Introduction to LAN/WAN

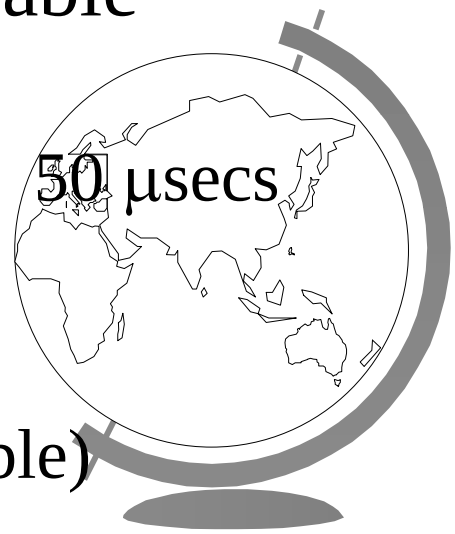
Medium Access Sublayer (Part II)

Now,Where Were We?

- Introduction
- Multiple Access Protocols
- IEEE 802 Standard
  - Ethernet (802.3) ←
- Wireless LAN Protocols
- Misc

Ethernet Performance

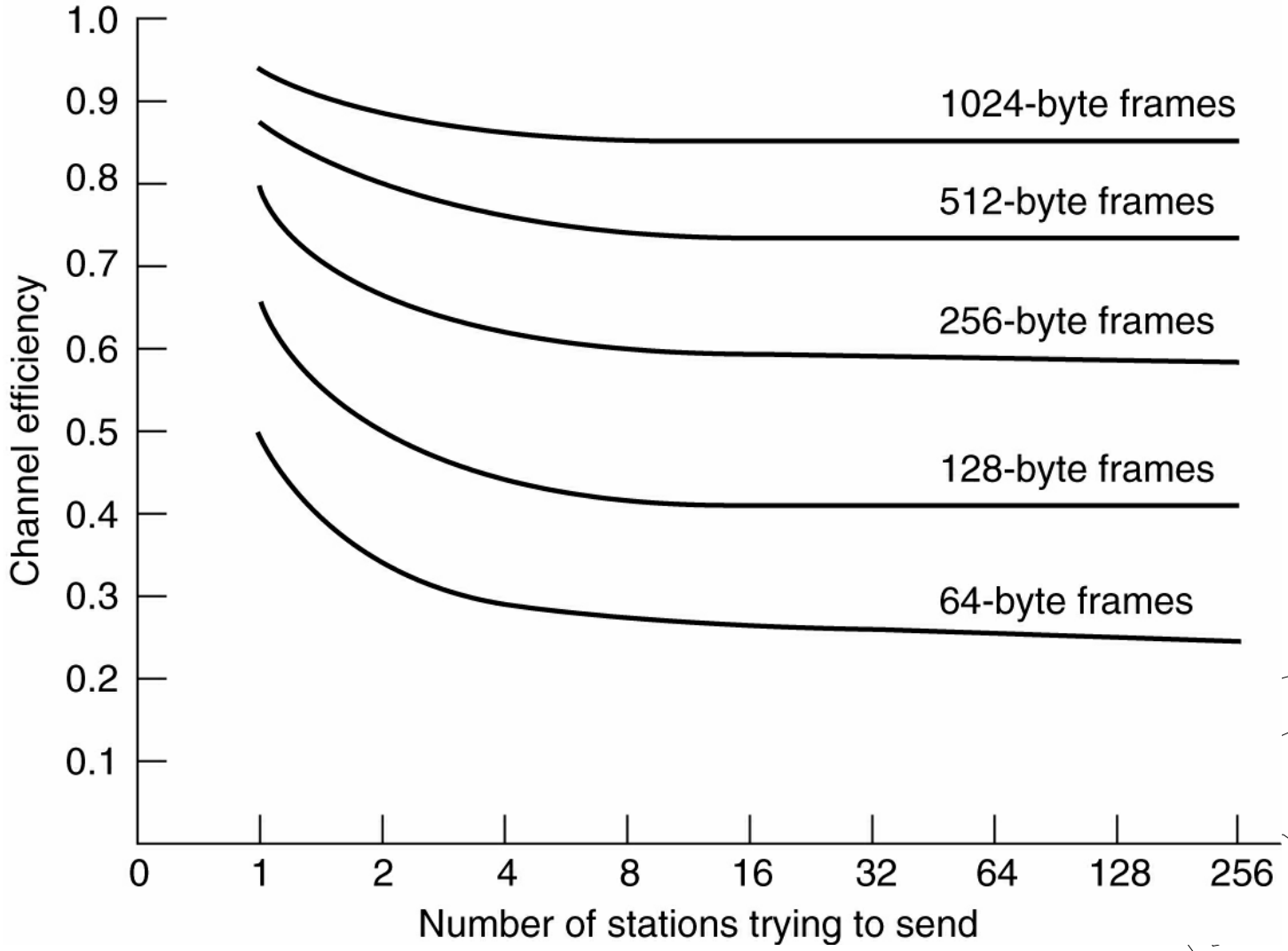
- Mean frame transmission time, P sec
- Probability that a frame transmits, A
  - (complicated stuff skipped)
- Channel Efficiency = $\frac{P}{P + 2\tau/A}$
- The longer the cable, the longer the contention period
- This is why Ethernet specifies maximum cable length (i.e. put limit on 2τ)
  - Longest allowed path is 2.5km + 4 repeaters ≈ 50 μsecs
  - Minimum frame must allow for at least this
  - At 10 Mbps is 512 or 64 bytes, shortest frame
  - 1 Gbps Ethernet is even longer! (or shorter cable)

