Chapter 4

Lesson 11: The Medium Access Control Sublayer

Ethernet

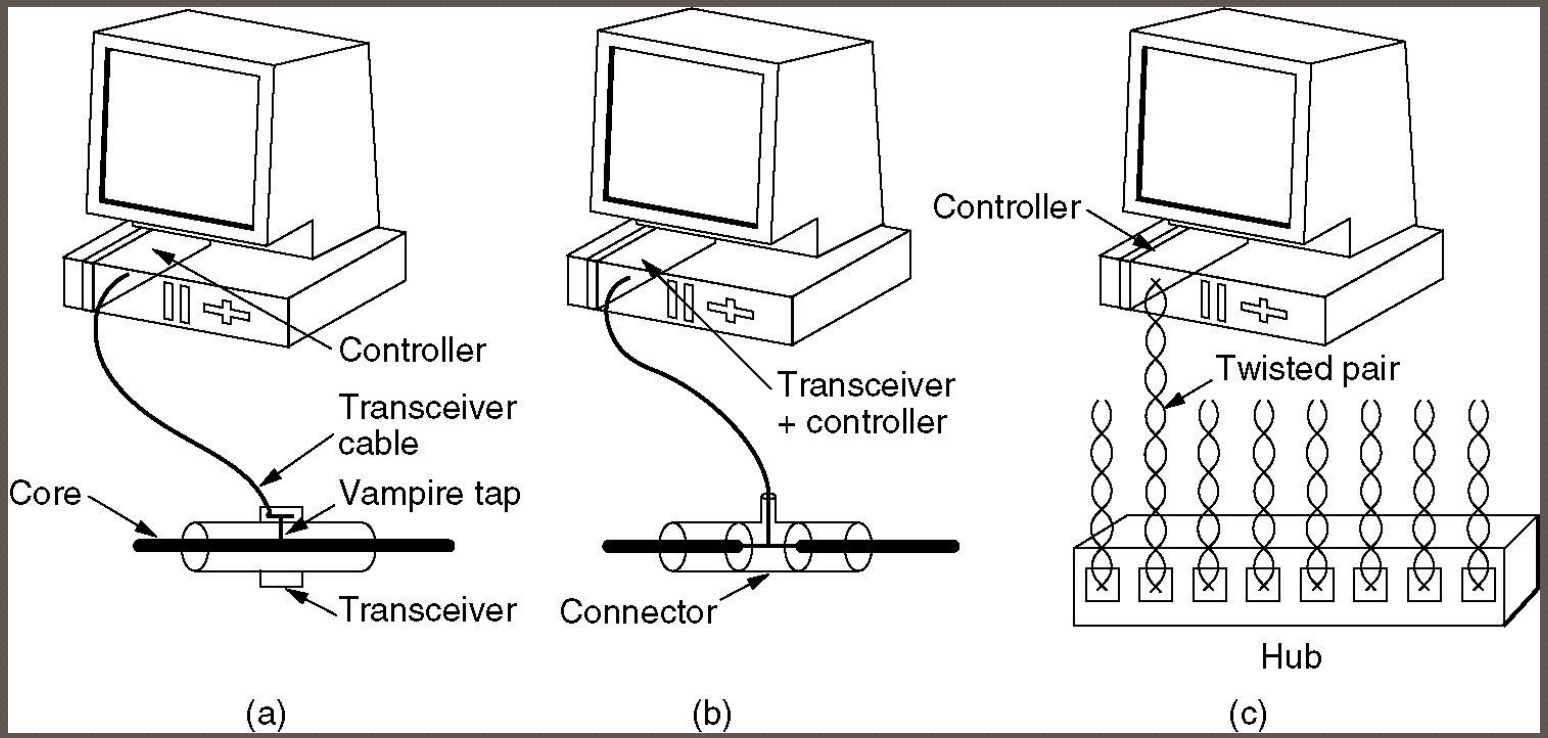
- Ethernet Cabling
- Manchester Encoding
- The Ethernet MAC Sublayer Protocol
- The Binary Exponential Backoff Algorithm
- Ethernet Performance
- Switched Ethernet
- Fast Ethernet
- Gigabit Ethernet

Ethernet Cabling

The most common kinds of Ethernet cabling.

