Ethernet

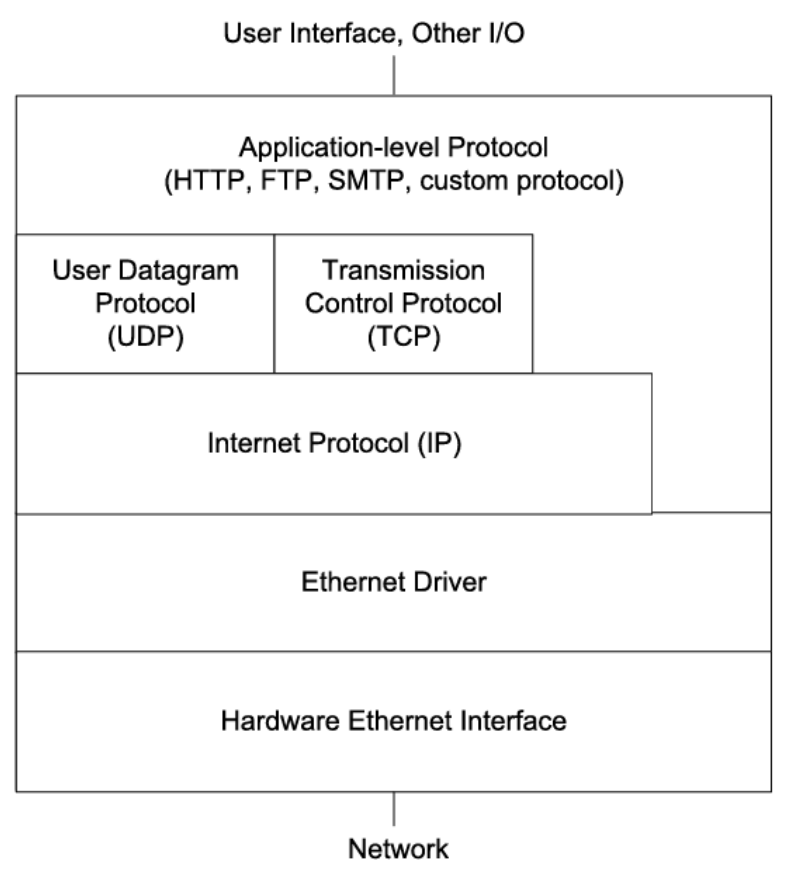
Last updated 4/29/20

Applications

- History

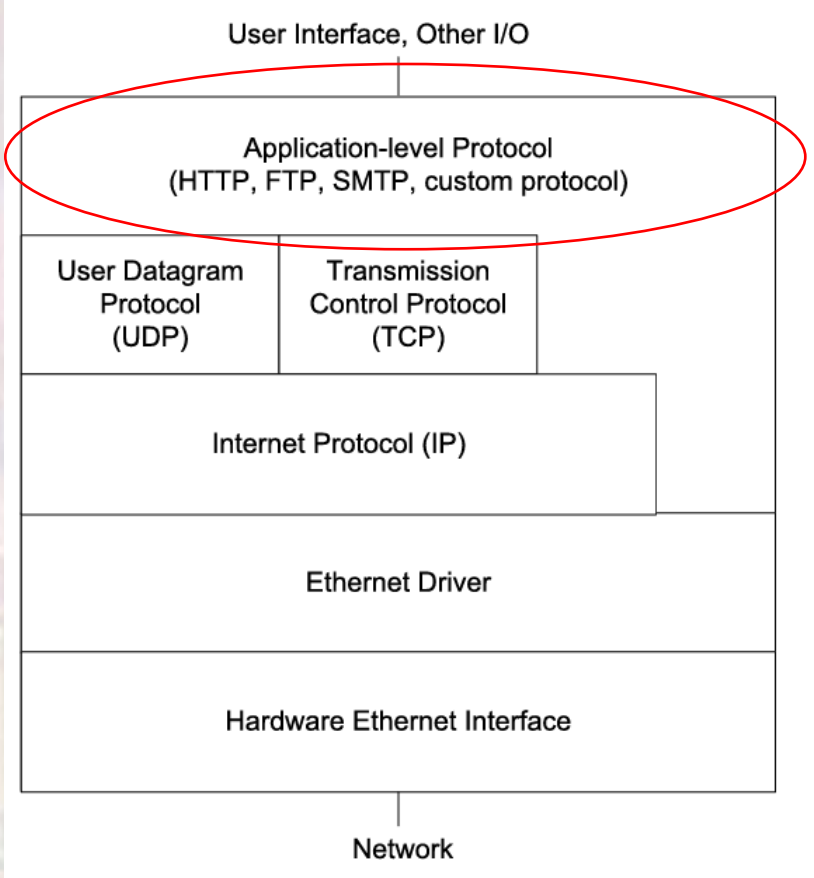
Applications

- OSI
  - Open Systems Interconnect
  - MAC
    - Media Access Layer
    - Network
    - Data Link
    - Physical



