CS25110

Ethernet

3 lectures

- The standards & protocols

- Physical components.

- Media access operation.

- Logical link, address structure.

- Bridges.

Protocol Standards

- Agreed structure of communications

Layered
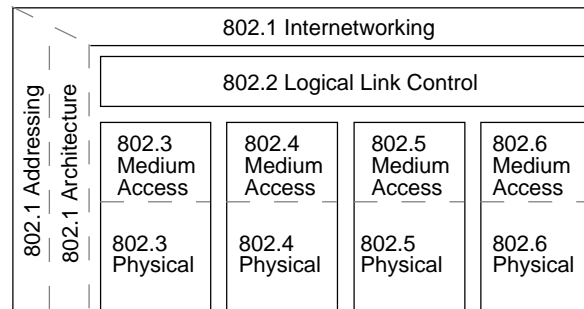- Higher layers - media independent
- Lower layers - media dependent
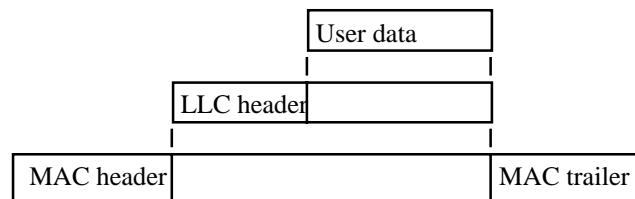
Major American activity
IEEE Project 802

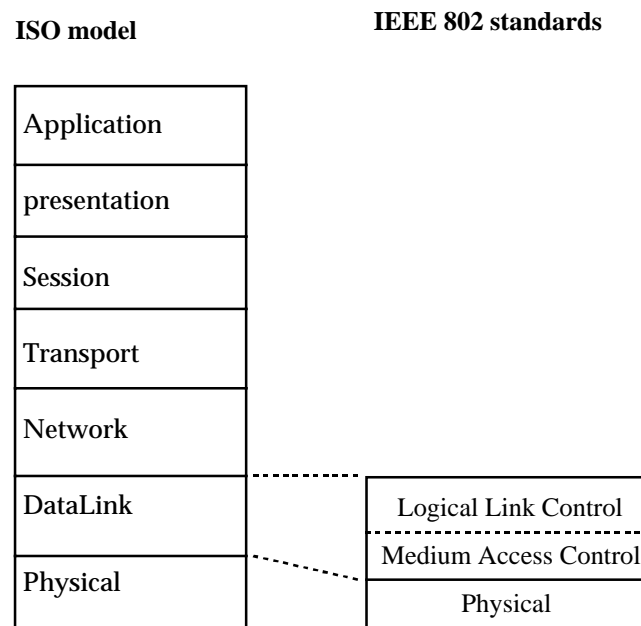**Major British activity**
Cambridge ring

IEEE 802 standards

802.1 Internetworking			
802.2 Logical Link Control			
802.3 Medium Access	802.4 Medium Access	802.5 Medium Access	802.6 Medium Access
802.3 Physical	802.4 Physical	802.5 Physical	802.6 Physical

802.1 Addressing
802.1 Architecture

Encapsulation at each level

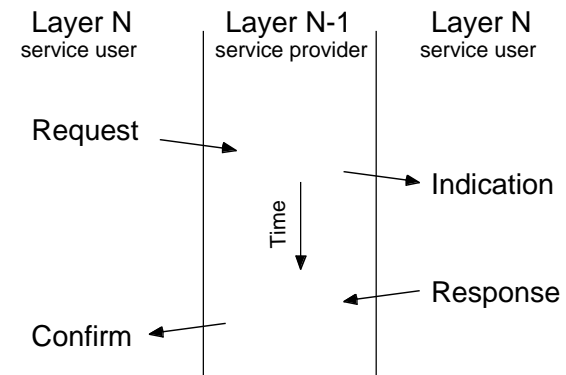|	User data	
	LLC header	
MAC header		MAC trailer

IEEE Project 802

- Media Level and Physical Layer
  - 802.3 Bus - CSMA/CD
  - 802.4 Bus - Token Passing
  - 802.5 Ring - Token Passing
  - 802.6 Metropolitan Area Network

- Link and Internetworking
  - 802.1 Internetworking
  - 802.2 Logical link control

Relationship to ISO model

ISO model   **IEEE 802 standards**

ISO model
Application
presentation
Session
Transport
Network
DataLink
Physical

IEEE 802 standards
Logical Link Control
Medium Access Control
Physical

ISO Service Model

Layer N service user	Layer N-1 service provider	Layer N service user

Request →

Indication

Time ↓

Response

Confirm ←

CSMA/CD only supports one service
class - unacknowledged connectionless;
only Request and Indication services
are provided by LLC to the network.