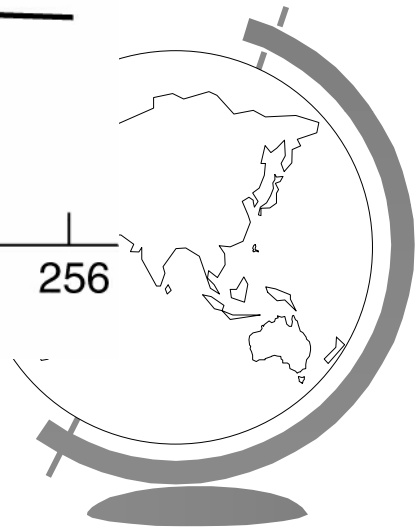


Ethernet Performance (cont.)

- Convert previous formula to:
  - Frame length F
  - Network bandwidth B
  - Cable len L
  - Cable propagation speed c
  - (complicated stuff skipped)
- Channel Efficiency = $\frac{1}{1 + 2BLe/cF}$
- Increasing B x L reduces efficiency
- But everyone wants high-bandwidth, WAN!
  - Then they better not use Ethernet

Ethernet Performance and Frame Size





Ethernet Perf Final Thoughts ...

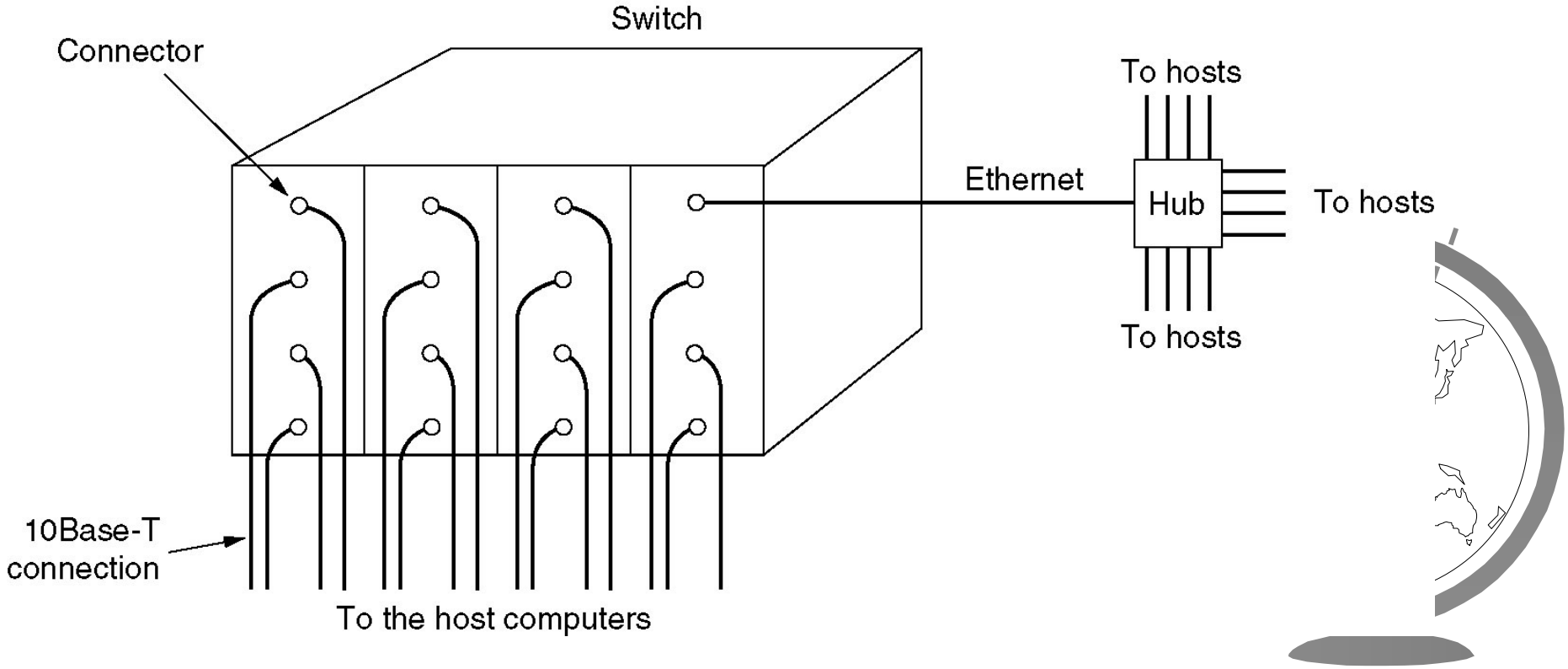
- Lots of theoretical work on Ethernet perf
  - all assumes traffic is Poisson
- Turns out, traffic is self-similar
  - averaging over long-periods of time does not smooth out traffic (same variance each time interval)
  - bi-modal (packets are either big or small)
- Take models with grain of salt

