FAST ETHERNET, GIGABIT ETHERNET & WIFI

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FAST ETHERNET

Originally Ethernet had a max speed of 10 Mbits/ second

- 10 megabits every second

This is pretty slow (4G LTE can reach ~50Mbits/s)

A new standard for Ethernet in was introduced in 1995

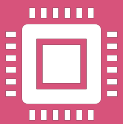
This standard (802.3u) can achieve speeds of 100Mbits/s

This is called Fast Ethernet

FAST ETHERNET

The only difference between Fast and normal internet is the *speed*

The structure of the Frame, Payload and MAC are all the same

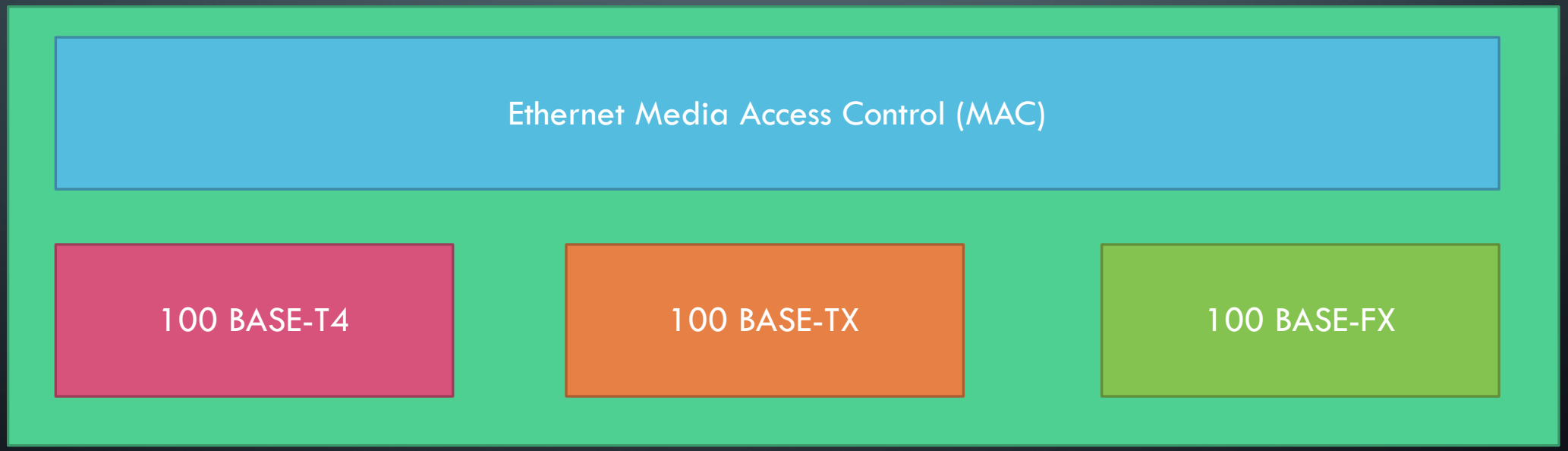


If a Fast Ethernet card talks to a normal ethernet card

The fast card changes its speed to accommodate the slower ethernet

FAST ETHERNET – CABLE STANDARD

There are three cable standards for fast ethernet



100 BASE-TX

This is the standard that is used today

The others are basically obsolete

- 100 is the speed (100 Mbits/second)
- BASE – stands for baseband
- T4 – 4 pairs of Twisted Pair cables
- TX – 8 pairs of Twisted Pair cables
- FX – Fibre

ETHERNET COMPONENTS

- There are three main parts of an ethernet port
- PHY (short for physical layer)
- MII (Media independent interface)
- Data Terminal Equipment (DTE)

ETHERNET PHY

- Short for physical layer
- A chip on an ethernet card used to implement the physical layer components
  - Analog-Digital
  - Allows the hardware to send/receive frames
- Does not handle addressing !

