LAN and MAC

A LAN consists of shared x-mission medium and set of h.w & s.w for interfacing devices to the medium to facilitate regulation and orderly access to the medium. Key technology ingredients that determine LAN or (MAN - Metropolitan Area Networks) are:

- Topology
- Transmission medium
- Medium Access control Technique

Topology: The physical topology of a LAN refers to the way in which stations are physically interconected.

The physical topology of a LAN should have following desirable features

- Toprology should be flexible to accomodate change in physical location of the stations, increase in no. of stations, increase in geographic coverage.
- Cost of physical media and installation shall be economical w.r.t its use.
- Should not have single point of failure (Fully tolerant)

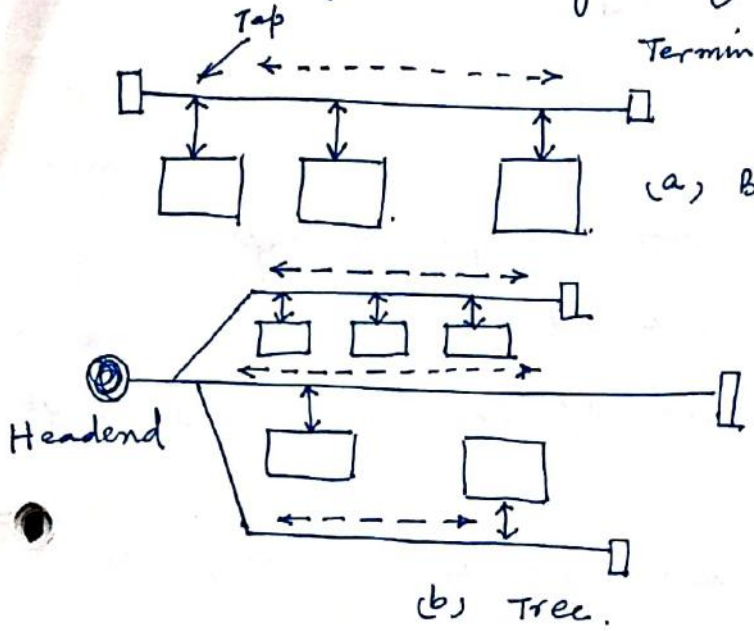
Basic Topologies:

* Bus topology / Tree topology
* STAR topology
* Ring topology. Apart from these MESH also exists.

(Multipoint: No. of devices share a medium. Addressing is reqd.)

IS topology & Tree topology

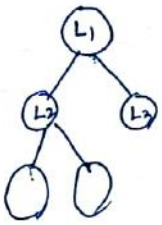
A tree topology is a generalization of a bus topology.



→ Absorbs a signal removing it from bus

* Both topologies characterized by use of multipoint medium
* All stations attach through h.w. interface "tap" to bus. directly to a linear xmission medium or bus. (Full duplex operation)

Tree topology: Generalization of bus, ~~xmission medium~~

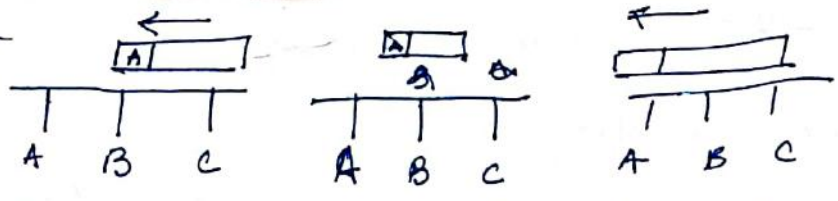


Xmission medium is branching cable with no closed loops.
Tree layout begins at pt. headend, One or more cables can start at head end and each of these may have branches; branches may have additional branches and so on. Xmission starts from a station & propagate throughout medium.

~~Problems~~: To ensure delivery at its proper destination and to regulate traffic.

* Xmission from a station can be received by all stations; ~~Whenever stations transmitting blocks frames~~ ~~these~~ (PDU) Header frame being xmitted from a station
* Each frame is included with a header that includes
  * Destination address
  * Control information ~~for that~~ for regulating traffic
* Stations take turns for data xmission in a cooperative fashion. No spl. action needs to be done to remove data from the bus

—3—



C xmits to A | frame not add. to B (ignores) | A copies frame & it

Advantages:

- Stations are connected to bus by passive taps
- Least length of xmission is used
- Coverage can be increased by extending bus through use of repeaters
- New stations can be added by tapping a bus

Xmission media:

- Twisted pair
- Base band coaxial cable
- Broad band coaxial cable
- Optical fiber (not used) because expensive optical fiber taps.

