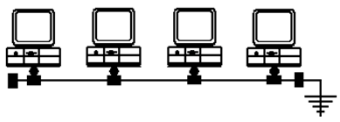
Lecture 8: Switched Ethernet & Collision Domains

Prof. Mohammed Hawa
Electrical Engineering Department
The University of Jordan

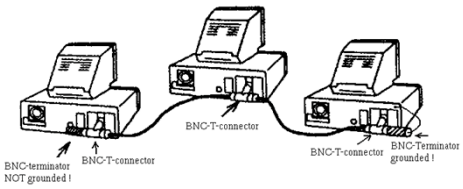
Old Ethernet Wiring: Coax

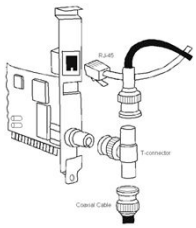
- **10BASE5**
- Thick coaxial cable RG-8/U (≈ 9.5 mm diameter).
- 500 meter maximum segment length, with repeater/regenerator between segments.
- 2.5 km maximum total length of all segments.



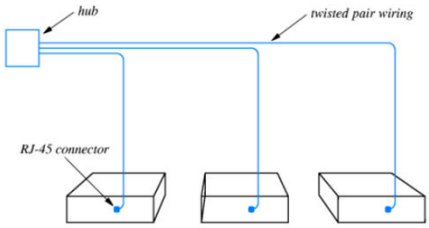
Cheaper Coaxial Cable

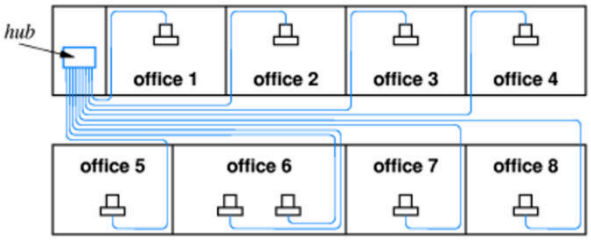
- **10BASE2**
- Thinner, cheaper, more flexible, RG-58A/U cabl (≈ 5 mm diameter).
- 185 m maximum segment length, with repeater/regenerator between segments.
- Maximum 4 repeaters (5 segments), so 925 m maximum total length.





Ethernet Installation: UTP Cable





Ethernet *Hub*

- Electronic device at the center of the network that replaces the coaxial cable used in earlier versions of Ethernet.
- The hub has physical *ports* (not to be confused with TCP port number).
- Each machine connects to one of the hub ports using either an unshielded twisted pair (UTP) or an optical fiber cable.
- The hub connects all the cables on its ports electronically (as if they were soldered together inside the hub).
- The hub **does not buffer** incoming frames. Instead if a voltage appears on one if its ports, the hub **retransmits** the same voltage on **all other** ports.
- Hence, the hub acts as a zero-length shared bus (like the old coaxial cable).
- We say that the logical topology is still bus topology, even though the physical topology is a star topology.

Ethernet *Hub* [2]

- Provides more reliable connection than a coax T-connector, and does not have impedance mismatch issues when a cable is accidentally disconnected, which means each port disconnection affects only one machine.
- Using twisted pair is popular because it is the cheapest of all cables.
- Maximum UTP cable run from the hub to the PC is only 100 m due to noise & attenuation.
- Fiber cables are used for longer runs (to connect different buildings). Runs up to 1 km or 2 km between the computer and the hub are allowed (but maximum distance between any two computers is limited to 2.5 km).
- Hub is different than switch or gateway or router (*see later*).

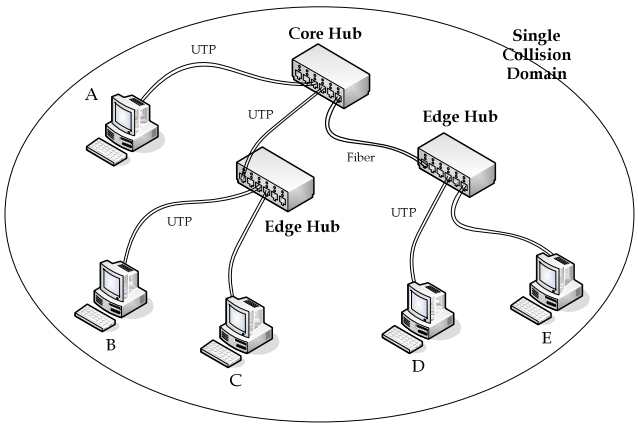
Twisted Pair and Fiber

- Twisted Pair Ethernet: 10Base-T, 100Base-TX, 1000Base-T, etc.
- Fiber Optics: 10Base-F, 100Base-FX, 1000Base-LX, etc.
- Wiring Closet: yellow cables are single mode fibers; orange and blue cables are multi-mode fibers: 50/125 μm OM2 and 50/125 μm OM3 fibers respectively; grey cables are twisted pairs.

