

Introduction to Computer Networks

Ethernet

CS640

<https://pages.cs.wisc.edu/~mgliu/CS640/S25/index.html>

Ming Liu

mgliu@cs.wisc.edu

Outline

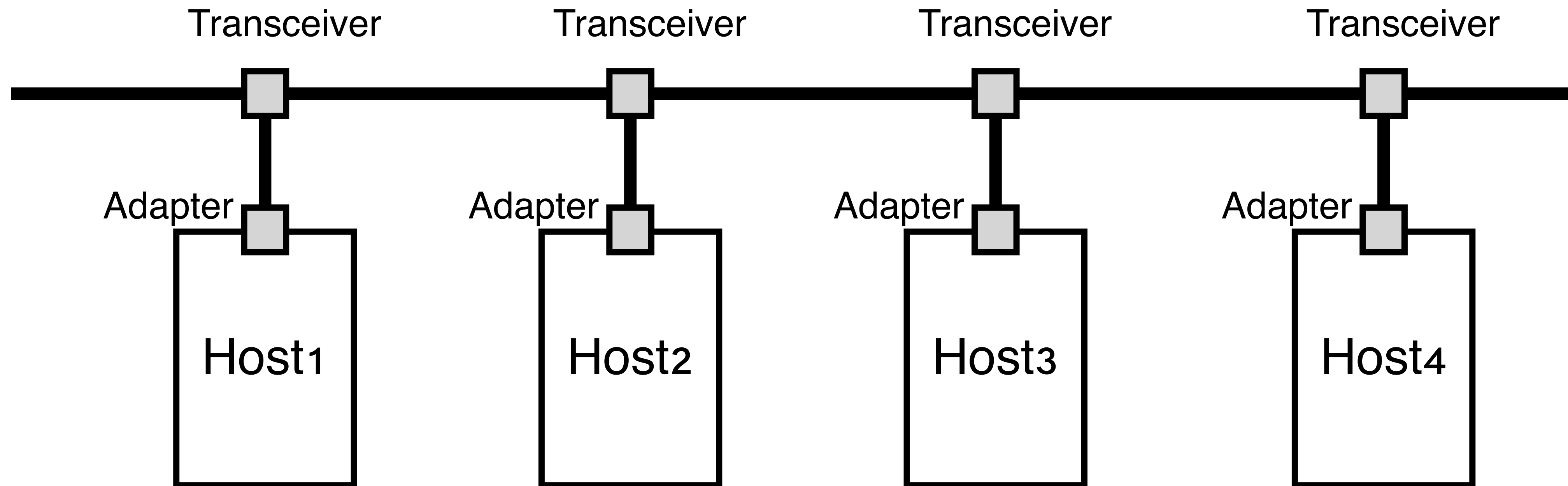
- Last
 - L2 Switching
- Today
 - Ethernet
- Announcements
 - N/A

Ethernet Dominates Local Area Network (LAN)

- LAN connects computers within a limited area
 - Popular in residence, campus, and building
 - Great competition in the 1980s, e.g., token ring, FDDI, ATM, Ethernet
- Why Ethernet succeeds
 - #1: The first widely deployed high-speed LAN
 - #2: Simple and cheap
 - #3: Sustain a higher data rate for each version
 - #4: Ethernet hardware becomes commodity