Suited for WAN

Expansion is simple

Large no. of nodes can be connected to n.w.

Routing is simple

Existing PSTN is this topology

Ethernet uses bus topology

g Topology:

Network consists of a set a repeaters joined by point to point links in a closed loop.

Repeaters, simple and capable of receiving data on one link & transmitting them bit by bit, on the other link as fast as they are received.

- Links unidirectional, data flows either in clockwise or ~~ct~~ anti clockwise fashion only
- * Data are xmitted in frames (like bus or tree). As the frame circulates past all other stations, the destination station recognizes the address, copies the frame into local buffer as it goes. The frame continues to circulate until it returns to source station, where it is removed.
- * Since multiple stations share the ring, "Medium Control" is reqd. to determine at what time each station may insert frame
- * For ring to operate in a comm. ~~media~~ nw. three functions are reqd.
  - (a) Data Insertion (By repeater)
  - (b) Data reception (By repeater) } like bus/tree
  - (c) Data removal

~~Repeater~~ These fns. are done by repeaters, which in addition to serve as active element on the ring serves as device attachment point. Insertion done by repeater, data xmitted in packets containing dest. add

Data removal is difficult, since ring is a closed loop a packet circulates indefinitely unless removed

Media

Twisted pair
Baseband coax
Fiber optic
Broadband coax can be employed
Each repeater will have ~~to be able to~~
be capable, asynchronously, of receiving & xmitting data
on multiple channels.

Potential ring problems

A break in link or failure of repeater disables the entire n/w. Installation of a new repeater to support new devices requires the identification of two nearby topologically adjacent repeaters.
Timing jitter must be dealt with
Because the ring is closed, a means is required to remove circulating packets, with backup techniques to guard against error

* Protocol is one (to be discussed later),

Star Topology

In Star LAN topology, each station is directly connected to a common central node (hub) usually via two pt. to pt. links one for transmission & one for reception).

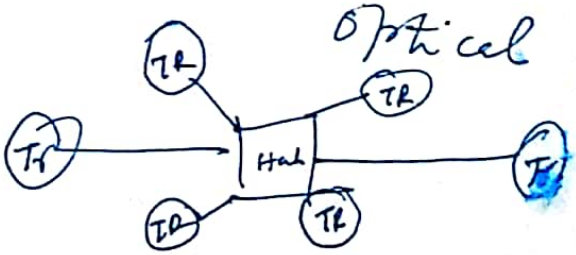
Two alternatives for operation of central node:

1. Central node operates in broadcast fashion. A transmission of a frame from one station to node is broadcast to all outgoing (receive connection) stations). In this case physically star but logically a bus.
2. Central node may act as a frame switching device. An incomming frame is buffered in the node & then retransmitted on an outgoing link to the destination station. Congestion occurs if the central station if the stations have lot of messages for each other

When the central hub is a passive device, then a power splitter is used which divides all the incoming signals equally among outgoing paths. For transmission polling is done on each node requests for permission & transmit

Star topology used for LAN or WAN by using satellite & hub.

Transmission media: Twisted pair, Coaxial cable Optical fibre cable



Concern in peer to peer n.w.s is Loss, Delay, Resequencing

Medium Access Control — 7

MAC Concern: Interference for other users

LANS & MANS consist of collection of devices that must share the n.w. xmission capacity. ~~Some means of C~~

To control access to the xmission medium by various devices in a LAN or MAN setup, MAC Protocol is reqd. for providing the xmission medium in orderly & efficient manner.

Two schemes of MAC (key parameter, where? & How?

Where?

(i) Centralized: A controller has authority to grant access. A station wishing to get access to media (or xmission) has to wait till it receive permission from controller.

(ii) Distributed: Each station performs job of acquiring com. channel on his own following certain rules & regulations. The stations collectively perform a medium access control function to dynamically determine the order in which stations ~~must~~ transmit.

Adventages of Centralized Schee.

- It may afford greater control over the access for providing such things as priorities, overrides & guaranteed capacity.
- Enables use of simple access logic at each stn.
- Avoids problems of distributed co-ordination among peer entities.

