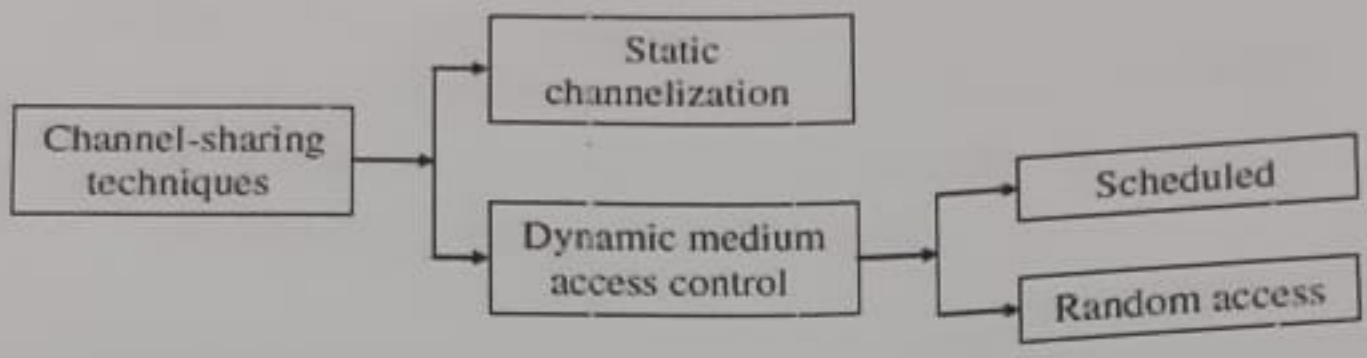
4th Year IT-IS-SW

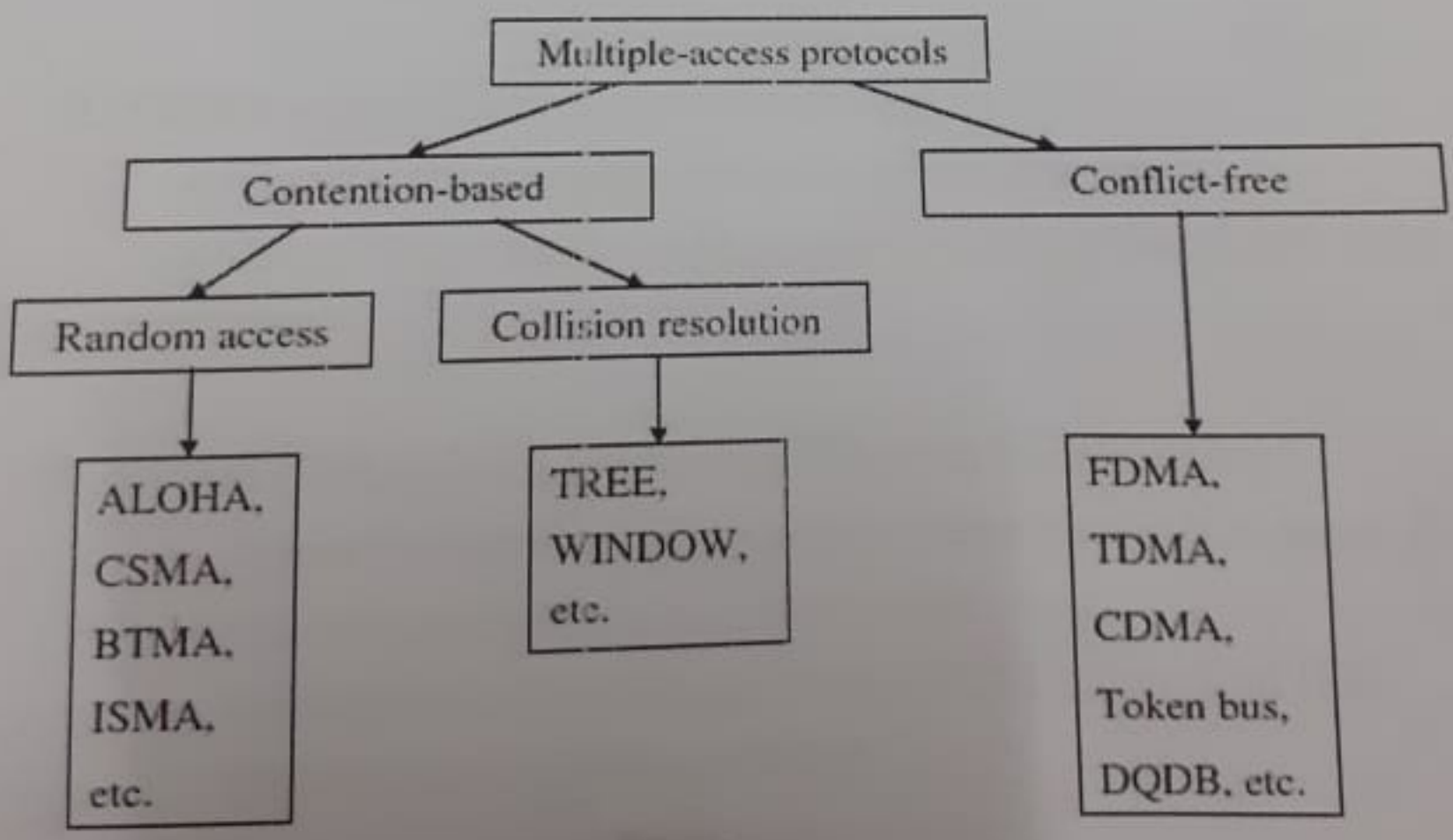
ALOHA vs CSMA
(Lecture 8)