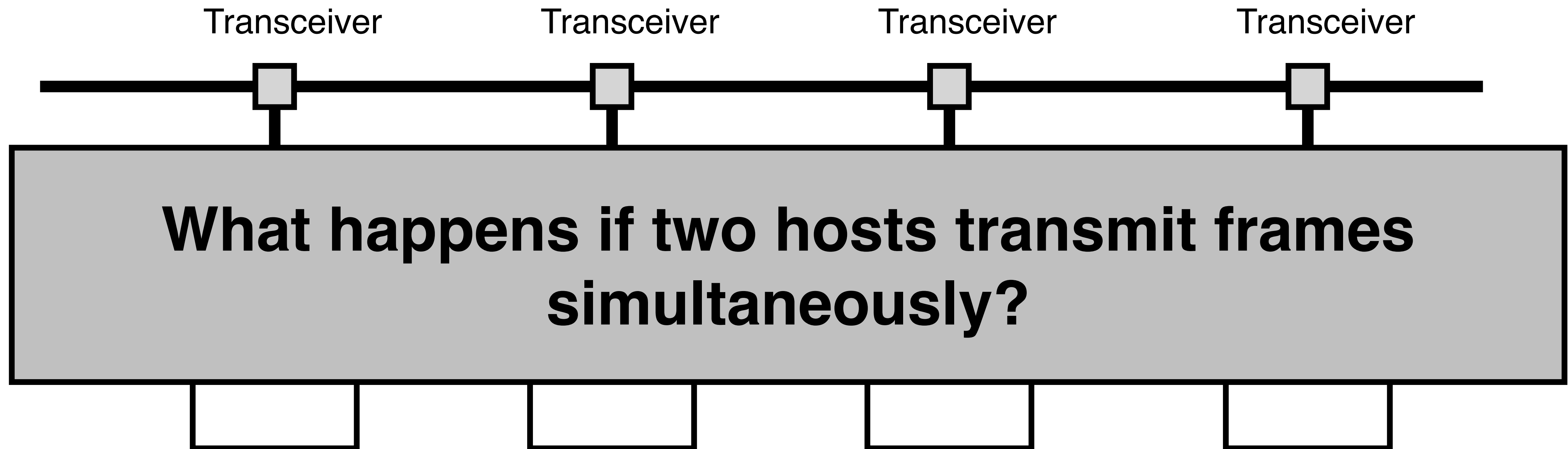
Ethernet (1970s to mid-1990s)

- Design for multiple access over a shared physical medium
 - Bus topology
 - All transmitted frames travel to and processed by all adapters connected to the bus



