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## Pure Aloha

The node immediately transmits its frame completely
If the frame is collided it retransmits the frame again with the probability p.

## Slotted Aloha

Frames are of the same size
time is divided into equal size slots

## Operation

- **when node obtains fresh frame**, it transmits in next slot
- **no collision**, node can send new frame in next slot
- **if collision**, node retransmits frame in each subsequent slot with prob. p until success

# Lecture 2
# Carrier Sense Multiple Access(CSMA)

Invented to minimize collisions and increase the performance
A node should not send if another node is already sending

## Persistence methods:

1. Non-persistent strategy
2. Persistent strategy
3. P-persistent strategy

## CSMA with Collision Detection (CSMA/CD)

There are many collision detection methods!

- detecting voltage level on the line
- detecting power level
- detecting simultaneous transmission & reception

## CSMA with Collision Avoidnes (CSMA/CA)

Priorities:
SIFS : highest priority, forACK, CTS, pollingresponse
PIFS : medium priority, for time-bounded service using PCF
DIFS : lowest priority, for asynchronous data service

## Random Contention Access

Slotted contention period:

- Used by all carrier sense variants
- Provides random access to the channel

## Contention Window

- Random number selected from [0,cw].
- Small value for cw
- Optimal cw for known number of contenders & know packet size

## 802.11 - CSMA/CA unicast

Sending unicast packets :

- Station has to wait for DIFS before sending data
- Receiver acknowledges at once (after waiting for SIFS ) if the packet was received correctly (CRC)
- Automatic retransmission of data packets incase of transmission errors

Procedure :

- Similar to CSMA but instead of sending packets control frames are exchanged
- RTS = request to send
- CTS = clear to send
- DATA = actual packet
- ACK = acknowledgement

Advantages :

- Small control frames lessen the cost of collisions (when data is large)
- RTS + CTS provide “virtual” carrier sense which protects against hidden terminal collisions (where A can’t hear B)

## 802.11 DCF (CSMA-CA)

- Full exchange with “virtual” carrier sense (called the Network Allocation Vector)

## Carrier Sense Multiple Access (CSMA)

Procedure

- Listen to medium and wait until it is free (no one
- else is talking)
- Wait a random back off time then start talking

Advantages

- Fairly simple to implement
- Functional scheme that works

Disadvantages

- Can not recover from a collision
(inefficient waste of medium time)

## Virtual Carrier Sense

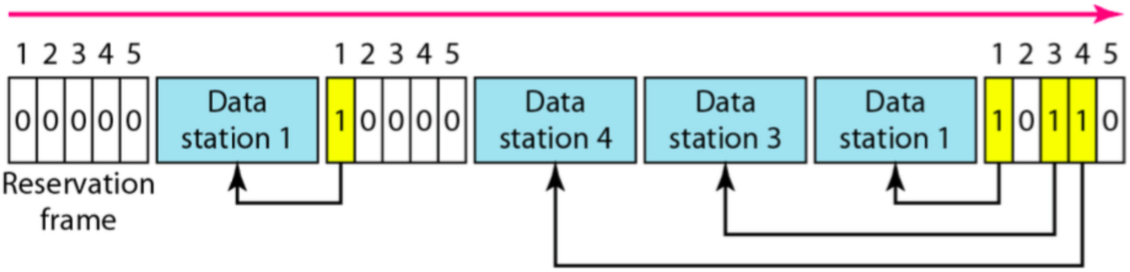
- Provided by RTS & CTS
- Designed to protect against hidden terminal collisions (when C can't receive from A and might start transmitting)

