

CSET 2200 Lecture 4

Ethernet - Layer 1/2

- ▶ Primary access used by wired clients
- ▶ Defined by IEEE
- ▶ Originally 802.3 group but others

Ethernet - Layer 1/2

- ▶ Ethernet PHY describes layer 1 piece
- ▶ Electrical standards over Coax or Twisted Pair
- ▶ Names are (speed)Base(Technology)

Coax

10Base5

- ▶ 10mbps over thick coax
- ▶ Used N connector or vampire tap
- ▶ Bus based - shared access



10Base2

- ▶ 10mbps over thin coax
- ▶ Called thinnet
- ▶ Used BNC connectors
- ▶ Also bus based - used a terminator



Figure 2: 10Base2

Twisted Pair

10BaseT

- ▶ T means Twisted Pair
- ▶ 10Mbps over 8P8C cable (RJ45/Cat 3)
- ▶ 100m max length
- ▶ Star - requires hub or switch



Figure 3: 10BaseT

100BaseT

- ▶ 100mbps over Cat 5 cable
- ▶ Uses 2 pairs
- ▶ 100m max length
- ▶ 100BaseT4 for a 4 pair version over cat 3

1000BaseT

- ▶ 1gpbs over Cat 5 ot 5e cable
- ▶ Uses all 4 pairs
- ▶ Full Duplex only in practice
- ▶ Also 100m max length

10GBaseT

- ▶ 10gbps over Cat 6 (55m) or Cat 6a (100m)
- ▶ 2.5GBaseT and 5GBaseT variants exist
- ▶ Just gaining use

Fiber

- ▶ Multimode
 - ▶ Larger - 50/125 or 62.5um/125
 - ▶ Light bounces
 - ▶ Slower - shorter distances
- ▶ Single Mode
 - ▶ 8-10.5um/125
 - ▶ Light goes straight
 - ▶ Faster - longer distances