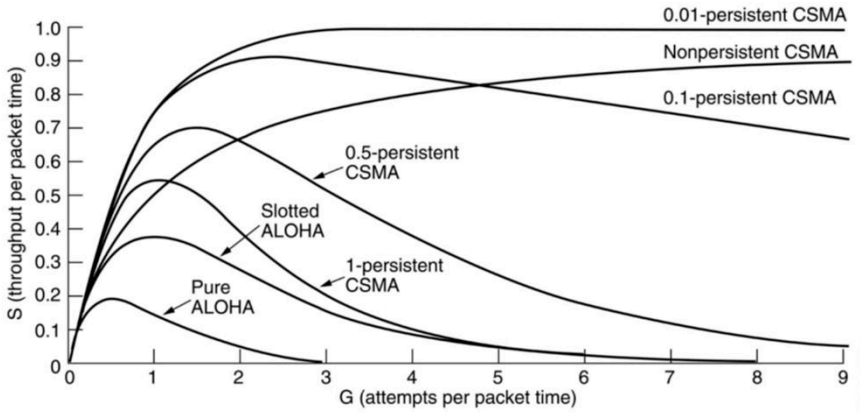
Non-Switched (Hub-based) Ethernet

Limitations:

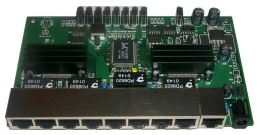
1. Signal strength considerations.
2. Half-duplex transmission (collisions).
3. MAC protocol considerations.
4. Heavy load affects throughput.
5. Broadcast storms are possible.



Throughput

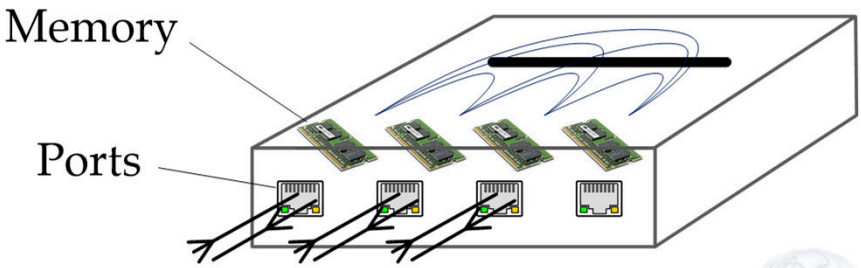


Ethernet *Switch*

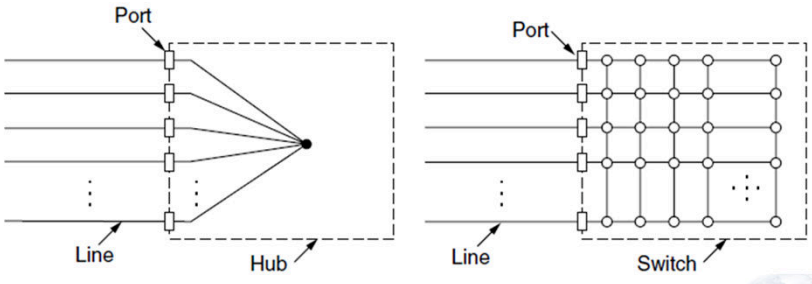


- An Ethernet switch physically resembles a hub, but is different.
- A switch **buffers** any frame it receives on one of its ports into its memory (RAM), then sends the frame on an internal high-speed backplane (switching fabric) to the destination port. The switch uses the backplane to transmit the frame to all other ports without collisions (except maybe the port the frame arrived at).
- Hence, each port of an Ethernet switch is its own **collision domain**.
- Sometimes, the switch is connected to the computer NIC using two pairs of twisted wires (4 wires) to allow full duplex communications without collisions on that port, as data can flow from the computer to the buffers of the switch and backwards simultaneously.
- This was advertised as double the link speed (e.g. 200 Mbps Ethernet instead of 100 Mbps), but is called full-duplex 100 Mbps.