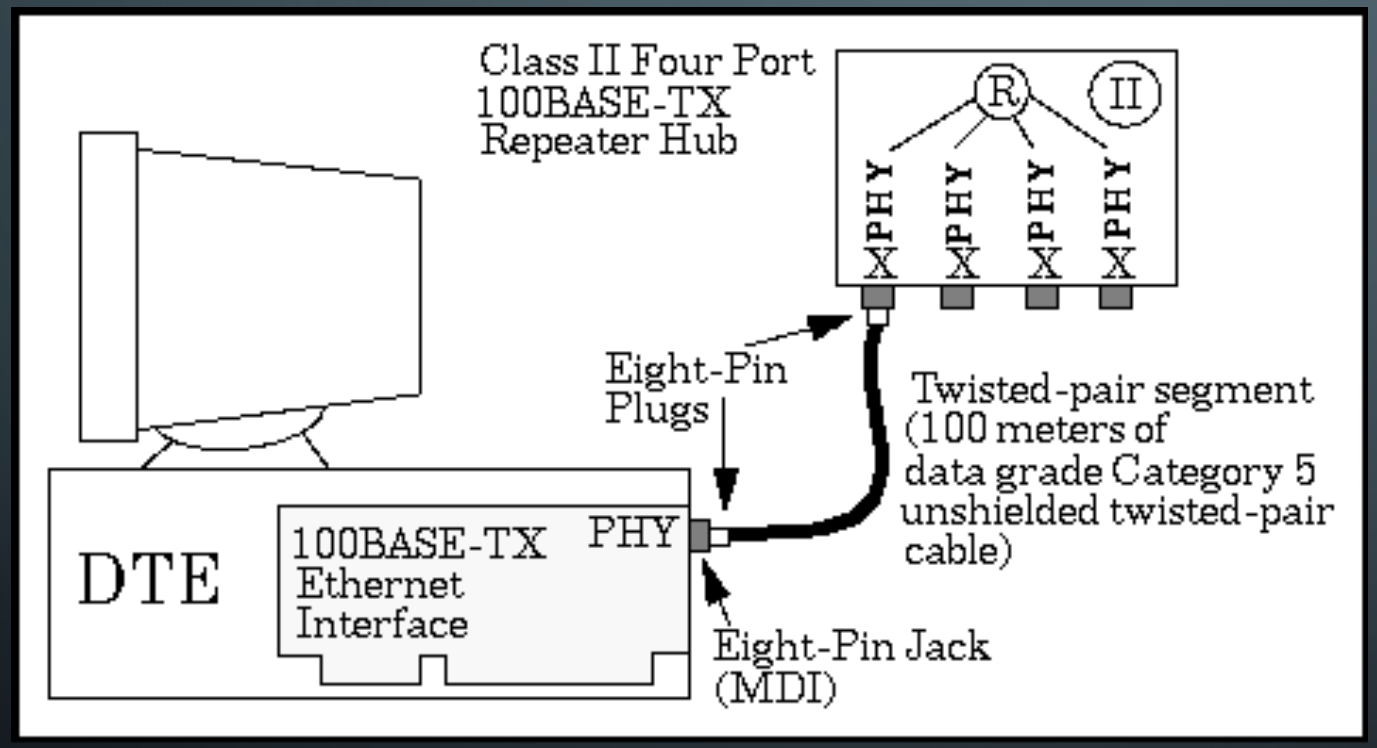
ETHERNET MII

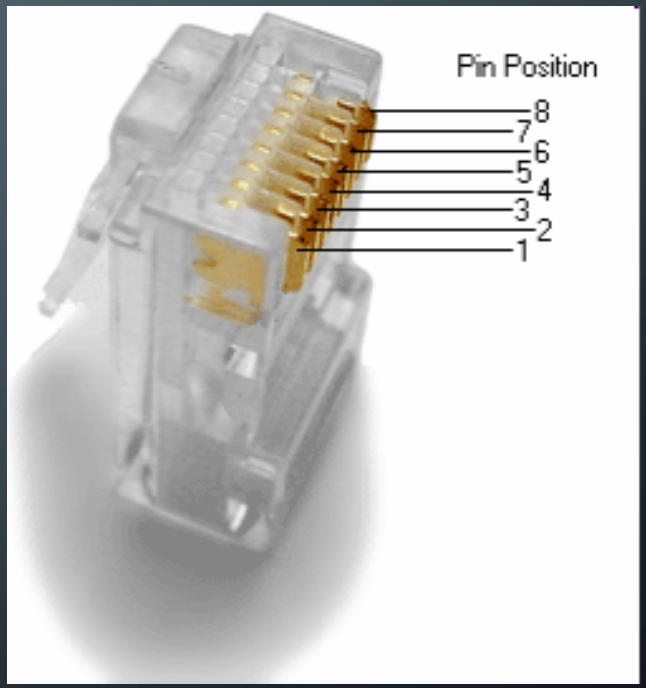
- Media Independent Interface
- Interface to connect to fast ethernet
- Part of the ethernet standard
- Connects to the PHY chip
- Provides flexibility