Saturated LAN

- Net saturated? Add bandwidth … good idea?
  - Expensive to replace cards
  - Efficiency
  - Instead *Switched LANs*
- Switch with high-speed *backplane* with connected *cards* (typically, 1 Gbps)
- 4 to 32 plug-in cards
- Each plug in card can support 1 to 8 connectors (computers)
- Can reduce or eliminate contention

Switched LANs

- When receives frame, sees if destined for another on same line, forwards as needed
  - different than hub or repeater
  - Run classic ethernet on same card
  - Proprietary protocol between cards



Fast Ethernet

- As 10 Mbps proved too slow, two proposal:
  - FDDI (Fiber Distributed Data Interface)
  - Fibre Channel (uses crossbar switch)
- FDDI
  - Two fiber rings, one in each direction
  - Token-based protocols (token bus, token ring)
  - Several tokens (packets) in the ring.
  - Station must grab 1 token to transmit
  - Priority tokens based on timers

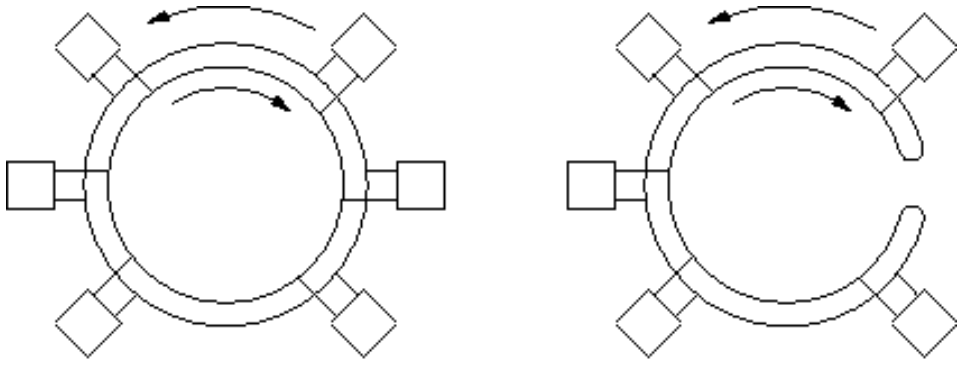


Fig. 4-45. (a) FDDI consists of two counterrotating rings. (b) In the event of failure of both rings at one point, the two rings can be joined together to form a single long ring.