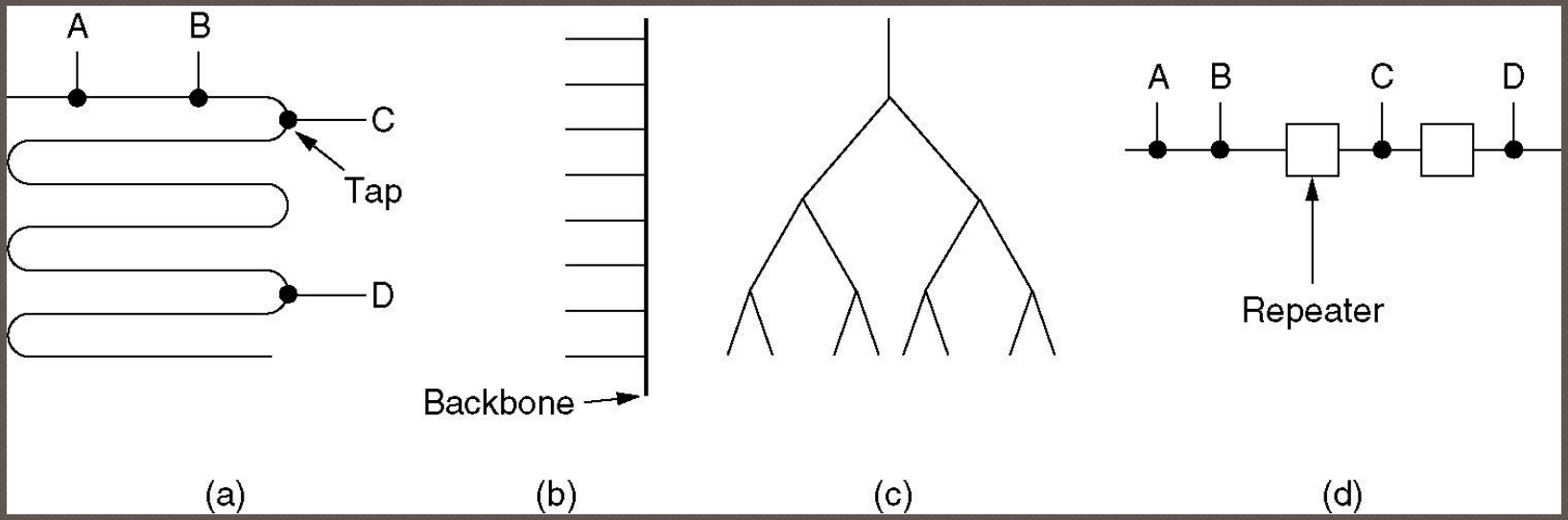
Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
10Base2	Thin coax	185 m	30	No hub needed
10Base-T	Twisted pair	100 m	1024	Cheapest system
10Base-F	Fiber optics	2000 m	1024	Best between buildings

Ethernet Cabling (2)