DATA TERMINAL EQUIPMENT

- This constitutes the network card as a whole
- For ethernet this is layers 1 & 2 of the OSI model
- Physical (1's and 0's)
- Data Link

THE 100 BASE-TX SYSTEM





100 BASE-TX SYSTEM

- 100BASE-TX system operates over two pairs of wires
- One pair for receive data signals and the other pair for transmit data signals.
- Most popular wiring is unshielded twisted-pair.
- The two wires in each pair of the cable must be twisted together for the entire length of the segment
- Must be kept twisted to within approximately 1/2 inch of any connector or wire termination point

100 BASE TX COMPONENTS

- Network Medium
- 100BASE-TX Repeaters
- 100BASE-TX Crossover Wiring
- 100BASE-TX Link Integrity Test

NETWORK MEDIUM

- Allows segments of up to 100 meters in length
- EIA/TIA standard recommends segment length 90 m between the wire termination equipment in the wiring closet, and the wall plate in the office
- This provides 10 m of cable allowance to accommodate patch cables at each end of the link
- Accommodate for signal losses in intermediate wire terminations on the link, etc.

NETWORK MEDIUM - PIN LAYOUT

TABLE 0.1 100BASE-TX eight-pin connector

Pin Number	Signal
1	Transmit+
2	Transmit–
3	Receive+
4	Unused
5	Unused
6	Receive–
7	Unused
8	Unused