Fast Ethernet

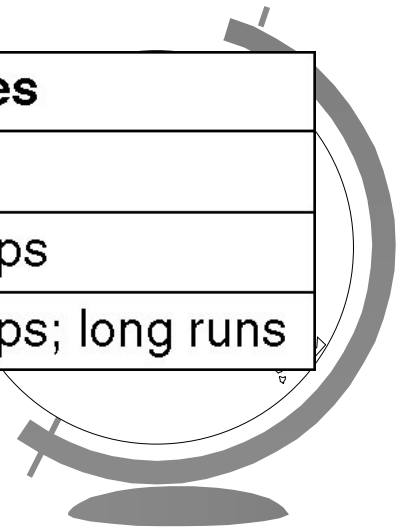
- FDDI, Fibre channel too complicated, didn’t become LAN
- Used as backbones, no widespread success
- Made 802.3 committee think tank (in 1992)
  - keep Ethernet, make faster (winner, 802.3u)
  - make new LAN, call Ethernet (802.12) (loser:flopped!!)
- Reasons 802.3 won:
  - Backwards compatible
  - New protocol = new unforseen problems
  - Quicker deployment

Fast Ethernet

- Change bit time from 100 nsec to 10 nsec
  - all must use hubs
  - shorter “wire-length” to hub
  - Wiring changes
  - Mostly copper (10BaseT) (successful)

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

The original fast Ethernet cabling.

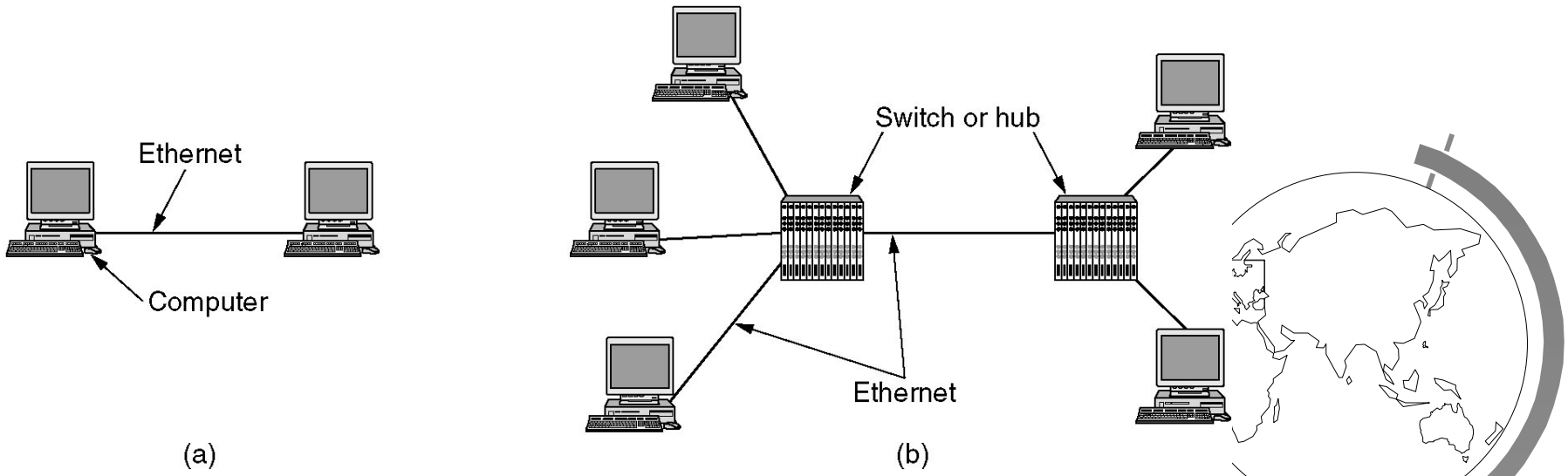


Gigabit Ethernet

- Even faster ethernet!!
- 802.3*z* (*z* indicates the end of the road)
- Design goals:
  - make Ethernet 10 times as fast but backwards compatible (again??)
  - Offer unacknowledged datagram service
  - Same 48-bit addressing scheme
- All configurations are point-to-point

Gigabit Ethernet

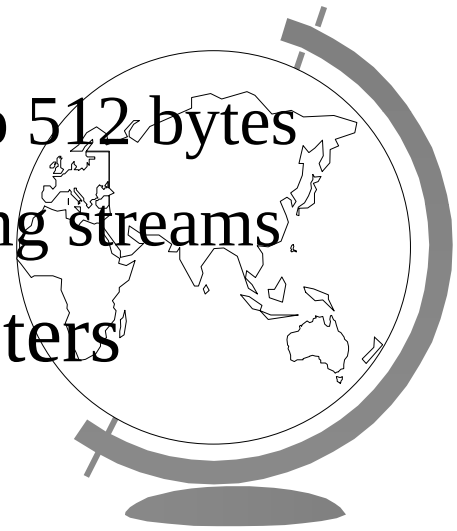
- Two modes:
  - Full-duplex
  - Half-duplex
- Full duplex used when a switch is used (b)
- No contention since line is FD, so no CSMA/CD