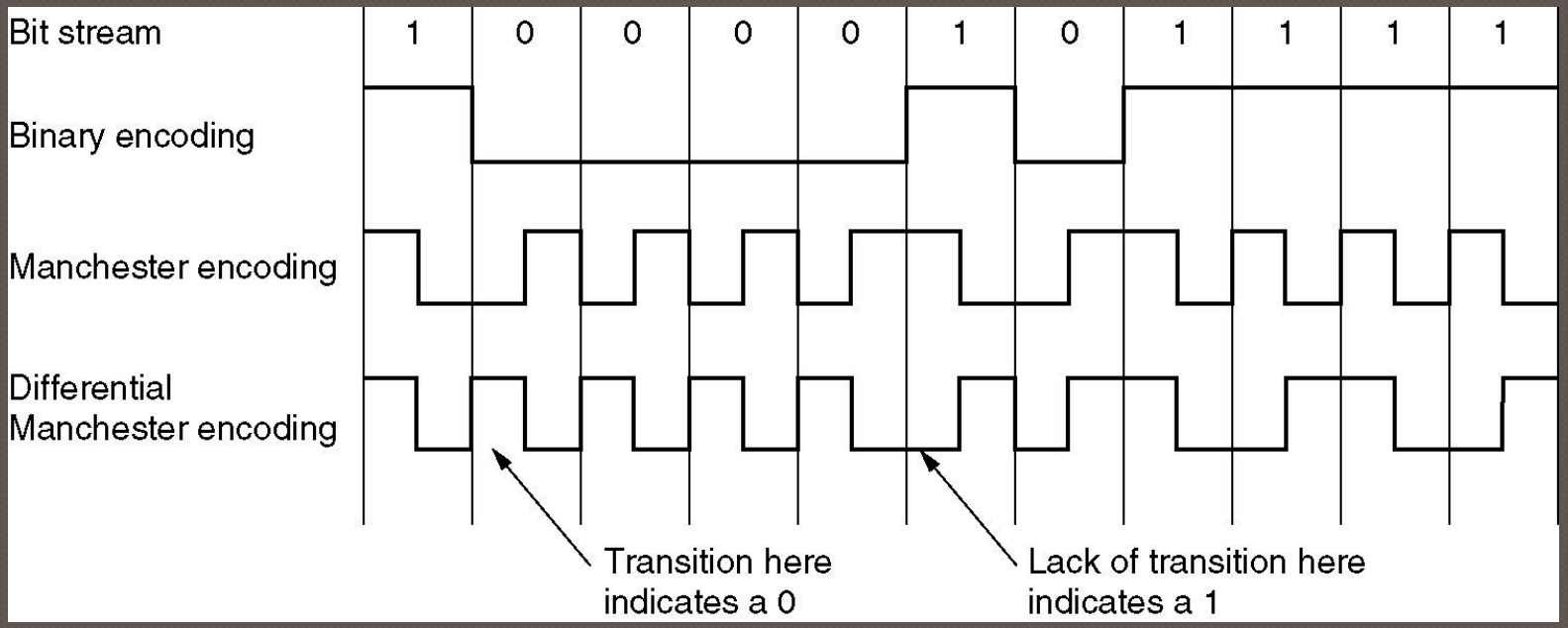


Ethernet Cabling (3)

Cable topologies. (a) Linear, (b) Spine, (c) Tree, (d) Segmented.

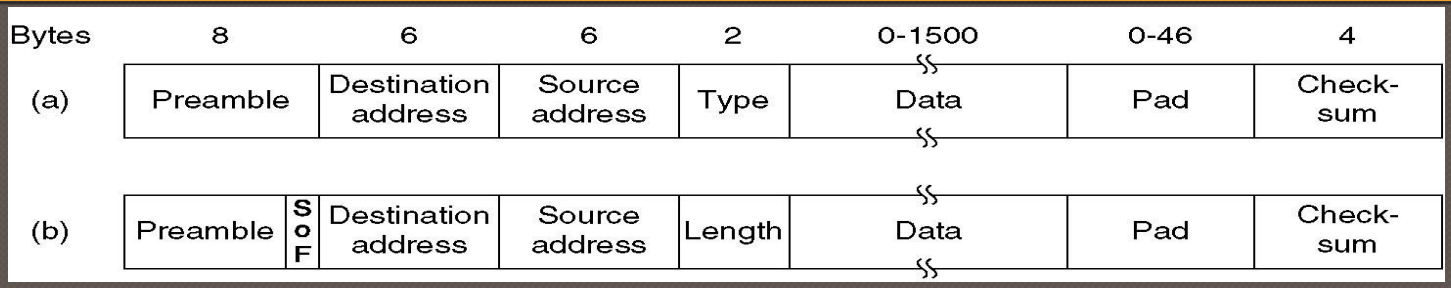


Ethernet Cabling (4)



(a) Binary encoding, (b) Manchester encoding, (c) Differential Manchester encoding.

Frame formats.



(a) DIX Ethernet, (b) IEEE 802.3.

Preamble:

- 7 bytes with pattern 10101010 followed by one byte with pattern 10101011
- Used to synchronize receiver, sender clock rates

Type (>1500):

- indicates the higher layer protocol, (mostly IP but others may be supported such as Novell IPX and AppleTalk)