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CSMA/CD Overview

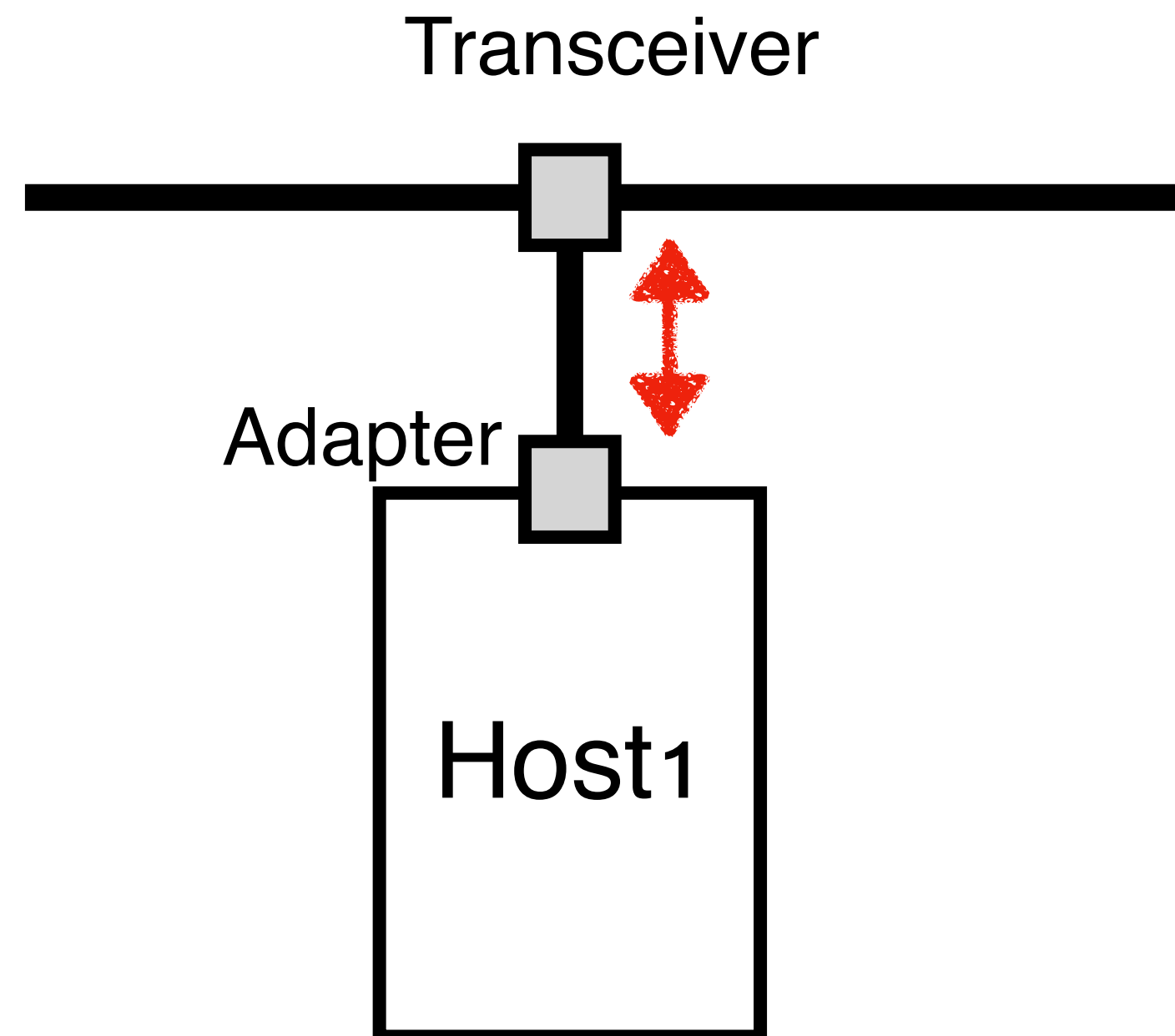
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CSMA/CD Overview

- Key idea: access the channel in a “random” fashion
 - When collisions occur, wait for a random interval and retransmit
- CSMA/CD Scheme:
 - #1: Carrier Sense (CS)
 - #2: Multiple Access (MA)
 - #3: Collision Detection (CD)