# Lecture 2

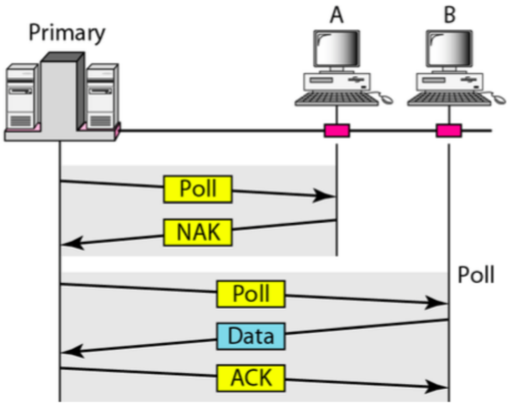
# Controlled Access Protocols

It means which station has the right to send

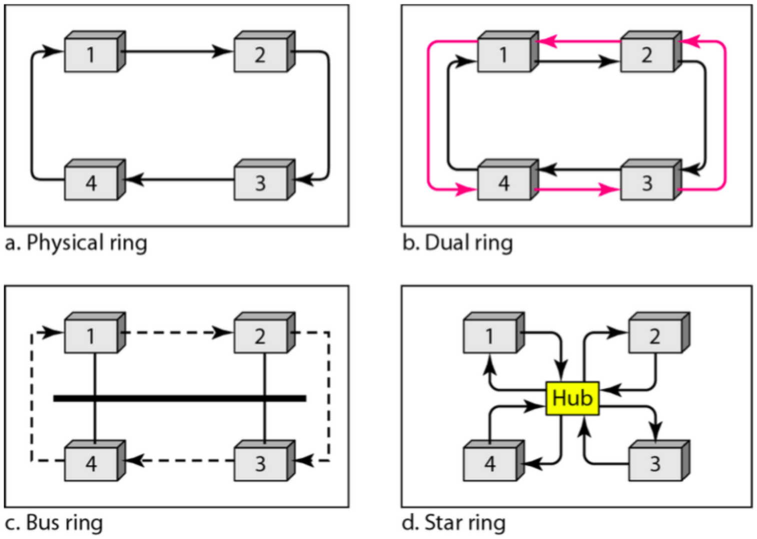
## Reservation



## Polling



## Token passing

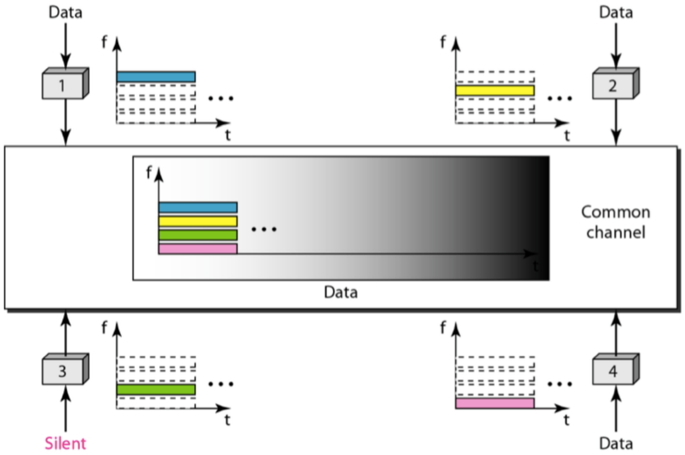


# Lecture 3

# Channelization Protocols

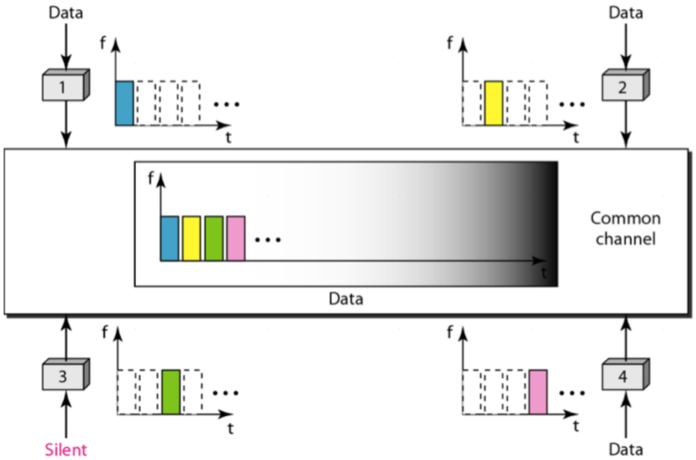
It is multiple-access method in which the available bandwidth of a link is shared in Time , frequency or through code.

## Frequency-division multiple access (FDMA)



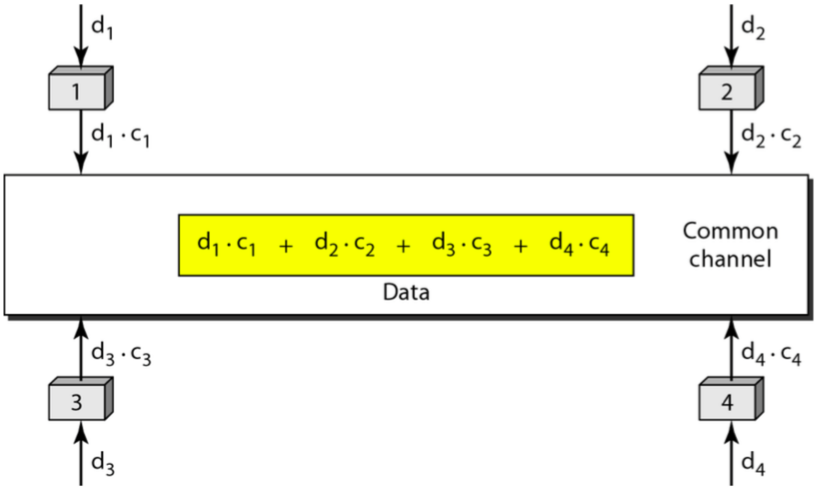
In FDMA, the available bandwidth of the common channel is divided into bands that are separated by guard bands.

