Chapter 7: LAN/MAN Systems

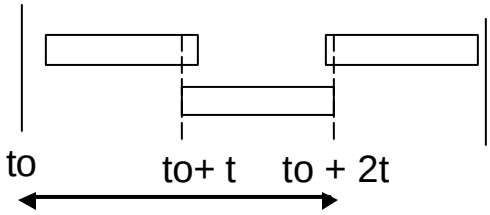
- Ethernet
- Token Ring
- Fiber channel
- Wireless LANs
- ATM LANs

ALOHA Protocols

- Pure ALOHA
  - » Developed for Packet Radio networks, 1970
- When station has frame, it sends
- Station listens (for max round trip time)plus small increment
- If ACK, fine. If not, retransmit
- If no ACK after repeated transmissions, give up
- Frame check sequence (as in HDLC)
- If frame OK and address matches receiver, send ACK

ALOHA Protocols (Cont.)

- Frame may be damaged by noise or by another station transmitting at the same time (collision)
- Any overlap of frames causes collision
- Max utilization 18%



Vulnerable period

ALOHA Protocol Performance

- Assume that k frames are generated during a given frame time is given by Poisson distribution

$$\Pr[k] = \frac{G^k e^{-G}}{K!}$$

- G: The total rate of data presented to network old and new packets(offered load)

ALOHA Protocol Performance

- Throughput of the network; S
- S = Offered load * probability of successful transmission; P
- P = probability of no other traffic being initiated during the vulnerable period (2t)
- $P ? e^{?2G}$
- $S ? Ge^{?2G}$

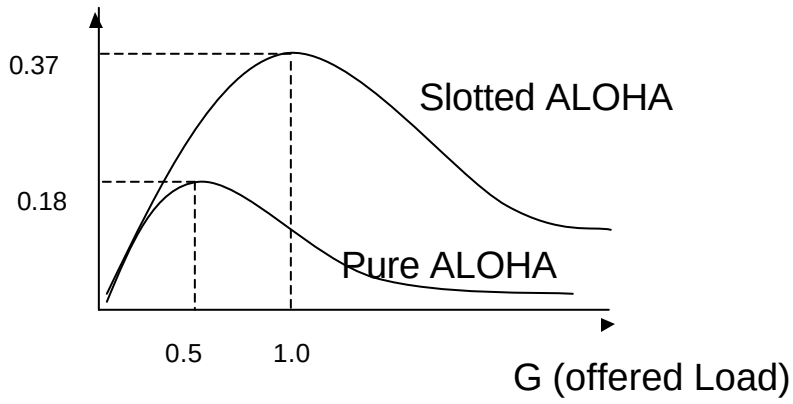
Slotted ALOHA Protocol

- Time in uniform slots equal to frame transmission time
- Need central clock (or other sync mechanism)
- Transmission begins at slot boundary
- Frames either miss or overlap totally

ALOHA Protocol Performance

- P = probability of no other traffic being initiated during the vulnerable period (2t)
- $P ? e^{?G}$
- $S ? Ge^{?G}$
- Max utilization 37%

ALOHA Protocol Performance



Carrier Sensing Multiple Access

- Observations:
  - » For LANs, the propagation delay between stations is usually very small compared to frame transmission time
    - » Example: 10-Mpbs Ethernet
  - » All stations know that a transmission has started almost immediately