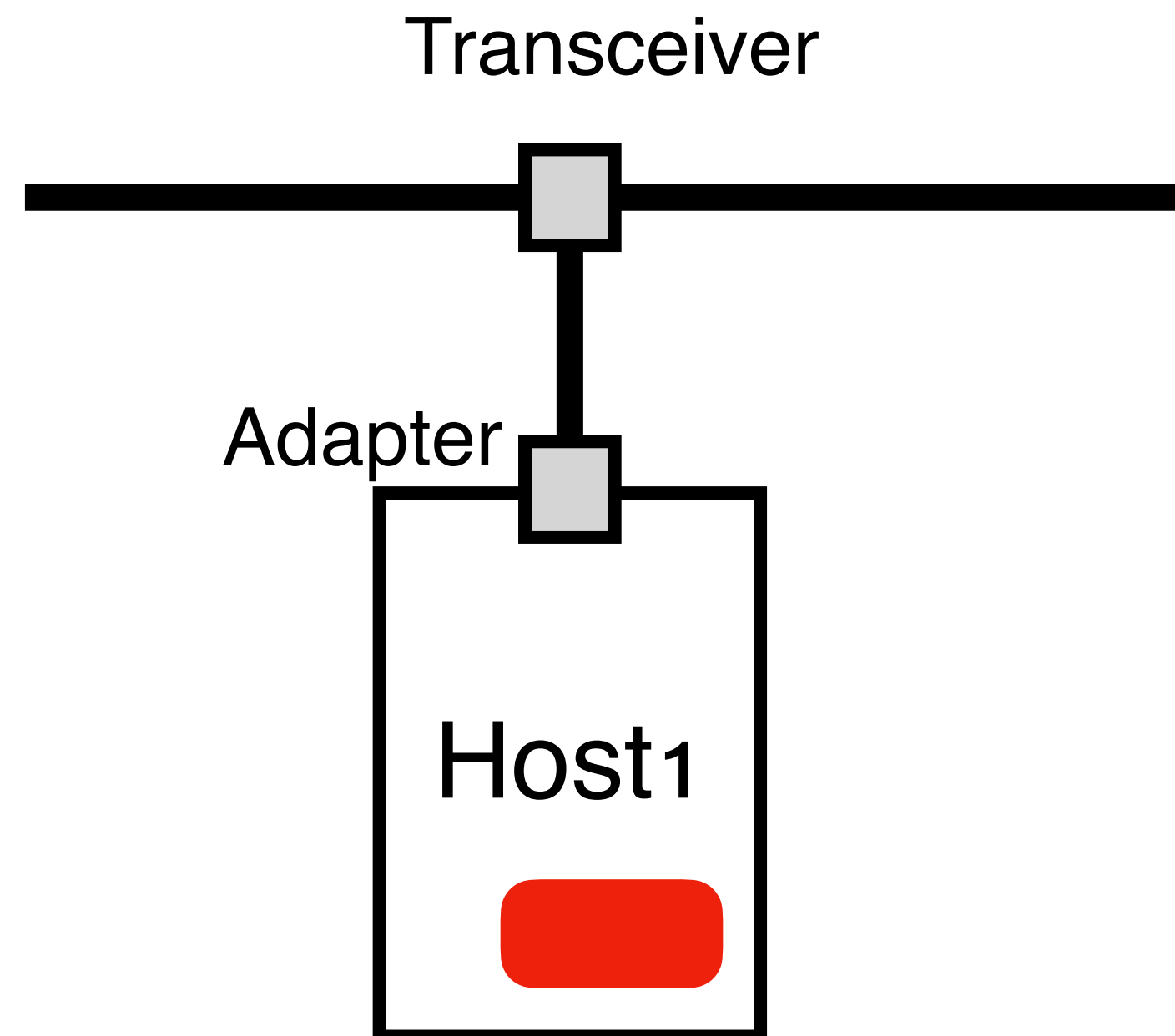
#1: Carrier Sense (CS)

- The transmitter senses the state of the communication carrier
 - Idle or busy
 - We use “transmitter” here to describe the host that sends a frame