## Time-division multiple access (TDMA)



the bandwidth is just one channel that is timeshared between different stations.

## Code-Division Multiple Access (CDMA)



In CDMA, one channel carries all transmissions simultaneously.

# Lecture 3
# Local Area Network
# (Ethernet)

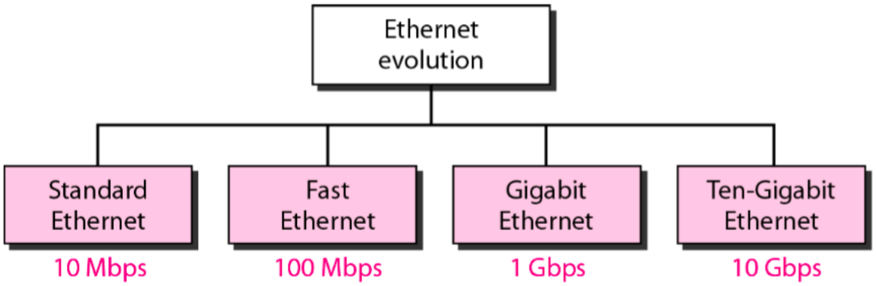
It is the dominant LAN technology.

- Cheap
- First widely used LAN technology
- Simpler and cheaper than token LANs
- Kept up with speed race: 10, 100, 1000 Mbps

## Physical layer

- Physical layer is dependent on the implementation and type of the physical media used.
- IEEE define detailed specifications for each LAN implementation.

## Ethernet evolution



## Ethernet Frame Format

- Sending adapter encapsulates network layer protocol packet such as IP datagram in Ethernet frame

## Preamble:

- 7 bytes with pattern 10101010.
- Used to synchronize receiver, sender clock rates.

## SFD:

- One byte with pattern 10101011 to signal the start of the frame.

## Addresses:

6 bytes, frame is received by all adapters on a LAN and dropped if address does not match

## Length/Type:

indicates the higher layer protocol or the number of bytes in the data field.

## CRC:

checked at receiver, if error is detected, the frame is simply dropped

## Minimum and Maximum Lengths

Minimum: 64 bytes (512 bits)
Maximum: 1518 bytes (12,144 bits)

## Unicast and multicast addresses

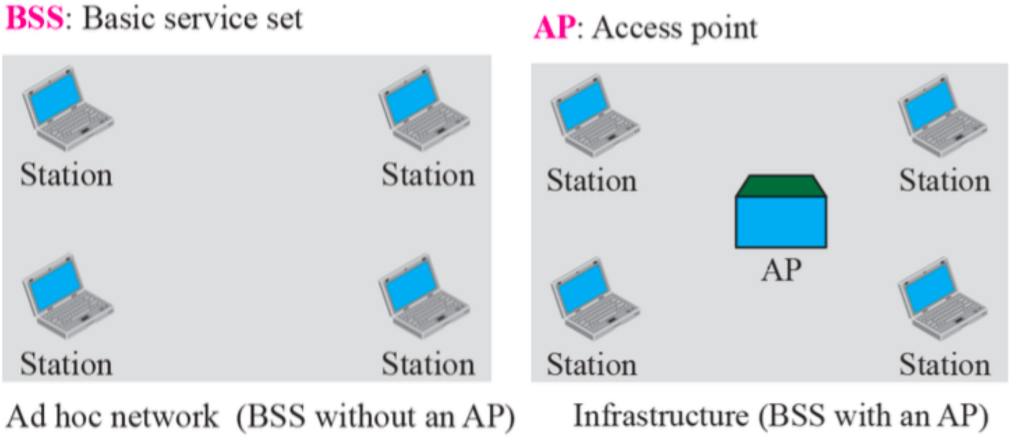
The least significant bit of the first byte defines the type of address. If the bit is 0, the address is unicast; otherwise, it is multicast or broadcast.
The broadcast destination address is a special case of the multicast address in which all bits are 1s. (FF:FF:FF:FF:FF:FF)