1-Persistent CSMA

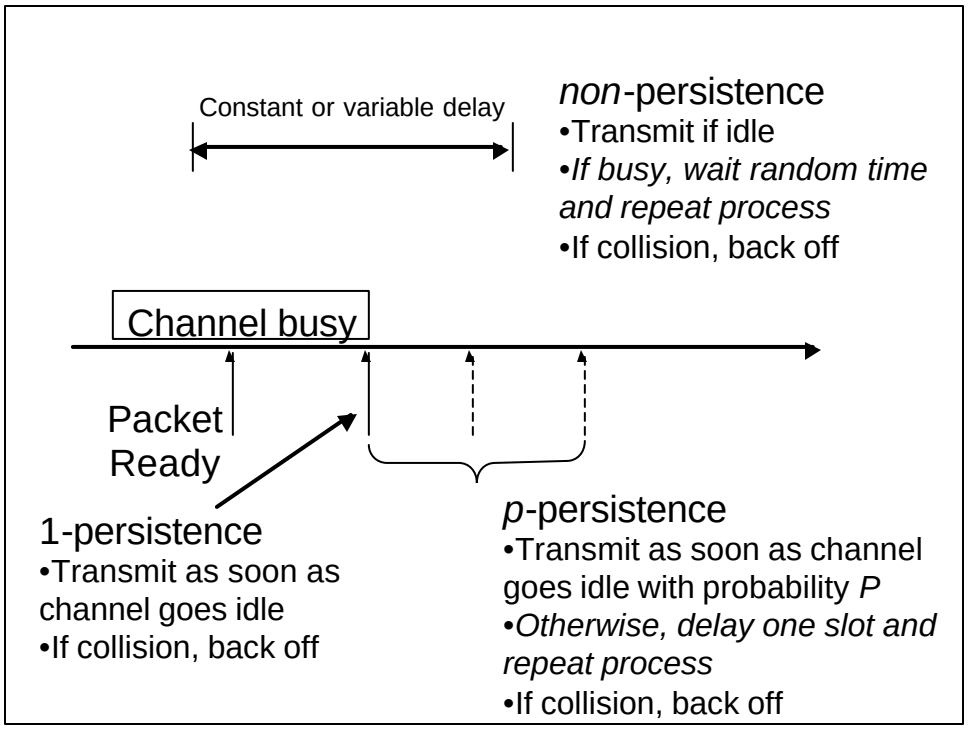
- First listen for clear medium (carrier sense)
  - » If medium idle, transmit
  - » If medium busy, wait until becomes idle
- If two stations start at the same instant, collision
- Wait reasonable time (round trip plus ACK contention)
- No ACK then retransmit
- Max utilization depends on propagation time (medium length) and frame length
  - » Longer frame and shorter propagation gives better utilization

P-Persistent CSMA

- First listen for clear medium (carrier sense)
  - » If medium idle,
    - – transmit with probability *p*
    - – Defer until next slot with probability *1-p*
    - – If the slot is also idle, it either transmit or defers again
    - – Process continues until either the frame transmitted or another station has begun
    - – If another station had begun, defer for random time
  - » If medium busy, wait until becomes idle

Non-Persistent CSMA

- First listen for clear medium (carrier sense)
  - » If medium idle, transmit
  - » If medium busy, wait for a *random time* until becomes idle
  - » Exhibits better channel performance and longer delay

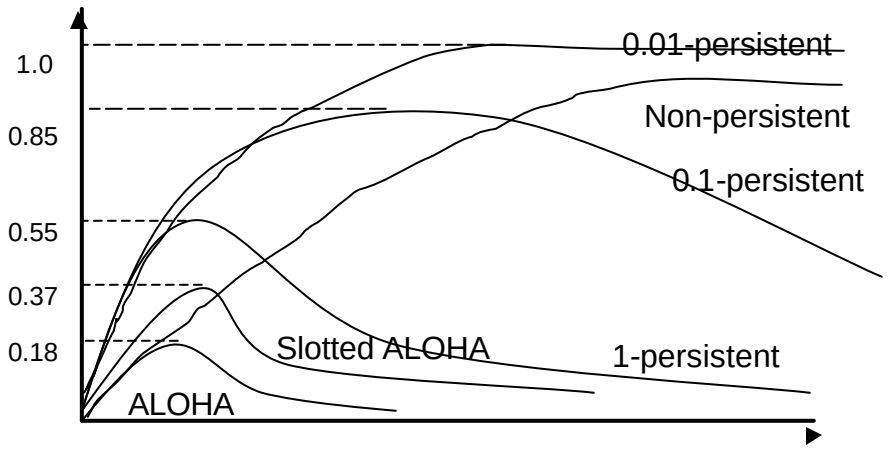


non-persistence
•Transmit if idle
•*If busy, wait random time and repeat process*
•If collision, back off

1-persistence
•Transmit as soon as channel goes idle
•If collision, back off

p-persistence
•Transmit as soon as channel goes idle with probability *P*
•*Otherwise, delay one slot and repeat process*
•If collision, back off

CSMA performance



CSMA with Collision Detection (CMSA/CD)

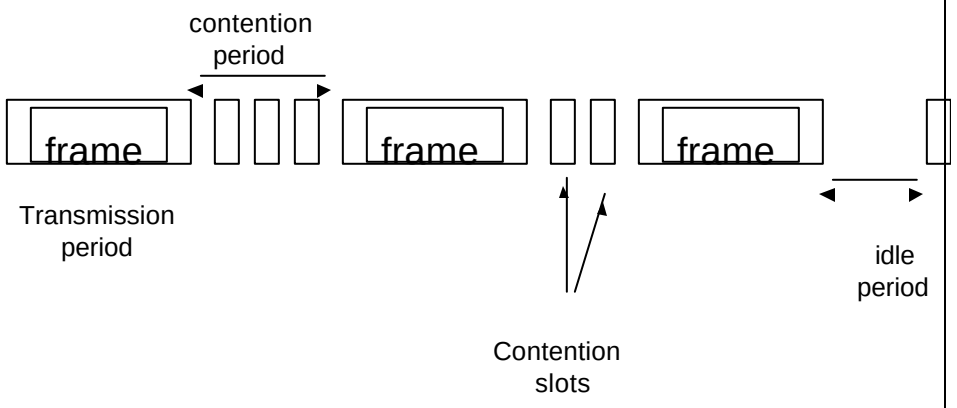
- Example:

  Consider a 10-Mpbs Ethernet LAN. Propagation time is about 5 ?sec/Km for a coaxial cable. For a 500m cable:

  What is the contention period?