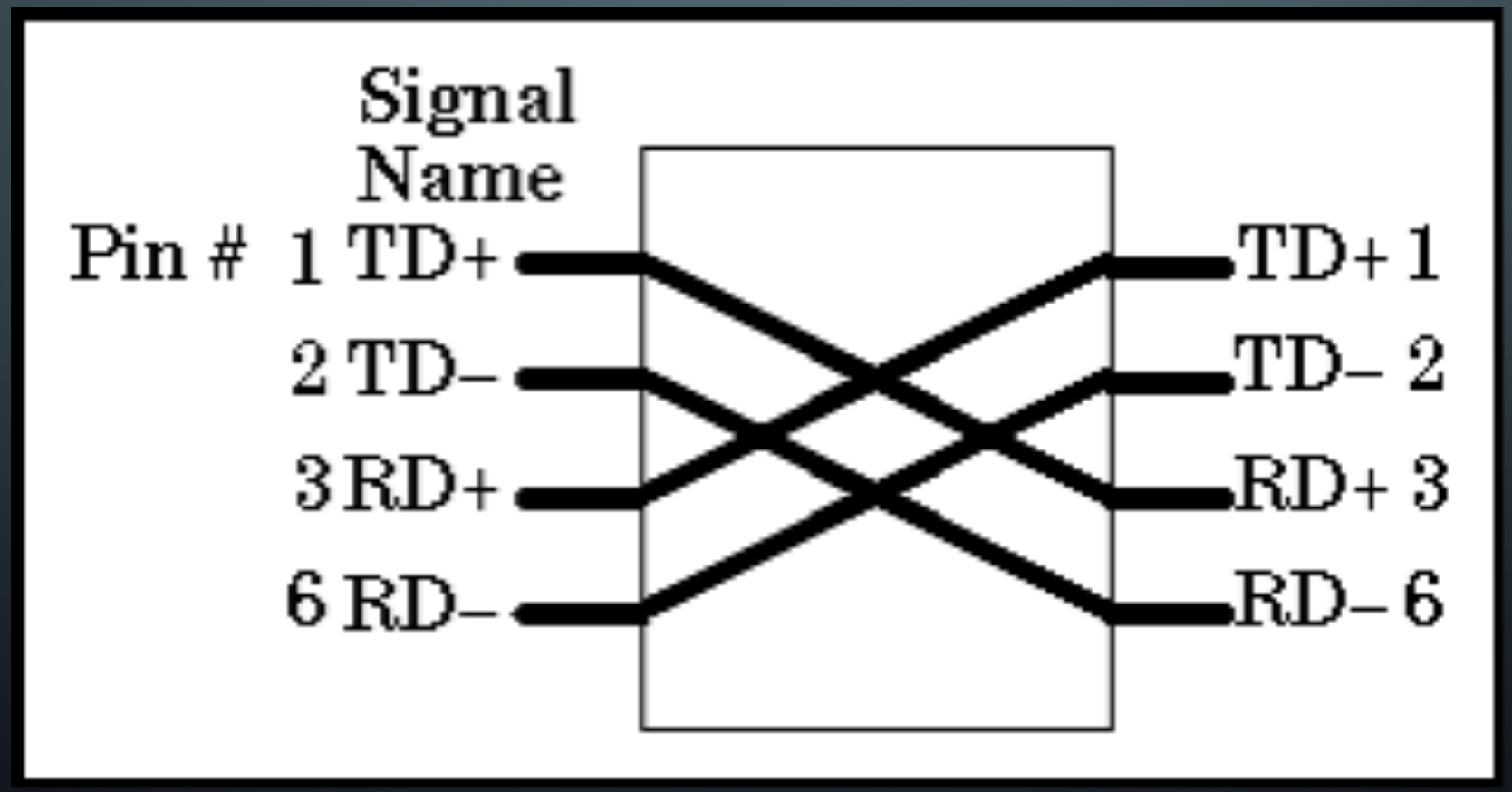
100 BASE TX-REPEATERS

- Two types of repeater: Class I and Class II.
- A Class I repeater allowed to have larger timing delays, and operates by translating line signals on an incoming port to digital form, and then retranslating them to line signals when sending them out on the other ports.
- Possible to repeat signal between media segments that use different signaling techniques, such as 100BASETX/ FX segments and 100BASE-T4 segments
- Class II repeaters:- restricted to smaller timing delays, and immediately repeats the incoming signal to all other ports without a translation process ;connect only to segment types that use the same signaling technique

100 BASE TX - CROSSOVER WIRING

- Wiring multiple segments in a building.
- Easier to wire cable connectors "straight through" do crossover wiring inside the repeater hub
- For single segment connecting 2 PCs, build special crossover cable
- transmit pins on eight-pin plug at one end wired to receive data pins on eight-pin plug at other end of crossover cable.

100 BASE TX - CROSSOVER WIRING



100 BASE TX - CONFIGURATION

Connect the Ethernet interface in your computer to one end of the link segment, and the other end of the link segment is connected to the hub.

That way you can attach as many link segments with their associated computers as you have hub ports, and the computers all communicate via the hub.

100 BASE-TX SEGMENT CONFIG GUIDELINES

100BASE-TX segment configuration guidelines

Maximum Segment Length		Maximum Number of MAUs	
100BASE-TX	100 m (328 ft.)[a]	Per Link Segment	2

a. 100BASE-TX segments are limited to a maximum of 100 m.

GIGABIT ETHERNET

GIGABIT ETHERNET

- We first had ethernet which could handle 10Mbits/s
- The we had *fast ethernet* which could handle 100Mbits/s
- Now we have gigabit ethernet which can handle 1000 Mbits/s
- 1000 Mbit = 1 Gbit

GIGABIT ETHERNET

- Why scale up more?
- New applications requiring more bandwith
- The explosion of the web
- Easy to migrate to

MIGRATION ISSUE – FRAME FORMATS

- Same variable length (64 to 1514 byte) frames
- Allows seamless integration
- No frame translation necessary
- Where to install the upgrade (desktop to switch to backbone) ?

PHYSICAL LAYER

- 1000 Base-X based on **F**iber **C**hannel **P**hysical **L**ayer (FCPL)
  - Proven technology
  - 1000 Base-SX :- 850 nm laser multimode
  - 1000 Base-LX :- 1300 nm laser single and multimode laser
  - 1000 Base-CX copper Shielded Twisted Pair
- 1000 Base-T:- long haul 4 pair category 5 UTP cable (802.3ab task force)

MAC LAYER – CARRIER EXTENSION

- 10 times faster than Fast Ethernet, 10m would be max slot size…. Problem
- Slot size of 1512 bytes employed, with pads.
- Carrier Extension allows longer distances
- Transparent to LLC (Logical Link Control)