## Slot time

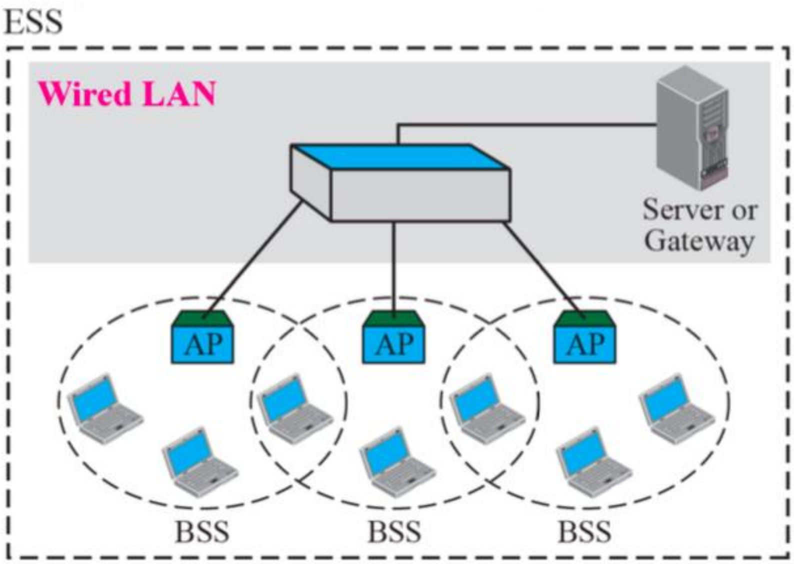
**Slot time** = round-trip time+ jam sequence time.
**Max Length** = propagation speed * (slot time/2)

## WIRELESS LANS

## Basic service sets (BSSs)



## Extended service sets (ESSs)



## 802.11 Wireless LAN

A client is always associated with one AP and when the client moves closer to another AP, it associates with the new AP (Hand-Off)

## Wireless LAN Protocols

Wireless has complications compared to wired.

Nodes may have different coverage regions

- Leads to hidden and exposed terminals

Nodes can’t detect collisions, i.e., sense while sending

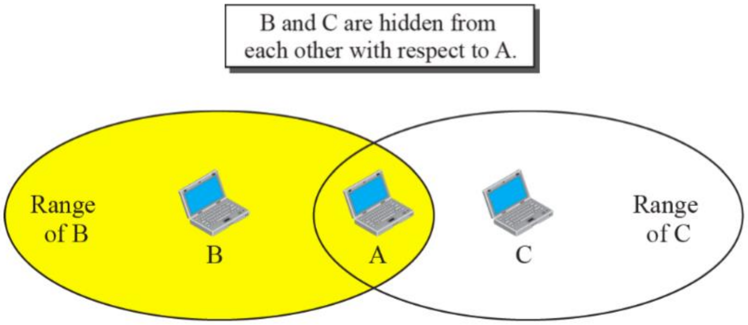
- Makes collisions expensive and to be avoided

## Wireless LANs – Hidden terminals

**Hidden terminals** are senders that cannot sense each other but nonetheless collide at intended receiver

- Want to prevent; loss of efficiency
- S1 and S2 are hidden terminals when sending to R

## Hidden Terminal problem

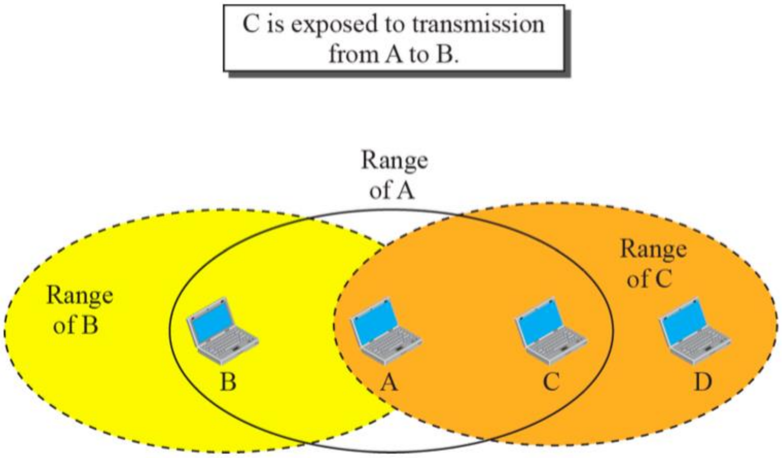

B and C are hidden from each other with respect to A.

Before every data transmission

- Sender sends a Request to Send (RTS) frame containing the length of the transmission
- Receiver respond with a Clear to Send (CTS) frame
- Sender sends data
- Receiver sends an ACK; now another sender can send data

When sender doesn't get a CTS back, it assumes collision

## Exposed Terminal problem


C is exposed to transmission from A to B.

Exposed terminals are senders who can sense each other but still transmit safely (to different receivers)

- Desirably concurrency; improves performance
- S1 > R1 and S2 > R2 are exposed terminals

## Wireless LANs – MACA

MACA protocol grants access for A to send to B:

- A sends RTS to B;B replies with CTS.
- A can send with exposed but no hidden terminals