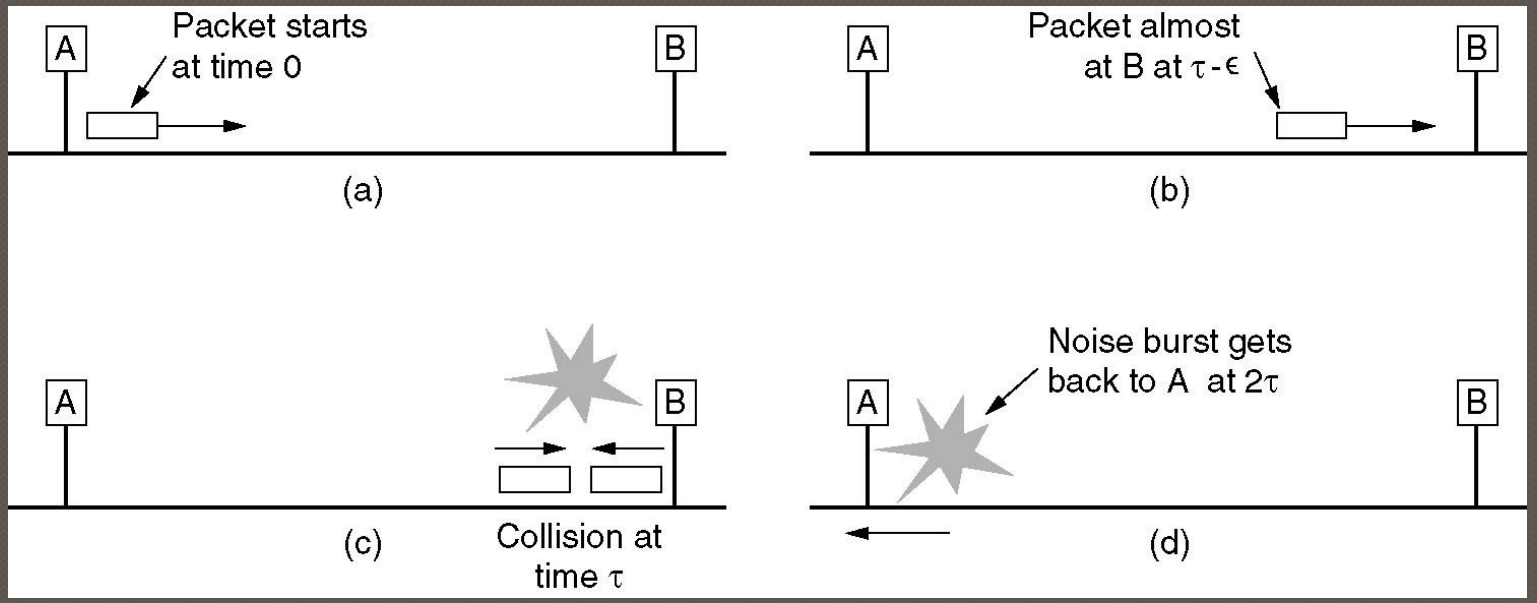
Length(<1500)

- Both Type and Length supported

Checksum:

- CRC, checked at receiver, if error is detected, the frame is simply dropped

Collision Detection



Collision detection can take as long as 2τ.