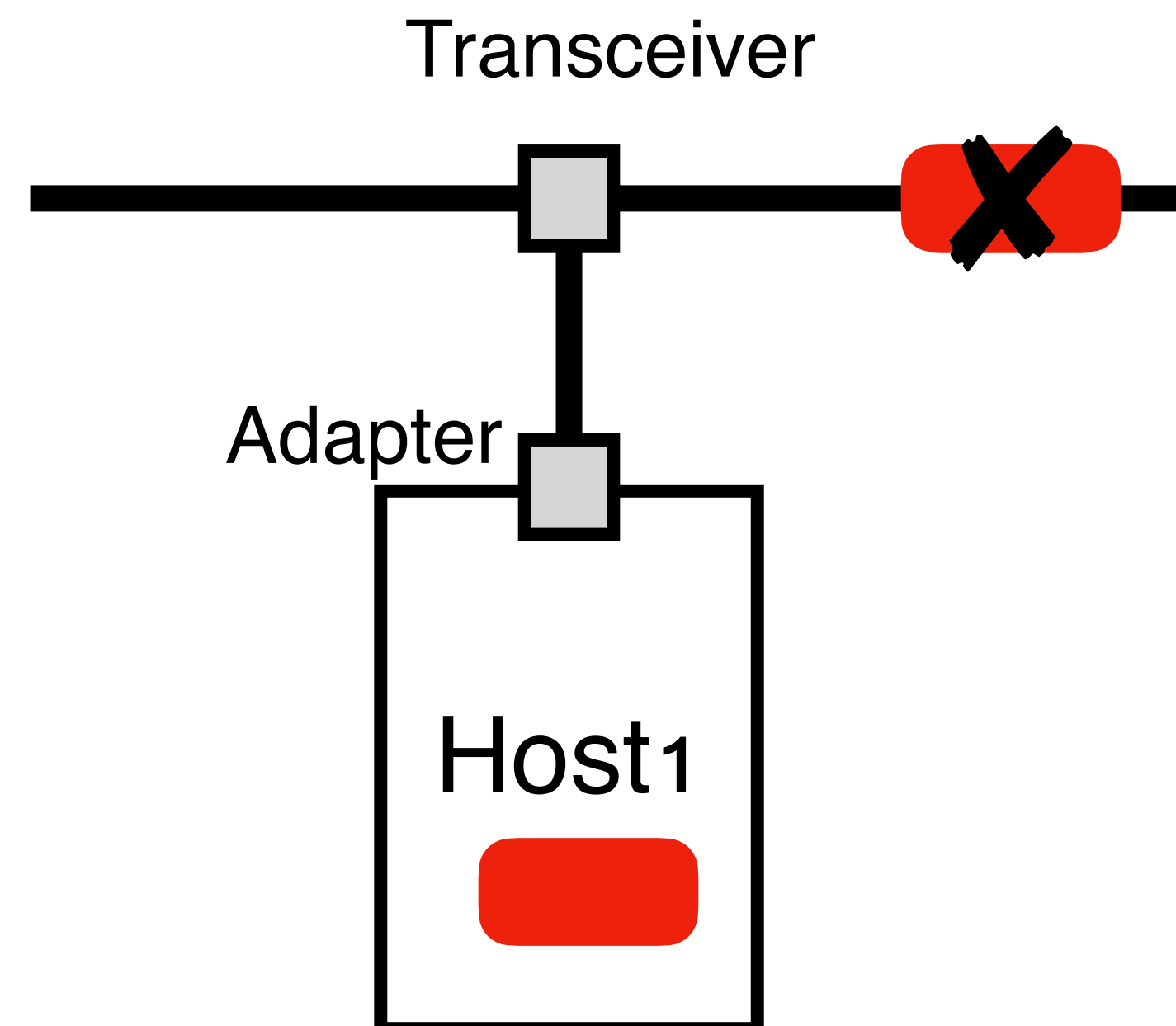
#2: Multiple Access (MA)

- The transmitter sends the frame with a **probability p** when idle
 - No coordination
 - The device makes the decision at the beginning of each time slot
 - p is pre-determined



#3: Collision Detection (CD)

- Under collision, the transmitter aborts the communication, performs exponential back-off, and sends the frame again
 - Postpone the transmission by an interval of T
 - The length of the interval T increases with every collision
 - $T = 2^{(i-1)} * X$, where i is the number of retries
 - X was configured as 51.2us originally