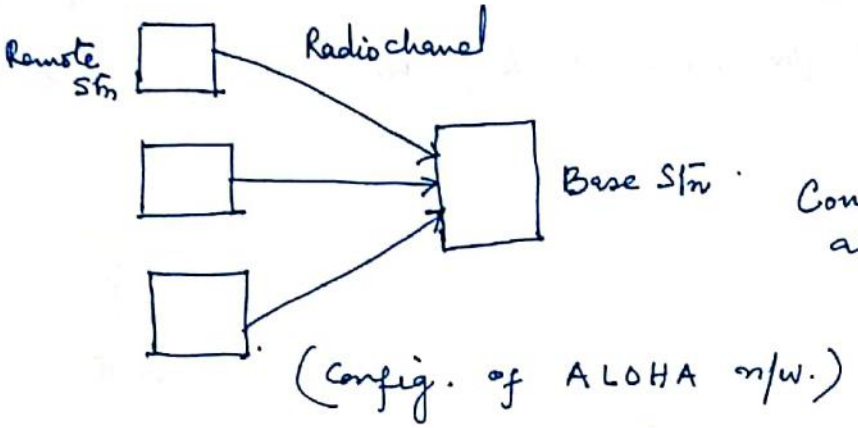
Disadventages

- Creats a single pt. of failure
- It may act as bottleneck reducing performance.

How? MAC techniques may be Synchronous or Asynchronous (How is constrained by topology and is trade off of the competing factors, viz, cost, performance & complexity

ALOHA

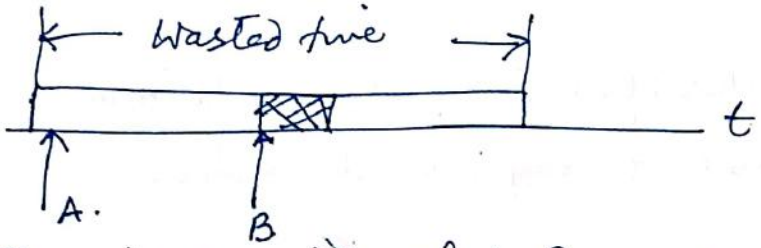
This access mechanism was developed for packet radio ~~n.w.~~ networks. However, applicable to any shared medium.



(Config. of ALOHA n/w.)

The basic scheme is as under:

- A station can xmit whenever it wants, there is no pre-assigned time or sequence
- If a stn. wants to xmit when another xmission is already in progress, the collisions will occur. However, there will be instances when xmission will reach the destination without any collision. i.e., If only one stn. xmits and other stns. are inactive during that period.
- Mechanism collision detection:
When a stn. sends the frame, it waits for an amount of time equal to the maximum possible round trip propagation delay on the n.w. (Twice the time it takes to send a frame between two most widely separated stns.) + a small fixed time increment (Processing time). If the stn. does not get an acknowledgement within that time it resends the frame. If stn. fails to receive acknowledgement after repeated xmissions, it gives up.



Even if there is overlap for a small time, while time gets wasted.

Throughput of Pure ALOHA :

Throughput (S) is defined as successful traffic transmitted between stns. per unit time.

Per unit time ≜ Slot time which is time reqd. to xmit a frame (all the frms of same size)

At the most one frame can be sent per slot time

∴ Max. Value of $S = 1$

When collision occurs, some of the frms are lost

∴ $S < 1$ (always)

Let offerd traffic in network = G (packets)

G is average number of frams per slot time (tp) which is presented to n.w. for xmission by stns. (G can have value between 0 to ∞)

Subjectively

If $G < 1$ (Low) Then will be few collisions or (no collision)

or $S \simeq G$. [All stns except one is inactive]

If $G \geq 1$ (High) Then will be many collisions.

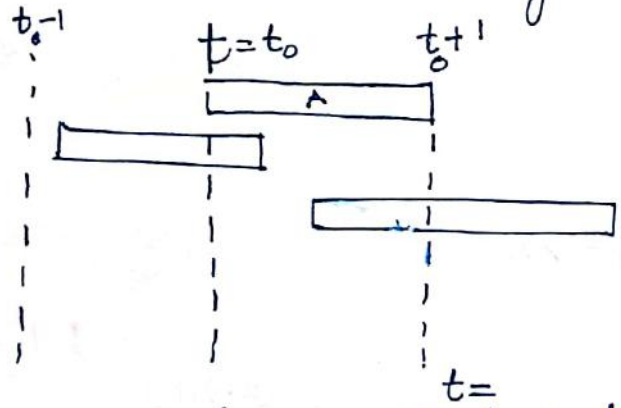
lot of wasted time

and $S < 1$.