- Observations:
  - » Any overlapping is considered as Collision.
  - » Drawback of CSMA: when two frames collide, the medium remains unusable for the duration of transmission of both damaged frames.
  - » Why don't stop transmission as soon as a collision is detected?

CSMA/CD (Cont.)



CSMA/CD tree possible states: idle, contention, or transmissio

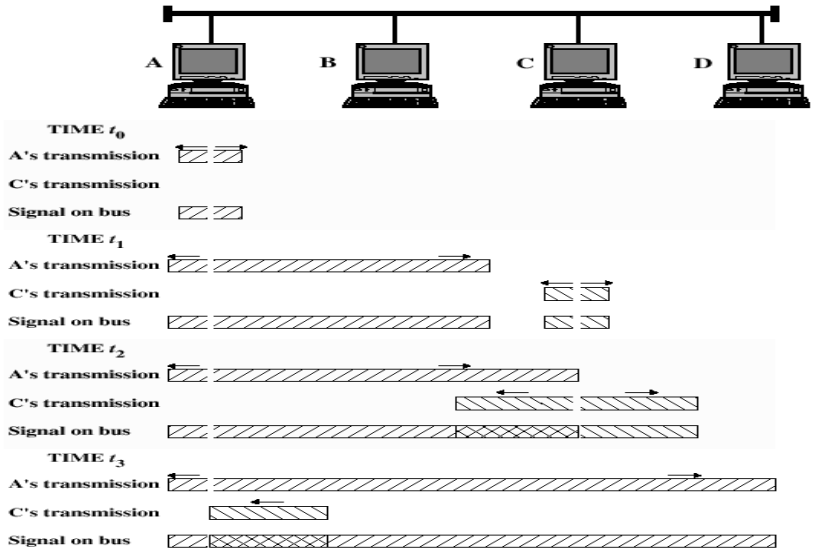


Figure 14.1 CSMA/CD Operation

CSMA/CD (Cont.)

- CSMA/CD:
  - » 1. if the medium is idle, transmit; otherwise, go to step 2.
  - » 2. if the medium is busy, continue to listen until the channel is idle, then transmit.
  - » 3. if a collision is detected during transmission, transmit a brief jamming signal to inform other stations that a collision had occured
  - » 4. after transmitting a jamming signal, wait a random amount of time, then attempt to transmit.

CSMA/CD (cont)

- Collisions occur only when more than one user begins transmitting within the period of propagation delay.

- To detect collision, the station's hardware must listen to the cable while it is transmitting. If what it reads back is different from what it is putting out, it knows a collision is occurring.

CSMA/CD (cont)

- Minimum detection time: propagation time from one station to the other
- Maximum propagation time is not greater that twice the End-to-End propagation time
- Ratio of frame transmission time to propagation time is a very important design parameter
- If shorter frames are used, collision detection does not occur, Then, CSMA/CD shows the same performance as the less efficient CSMA protocol

Ethernet

- Access methodology: CSMA/CD
- Logical topology: broadcast
- Physical topology: traditionally, BUS; currently, most often STAR
- Standard: IEEE 802.3

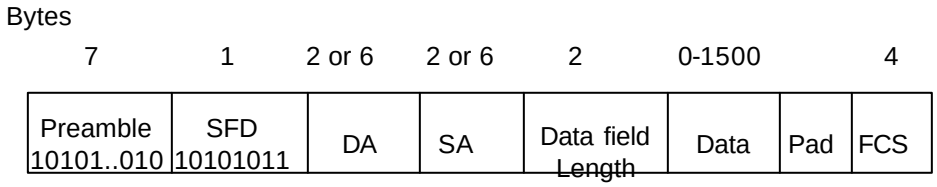
Ethernet and IEEE 802.3

- Ethernet uses 1-persistent CSMA/CD
  - » when a station wants to transmit, it listens to the cable. If the cable is busy, the station waits until it goes idle; otherwise it transmits immediately.
  - » when collision occurs, all colliding stations terminate their transmission, the first station detects a collision it sends a 48-bit noise burst to warn other stations, wait a random time, and repeat the whole process again
  - » No acknowledgment is provides