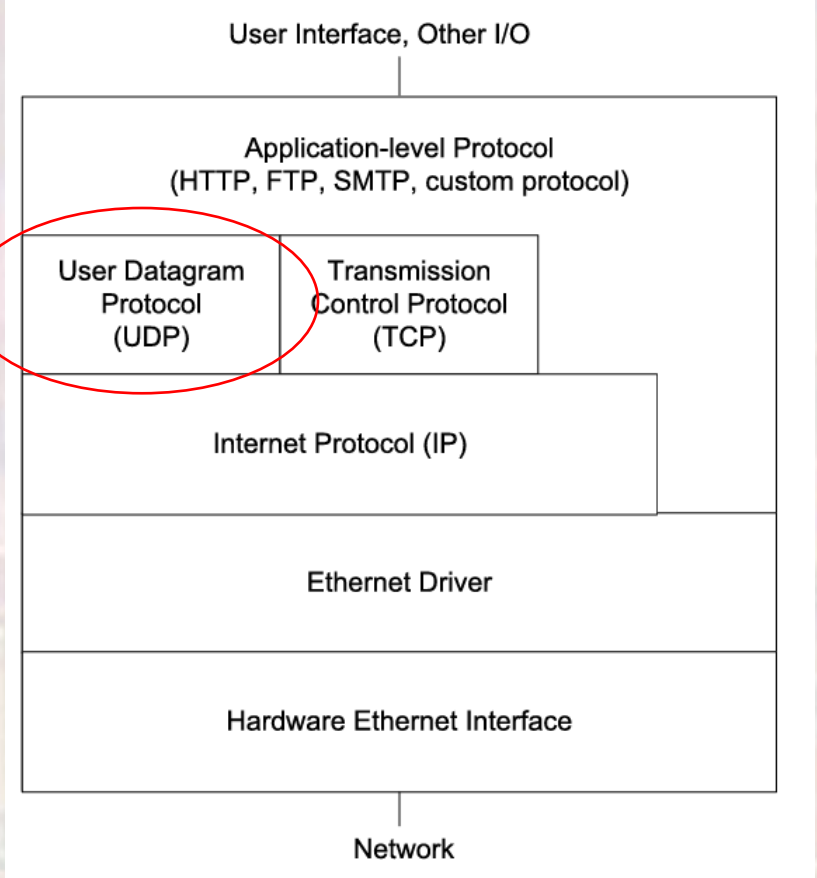
Applications

- OSI
  - Application Level
    - HTTP
    - FTP
    - POP



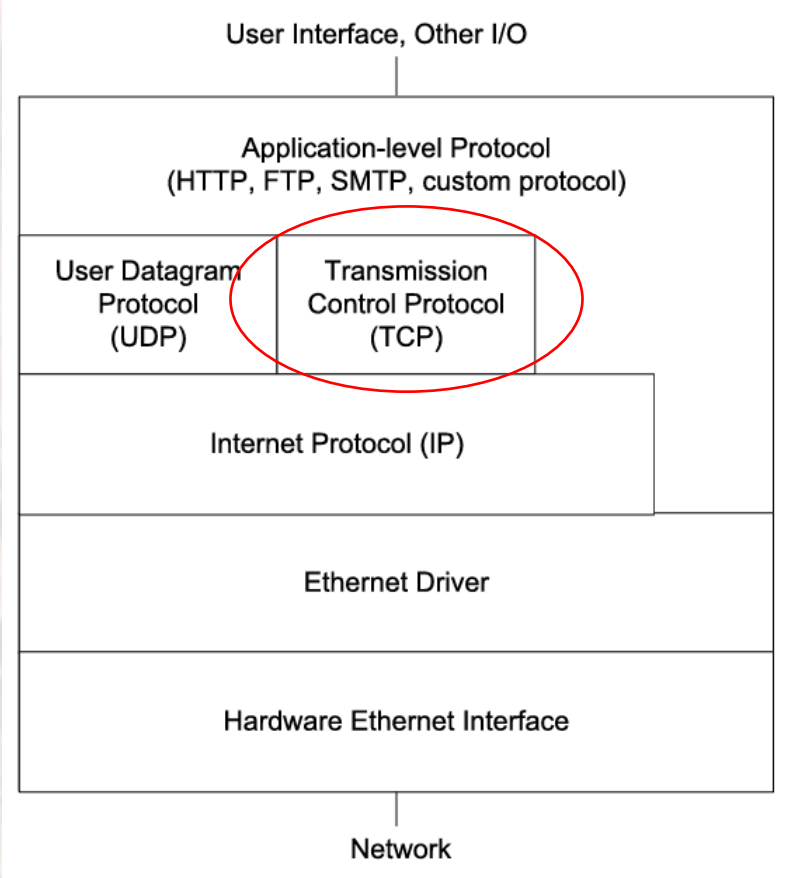
Applications

- OSI
  - User Datagram Protocol
    - UDP
    - Takes data from application
    - Adds a header
    - Adds end application data
      - Port or Process information
    - Optionally – error detection
    - And reverse