Early Ethernet Standards

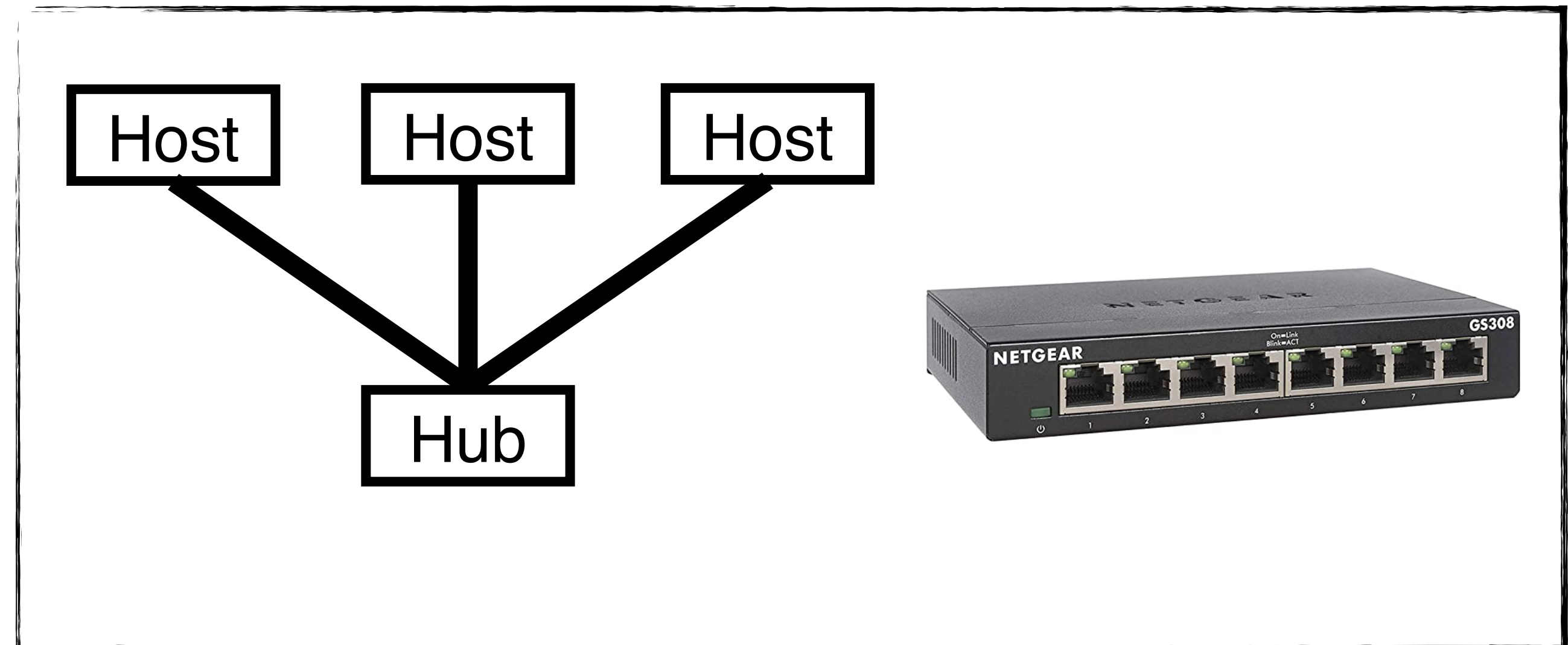
- Ethernet defines both the physical and link layers
 - 10BASE-T, 10BASE-2, 10BASE-5
- Naming
 - #1: “10” —> data rate: 10Mbps
 - #2: BASE —> Baseband Ethernet, i.e., the physical layer only carries Ethernet traffic
 - #3: Physical media itself
 - T —> Twisted-pair copper wires
 - 2 —> Thin coaxial cables
 - 5 —> Thick coaxial cables

Ethernet (mid-1990s to late-1990s)

- Ethernet is widely deployed at companies and universities
 - Bus topology —> Hub-based star topology
 - An Ethernet segment originally could support 500m at most
 - CSMA/CD is still needed



