Tutorial - 8
ELEC - 4120

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What are we going to understand today?

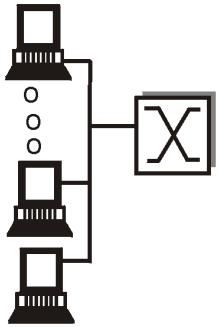
Multiple Access Protocols

- Pure ALOHA
- Slotted ALOHA
- CSMA (Carrier Sense Multiple Access)

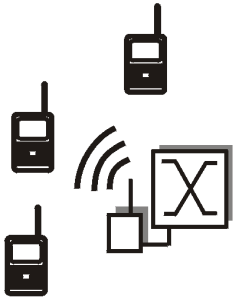
What is Multiple Access

Terms to understand :

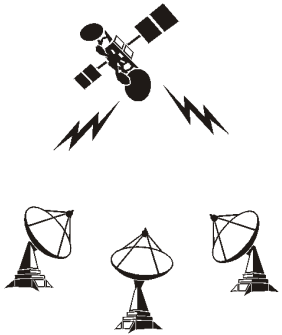
1. Shared medium / Same collision domain



shared wire
(e.g. Ethernet)



shared wireless
(e.g. Wavelan)



satellite

cocktail party

Live Demo…….Group Discussion

If everyone talks simultaneously it would sound garbled

No one understands what is being said clearly

How to we solve this problem?

Everyone wants to understand what everyone else says

Solution to this situation

Have rules about when to talk

eg-1: ‘a’ talks 1st, then ‘b’ talks next, then ‘c’ talks and then ‘a’ talks again, then ‘b’ and so on…

eg-2: Passing the parcel. The one who holds the parcel talks

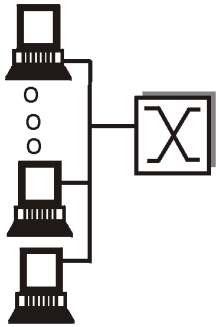
eg-3: No 2 girls talk together, no 2 boys talk together. Talking is allowed in pairs

eg-4: Listen before you speak.

What is Multiple Access?

Terms to understand :

1. Shared medium / Same collision domain



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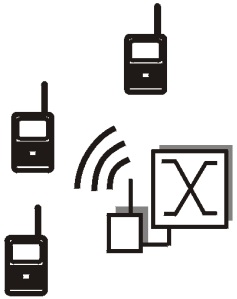

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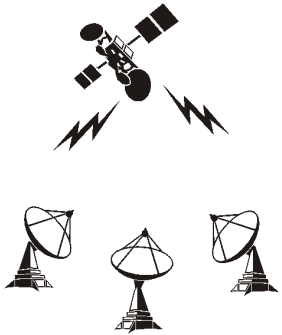
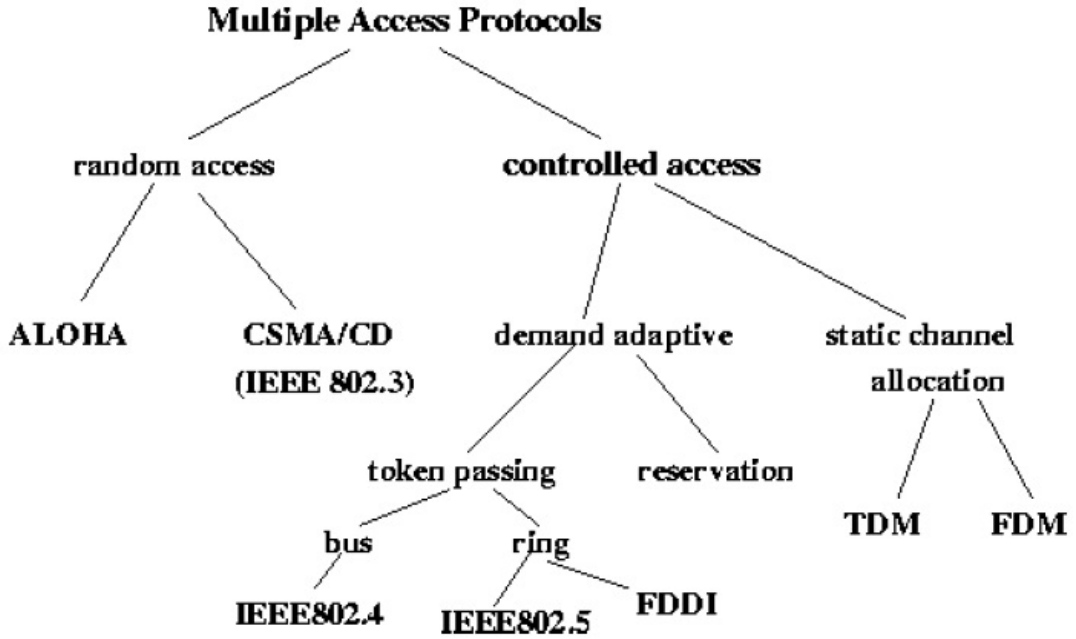