Channel Sharing Techniques



- **Static Channelization methods (conflict-free)** – channel allocation and assignment is done is a pre-defined way and does not change
- **Dynamic (contention-based)** – channel is allocated as needed and allocation changes with time

Classifications of Multiple Access Protocols



Static (collision free)

1. **FDMA** (frequency division multiple access)
   - Channel spectrum divided into frequency bands
   - Each station assigned frequency band
   - Unused frequency bands go idle

2. **TDMA** (Time division multiple access)
   - Access channel in rounds
   - Each station gets fixed length slot (length =pkt trans time) in each round
   - Unused slot go idle
   - TMDA system operates in two modes
     - ✓ **Frequency division duplexing** (FDD) – uplink and downlink frequencies differ
     - ✓ **Time division duplexing** (TDD) - uplink and downlink frequencies are the same

3. **CDMA** (code division multiple access)
   - Each station assigns unique code to transmit
   - Many Stations share the same frequency band and time slot

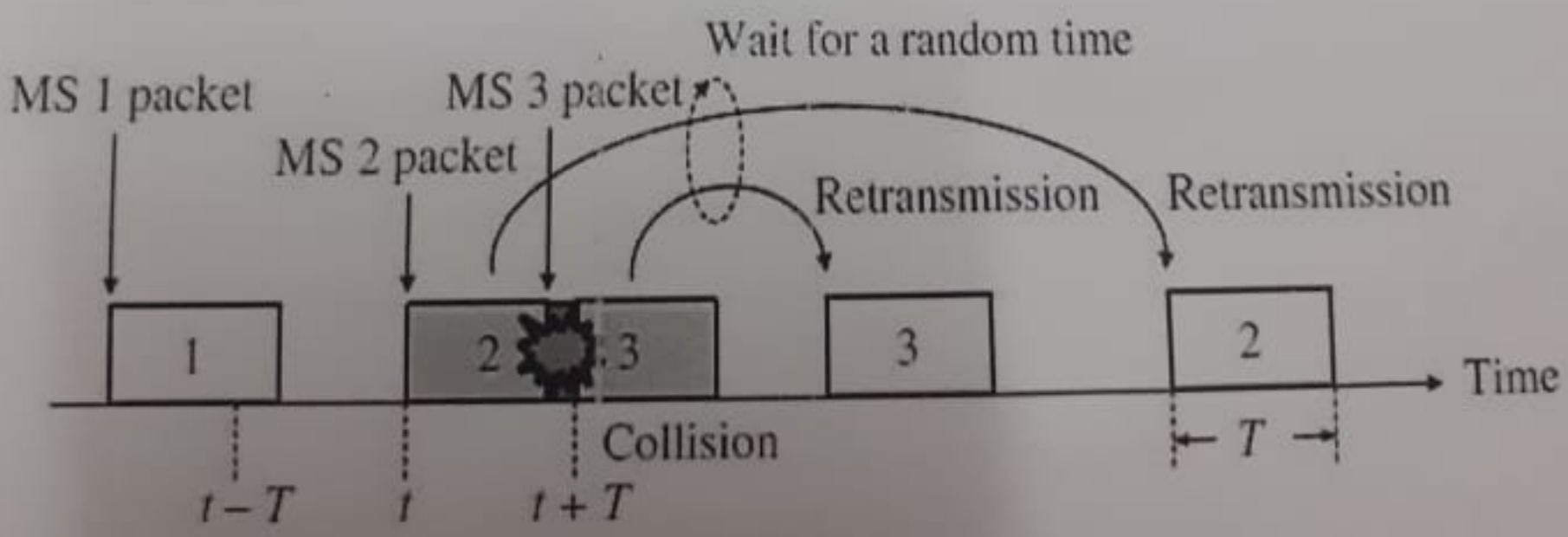
4. **OFDM** (Orthogonal Frequency Division Multiplexing)
   - Allow multiple users to access same channel at same time
   - Use orthogonal sin and cos modulation
   - Current WLANs such as IEEE 802.11 a/g/n and IEEE 802.16d are based on OFDM