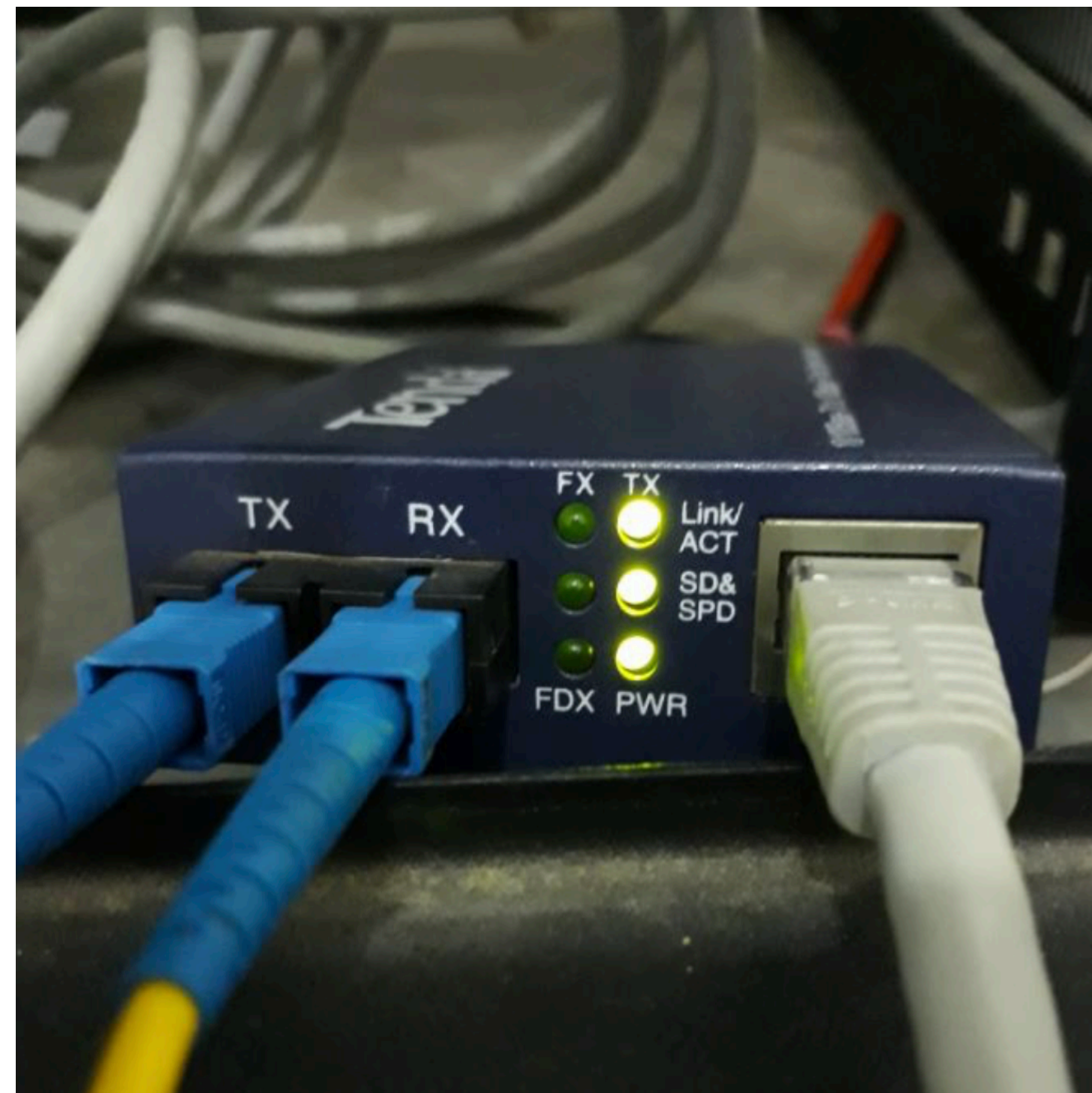
Network repeater



Network Hub

Ethernet Standards Envolving

- 100Mbps becomes widely used
 - Twisted-pair copper wires (100BASE-T)
 - Fiber optical (100BASE-FX, 100BASE-SX, 100BASE-BX)