The prob. that k transmissions are attempted for a slot time is

$$P_k = \frac{G^k e^{-G}}{k!} \quad \text{(Using Poisons Distribution)}$$

Transmission of A is successful if



(i) There is no frame after t_0-1 to t_0+1 (except one frame A)

(ii)

Prob. that there is no transmission (0 xmissions) during

$t_0 - 1 \le t \le t_0 + 1$

$$P(k=0) = \frac{G^0 \cdot e^{-G}}{0!} = e^{-G}$$

Prob. that there is one xmission during $(t_0 \le t \le t_0+1)$

$$= \frac{G \cdot e^{-G}}{1!} = G e^{-G}$$

Prob. that xmission is successful

$$= P(\text{0 xmission in } t_0-1 \le t \le t_0) \cdot P(\text{1 xmission in } t_0 \le t \le t_0+1)$$

$$= e^{-G} \cdot G \cdot e^{-G} = G e^{-2G}$$

This is equal to throughput also S

$$\therefore \quad S = G e^{-2G}$$

$$\frac{ds}{dG} = e^{-2G} + (-2)\,G\,e^{-2G}$$

For Maxima

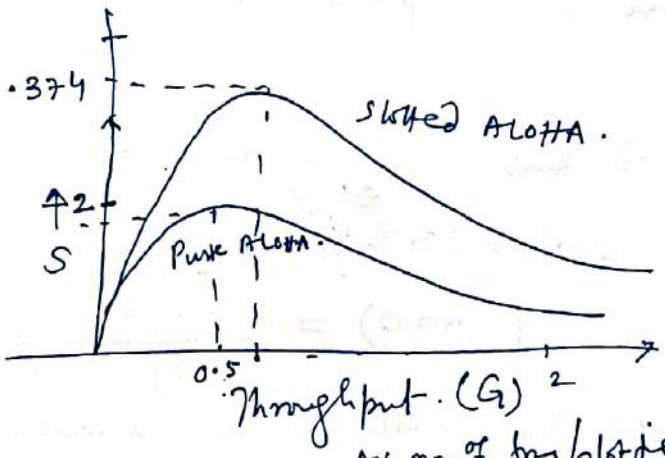
$$\frac{ds}{dG} = 0$$

or $e^{-2G} = 2\,G\,e^{-2G}$

or $2G = 1 \Longrightarrow G = 1/2$

$\therefore$ $S_{max} = \frac{1}{2}\, e^{-2 \cdot 1/2} \cdot \frac{1}{2e} = \frac{1}{2(2.718)} = 0.186$

$= 18.6\%$



SLOTTED ALOHA

In slotted ALOHA, the time available on channel is organized into uniform slots whose time equals frame xmission time. Some central clock ~~is used~~ or other technique is needed to synchronize all stns. Transmission is permitted to begin only at a slot boundary. Thus if the frames overlap, they will overlap in totality. Collision occurs if two frames transmit simultaneously at the beginning of a slot, reducing vulnerable period to tp only (instead of 2*tp.)

The xmission is successful if only (one) stn. attempts to xmit at the beginning of the slot

$$P(\text{one xmission}) = G\,e^{-G} = \text{Throughput}$$

$$\frac{dS}{dG} = e^{-G} - G\,e^{-G} = 0$$

$$1 - G = 0 \Rightarrow G = 1$$

$$S_{max} = G\,e^{-G} = 1 \cdot e^{-1} = 1/e = \frac{1}{2.718} = 37.4\%$$

* ALOHA & SALOHA have poor utilization
* Both fail to take adv. of key propsths of packet radio & LANs, which is that prop. delay between stns. is v. small copared to xmissn tme of frme.

CSMA/CD (Jointly developed by Dec, Intel, Xerox They called this n.w. Ethernet]

The specifications were later adopted by IEEE's their standard IEEE 802.3

In CSMA continues to xmit even if collision takes place, resulting in wastage of channel time.

i.e. When two frames collide, medium remains unusable for duration of xmission of both damaged frames. For long frames, compared to propagation time, amount of wasted capacity can be considerable.

The waste can be reduced if station continues to listen to medium while transmitting. This leads to following algorithm for CSMA/CD

1. If medium is idle, transmit; otherwise, go to step 2
2. If medium is busy, continue to listen until channel is idle, then xmit immediately
3. If collision is detected during xmission, transmit a brief jamming signal to assure that all stations know that there has been a collision and then cease transmission
4. After xmitting jamming signal, wait a random amount of time, then attempt to xmit again (repeat for step 1)

hw: wireless