CSIS 625 Week 8

Overview - LAN

- LAN types
  - Ethernet
  - Token Ring
  - FDDI
  - ATM
  - MAP - Token Bus
  - Fibre Channel

MAC - Media Access Control

- When there are multiple nodes that can all transmit on a given link, a means of controlling them is necessary
- The MAC layer is a sub-layer of data link layer in these situations.
- The Logical Link Control (LLC) Layer is the other sub-layer

MAC assumptions

1 - Station Model
- There are *N* independent stations (aka nodes) that generates frames of data for transmission

2 - Single Communications Channel

3 - Collision detection
- All stations can detect collisions

4 - Time frame
- Continuous time - any frames starts at any time
- Slotted time - Time divides into discrete slots

5 - Carrier sense (or not)
- The nodes can detect if the channel is busy

ALOHA protocol

- Ground based radio broadcasting
- Developed at University of Hawaii
- Pure ALOHA
  - Any node starts transmitting at any time
  - Receiving node detects if a collision occurs
    - Same if partially or completely clobbered
  - If data not properly received, the transmitter waits a random amount of time and resends.

ALOHA Protocol

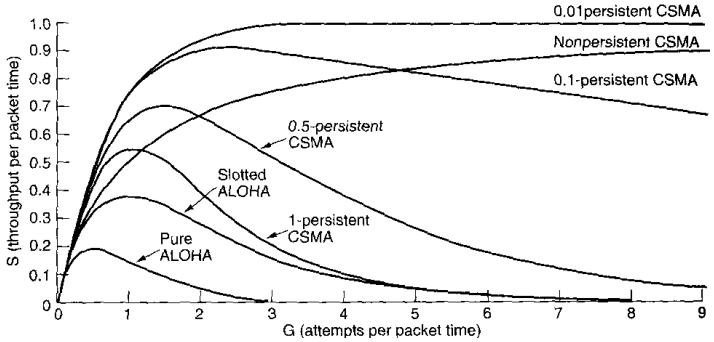
- Slotted ALOHA
  - A special node emits a “pip” at the start of each interval.
  - All frames start at the beginning of an interval
- Both Pure ALOHA and Slotted ALOHA have a point at which adding more traffic results in worse throughput
  - The collisions keep piling up and causing more and more collisions
  - Slotted ALOHA will take about 2x as much load as Pure ALOHA

Carrier Sense Multiple Access (CSMA) Protocols

- Nodes listen to see if someone else is transmitting before they send their packet.
  - Better performance than ALOHA
- 1-Persistent CSMA
  - Transmitter waits until the the line is idle and sends immediately
- Nonpersistent CSMA
  - Transmitter waits random time time if the line isn't idle
  - Leads to better utilization AND longer delays

CSMA Protocols continued

- p-Persistent CSMA
  - Uses slotted channels - If slot is idle there is a probability of p that transmitter will use the channel.



CSMA/CD - Carrier Sense Multiple Access with Collision Detection

- Extend the idea so that if two nodes detect a collision they stop transmitting immediately
- Quickly terminating the transmission saves time and bandwidth
- To detect collision, need to transmit for 2x the maximum propagation time.
  - Time for signal to transmit from one end to the other
  - PLUS Time for colliding signal to transmit from far end back

Wireless Protocols

- Typically nodes are all trying to talk with a central (wired) hub
- Sometimes (but not always) the nodes can "hear" one another
- Hidden station problem
  - When one node can't hear another and tromps on transmission to a third node
- Exposed station problem
  - When one node hears another node and so won't transmit to a third, even through it could.

Wireless Protocols and CSMA

- CSMA tells the transmitter if there is activity near, but you want to know if there is activity by the receiver.
- MACA - Multiple Access with Collision Avoidance.
- MACAW - MACA with refinements
- CSMA/CA - another name for MACA like system

Wireless Protocols continuted

- MACAW basics - A sending to B
  - A sends B an RTS (Request to Send) frame with length
  - B sends A a CTS (Clear to Send) frame with length
  - A sends B the data frame
  - Other nodes that hear CTS know to be quiet for that time period (based on length)

IEEE 802 Standards for LANs

- IEEE has produced many standards for LANs (and MANs)
- The 802 standards include
  - CSMA/CD (Ethernet)
  - Token bus
  - Token ring
- The 802 standards include a lot of different physical and MAC layer, but are compatible at the data link layer

802.3 Standard

- This is basically the Ethernet standard
- Ethernet started as a 2.94Mbps over a 1km coaxial cable at Xerox PARC - modeled after ALOHA system
- Xerox, DEC and Intel created 10Mbps Ethernet that became the 802.3 standard.
- 1-persistent CSMA/CD LAN

802.3 Cabling

- 10Base5 - Thick Coax - 400m segment - 100 nodes
- 10Base2 - Thin Coax - 200m segment - 30 nodes
- 10Broad36 - Thin coax - 1800m segment - uses RF modulation
- 10Base-T - twisted pair - 100m segment - 1024 nodes
- 10Base-F - fiber optics - 2000m segment - 1024 nodes
- 100Base-T - twisted pair - 100m segment - uses 2 pair Cat 5 cabling - full duplex
- 100Base-T4 - twisted pair - 100m segment - uses 4 pair Cat 3 cabling (not used)
- 100Base-FX - fiber - 2000m segment - full duplex
- 1000Base-T - twisted pair - 100m segment - uses 4 pair Cat 5

802.3 MAC sublayer

- Preamble - 7 bytes of 10101010 so that receiver's clock can synchronize with the senders clock
- Start of frame delimiter - 1 byte of 10101011
- Destination Address - 6 byte unique address
- Source Address - 6 byte unique address
- Length - 2 bytes (At least 46 bytes)
- Data - 0-1500 bytes
- Pad - 0-46 bytes
- CRC - 4 bytes

802.3 MAC sublayer

- Addresses
  - High order bit is 0 for ordinary, 1 for multicast addresses
  - An address of all 1's is for broadcast
  - bit 46 (next to high order bit) is local/global administration
  - 2^46 = 70,368,744,177,664 addresses
  - IEEE sells blocks where manufacturer is given the first 3 bytes, and then the manufacturer is responsible for the last 3 bytes.