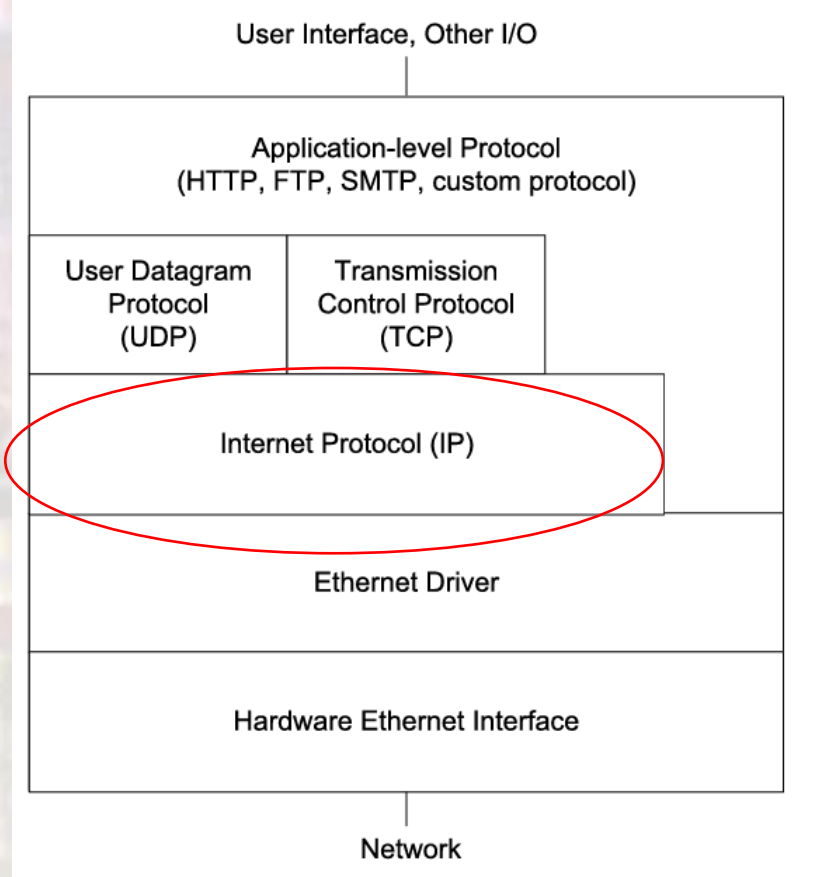
Applications

- OSI
  - Transmission Control Protocol
    - TCP
    - Takes data from application
    - Adds a header
    - Adds end application data
      - Port or Process information
    - Supports flow control
    - Adds error detection
    - And reverse



Applications

- OSI
  - Internet Protocol
    - IP
    - Takes the UDP or TCP datagram and adds
      - Header
        - Source and destination IP address
        - Error checking
        - Routing info
        - Protocol type (UDP/TCP/…)