Binary Exponential Back-off

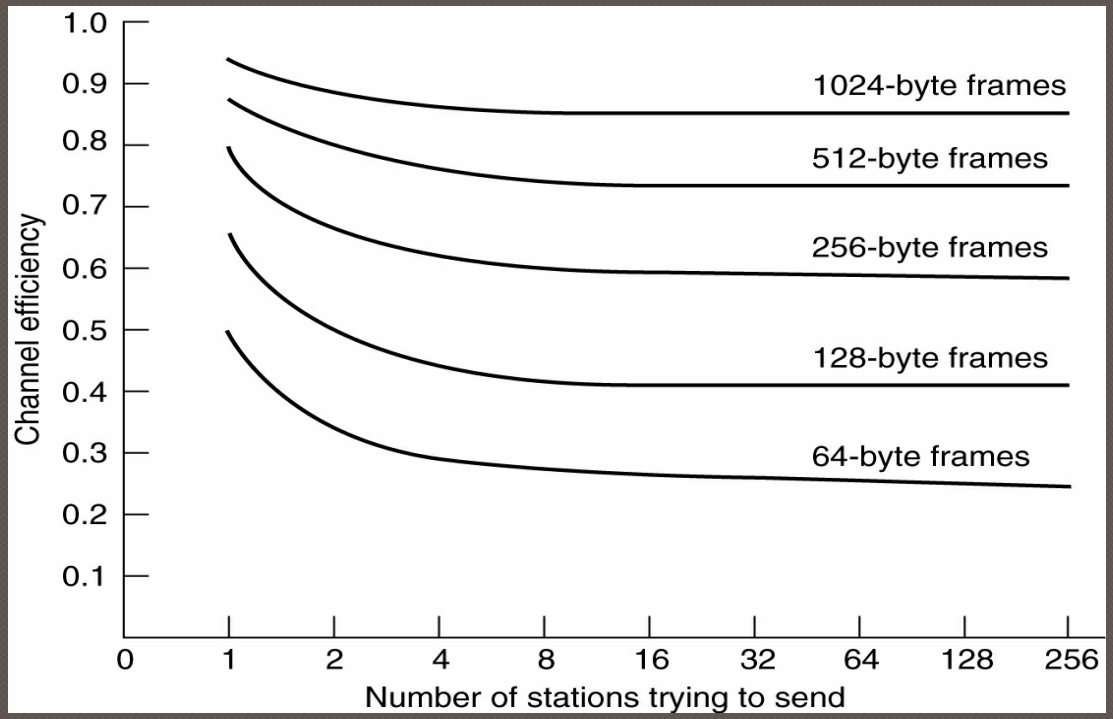
- After first collision, each station waits either 0 or 1 time (i.e. 2^1) slot before trying again.
- If these is another collision, the stations wait 0,1,2 or 3 time slots (i.e. 2^2) before re transmitting; ect. – i.e. the time slots double after a collision.
- After 10 collisions the stations wait 0-1023 time slots
- After 16 collisions, that system declare failure.

Ethernet

- Ethernet uses 1-persistent CSMA/CD on coaxial cable at 10 Mbps
  - 802.3 allows other speeds & media
  - CSMA/CD implemented at hub
- The maximum cable length allowed: 500m
- Longer distances covered using repeaters to connect multiple "segments" of cable
  - No two stations can be separated by more than 2500 meters and 4 repeaters
  - Including the propagation delay for 2500m and the delay in 4 repeaters, the maximum time for a bit to travel between any two stations is τ=25.6μs (one way) i.e. 2τ=51.2 μs (round-trip)

Ethernet Performance

Efficiency of Ethernet at 10 Mbps with 512-bit slot times.



Channel Efficiency

- p=Probability of transmission for one station
- A= Probability of transmission in one slot
- 2λ= Duration of a slot
- P=Mean frame duration
- F=Frame length
- B=Network bandwidth
- L= Cable length

Channel Efficiency

- Let p is the probability that one station acquires the channel. The probability that any one of the k stations acquires the channel in a slot is:

$$A = k * p * (1-p)^{k-1}$$

- A is maximized when: $p_0 = \frac{1}{k}$ $k \to \infty, A = \frac{1}{e}$
- The probability that it requires exactly j slots is:

$$A(1-A)^{j-1}$$

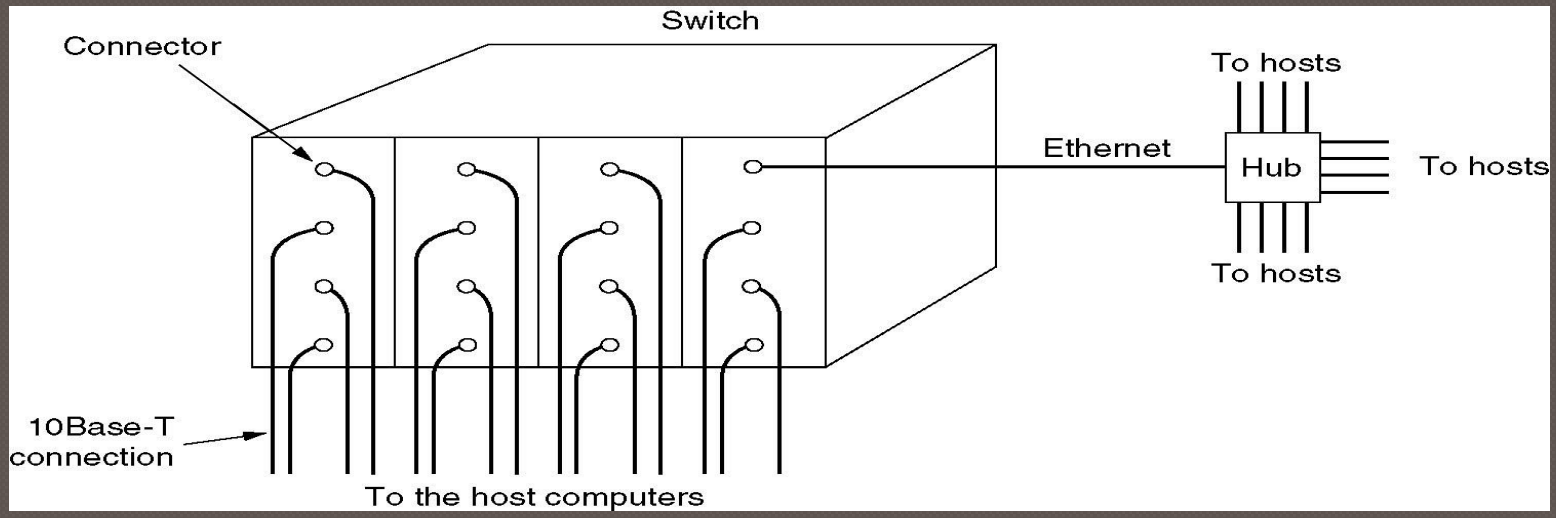
- The average number of slots per contention is:

