The Multiple Access Protocols and Ethernet

CS158a

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Mar 19, 2007.

Outline

- Slotted Aloha
- Carrier Sense Multiple Access Protocols
- Wireless LAN Protocols
- Ethernet

Slotted Aloha

- Slotted Aloha was developed shortly after pure Aloha in 1972 by Roberts.
- Time is divided into discrete intervals.
- So that everyone agrees on the intervals boundaries a special station emits a signal to denote the start of an interval.
- Using slots halves the vulnerable period.
- So the throughput per frame time now becomes $S=Ge^{-G}$.
- Maximizing S with respect to G gives S=1/e or about .37, twice pure Aloha.

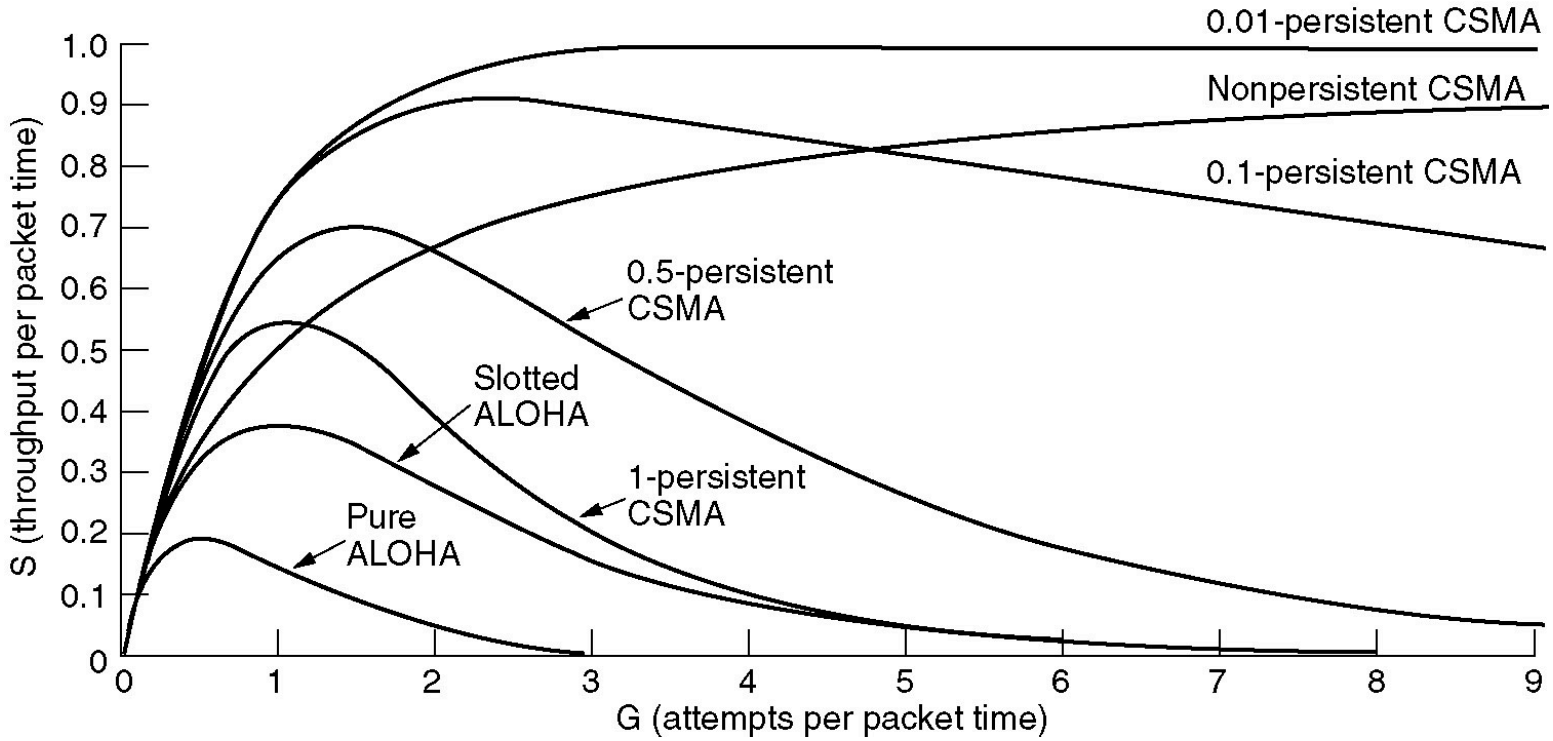
Carrier Sense Multiple Access Protocols

- In our set-ups so far, the machines were not able to do carrier sense.
- If one allows carrier sense (so one has a **carrier sense protocol**), one can improve throughput.
- Several such protocols were developed by Kleinrock and Tobagi (1975).