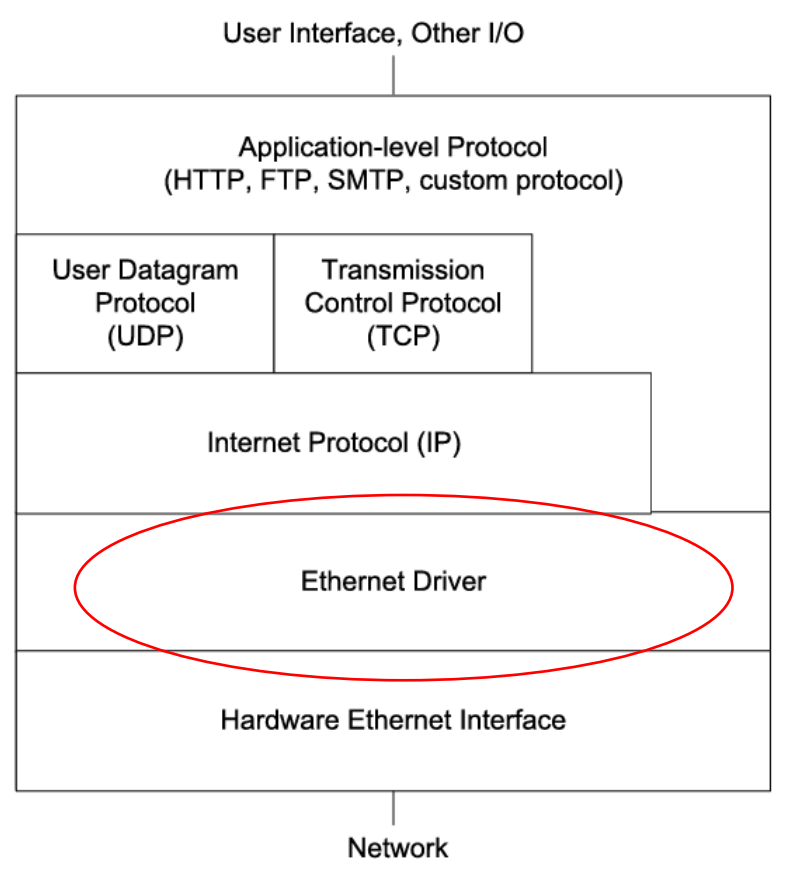


Applications

- OSI
  - Internet Protocol
    - All computers on the internet must have a unique IP address
    - DHCP
      - Dynamic Host Configuration Protocol
      - Computer tasked to assign local network computers an IP address
    - DNS
      - Domain Name System
      - Computer hosting a look-up service (name to IP)
    - ARP
      - Address Resolution Protocol
      - Computer mapping IP addresses to physical Ethernet addresses on the local network

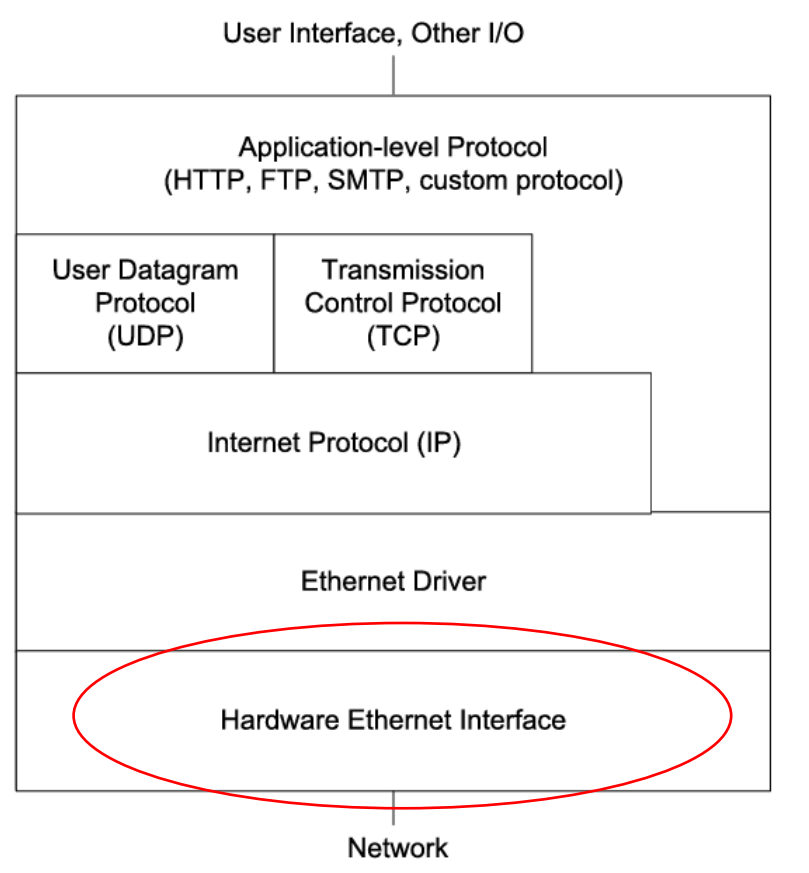
Applications

- OSI
  - Ethernet Protocol (driver)
    - Takes the IP datagram and adds
    - Header
      - Addressing
      - Error correction
    - When listening
      - Checks for address
      - Does reverse



Applications

- OSI
  - Ethernet Physical Layer
    - Encodes the data
    - Transmits on the network