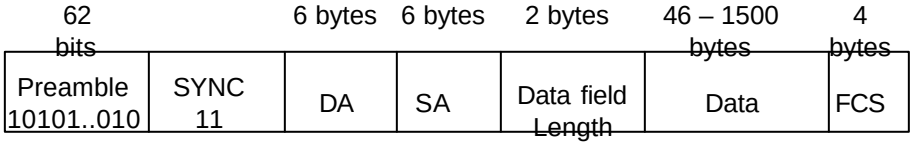
Ethernet and IEEE 802.3

- The binary exponential backoff algorithm is used.
- After collision time is divide up into discrete slots
- Slot's length is equal to the worst case round-trip propagation time (2?)
- The delay is an integer multiple of slot time

The 802.3 Frame Format



IEEE 802.3 frame format



Ethernet frame format

The 802.3 Frame Format

- What is the minimum frame size?
  - » 64 bytes not including the start of frame, why?
    - – To distinguish valid frames
    - – To prevent a station from transmitting short frames such that transmission ends before it reach the far end
  - » Example:

    A 10 Mbps LAN, with a maximum length of 2500 m and four repeaters, the minimum allowed frame must take 51.2 ?sec.

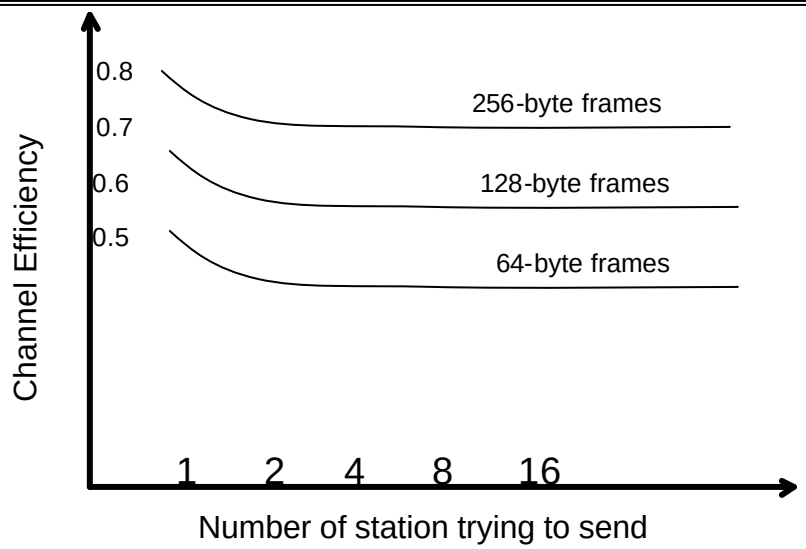
    This corresponds to 64 bytes.

    What about if we have 100 Mps LAN
- Preamble patterns: 10101… to allow the receiver's clock to lock with the sender's

The 802.3 Frame Format

- DA & SA:
  - » LSB transmitted first
  - » If the first bit of DA is '1', it means that a group address
  - » To broadcast to all users, DA is set to all 1s.
  - » Who is responsible for location destination address?
  - » The first 3 octets to identify the manufacturer and are assigned by IEEE
  - » The last 3 octets to produce unique MAC layer addresses and the are assigned by the manufacturer

Efficiency of 802.3



Cabling

- 10BASE5

  <data rate in Mbps> <signaling method> <maximum segment length in hundreds of meters>

Name	cable	Max. segment	Nodes/seg	advantages
10Base5	Thick coax	500m	100	Good for backbone
10Base2	Thin coax	200m	30	Cheapest system
10Base-T	Twisted pair	100m	1024	Easy maintenance
10Base-F	Fiber optics	2000m	1024	Best between buildings

Ethernet (Cont.)

- What is the maximum length of a network segment?
  - » IEEE 802 restricts the maximum to 500 m
  - » Maximum of 4 repeaters
  - » Therefore, maximum span is 2500 m
- Collision detection is easier in the STAR-Wiring approach
  - » If any hub detects activity on more than one input port, a collision is assumed

Ethernet Technologies

- 10-Mbps Ethernet
- 100-Mbps Ethernet
- Gigabit Ethernet

Ethernet Technologies

Parameter	10-Mbps	100 Mbps	1Gbps
SlotTime	512-bit time	512-bit time	4096-bit time
interFrameGap	9.6 ?sec	0.96 ?sec	0.096 ?ses
attemptLimit	16	16	16
backoffLimit	10	10	10
jamSize	32 bits	32 bits	32 bits
MaxFrame Size	1518 bytes	1518 bytes	1518 bytes
MinFrameSize	64 bytes	64 bytes	64 bytes
Burstlimit	N/A	N/A	8192 bytes