802.3 CSMA/CD Bus

Derivative of work by:

- Xerox
- Intel
- Digital (DEC)

Published in Ethernet (DIX Blue Book) V1.0, September 30th 1980.

802.3 Revision D dated December 1982 published by IEEE.

Revision F published July 1984 and also issued as DP 8802/3 by the ISO.

Operation: Carrier Sense Multiple Access with Collision Detection. Distributed Control

- Contend for use.
- Acquire access and send a data packet.
- No priority.

Simple algorithm:

1. Check if active, if yes return to 1.
2. Transmit and check for collisions.
3. Collision ? if so transmit JAM and then delay and go back to 1.
4. Transmission completed.

Typical Large Ethernet

segment1

s2

transceiver

station

repeater

s3

coaxial cable

link

s4

s5
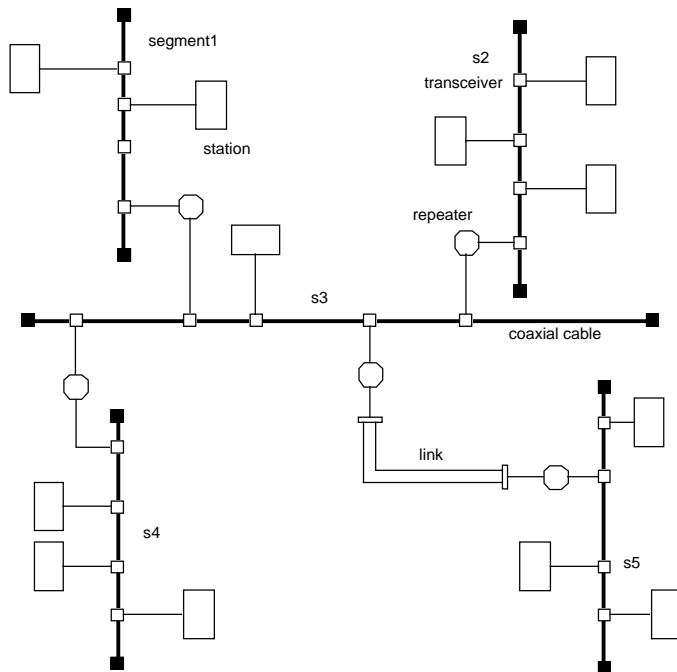
Ethernet Components

- Coaxial cable
- transceiver (MAU)
- repeater
- terminator
- Point to point link
- Internetworking devices
  - Bridge (selective forward of packets between similar networks).
  - Router (IP level forward, possible between different network types).

- 10BASE-T
  - Unshielded Twisted Pair (UTP)
  - Hubs (Multi port repeater)
  - Switches

Other Medium Options
(IEEE 802.3)

- Original (10BASE5)
  - 10Mbps using baseband coaxial cable, segment length 500m, max. 100 taps per segment, max. 4 repeaters between any pair of stations.
- 10BASE2 (issued 1985)
  - thinner coaxial cable, segment length 185m, max. 30 taps per segment.
- 1BASE5 (StarLAN)
  - unshielded twisted pair, 1Mbps, passive star topology, aimed at PC users.
- 10BASE-T
  - similar to 1BASE5 but at 10Mbps.

Slot time

packet →

A   B
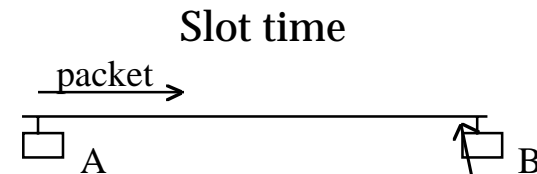
Worst case:

B starts transmitting when 'A's packet has nearly reached 'B'.

B must corrupt at least the last bit of 'A's packet.