$$\sum_{i=0}^{\infty} jA(1-A)^{j-1} = 1/A$$

- Channel Efficiency = $\eta = \frac{P}{P + \frac{2\lambda}{A}} = \frac{1}{1 + 2BLe/cF}$

Switched Ethernet

- A simple example of switched Ethernet.
- No collisions
- Concentrators connect via a hub to many stations



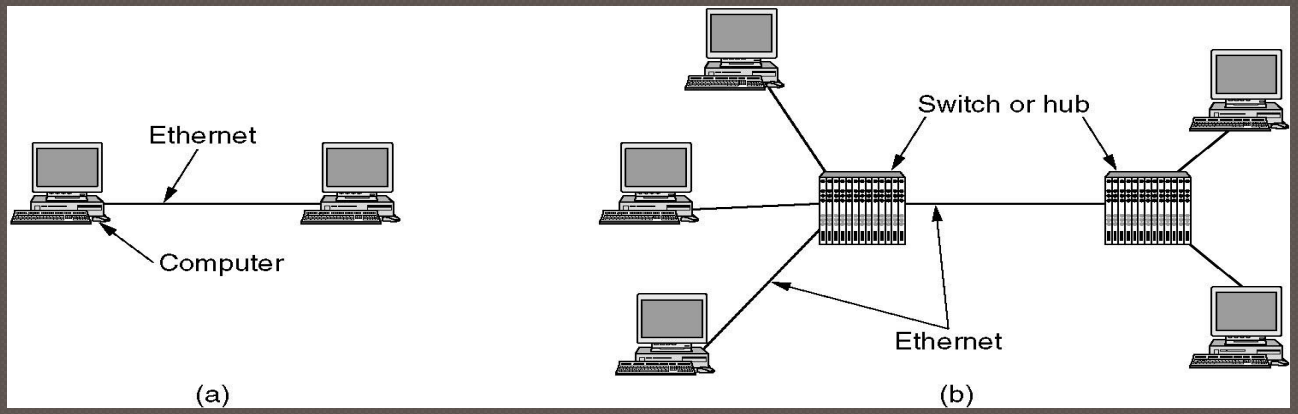
Fast Ethernet

The fast Ethernet cabling.

- At 100Mbps instead of the 10Mbps of the original;
- Adapts the original Ethernet version instead of creating a new one.

Name	Cable	Max. segment	Advantages
100Base-T4	Twisted pair	100 m	Uses category 3 UTP
100Base-TX	Twisted pair	100 m	Full duplex at 100 Mbps
100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs

Gigabit Ethernet



(a) A two-station Ethernet. (b) A multistation Ethernet.

Gigabit Ethernet cabling.

Name	Cable	Max. segment	Advantages
1000Base-SX	Fiber optics	550 m	Multimode fiber (50, 62.5 microns)
1000Base-LX	Fiber optics	5000 m	Single (10 μ) or multimode (50, 62.5 μ)
1000Base-CX	2 Pairs of STP	25 m	Shielded twisted pair
1000Base-T	4 Pairs of UTP	100 m	Standard category 5 UTP

Next Time

- Wireless LAN