satellite

cocktail party

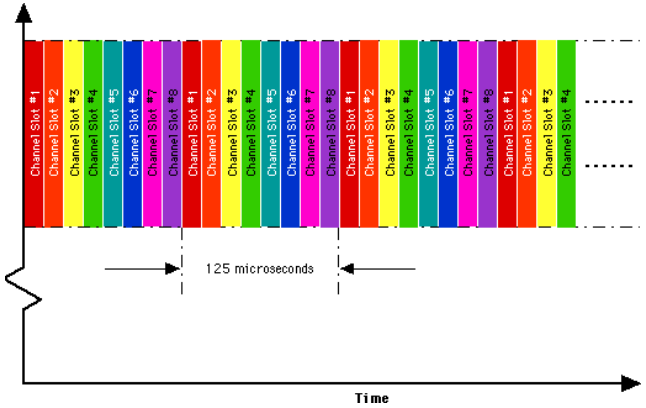
Multiple Access Protocols - Categories



http://en.wikipedia.org/wiki/Channel_access_method

Time Division Multiple Access (TDMA)

Each connected device gets its turn in a round-robin fashion



Applications:

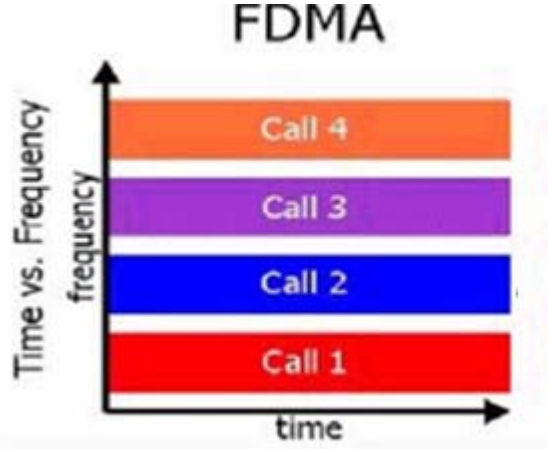
2G mobile networks, bluetooth

http://en.wikipedia.org/wiki/Time_division_multiple_access

Frequency Division Multiple Access

Each device transmits at different frequencies

(Related to frequency modulation FM)



Applications:

3G mobile networks, Wifi, Satellite Communication

Know more about Mobile Networks

2G - TDMA

3G - OFDMA (Orthogonal FDMA)

4G - CDMA (Code division multiple access)

http://en.wikipedia.org/wiki/Orthogonal_frequency-division_multiple_access

http://en.wikipedia.org/wiki/Global_Positioning_System

http://en.wikipedia.org/wiki/3G (search for multiple access in these wiki links)

http://en.wikipedia.org/wiki/4G

http://en.wikipedia.org/wiki/5G

Note: If you remember, few years back (around 2006-2008), we used to have a CDMA phone and GSM phone. This CDMA was called CDMAone. The CDMA used in 4G is CDMA2000. Looking at corresponding wikipedia page may be interesting info.

Disadvantages of Division based protocols

TDMA

- Too many users can result in a long delay
- Wasteful, if device does not want to transmit

FDMA

- Bandwidth is expensive
- Cross-talk

Random Access Protocols

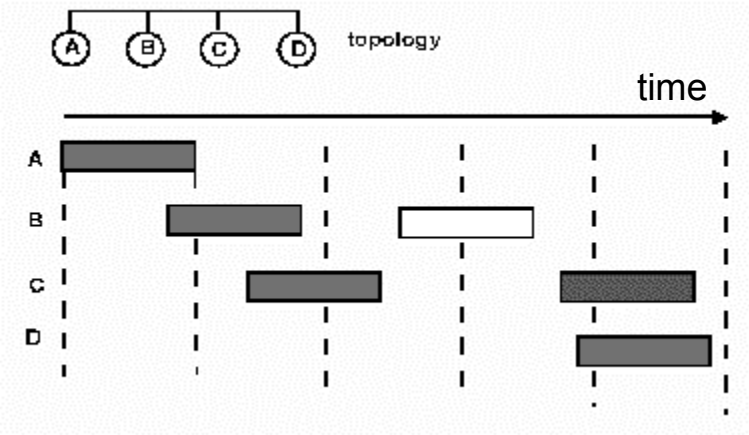
1. ALOHA
2. Slotted ALOHA
3. CSMA (Carrier Sense Multiple Access)

