Speeds of LANS & Computers

• LAN speeds are fast compared to CPU speeds.

• Example: A 500 MHz CPU can execute at most 5 instructions for each bit on a 100 Mbps Ethernet. Several instructions are required for each bit.

• It does not make sense to operate a network at a speed suitable for the slowest CPU.

• On the other hand, it does not make sense to require that all computers operate at the same speed.
Speeds of LANS & Computers

• LAN speeds are defined independently of processor speeds.
  - Allows for a mix of attached systems.
  - New computers can be attached without affecting the LAN speed.
Network Interface Hardware

• Since a CPU can’t process data at network speeds, computer systems use special-purpose network hardware.

• **network adapter card or network interface card (NIC)** - a hardware device that plugs into a computer and connects to a network.

• Most computers come with a NIC preinstalled.

• A NIC is built for one kind of physical network.
NIC & CPU Processing

• A NIC contains sufficient hardware to process data independently of a computer’s CPU.
  - Some NICs contain a separate microprocessor.
  - A NIC includes analog circuitry, an interface-to-system bus, buffering, and processing.
• A NIC looks like any other I/O device to the system CPU.
NIC & CPU Processing

• To transmit:
  - The CPU forms packets and instructs the NIC to begin transmission.
  - The CPU can do other things while the NIC handles transmission details.
  - When finished transmitting, the NIC interrupts and informs the CPU.
NIC & CPU Processing

• To receive:

  - The NIC interrupts the CPU only when it receives frames intended for the computer.
  - The NIC discards frames not intended for the computer without bothering the CPU.
Connecting a NIC & a Network

• Two possibilities:
  - The NIC contains all the circuitry and connects directly to the network medium.
  - A cable from the NIC connects to additional circuitry that then attaches to the network medium.

• **Example:** Thin Ethernet vs 10Base-T. Both are Ethernet, and yet each uses a different connection style.
Thick Ethernet Wiring

• The original Ethernet wiring scheme.
• Uses a thick coaxial cable.
• Formally called 10Base5.
• An Attachment Unit Interface (AUI) cable carries a digital signal from a NIC to a transceiver.
• The transceiver attaches directly to the coax. Its function is to convert a digital signal from a NIC to an analog signal on the coax and vice versa.
Thick Ethernet Wiring

• In addition to carrying digital signals, an AUI cable has wires to supply power to the transceiver and wires to control the transceiver.

• Each end of the Ethernet cable requires termination.

• terminator - a device (essentially a resistor) to prevent electrical signals from reflecting back.
Connection Multiplexing

• Thick Ethernet wiring with a transceiver for each station can be inconvenient.

• A connection multiplexor can be used to connect several computers to a single transceiver.
  - Each computer’s AUI cable is connected to a connection multiplexor.
  - Only one AUI cable runs from the multiplexor to the Ethernet coax.

• The connection multiplexor is completely invisible to the attached computers.
Thin Ethernet Wiring

• Uses a thinner more flexible coaxial cable.
• Cheaper and easier to install.
• The transceiver electronics are built into the NIC.
• Thin Ethernet does not use an AUI cable.
• The connection from a NIC to the Ethernet cable is made with a BNC connector.
Thin Ethernet Wiring

• The thin Ethernet coax runs directly to the back of each computer.
• A T connector attaches directly to a NIC.
Thin Ethernet Wiring

- Thin Ethernet is useful when many computers are located near each other.
- May be unreliable.
Twisted-Pair Ethernet

• Also called 10Base-T or TP Ethernet.
• Replaces AUI cable with twister-pair cable and RJ-45 connectors.
• Replaces thick coax with a hub.
Hubs

• A hub is an extension of the connection multiplexing concept.
• Sometimes called an “Ethernet in a box.”
• A hub is effectively a very short Ethernet cable with very long AUI cables.
• Hubs come in all sizes.
Protocol Software & Ethernet Wiring

- All wiring schemes use the same Ethernet specification.
  - Same frame format.
  - Same CSMA/CD algorithms.
- A NIC can provide connections for all 3 wiring schemes.
- The protocol software does not and cannot distinguish the wiring scheme.
Comparison of Wiring Schemes

• Separate transceivers allow computers to be turned off or disconnected from a network without disrupting others.
• Transceivers are often located in inconvenient locations.
• Finding a malfunctioning transceiver can be difficult.
• The original thick Ethernet coax is more expensive than thin Ethernet coax which, in turn, is more expensive than 10Base-T.
Comparison of Wiring Schemes

- Disconnecting one computer from a thin Ethernet or a loose connection on a thin Ethernet can disrupt an entire network.

- Hub wiring centralizes the electronics and makes management easier.

- Disconnecting a single wire from a hub disables only one computer and not the rest of the network.

- **Bottom line**: 10Base-T is the most popular wiring scheme.

  **Reason**: Cost.
Physical vs Logical Topologies

- Be careful to distinguish between a network’s physical and logical topologies.

<table>
<thead>
<tr>
<th>Physical</th>
<th>Logical</th>
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<tbody>
<tr>
<td>10Base-T Ethernet</td>
<td>star</td>
</tr>
<tr>
<td>“bus in a box”</td>
<td></td>
</tr>
<tr>
<td>Hub Token Ring</td>
<td>star</td>
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<tr>
<td>“ring in a box”</td>
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