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

Gigabit Ethernet

- Half-duplex used when a hub is used instead of a switch
- Hub cannot buffer packets, switch can
- Collisions are possible so CSMA/CD
- Higher bandwidth means shorter longest distance
- Solutions:
  - Carrier extention: stations pad min. frames to 512 bytes
  - Frame bursting: concatenate multiple outgoing streams
- Result: extends network radius to 200 meters



Gigabit Ethernet (2)

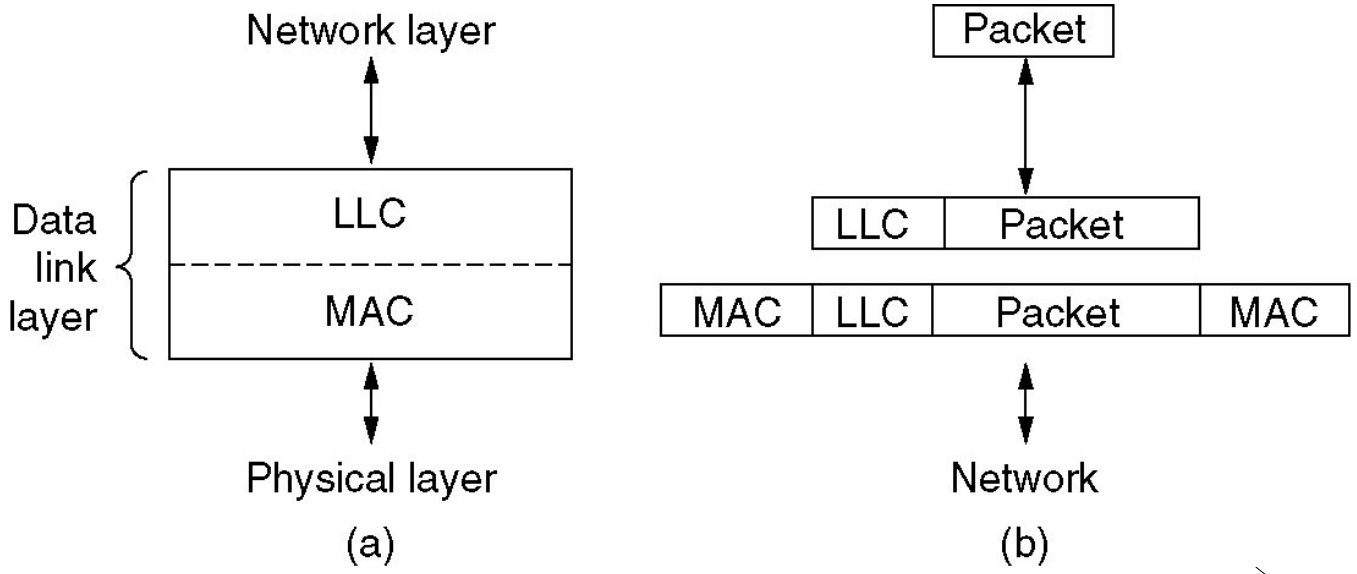
- Supports both copper and Fiber
- Manchester encoding at 1Gbps would require 2Gbaud signal. New encoding used on fiber
- New encoding scheme used: 8B/10B
- Basically encodes an 8-bit byte as 10 bits on fiber

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

Gigabit Ethernet cabling.

IEEE 802.2: Logical Link Control

- So far Ethernet and MAC protocols offer no reliable service (e.g. stop-and-wait, etc)
- IEEE defined LLC to run above MAC to provide these services
- Closely based on HDLC



(a) Position of LLC. (b) Protocol formats.

Ethernet Retrospective

- Been around for over 20 years
- Few technologies make it that long (operating system, architecture, etc)
- Ethernet
  - pros: popular, simple, reliable, flexible, cheap
  - cons: non-deterministic, no priorities, min frame size

Now, Where are We?

- Introduction
- Multiple Access Protocols
  - contention
  - collision-free
- Ethernet
- Wireless LAN Protocols ←
- Bridges
- Misc (brief)
  - High-Speed LANs
  - Satellite Networks