ALOHA

Rules:

1. If you have data to send, send the data
2. If the message collides with another transmission, try resending "later"
3. On collision, sender waits random time before trying again

ALOHA



http://www.youtube.com/watch?v=0DF6ekaFC8U

http://www.youtube.com/watch?v=fgrYDvP_Nyk

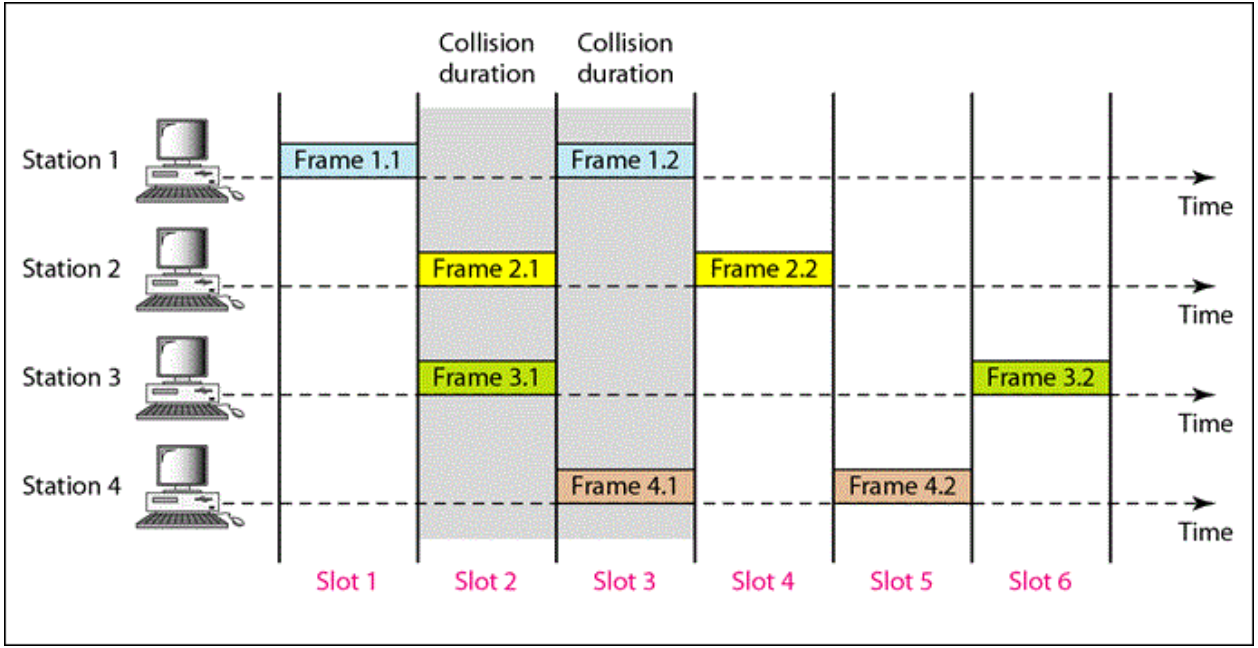
Slotted ALOHA

Almost same as ALOHA.

Only Difference :

Transmit only at start of time-slot

Slotted ALOHA



http://www.youtube.com/watch?v=0DF6ekaFC8U

http://www.youtube.com/watch?v=fgrYDvP_Nyk

Carrier Sense Multiple Access (CSMA)

Similar to slotted ALOHA

Difference:

Uses “Listen before you talk” strategy

(Transmit only if no one else is transmitting)

Efficiency of CSMA

$$\text{efficiency} = \frac{1}{1 + 5t_{prop} / t_{trans}}$$

Note: Derivation of this is beyond the scope of this course

Things to know for numericals

ALOHA

Max Efficiency :

~18%

Avg. # of successful transmissions :

G*exp^(-2*G)

Slotted ALOHA

Max Efficiency :

~ 36%

Avg. # of successful transmissions :

G*exp^(-G)

G : # of packets in 1 time slot T(transmission time). This is ‘G’ refers to ‘alpha’ in Prof. Lea’s Notes

Derivations … Nice to know

Need to have a little background about probability & stochastic processes

Core thing:

Total traffic ‘G’ can be thought of as Poisson Distribution. Find maxima (with 1st derivate) of this function to get the maximum efficiency

http://www.cse.cuhk.edu.hk/~cslui/CSC6480/wireless.pdf

http://www.eecs.wsu.edu/~hauser/teaching/CS455-F01/LectureNotes/4-8a-4up.pdf

Note: Knowing the derivations are not important from exam point of view. But if you are serious about the course, try and understand these derivations. Don’t hesitate to contact me to know more about this.

