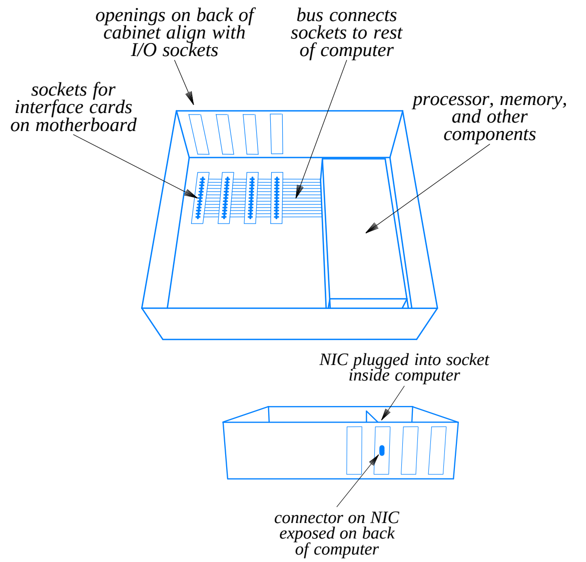
LAN WIRING, PHYSICAL TOPOLOGY, AND INTERFACE HARDWARE

Network Interface Hardware

- Many local area networks operate at a very high speed
- Usually, the CPU of a computer can not process bits at a network speed
- To solve this problem, a special-purpose hardware is needed to
  - Handle all the details of packet transmission/reception
  - Connect a computer to a network
- This special-purpose hardware is a printed circuit board; it is known as a *network adapter card*, or *Network Interface Card* (NIC)
- The NIC is a network dependent card; it only
  - Understands the electrical signals used on that network
  - Understands the details of the frame format of that network
  - Operates at a rate which is suitable to send/receive data from the network

For example, an NIC designed to be used with Ethernet network can not be used with a Token Ring network, and vice versa

- An NIC operates independent of the computer's CPU
- From the CPU's point of view, an NIC appears to operate like any I/O device
- An NIC only interrupts the CPU
  - When a correct frame belonging to the computer arrives
  - To inform the CPU that the required transmission is done



The location of I/O sockets inside a typical computer, and how an NIC is connected

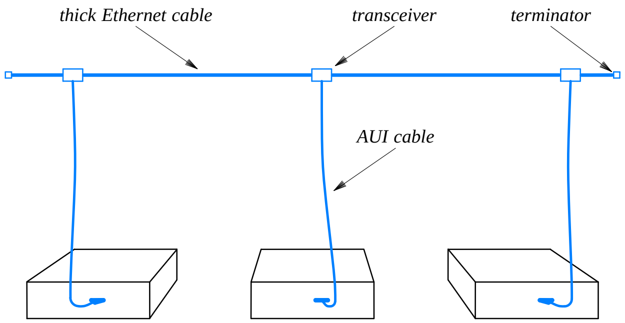
The Connection Between An NIC and A Network

- The type of connection used between an NIC and a network depends on the network technology
- In some technologies, the NIC contains most of the necessary hardware and it is attached directly to the network medium
- In many other technologies, the NIC does not contain all the electronic circuitry needed to attach directly to the network; instead, the cable from an NIC attaches to an additional electronic component that then attaches to the network
- The exact details of the connection between an NIC and a network are not determined by the network technology, i.e., a given network technology can support multiple wiring schemes
  - Example: Ethernet technology supports three dramatically different wiring schemes, even though all of them use the same Ethernet frame format, CRC, ...etc

Original Thick Ethernet Wiring

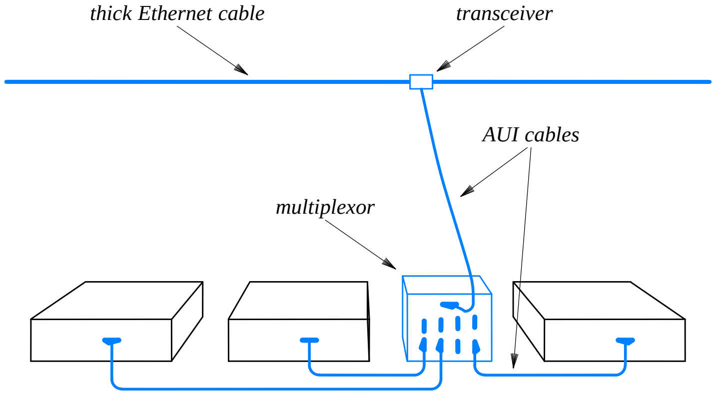
- The communication media consists of a large coaxial cable, *thick wire* (10Base5)
- 10Base5 means
  - Bit rate is 10 Mbps
  - Signaling method is Baseband
  - Maximum segment length is 500 meters
- The wiring scheme is called *thick wire Ethernet*, or *thicknet*
- The NIC contains circuitry that handles the digital aspects of communication, but it does not handle analog signals, e.g., detect a carrier, covert bits into appropriate voltages for transmission
- To connect a computer to a thicknet, you have to have an external hardware device called *transceiver*

- The cable connecting an NIC to a transceiver is known as an *Attachment Unit Interface* (AUI) cable
- The connectors on the NIC and transceiver are known as AUI connectors
- A terminator, which consists of a resistor that connects the center wire in the cable to the shield, is essential
- The transceiver electrical power comes from the NIC



A thick Ethernet

- Connecting more than a computer to the same transceiver is possible, by using multiplexor