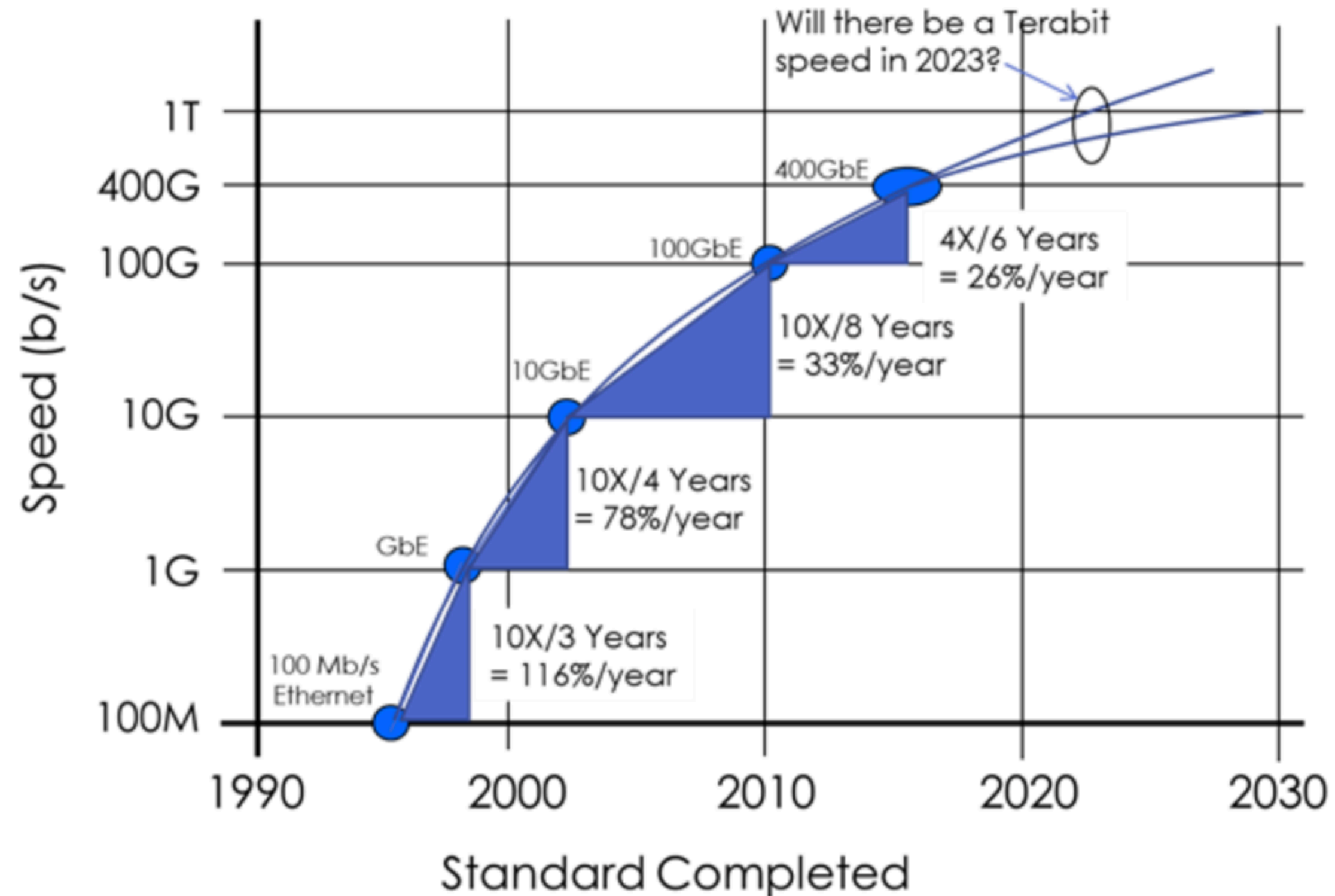


Ethernet (Since 2000s)

- Gigabit Ethernet
 - Ethernet switches are used and dominated
 - Full-duplex (send and receive happen simultaneously) device is common
- More importantly, CSMA/CD is no longer needed
 - Hub-based star topology → Switch-based star topology
 - Point-to-point communication → Isolated communication domain
 - Full-duplex mode → No send-and-receive interference

Rising Ethernet Data Rate

- 800GBASE is standardized
 - QSFP-DD and QSFP-112 transceivers are available
 - 1.6 Terabit Ethernet is under development



Summary

- Today
 - Ethernet

- Next lecture
 - Reliable communication at the link layer