

Recitation 7: Ethernet

Question

What problem are the authors trying to solve?

Answer: The authors aim to develop a simple, scalable, and cost-effective system for interconnecting multiple computers within a local network. At the time, there was a need for a reliable way to allow multiple machines to communicate without excessive wiring or centralized control, particularly in environments like research labs or offices.

Key challenges they address:

- Efficient sharing of a communication medium (minimizing collisions and delays)
- Decentralized control (avoiding single points of failure)
- Scalability (supporting more devices without significantly increasing complexity)
- Broadcast and packet switching capabilities (for flexibility in networked applications)

Question

What choices do they make, and how do they explain or justify those choices?

Answer:

- Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
 - Ethernet uses CSMA/CD, meaning:
 - * Devices listen before transmitting (Carrier Sense).
 - * Multiple devices can access the medium (Multiple Access).
 - * If two devices transmit simultaneously, they detect the collision and retry (Collision Detection).
 - * Justification: Avoids the need for central coordination and ensures fairness.
- Packet-Switched Rather Than Circuit-Switched Design
 - Data is sent in discrete packets rather than maintaining a dedicated connection.
 - Justification: More efficient use of network bandwidth and supports dynamic communication patterns.
- Exponential Backoff for Collision Handling
 - After a collision, each sender waits a random amount of time before retrying, with the waiting time increasing exponentially if collisions persist.
 - Justification: Prevents repeated collisions and helps the network recover from congestion.
- Use of a Shared Coaxial Cable as a Broadcast Medium
 - All devices connect to a single coaxial cable where packets are broadcasted and addressed.
 - Justification: Simplicity, cost-effectiveness, and ease of adding more devices.

Question

Do they mention alternatives? If so, what do they say is undesirable about those alternatives?

Answer:

- Time Division Multiplexing (TDM). Assigns fixed time slots for communication. Drawback: Inefficient when devices do not always need to transmit, leading to wasted slots.

- Centralized Control (e.g., Token Ring). A central entity or token-passing scheme determines when a device can transmit. Drawback: Adds complexity, increases latency, and introduces potential failure points.
- Circuit-Switched Networks. Establishes dedicated end-to-end connections. Drawback: Inefficient for bursty data traffic and limits flexibility.

Question

What is the connection between this paper and lecture?

Answer: The paper discusses efficiency, scalability, and fairness. We discussed these topics in lecture 1. Relating to the textbook chapters:

- Packet Forwarding Delay (7.1.2): Ethernet uses packet-switching rather than circuit-switching, which introduces potential delays due to collisions and retransmissions in CSMA/CD.
- Buffer Overflow Discarded Packets (7.1.3): Since Ethernet does not guarantee delivery, packets may be discarded if the receiver is overwhelmed, requiring higher-layer protocols to handle retransmission.
- Duplicate Packets Duplicate Suppression (7.1.4): Collisions and retransmissions can lead to duplicate packets, a problem mitigated by mechanisms at higher layers.
- Damaged Packets Broken Links (7.1.5): Ethernet's reliance on electrical signals over coaxial cable means that noise and physical damage can corrupt packets, necessitating error detection (e.g., CRC checks).