1-Persistent Carrier Sense Multiple Access

- In this set-up when a station has data to send, it first listens to the channel to see if anyone else is transmitting at that moment.
- If the channel is busy, it waits until it becomes idle.
- When the channel becomes idle, it sends a frame.
- It is called **1-persistent** since if the channel is idle, one transmits with probability 1. This protocol could be used in slotted or non-slotted settings.
- In slotted setting, one can have **p-persistent CSMA**, where when the channel is idle, one transmits with probability p, and defers to the next slot with probability 1-p.
- One can still have collisions in these set-ups, since the channel may have a delay to it, so although it appears idle someone else might have started transmitted less than the delay time ago.
- Even if there is no delay one can still have collisions, since two stations may become ready while a third one is transmitting. When the third station stops, both will immediately transmit, causing a collision.
- One way to avoid this is to wait a random time before trying again if one senses the line is busy. This is called **non-persistent CSMA**.

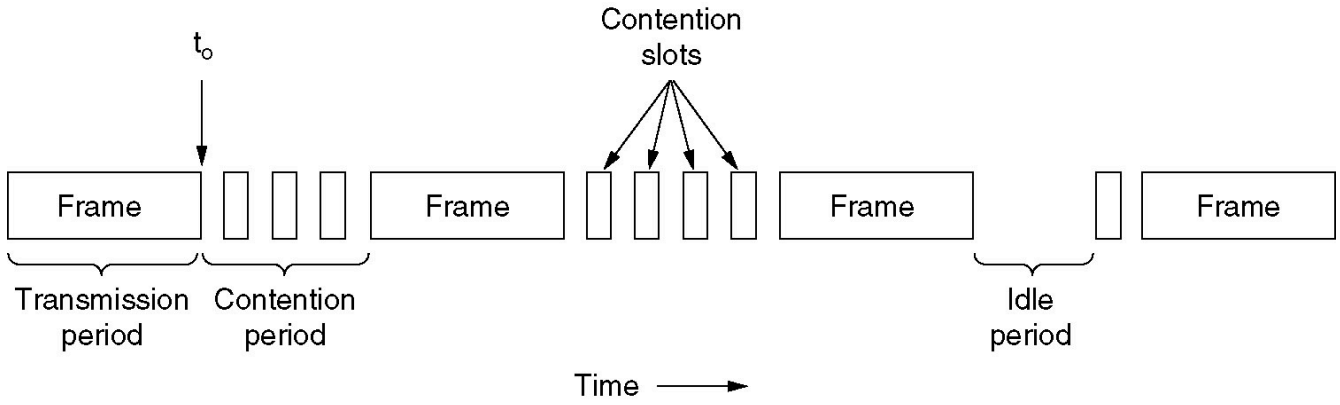
Throughputs of Various Protocols



CSMA With Collision Detection

- One way to improve CSMA is to have stations immediately abort sending as soon as they see a collision rather than transmit their whole frame.
- This is called **CSMA/CD** (CSMA with Collision Detection.
- It is used by Ethernet LANs.
- To detect collisions, a stations compares the power it output on the line to the power it receives.
- When a collision is detected a station waits a random period of time and then tries again.

More on how CSMA/CD works



- Let T be the delay between the farthest stations.
- After station to transmit, a station needs to wait 2T to be sure that no one else is trying to transmit
- So after time t_0 above one enters a contention state which can be modeled as a slotted Aloha system of with slots of width 2T.
- To detect collisions the voltage on the line needs to be non-zero, so this requires we send data with a special encoding.

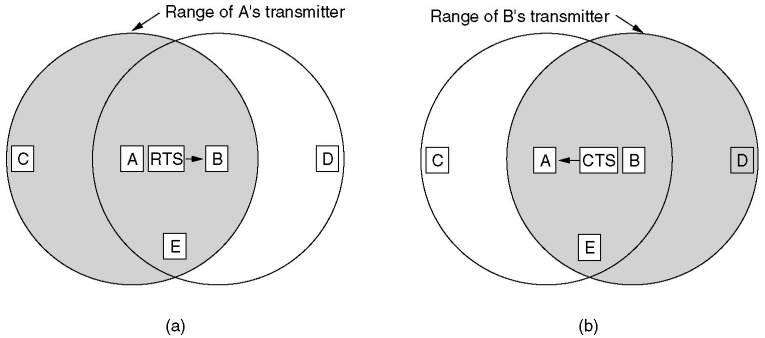
Wireless LAN Protocols

- We now briefly consider some issues in modifying CSMA for the wireless setting.
- One problem is that not everyone can necessarily see the same stations. (**Hidden station problem**). For instance, below A is sending to B, but C cannot see then and also starts sending to B.

- Another problem is sometimes stations might think they cannot send when in fact it would be okay. (C to D). This is called the **Exposed station problem.**

MACA and MACAW

- MACA (Multiple Access with Collision Avoidance) was an early (1990) protocol for wireless LANs.
- MACAW is **MACA for Wireless** is a later (1994) improved scheme.