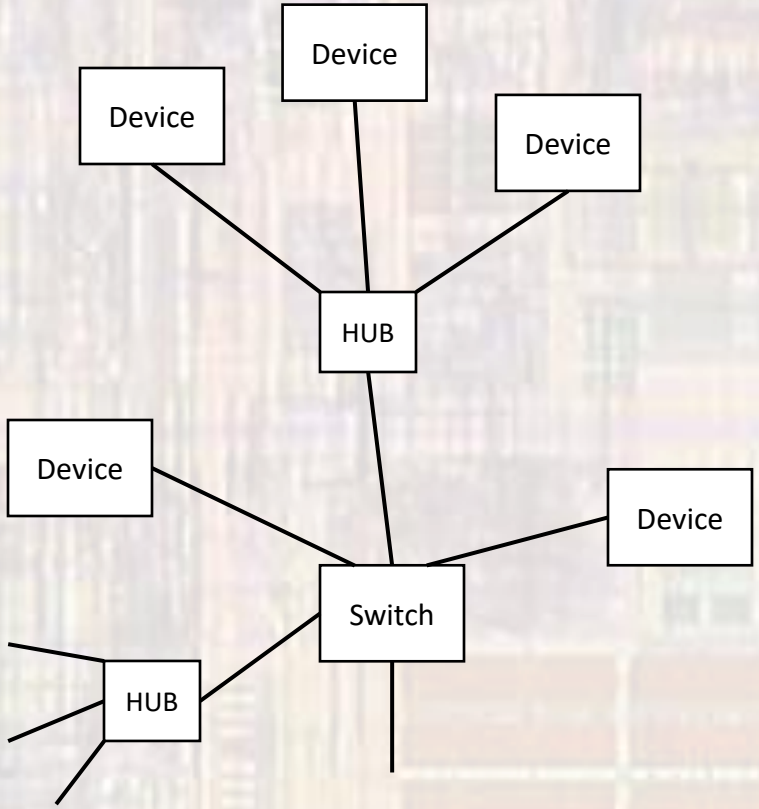


Applications

- 802.3
  - Ethernet is an IEEE standard
  - 802: standards concerning local and metropolitan networking
  - 802 part 3 : Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications .
    - 10Mb/s, 100Mb/s, 1Gb/s, 10Gb/s, 40Gb/s, 100Gb/s

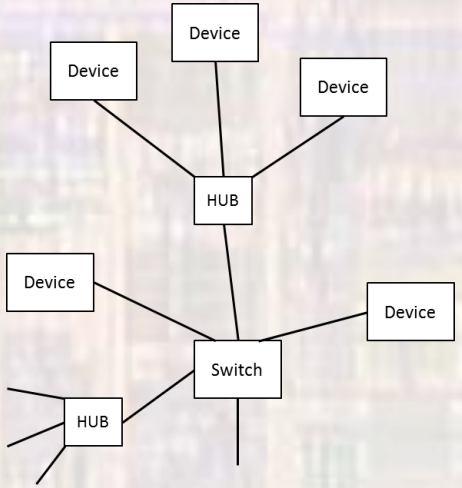
Applications

- Network Configuration
  - Star Network
    - Point to point communication
      - Half duplex
      - Full duplex
    - Hubs – repeaters
    - Switches - selectors



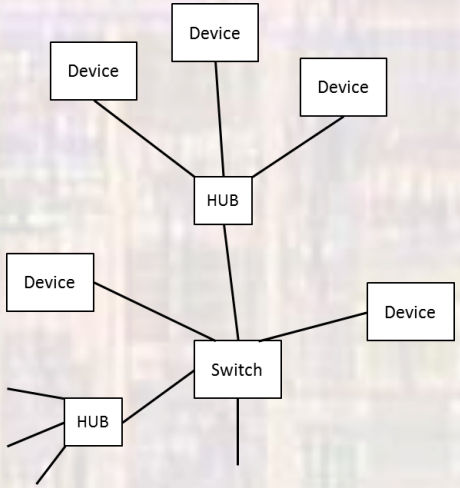
Applications

- Network Configuration
  - Connections
    - Coax
    - Optical
    - Twisted Pair **
      - 4 pairs / cable
      - Half duplex – 1 pair used
      - Full duplex – 2 pair used



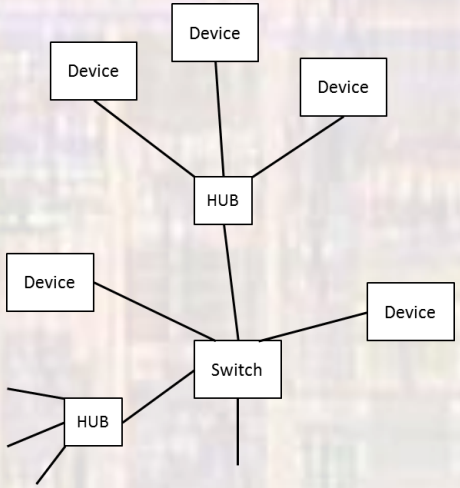
Applications

- Network Configuration
  - Devices
    - NIC
      - Network Interface Controller
    - Hub
      - Repeater
      - Takes whatever is sent in and replicates it out all ports
    - Switch
      - Selector
      - Takes whatever is sent in and tries to only forward it to the correct port
      - Maintains a mapping memory
      - Maintains a transmission memory – orders conflicting requests