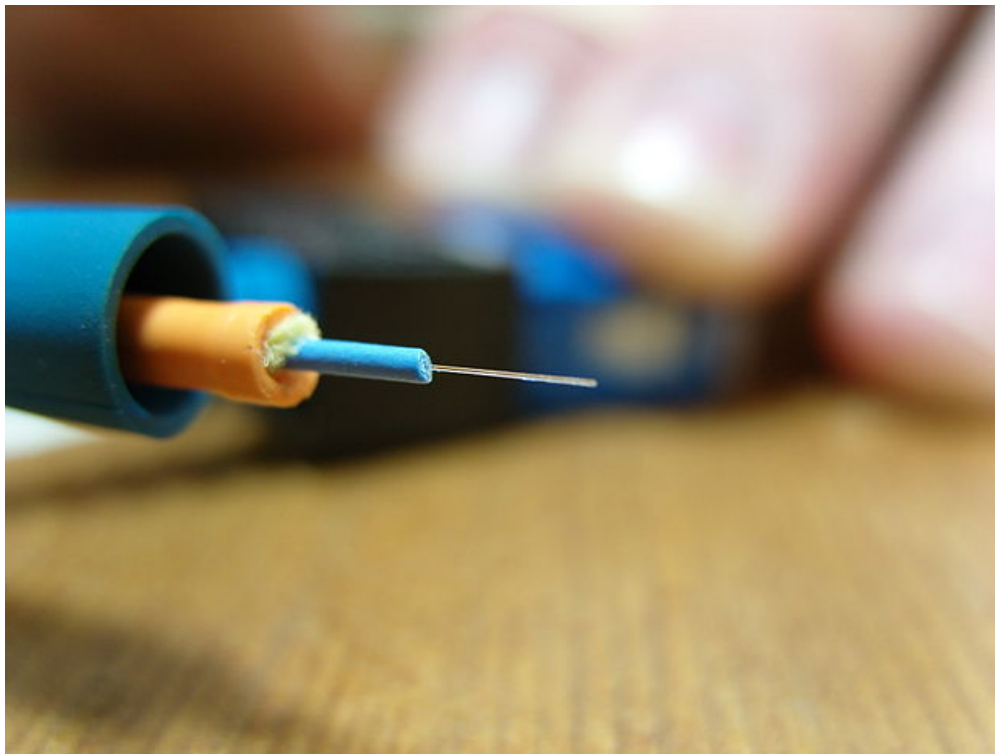


Figure 4: Multimode Fiber

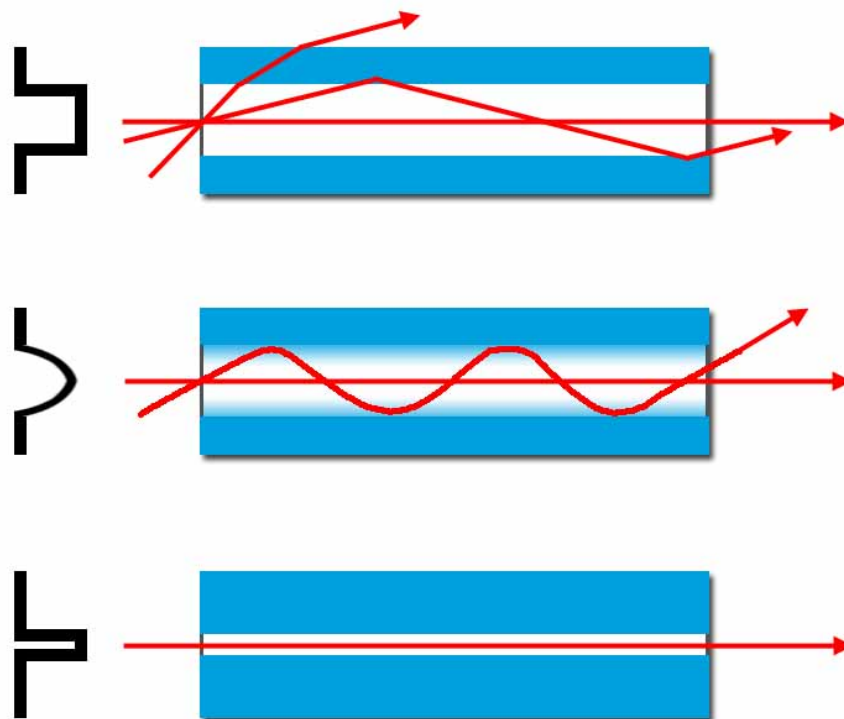


Figure 5: Fiber Modes

10BaseFL

- ▶ 10Mbps over Multimode Fiber
- ▶ Up to 2km
- ▶ Rarely used - usually 100Mbps+

100BaseFX

- ▶ 100Mbps over Multimode fiber
- ▶ 400m for half duplex (Collision detection), 2km full duplex
- ▶ Commonly uses SC or ST

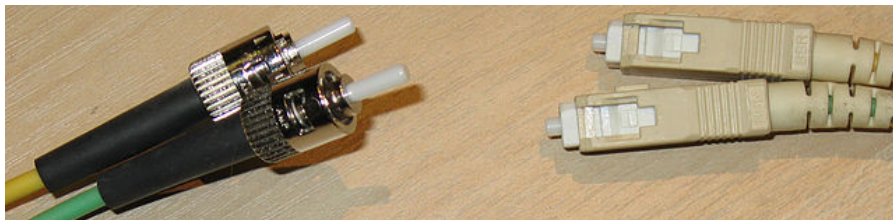


Figure 6: SC/ST

1000BaseSX

- ▶ 1gbps over multimode
- ▶ 550m max
- ▶ Uses SC, ST and LC

Other Media

- ▶ 100BaseBX/LX - long haul 100mbps over Single Mode fiber
- ▶ 1000BaseLX/BX/ZX - 1gbps over Single Mode Fiber

Layer 1 meets layer 2

- ▶ Layer 1 defines electrical signals
- ▶ Electrical signals have properties
- ▶ If two transmit at once the waves combine or cancel
- ▶ Need a method to detect

Broadcasts

- ▶ Ethernet is a broadcast medium
- ▶ Every station sees every frame
- ▶ This is not entirely true at this time with wired
- ▶ Is true with wireless

CSMA/CD

- ▶ Carrier Sense Multi Access with Collision Detect
- ▶ Each station listens if it has a packet to transmit
- ▶ Keeps listening while transmitting
- ▶ If collision jams and backs off for a random time

Collision Domain

- ▶ All stations which share an electrical medium
- ▶ On coax includes all stations on the same cable
- ▶ On UTP networks, all stations on a “hub”
- ▶ Switched networks limit collision domains

Full Duplex vs Half Duplex

- ▶ Full can transmit and receive at once
- ▶ No collisions on Full Duplex - collision domain of one
- ▶ Separate transmit and receive pairs
- ▶ Normally switch vs hub - we'll discuss later