- If A wants to send to B, it first sends a **request-to-send** (RTS) with the frame length it will send.
- Machines in A's sphere hearing this stay silent until B's response period passes.
- B, if it is not receiving from another station, then sends a **clear-to-send** (**CTS**) also with this frame length.
- Machines in A's sphere which don't hear the clear-to-send know they can transmit while A is transmitting.
- Machines in B's sphere know not ot trasmit for the frame length duration.
- A can now send.

Ethernet

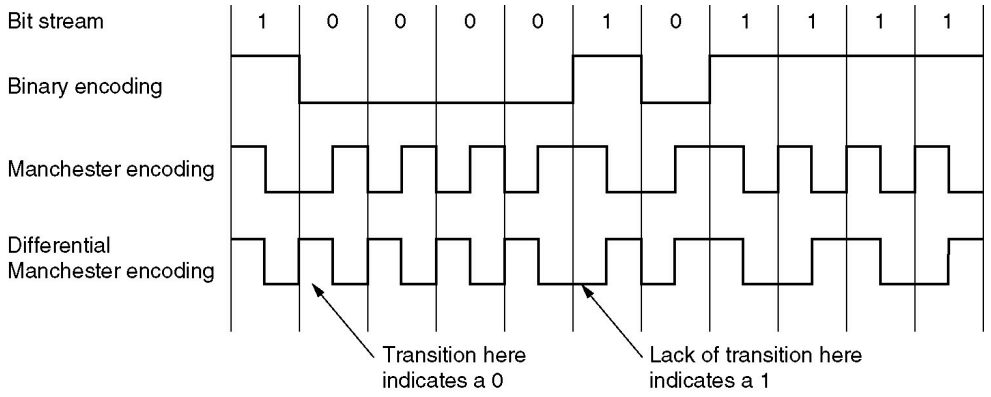
- Ethernet can refer to the cable or the protocol used over the cable.
- Here are the different types of ethernet cables

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

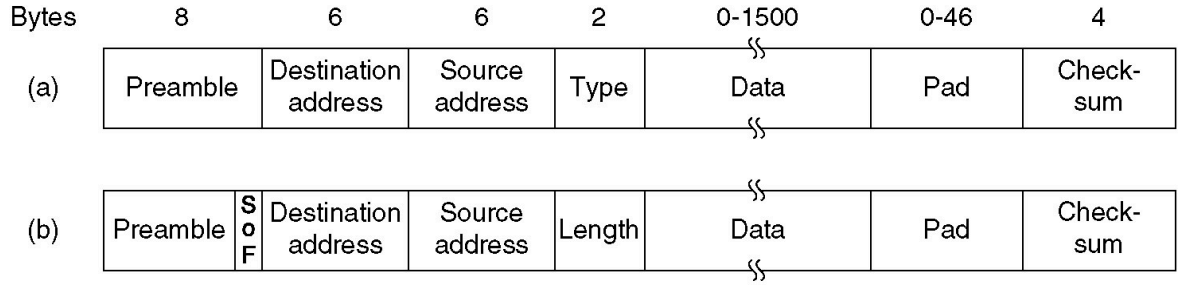
- 10Base5 uses **vampire taps** (pins placed into the cable to connect a wire to a machine)
- 10Base2 use T junctions.
- 10BaseT uses twisted pair wires connected to a hub

Manchester Encoding

- As we already mentioned, we need to have a voltage on the line to do carrier sense.
- It is also useful to know when a 0 or 1 starts and when it ends.
- So we want sending a 0 or a 1 to both involve changing a voltage on the line.
- Ethernet uses Manchester encoding to do this.
- Token Ring uses Differential Manchester encoding



Ethernet Frame Structure



- (a) is DEC, Intel, Xerox Ethernet, (b) is 802.3
- Each byte of preamble of form 10101010, which using Manchester encoding, looks like a square wave and can be used to synchronize the receiver's clock.
- In 802.3, the last byte of the preamble becomes a start of frame delimiter to make it compatible with 802.4 and 802.5
- The high order bit of the destination address can be used to say single or group addresses (multicast).
- The next 46 bits of the address are a global MAC address (assigned centrally by IEEE)
- The type says which network protocol to hand the frame to.
- Pad is used if the frame would fall under 64 bytes because of too little data.
- The checksum uses a CRC code.

The Binary Exponential Backoff Algorithm

- Suppose a station want to send a frame and is involved in a collision.
  - The station bumps the count i of the number of times it has tried to send the frame (initially, 0).
  - It computes a number w between 0 and 2^i-1
  - It waits that many frame intervals and tries to send again.
- Once, the station successfully sends, its i is reset to 0.