Applications

- Network Configuration
  - Collisions
    - Ethernet is a random access protocol
    - Half duplex
      - 2 devices try to transmit at the same time
    - Full duplex
      - No collision problem
    - Cheap switches and NIC → almost all systems use full duplex



Applications

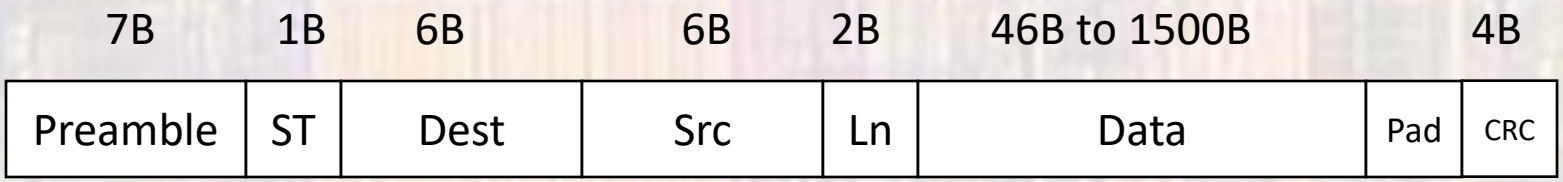
- Network Configuration
  - Collisions – CSMA/CD
    - Carrier Sense Multiple Access with Collision Detection
    - Only included for backwards compatibility – but interesting
    - Carrier Sense – signal
    - Multiple Access – multiple devices

Applications

- Network Configuration
  - Collisions – CSMA/CD
    - Half duplex system must monitor the channel
      - If busy – must wait
      - If free – can transmit
        - but must also monitor channel
        - If collision sensed –
          must continue to transmit for a short period
          stop transmitting
          wait a random amount of time (increases with # of collisions)
          retry
          if fails too many times – flag an error

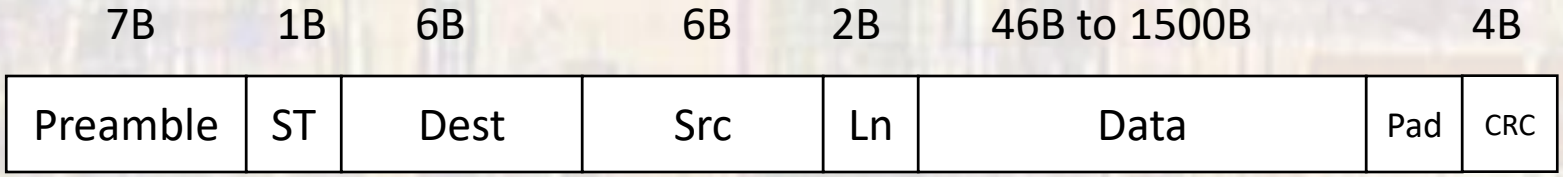
Applications

- Frame Structure



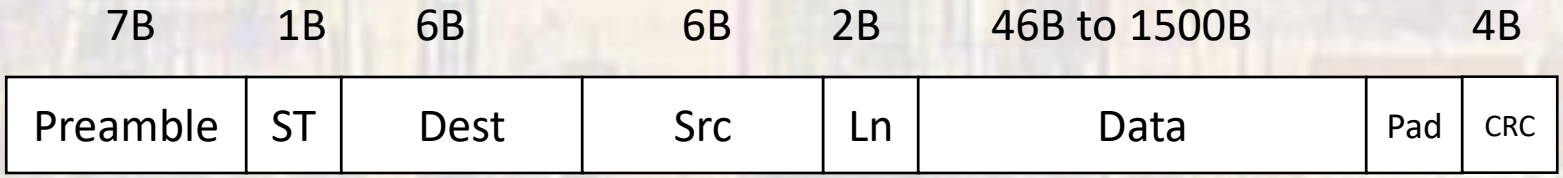
Applications

- Frame Structure
  - Preamble
    - Used for clock synchronization
    - 7 bytes of 10101010