Random Access Protocols

- When node has packet to send
  - ✓ Transmit full channel data rate R
  - ✓ If there are two or more transmitting nodes -> "collision"
  - ✓ Examples of random-access MAC protocols
    - Pure ALOHA (unslotted)
    - Slotted ALOHA
    - CSMA

unslotted ALOHA Steps

1. When MS has a packet to send, it sends it right away
2. Sender MS waits for if transmitted packet is acknowledged by receiver
3. *If* sender MS does not receive an **ack** message from receiver after a predefined time period, it concludes that a collision has occurred
4. *If* collision occurs, packet is retransmitted after random delay



unslotted ALOHA

- Simple
- No synchronization
- Collision probability increases
- Efficiency

P(success by given node) = P(node transmits) ·
P(no other node transmits in $[t_0-1,t_0]$
P(no other node transmits in $[t_0,t_0+1]$

$= p \cdot (1-p)^{N-1} \cdot (1-p)^{N-1}$

$= p \cdot (1-p)^{2(N-1)}$

... choosing optimum p and then letting n -> infty ...

$= 1/(2e) = .18$

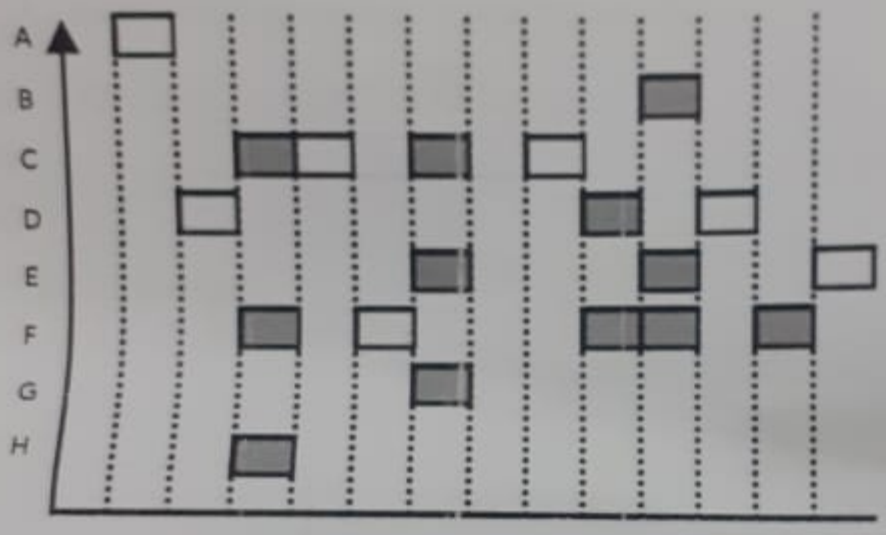
Even worse !