Some more things to know for numericals

1. T : Packet Transmission Time
2. Channel Capacity : # of packets transmitted per sec
3. Throughput : # of successful transmission per sec
4. Efficiency : ratio of # successful transmissions & total transmissions in 1 time slot

Solved Example - 1

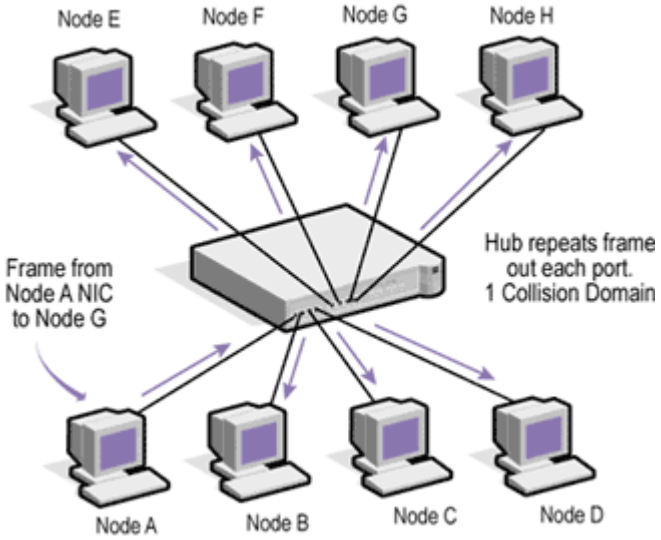
a. Out-link Capacity : 10 Mbps

b. 1 Packet is 1000 bits

c. 8 PCs

d. Uses slotted ALOHA

e. Each PC sends ~ 20 packets per sec



How many packets are generated in 1 transmission time?

How to think

1. First calculate transmission time of 1 packet
2. # of packets generated per sec

Use simple proportions to evaluate the answer

How many packets are generated in 1 transmission time?

Transmission time : 1000 bits / 2 Mbps

Thus, transmission time is 0.5*10^{-3} sec

# of packets generated per sec :

20 packets / sec * 8 PCs ⇒ 160 packets per sec

160 packets in 1 sec

x packets in .5*10^{-3} sec

Thus, x = 160 * .5 * 10^{-3} = .08

What is the efficiency ?

How to think:

Efficiency = # of successful transmission in 1 slot

Since this is slotted ALOHA network

# of successful transmission in 1 slot = G*exp^(-G)

G : # of packets in 1 time slot T(transmission time). Calculated in previous sub-part

Thus,

Efficiency = .08*exp(-.08)

= .07

which is 7%

What is the maximum rate at which we can out-link the data?

Efficiency is 7%

Out-link capacity : 2Mbps

Thus,
we can out-link data at max rate “7% of 2Mbps”

Solved Example - 2

a. N devices

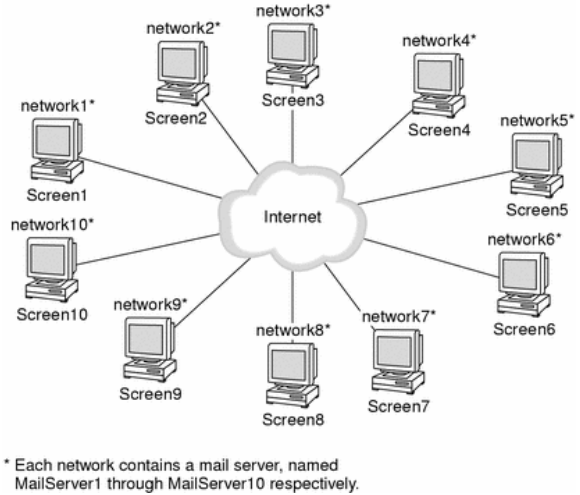
b. LAN Capacity: 1 Mbps

c. Packet size: 100 Kbits

d. Each device sends 1 packet in 100 sec

Assume ALOHA with maximum efficiency

Find maximum number of devices (N) this network can sustain



Maximum number of devices

Packet generation rate :

N * 100Kbits / 100 sec ⇒ 1000*N bits per sec

Max network capacity :

0.18 * 1 Mbps ⇒ 180 *10^3 bits per sec

Thus,

1000*N < 180 * 10^3 ⇒ N < 180