Switched Ethernet



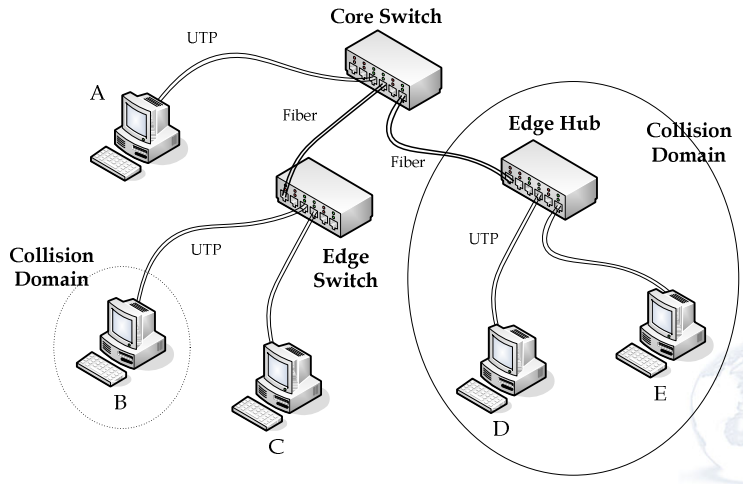
Switching Fabric



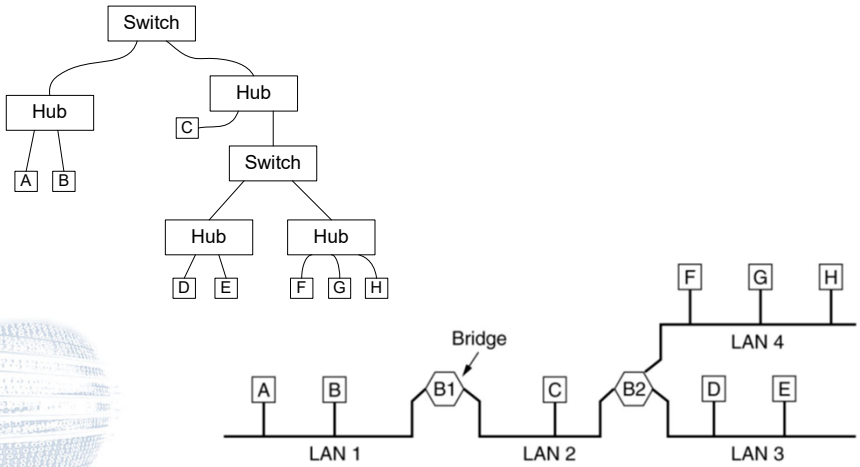
Ethernet *Switch* [2]

- Since collisions are avoided in an Ethernet switch, the different ports are allowed to receive and transmit frames at the same time, for parallel, full-duplex operation, something not possible with CSMA/CD on a single shared channel (a single collision domain).
- When full-duplex mode is used, the CSMA/CD protocol is switched off (new Ethernet NICs auto negotiate working in full-duplex or half-duplex depending if they are connected to a hub or switch).
- Ethernet switches are Layer 2 devices while hubs are Layer 1 devices. Switches understand the MAC layer of Ethernet, MAC addresses, etc, and they can negotiate half-duplex (with CSMA/CD) or full-duplex (no CSMA/CD) modes based on the situation.
- CSMA/CD limitations are removed in switched Ethernet, and performance (in terms of throughput and delay) is enhanced.
- Switches are also called bridges (bridges were used to connect LAN segments, or interface between different LAN technologies, such as Ethernet and Wi-Fi).

Switched Ethernet



Physical vs. Logical Diagram



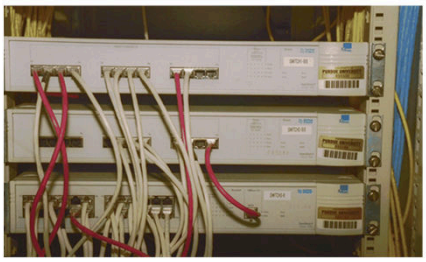
Equipment

- A Cat-5 UTP cable with connectors (RJ-45 connector)
- Low-end switches (used at the edge of the network) (Cost: $10 – $100)




Equipment [2]

- Medium-end switches (used at the edge and aggregation points of the network) (Cost: $300 – $1,000)
- Wiring closet



Equipment [3]

- High-end switches (used at aggregation points and the core of the network)
- (Cost: $2,000 – $60,000 depending on selected modules)
- (e.g, Cisco Catalyst 3500 Series, Cisco Catalyst 6500 Series, Juniper EX series, HPE, Huawei, Arista, etc).