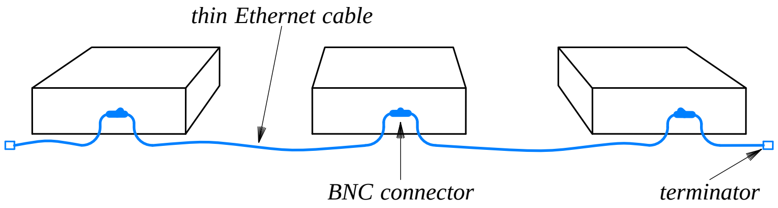


A connection multiplexor

Thin Ethernet Wiring

- The communication media consists of a thinner, more flexible, coaxial cable, thin wire (10Base2)
- 10Base2 means
  - Bit rate is 10 Mbps
  - Signaling method is Baseband
  - Maximum segment length is 200 meters
- The wiring scheme is called *thin wire Ethernet*, or *thinnet*
- The NIC contains circuitry that handles both the digital and analog aspects of communication; therefore, transceiver is not needed

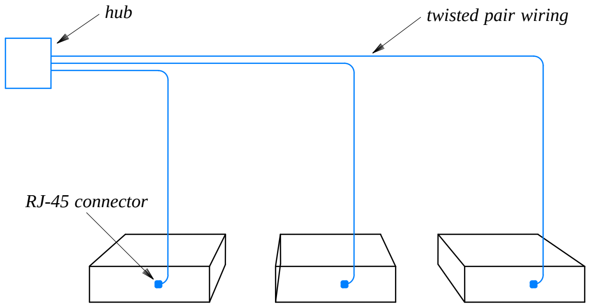
- The thinnet does not use an AUI cable to attach the NIC to the communication media; it attaches directly to the back of each computer using a *Bayonet Network Connector* (BNC)
- A terminator is essential



A thin Ethernet

Twisted Pair Ethernet Wiring

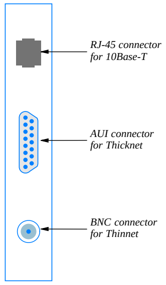
- The communication media consists of a twisted pair (10BaseT)
- The meaning of 10BaseT is similar to 10Base5 and 10Base2, but the T here means the media is Twisted pair
- The wiring scheme is called *twisted pair Ethernet*, or *TP Ethernet*
- The NIC contains circuitry that handles both the digital and analog aspects of communication; therefore, transceiver is not needed



A TP Ethernet

- TP Ethernet does not have a shared physical medium like the the thick and thin wiring schemes
- TP Ethernet extends the multiplexing idea; by using an electronic device which serves as the center of the network (Ethernet hub)
- The connectors on the NIC and the Ethernet hub are known as RJ-45 connectors (Registered Jack 45)
- RJ-45 connector is a larger version of the modular RJ-11 connectors used with telephones
- The electronic components in a hub simulate a physical cable, making the entire system operates like a conventional Ethernet; Think of it as if the entire shared cable is compressed and put inside the hub (i.e., *bus in a box* or *network in a box*)
- TP Ethernet is physically a star topology, but logically a bus topology; hence it is often called *star-shaped bus*

Network interface Cards and wiring Schemes



An NIC can support the three basic wiring schemes

- Main advantage: A site can choose a wiring scheme or change to different wiring without replacing the interface hardware, hence the computer physical address remains the same
- Although multiple connectors remain in place at all time, a given interface can use only one wiring scheme at a time
- Software in the computer must activate one of the connectors, while the others are not used

A Comparison Between Different Wiring Schemes

- Thicknet
  - If a transceiver fail, the rest of the network still can operate (transceivers are separate); advantage
  - Transceivers are often located in a remote locations that is difficult to reach, e.g., a hallway ceiling in an office building; in case of failure, it is tedious to find, test, or replace a transceiver; disadvantage
- Thinnet
  - Does not have an external transceiver; advantage
  - costs less per connection than the Thicknet; advantage
  - Thin wires are more flexible than thick wires; advantage
  - The whole network is subject to a disconnection; just un-plug the main cable; note that there are no tools required to disconnect the BNC connectors; disadvantage

- TP Ethernet
  - More immune to an accidental disconnection; disconnecting a twisted pair affecting only one machine; advantage
  - costs less per connection than the Thinnet; advantage
- The actual network cost is not an easy thing to calculate; it depends on
  - Number of computers
  - The distance between them
  - The physical placement of walls
  - The interface hardware and wiring cost
  - Diagnosing and repairing cost
  - How frequently new computers will be added
  - How frequently existing computers will be moved
- It is possible to mix wiring schemes on a single network

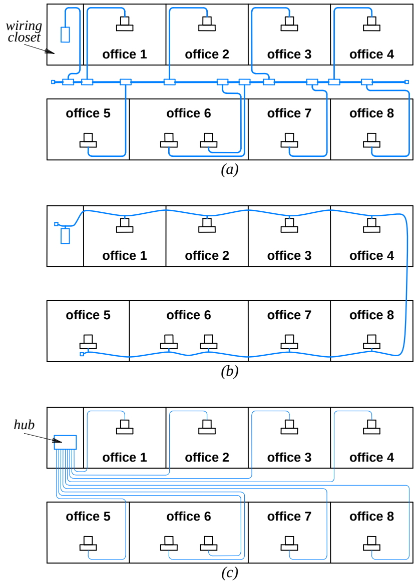


Illustration of computers in 8 offices