Onto Layer 2

Ethernet at Layer 2

- ▶ Remember, layer 2 PDU called a frame
- ▶ Ethernet frame defined in 802.3
- ▶ Multiple types of ethernet frames over the years

Ethernet Frame Format (Ethernet II)

- ▶ 7 byte Preamble
- ▶ 1 byte start frame delimiter
- ▶ 6 byte destination mac
- ▶ 6 byte source mac
- ▶ optional 4 byte tag (More later)
- ▶ 2 byte type
- ▶ 46-1500 byte payload
- ▶ 4 byte Frame Check Sequence (CRC)
- ▶ 12 byte inter packet gap

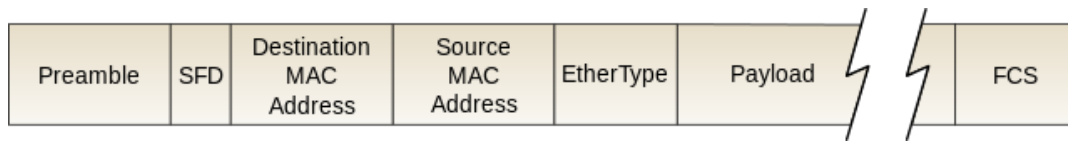


Figure 7: EthernetFrame

Preamble and SFD

- ▶ Preamble 7 bytes of alternating 10101010
- ▶ Allows clock sync
- ▶ 55 Hex (Ethernet sends least sig bit first)
- ▶ SFD is 10101011
- ▶ Represents end of header - get ready to receive data
- ▶ D5 Hex

CRC and Interpacket Gap

- ▶ Last 4 bytes are CRC of entire frame other than FCS
- ▶ CRC is complemented to allow end of frame to be calculated without length
- ▶ 0xC704DD7B is the magic number in this case
- ▶ CRC is math heavy - we won't cover it's internals
- ▶ Interpacket Gap is 12 bytes worth of silence - we leave the line alone
- ▶ There is an end of packet marker with some encodings

Other Misc before frame types

- ▶ Technically the Preamble, SFD and Interpacket Gap are layer 1 components
- ▶ Frame Check Sequence (CRC) is error detection for layer 2

Ethernet Frame Types

- ▶ Raw IEEE 802.3 - used by Novell for IPX
- ▶ IEEE 802.2 LLC - used by protocols implementing raw layer 3 over it
 - ▶ Used by Netware and some OSI models
- ▶ IEEE 802.2 SNAP - Extension of above providing additional “addresses”
 - ▶ Used by Appletalk
- ▶ Ethernet II - Most common in use
 - ▶ Defined an ethertype header which describes contents
 - ▶ Can optionally have a length - 802.3 allows both
 - ▶ Length comes before
 - ▶ 1536 max length

Ethernet II Frame Format

- ▶ 6 byte destination MAC
- ▶ 6 byte source MAC
- ▶ Optional 4 byte 802.1q header
- ▶ 2 byte EtherType or length
- ▶ 2 EtherType if length present
- ▶ 42-1500 byte payload (46 if no 802.1q)

MAC Addresses

- ▶ Stands for Media Access Control address
- ▶ 6 Octets
- ▶ First 3 are Organisationally Unique Identifier
 - ▶ Identifies manufacturer
- ▶ Next 3 bytes are unique to the NIC
- ▶ Unique, but can often be changed these days

MAC Addresses (Cont)

- ▶ OUI's assigned in blocks to manufacturers
- ▶ Last bits of first byte have meaning
- ▶ Bit 1 is Global or local (Should be flipped when edited)
- ▶ Bit 0 is Unicast vs Multicast

Mac Addresses (Cont)

- ▶ Last 3 bytes can be set as pleased
- ▶ Must be unique and usually burned in ROM
- ▶ As mentioned, many allow spoofing MAC these days

EtherType

- ▶ Used to specify type of payload frame
- ▶ If under 1536 assumed to be size
- ▶ If size, next 2 bytes are type
- ▶ Common values
 - ▶ 0x0800 - IPV4
 - ▶ 0x0806 - ARP
 - ▶ 0x86DD - IPv6

Examples

Questions

Next session

- ▶ Covering repeaters, hubs, switches, etc
- ▶ <https://en.wikipedia.org/wiki/Ethernet> and subpages
- ▶ Book chapters 15, 17, 19 (book is all over)