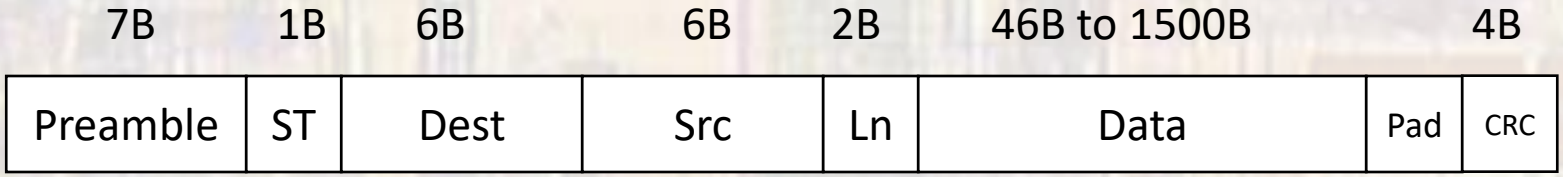
Applications

- Frame Structure
  - Start of Frame
    - 1 byte of 10101011



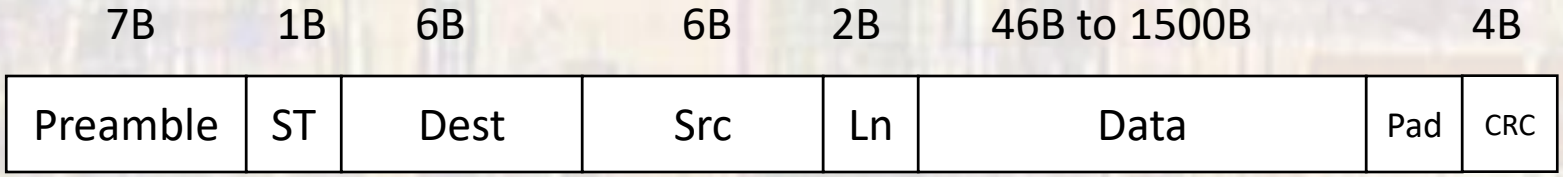
Applications

- Frame Structure
  - Destination
    - HW address for the destination
  - Source
    - HW address for the source



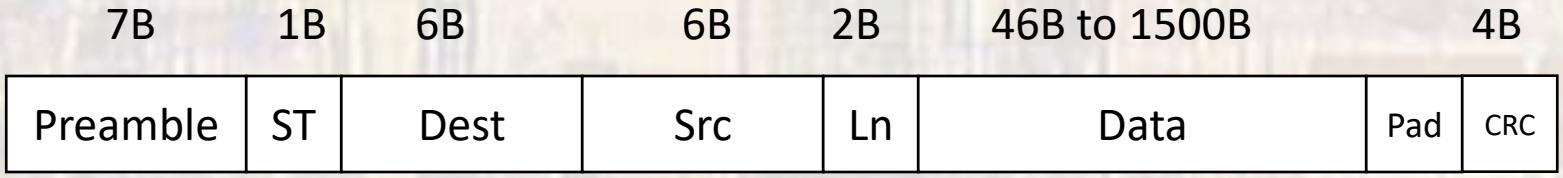
Applications

- Frame Structure
  - Length (Type)
    - If value is less than 46 – indicates the # of valid data bits
    - If value is less than 1500 – indicates the amount of data
    - If value is between 1500 and 1535 – invalid
    - If value is > 1535 – indicates the type of data
      - 0x800 = IP
      - 0x806 = ARP



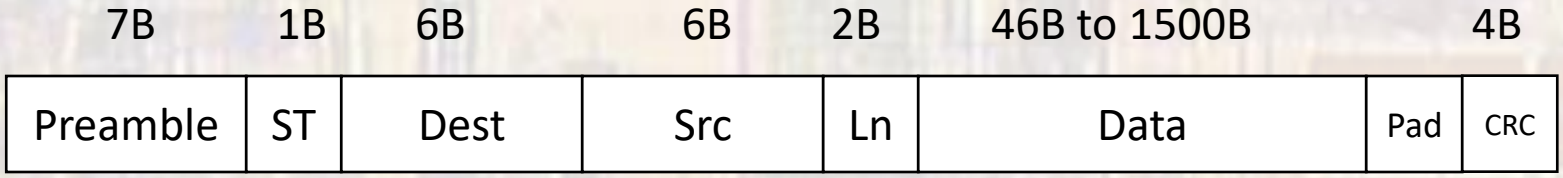
Applications

- Frame Structure
  - Data (Pad)
    - Minimum of 46 Bytes
      - If too short – must provide pad Bytes to get to 46
    - Maximum of 1500 Bytes
    - Longer transactions are broken into pieces



Applications

- Frame Structure
  - CRC
    - Cyclic Redundancy Code – error correction



Applications

- Physical Address Structure
  - NOT the IP address
  - 24 bits assigned to the manufacturer
    - Organizationally Unique Identifier (OUI)
  - 24 bits assigned by manufacturer to the specific device
  - 00-20-C3-C0-B3-EA
    OUI | Unique

