COMP202-08B
Computer Communications

Lecture 6 – Ethernet

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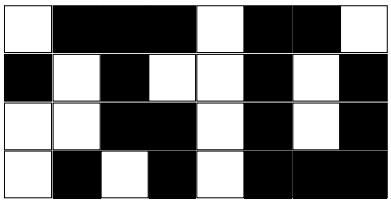
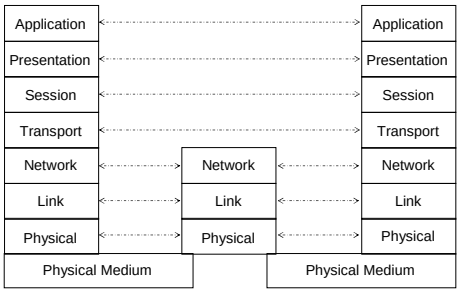
In-class demonstration

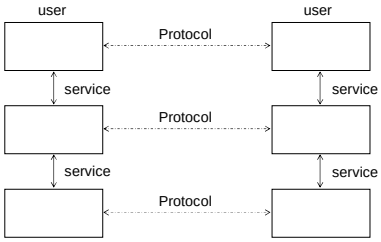


Open Systems Interconnection (OSI)

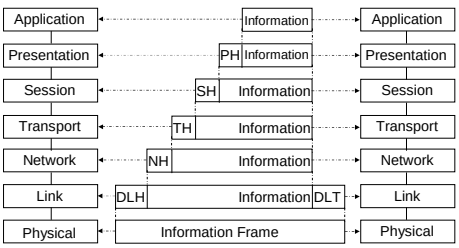


OSI layers

- Each OSI layer provides a service

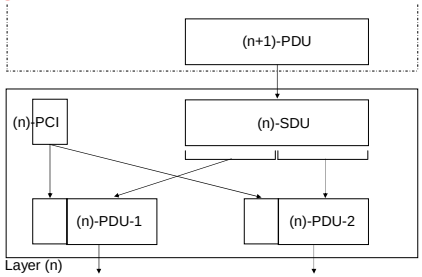


Encapsulation



- Information is encapsulated inside of headers
- Kind of like how a sub-class extends features of another class by adding something to the class
- Product is a 'Frame'

Segmentation



Lower layers will have a fixed maximum size. Sometimes a Protocol Data Unit (PDU) will have to be segmented to allow it to fit.
Protocol Control Information (PCI) is added to each Service Data Unit (SDU).

OSI Layers and the Internet

- Application
- Presentation
- Session
- Transport — TCP
- Network — IP
- Data Link — Ethernet
- Physical — Ethernet ← Today's focus

Ethernet Local Area Networks (LANs)

- Goal of a network is to connect a bunch of computers together
  - Could have many point to point links, but inefficient to do this in terms of resources required
- Local Area Network
  - Computers share a set of cables and take turns to exchange information in some organised way
    - Star (Ethernet)
    - Bus Topologies (Ethernet)
    - Ring (Token ring systems)

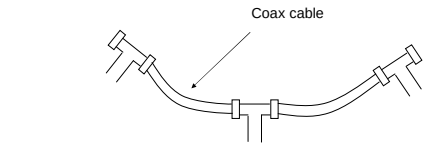
Ethernet

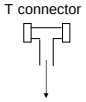
- Xerox 1970s: Metcalfe
- DEC, Intel, Xerox (DIX standard)
- Frames
- IEEE standard 802.3
  - Thick wire Ethernet (10Base5)
  - Thin wire Ethernet (10base2)
  - Twisted pair Ethernet (10baseT)
  - Optical fibre Ethernet (10baseFL)
  - Fast Ethernet (100base-…)
  - Gigabit Ethernet (1000base-…)
  - Speed (Mbps) + baseband + cabling standard

Ethernet

- Designed in the era of a shared coaxial cable being the medium
- Goal was to efficiently share the bandwidth available amongst connected nodes
- CSMA/CD
  - Carrier Sense: if a signal from another station is being broadcast, don't speak over the top
  - Multiple Access: multiple nodes want to share the medium
  - Collision Detect: if another station begins transmitting at the same time, back off a random amount of time and start again

