CS25010

Ethernet

2 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

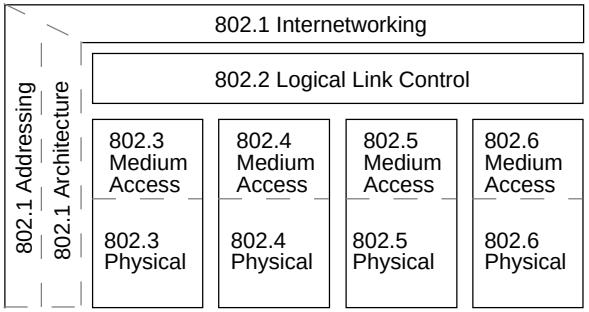
Major American activity

IEEE Project 802

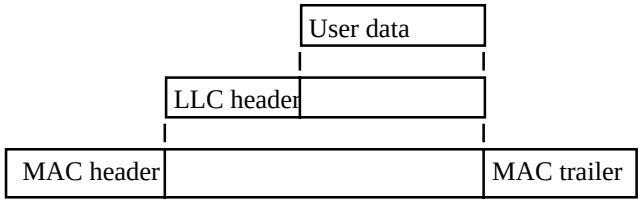
Major British activity

Cambridge ring

IEEE 802 standards



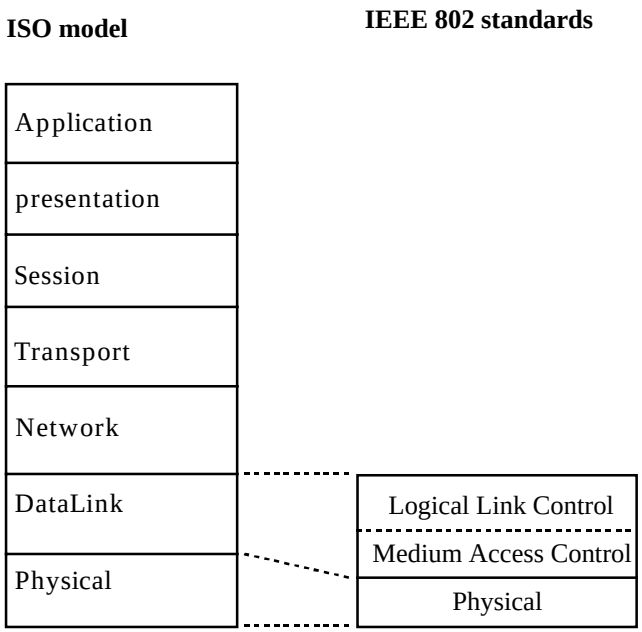
Encapsulation at each level



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



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.

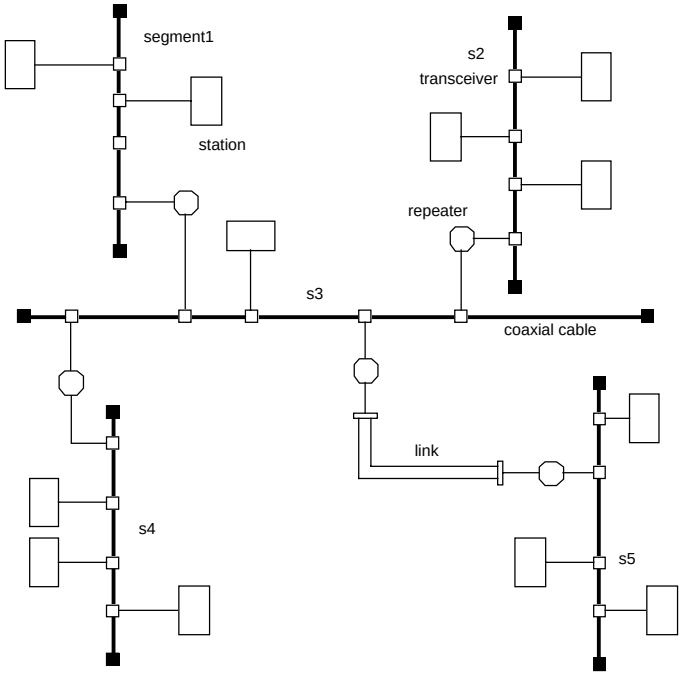
Operation: Carrier Sense Multiple Access with Collision Detection. Distributed Control

- 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



Ethernet Components

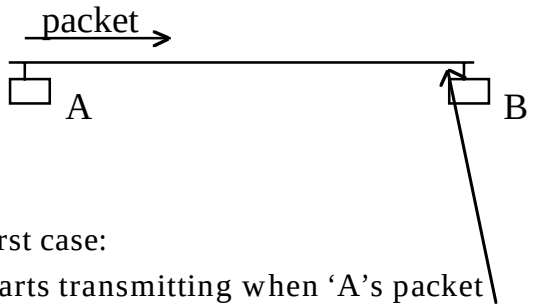
- Coaxial cable
- transceiver (MAU)
- repeater
- terminator
- Point to point link
- Internetworking devices
  - Bridge (selective forward of packets between similar networks).
  - Router (IP level forward, possible between different network types).

- 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.
- 100BASE-F
  - optical fibre
  - star topology, 2Km between repeaters

Slot time



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)

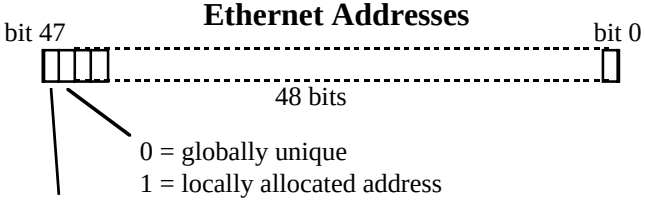
Event	Time
IDLE	0
A starts preamble	0
A finishes preamble	6.4
A starts packet	6.4
A finishes packet	6.4+51.2=57.6
B receives last bit	57.6+25.6=83.2
B starts interframe gap	83.2
B reaches end of gap	83.2+9.6=92.8

- 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



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

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

where, $k = \min(n, 10)$

for the n^{th} 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.