802.3 MAC sublayer

- The length of a frame must be at least 64 bytes
  - This is a 46 byte data/pad field + 18 bytes for header and CRC
  - A 10Mbps Ethernet with 2500m of cable and 4 repeaters (from the standard) has a transmission time of 25.6usec
  - 2x this time is 51.2usec which corresponds to 64 bytes

Binary Exponential Backoff Algorithm

- When collision - each station waits a number of time slots before trying again
  - A time slot is defined as 51.2usec
- After a collision each station waits for 0 or 1 slot times before trying again
- After the second collision - 0 - 3 slot times
- After each subsequent collision each station waits 0 to 2^n - 1 time slots
- After 10 collisions, the value for n is frozen
- After 16 collisions the controller throws away frame

Full-Duplex Ethernet

- Used on point-to-point links with Ethernet switches.
- Removes CSMA/CD - can always transmit at will

Ethernet terminology

- Runt - a frame that is less than 64 bytes long
- Capture effect - the tendency of a station to keep the segment because others keep backing off more and more
- BLAM - Binary logarithmic arbitration method - an alternative to Binary exponential backoff that reduces capture effect
- Collision Domain – the group of nodes that are using CSMA/CD between them.
- Bridge – a device which connects 2 or more networks at layer 2.
- Switch – a “modern” name for an Ethernet Bridge

Ethernet terminology

- Baseband – use of digital signals
- Broadband – use of RF modulated signals

Token Bus – 802.4

- Since CDMA/CD leads to unknown amount of delay before a packet is transmitted – Token passing architectures were developed.
- Token bus uses coaxial cable with broadband (RF) modulation.
- 1, 5, & 10 Mbps possible
- Token Bus allows for 4 priorities of traffic at each node.
- Frame format slightly different from 802.3

Token bus - Token Passing

- Each node gets a Token
- Node has the right to transmit for some time period.
- When done, Node transmits the Token to the next node
- Periodically, a node solicits bids from new nodes wanting to join the ring.
  - If one responds – it is inserted into the ring and placed in order after the solicitor
  - If two respond – a collision occurs and a
- To leave the ring, a node tells it's predecessor who it's successor is
- If transmission failure in token passing
  - Retry of sending token
  - Then, sending broadcast to find out who's next and giving them token

Token ring – 802.5

- Cabling of each node having two connections – one to each of it's neighbors.
- Shielded twisted pair
- 1, 4 or 16Mbps using differential Manchester
- Typically wired in a star shaped ring
  - All spokes plug into MAU that has relays that allow isolation of failed spokes.
  - MAU – Multi-Station Access Unit
- Each bit arriving at an interface is copied into a 1-bit buffer and then copied out onto the ring again.
  - Each interface creates a 1-bit delay
- Each node can prioritize traffic

Token Ring – Token passing

- A token circulates the ring when it is idle.
- Station wanting to transmit grabs the token and transmits data frame.
- When done with the frame, and the frame has come back around – node transmits a token again.
- As frames go by – there is a priority field that a node may modify if it has higher priority traffic
  - Other nodes that have lower priority traffic will then pass on the token until the requesting node gets it.

FDDI - Fiber Distributed Data Interface

- 100Mbps over Fiber optic lines – 2000m max
- Uses a token passing architecture similar to Token ring
- Typically is not set up with a star-shaped ring

Token vs. CSMA/CD

- Token passing architectures allow for prioritization of traffic and guarantees that this traffic will get through in a fixed amount of time.
  - Even if heavily loaded – high priority traffic gets through
- CSMA/CD architecture allows for lower latencies when the LAN is lightly loaded
  - A node doesn't have to wait for a token.
- CSMA/CD implementations tend to be simpler (and therefore cheaper)

ATM LANs

- They're dead Jim
- ATM allows for prioritization of traffic, mixing very time critical traffic with non-time critical traffic
- Protocol elegance has been overpowered by cheap silicon.
- Has nice idea of being able to use same protocols from WANs, MANs, and LANs – voice, video and data.
- In MANs/WANs ATM is over SONET links
  - OC-3, OC-12, OC-48 (155Mbps, 622Mbps, 2.4Gbps)
- In LANs, ATM is over twisted pair
- 25Mbps, or 51Mbps

Fibre Channel

- A high speed protocol over fiber optics that is tailored to use for computer interfaces.
- Looks similar to SCSI from a software perspective.
- Very common in Storage Area Networks (SANs)
- 1.06 Gbps
- Up to 10km over single mode fiber

HIPPI – HIgh Performance Parallel Interface

- 800 or 1600Mbps using 50 or 100 twisted pairs.
- Developed in late 80's when LAN was 10Mbps ethernet
- Used for supercomputer interfaces
- Was relatively cheap to create as it used parts from other technologies

Further reference

http://www.techfest.com/networking/index.htm