Ethernet and IEEE 802.3

- Ethernet is the dominant local area networking technology
  - A local area network (LAN) is a computer network covering a small geographic area (e.g., a home, an office, a building)

- History of Ethernet
  - Ethernet was developed at the Xerox Palo Alto Research Center (PARC) between 1973 and 1974.
  - DEC and Intel joined Xerox to define a 10-Mbps Ethernet standard (the DIX standard) in 1978.
  - DIX standard formed the basis for IEEE 802.3, which is a collection of IEEE standards defining the physical layer and data link layer's media access control (MAC) of wired Ethernet.

- The DIX Ethernet
  - An Ethernet segment is implemented on a coaxial cable of up to 500 m
    - Signal becomes weaker as it travels; this imposes a limit on the length of an Ethernet segment
  - Multiple Ethernet segments can be joined together by *repeaters*
    - A repeater has two ports; it forwards signals from one port to the other
    - A repeater is a physical layer device: it understands bits, not frames
  - No more than 4 repeaters may be positioned between any pair of hosts → An Ethernet has a maximum reach of 2500 m
• Any signal placed on the Ethernet by a host is broadcast over the entire network

• Varieties of Ethernet (specified in IEEE 802.3)
  • Cabling: coaxial, twisted pair, fiber optic
  • Speeds: 10Mbps, 100Mbps, 1Gbps, 10Gbps, 40Gbps, 100Gbps
  • Devices: repeaters, hubs
    ▪ A hub is a multi-way repeater for connecting multiple Ethernet devices together and making them act as a single network segment
    ▪ A hub forwards signals on all ports other than the incoming port
  • Limitation of repeaters and hubs: all hosts are in the same collision domain
    ▪ Data transmitted by any one host on the Ethernet reaches all the other hosts
    ▪ When two hosts transmit frames at the same time, collision occurs

• DIX Ethernet frame format
  • Preamble (64bit): Seven bytes of 10101010 followed by one byte of 10101011
    ▪ Allows the receiver to synchronize with the sender
  • Source and Destination Address (48bit each): identifies the sending Ethernet adapter and the receiving Ethernet adaptor
  • Type (16bit): identifies the higher level protocol to which the payload of this frame should be delivered.
    ▪ In IEEE 802.3: the Type field is replaced by the Length field, which indicates the size of the payload in bytes
    ▪ If the value of this field is greater than 1500, the field is used as Type; otherwise it is used as Length.
Body: at least 46 bytes, at most 1500 bytes
- CRC (32bit)

Ethernet addresses
- Each Ethernet adaptor has a unique 6-byte unicast address
  - E.g., 8:0:2b:e4:b1:2 (each byte is given by a pair of hexadecimal digits, leading 0s are dropped)
- An Ethernet address consisting of all 1s is a broadcast address
- An address that has the least significant bit in the first octet set to 1 but is not the broadcast address is called a multicast address

Ethernet adaptor receives all frames and accepts
- frames addressed to its own address
- frames addressed to the broadcast address
- frames addressed to a multicast address, if programmed to listen to that address
- all frames, if placed in promiscuous mode

Transmitter algorithm: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) – see slides

Why must an Ethernet frame be at least 64 bytes long?
- A host must transmit for \(2 \times d\) (\(d = \) link delay) to be sure that it detects all possible collisions
- The RTT of a maximally configured Ethernet (2500 m long with 4 repeaters) has been determined to be 51.2 \(\mu\)s; on 10 Mbps Ethernet this corresponds to 512 bits (64 bytes)
- In order for the sender to detect collision before finish transmitting a frame, the frame must be at least 64 bytes long

Ethernet provides unreliable service
- Receiver does not send ACKs
- Packets passed to network layer can have gaps
  - Ethernets work best under lightly loaded conditions
    - Under heavy loads, too much of the network’s capacity is wasted by collisions
- Why Ethernets have been so successful?
  - Easy to administer and maintain: no switches, no routing tables, easy to add a new host
  - Inexpensive