Slotted ALOHA

- Proposed to improve the **throughput** of Pure ALOHA
- Use slotted time with slot size equal to packet transmission duration
- Pros: Single active node can transmit in each slot
- Cons: collision wasting slots

Steps

- If MS has a packet to send, it waits until the beginning of the next slot before it sends the packet
- Transmission will be successful if and only if exactly one packet is scheduled for current slot



Slotted ALOHA protocol (shaded slots indicate collision)

- *suppose:* N nodes with many frames to send, each transmits in slot with probability *p*
- prob that given node has success in a slot = $p(1-p)^{N-1}$
- prob that *any* node has a success = $Np(1-p)^{N-1}$

Max efficiency = 1/e = .37

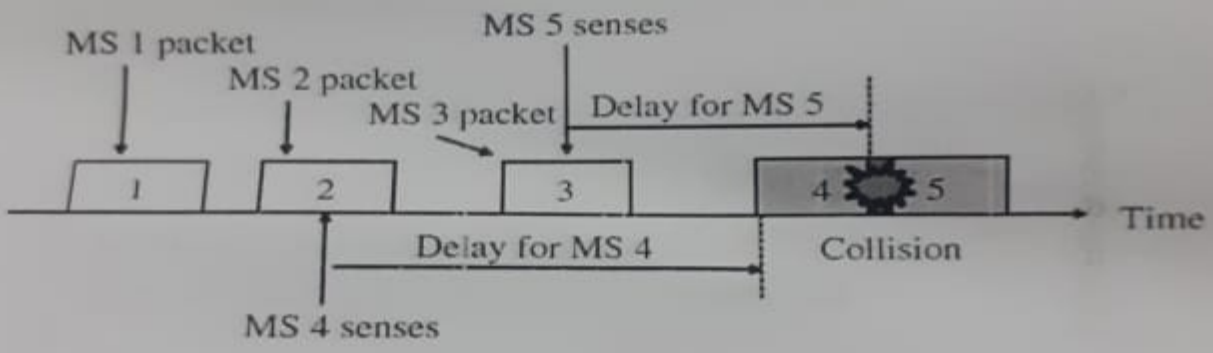
At best: channel used for useful transmissions 37% of time!

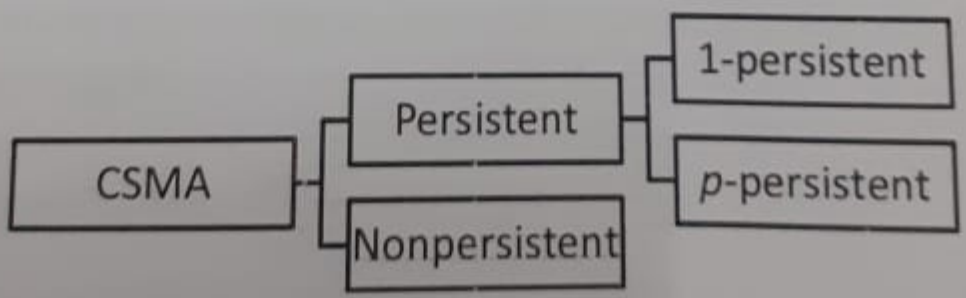
Carrier Sense Multiple Access (CSMA)

Each MS can listen to transmissions of other MSs

Characteristics

- Improve throughput of ALOHA and slotted ALOHA
- Support high-speed communications
- Attempt to prevent collisions





Nonpersistent CSMA

1. When MS has packet to send, it senses the medium first
2. If shared medium is busy, MS waits for a random amount of time and senses the medium again
3. If channel is idle, MS transmits packet immediately
4. If collision occurs, MS waits for a random amount of time and starts again

***1*-persistent CSMA**

1. When MS has packet to send, it senses channel
2. If channel is busy, MS keeps listening to the medium and transmits the packet immediately after channel becomes idle
3. A collision will happen if two or more MSs have ready packets and are waiting for channel to become free

***P*-persistent CSMA**

1. When MS has packets to send, it senses channel
2. If channel is busy, MS waits until next time slot and checks channel again
3. If channel is idle, MS transmits packet
4. If collision occurs, MS waits for random amount of time then starts again

Contention based Methods

Random access protocols	Scheduled Protocols
Allow an MS to retransmit collided message only after random delay	Follow scheduling schemes to control retransmission of collided messages

CSMA-CA and CSMA-CD

CSMA-CD	CSMA-CA
Collision detected within short time Easy and used in wired LAN	No collision (collision Avoidance)
Difficult in Wireless LAN	Used in Wireless LAN
Measure signal strengths, compare transmitted and receive signals	

Hidden Terminal Problem

- Packets may be collided when two or more hidden MSs that are out of each other's radio transmission range and send packets simultaneously
- Solution CSMA-CA with RTS CTS and use handshake frame exchange at the beginning of transmission