the ARP mechanism was visualized, showing how IP addresses are mapped to MAC addresses for devices to communicate on the same network. Understanding ARP is fundamental for networking in IIoT applications, where reliable and efficient device communication is critical.