Therefor, packet length must be such that time to transmit is greater than twice the 'transmission delay' for the longest route in the network.

For 2.5Km network (maximum allowed), 10Mhz bit rate, slot time is 51.2 micro seconds.

This is a 512 bit packet

Slot time delay > 2* Path Time

If 2.5 Km network in 5 segments then:

- 3 coax (with stations) 21.56 bits
- 2 links (no stations) 25.65 bits
- 4 repeater delays 7.5 bits
- transceiver delays 6.0 bits
- transceiver cable delays 2.57 bits
- etc.

Total about 499 bits worst case. Specified
as 512 bits to give safety margin.

Network JAMs

- Repeaters required to propagate JAMs.
- Must make sure all repeaters see JAMs.
- Time delay of 500m coax about   2.165 micro seconds.
- Specification requires JAM of 32 bits.

Thus JAM time is 3.2 micro seconds
exceeding the 2.165 micro second time
delay.

Throughput example

- Simple application like 'vi' editor using remote echo from remote host.
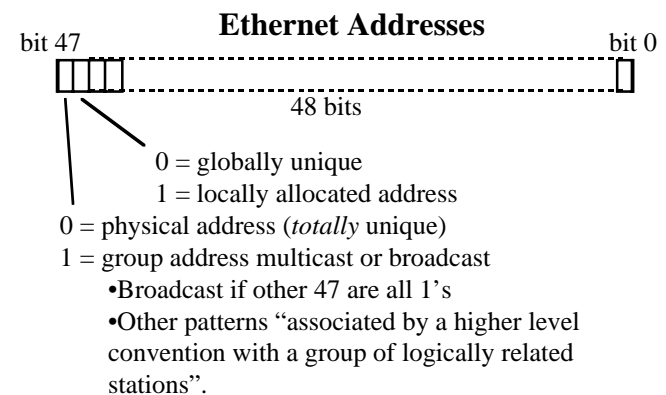- Packets of minimum Ethernet size.

Time for progress (micro seconds)

Event	Time
IDLE	0
A starts preamble	0
A finishes preamble	6.4
A starts packet	6.4
A finishes packet	6.4+51.2=57.6
B receives last bit	57.6+25.6=83.2
B starts interframe gap	83.2
B reaches end of gap	83.2+9.6=92.8

- The time to transmit single character and receive echo is thus 185.6 micro seconds.
- Number of characters per second = 5387.9.

MAC frame format

Number of Octets	Field Usage
7	Preamble
1	Start of Frame Delimiter
2 or 6	Destination Address ;6 (10Mhz)
2 or 6	Source Address; 6 (10Mhz)
2	Length
up to 64K	LLC data
?	Padding
4	Frame Check Sequence

Ethernet Addresses

bit 47   bit 0

48 bits

0 = globally unique
1 = locally allocated address
0 = physical address (*totally* unique)
1 = group address multicast or broadcast
- Broadcast if other 47 are all 1's
- Other patterns "associated by a higher level convention with a group of logically related stations".

Frame details:

- Minimum frame size 512 bits not including the preamble. ie. 46 octets of data.
- Maximum frame size 1518 octets. ie. 1500 octets of data.
- Above assumes 48 bit (6 octet) addresses which IEEE 802.3 says "shall be used" for 10 Mbps networks.
- Also 9.6 micro second interframe gap.
- Time for frame is 51.2 micro seconds plus 6.4 micro seconds for preamble.

Collision Backoff and Retransmission

- Transmitter retries for a maximum of 16 attempts to send a frame.
- The transmitter waits an integer multiple slot times determined by the following algorithm prior to each retry.
- Rescheduling of each transmission uses "truncated binary exponential backoff".
- This ensures a random but increasing delay if many collisions occur.

Delay strategy

$$\text{Delay Slots} = \text{rand}[0 \le r \le 2^k]$$

$$\text{where, } k = \min(n, 10)$$

$$\text{for the } n^{th} \text{ Transmission}$$

Probabilistic Characteristics of CSMA/CD

All access to the 802.3 LAN only completes with some probability. It is thus impossible to guarantee transfer rates. When the net is very busy collisions might go on forever !

Real Time Use

Debates often take place on the usability of CSMA/CD LANs for real time use. The answer depends on the true use intended rather than the LAN.