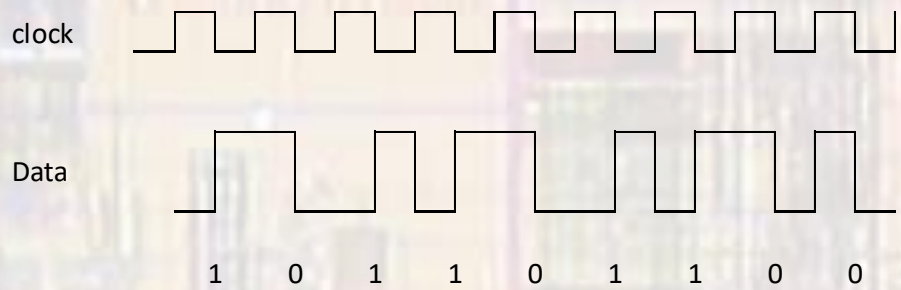
"ipconfig /all" from a windows system prompt

Applications

- Media Interface
  - Each class of Ethernet has it's own media interface specs
  - 10BASE-T – 10Mb/s – baseband – twisted pair
  - 100BASE –TX – 100Mb/s – baseband – twisted pair
  - 1000BASE-T – 1Gb/s – baseband – twisted pair
  - …
  - 100BASE –FX – 100Mb/s – baseband – single mode fiber optic

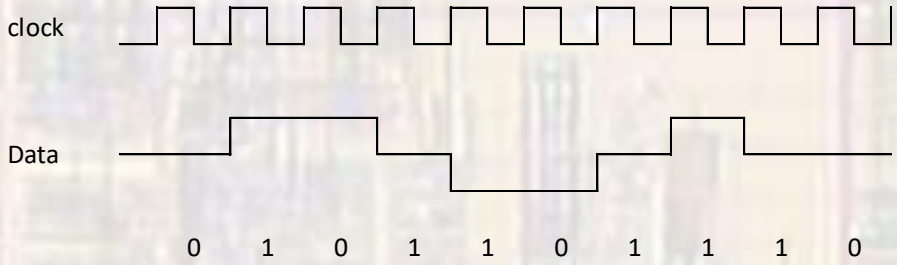
Applications

- Media Interface
  - 10BASE-T
  - Manchester encoding
    - 1st half clock signal 0, 2nd half 1 → 1
    - 1st half clock signal 1, 2nd half 0 → 0



Applications

- Media Interface
  - 100BASE-T
  - 4b/5b encoding
  - MLT-3 encoding
    - Sequentially rotate through -1,0,1
    - Change = 1
    - No-change = 0



Data (Hex)	Data (Binary)	4B5B Code
0	0000	11110
1	0001	01001
2	0010	10100
3	0011	10101
4	0100	01010
5	0101	01011
6	0110	01110
7	0111	01111
8	1000	10010
9	1001	10011
A	1010	10110
B	1011	10111
C	1100	11010
D	1101	11011
E	1110	11100
F	1111	11101

Applications

- Media Interface
  - 1000BASE-T
  - Uses all 4 twisted pair in each direction - simultaneously
  - Trellis coded modulation
  - 5 level PAM (pulse amplitude modulation)

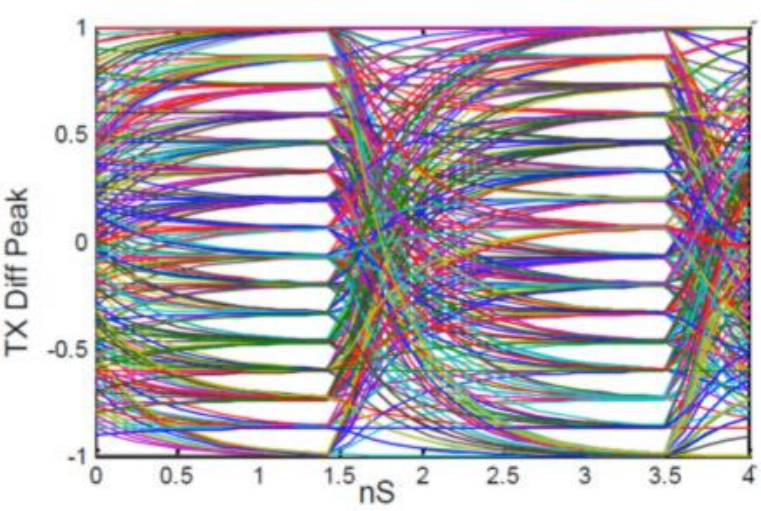
    8 bits → 4, 3 bit codes (one for each twisted pair)

    3 bit codes → 5 level PAM

Symbol	000	001	010	011	100	101	110	111
Line signal level	0	+1	+2	−1	0	+1	−2	−1

Applications

- Media Interface
  - 10GBASE-T
  - Uses all 4 twisted pair in each direction - simultaneously
  - Complex Coding w/ forward error correction (FEC)
  - 16 level PAM



Applications

- Media Interface
  - Cable lengths limited for each technology
  - Crossover
    - Switches include an automatic crossover capability
      - Effectively connects rx in to tx out
    - Computer to computer requires a special cable
      - Crossover cable
      - OR – crossover capability in the NIC