10base2 Ethernet



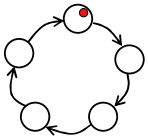


Bus topology

Shared Medium
Half duplex
185 metre range

Token ring

- Special type of organising a Bus topology to control access to medium
- Not seen very much these days
- A node may only transmit when it has the token
- Token is passed around (logically in a ring)



Transmitting and Receiving

- Half duplex
  - Station can transmit and receive on the same medium, but can't do both at the same time
- Full duplex
  - Station can transmit and receive on the same medium at the same time
- Simplex
  - Station can only transmit
  - Station can only receive

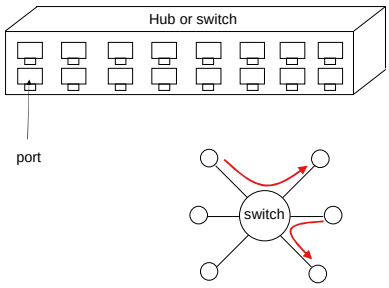
Ethernet Today

- Very few coaxial cable networks
  - Coax is heavy, expensive, and has limited bandwidth.
- Mostly twisted pair using Category 5 cables
  - Tighter the twist, the more resistant to interference
  - Full duplex: separate pairs for transmitting and receiving
- Some fiber-optic based Ethernet
  - Long distance
  - Does not conduct electricity!
  - Good when connecting two buildings by running cable under the ground.

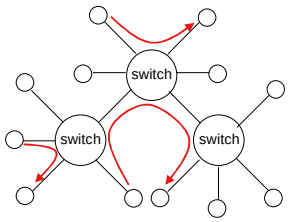
Cat5 Ethernets

- Category 5 twisted pair
- Most common scenario
- Hubs
  - Send frames out all ports (broadcast)
  - Cheap devices, inefficient, not seen very much now since switches are also cheap
- Switches
  - Listen to traffic arriving on ports, remember (learn) which nodes transmit through each port
  - Direct frames out appropriate port as learned

Cat5 Ethernets



Cat5 Ethernets



Frames can be switched so that the Ether can carry 3 frames simultaneously, since they use different physical paths

Cat5 Ethernets

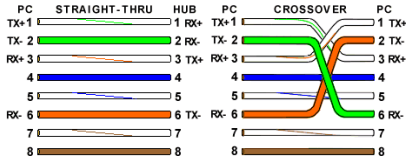


Image: DUX computer digest

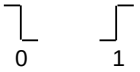
- Crossover cable
  - Cat5 cable where transmit pair at one end has been wired to receive pair at other end, and vice versa
  - Used to link hubs and switches together
  - Used to directly connect computers to each other without intermediate hub or switch
- These days, network interfaces are smart enough to figure out whether a crossover or straight-through cable has been used and adjust appropriately

Twisted pair: Signals and Timing

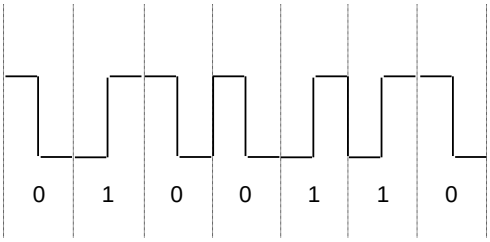
- Ethernet systems use an encoding system that combines signal and timing
- Goal is to provide regular transitions in voltage level so receiver can ensure their clock is running at an appropriate rate
- 10baseT: Manchester encoding
- 100baseTX: 4B5B

10baseT: 802.3 Manchester Encoding

- Goal is to ensure regular voltage transition for clocking
- 0 is conveyed by going from high to low
- 1 is conveyed by going from low to high
- Clock rate is twice the data rate: not terribly efficient



10baseT: 802.3 Manchester Encoding



Summary

- OSI 7 layer model
- Encapsulation of information to form frames
- Defined some physical characteristics of Ethernet

- Next lecture
  - Link-layer characteristics of Ethernet