CARRIER EXTENSION DIAGRAM

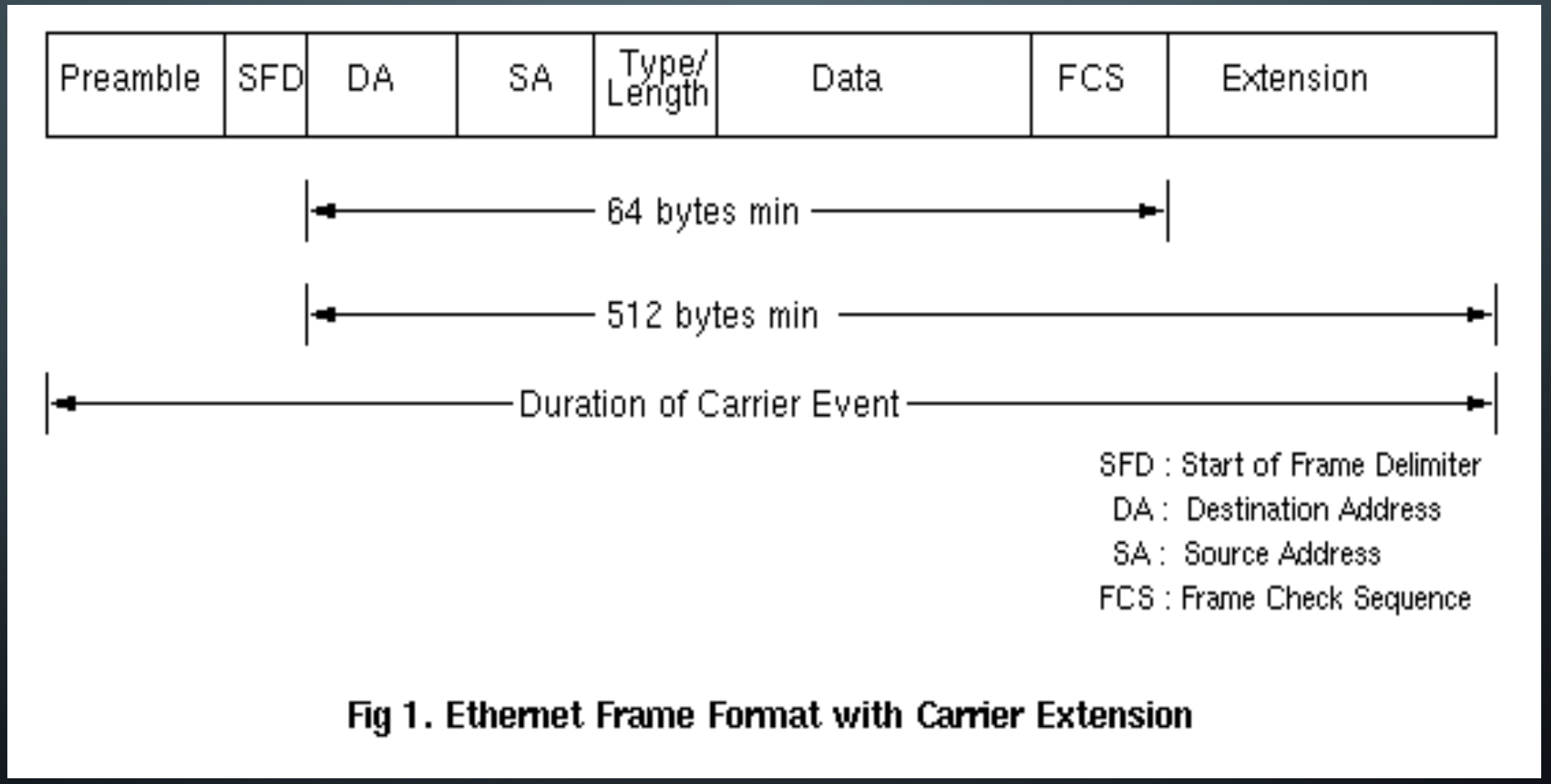


Fig 1. Ethernet Frame Format with Carrier Extension

MAC LAYER – PACKET BURSTING

Carrier extension wastes bandwidth, with 448 pad bytes in small packets.

For small packets, throughput only marginally better than fast Ethernet, 802.3X…. Problem !

Solution:- extend the Carrier Extension

Pad 1st packet to slot time (512 bytes), subsequent packets back to back with minimum inter-packet-gap until burst timer (1500 bytes) expires.

PACKET BURSTING

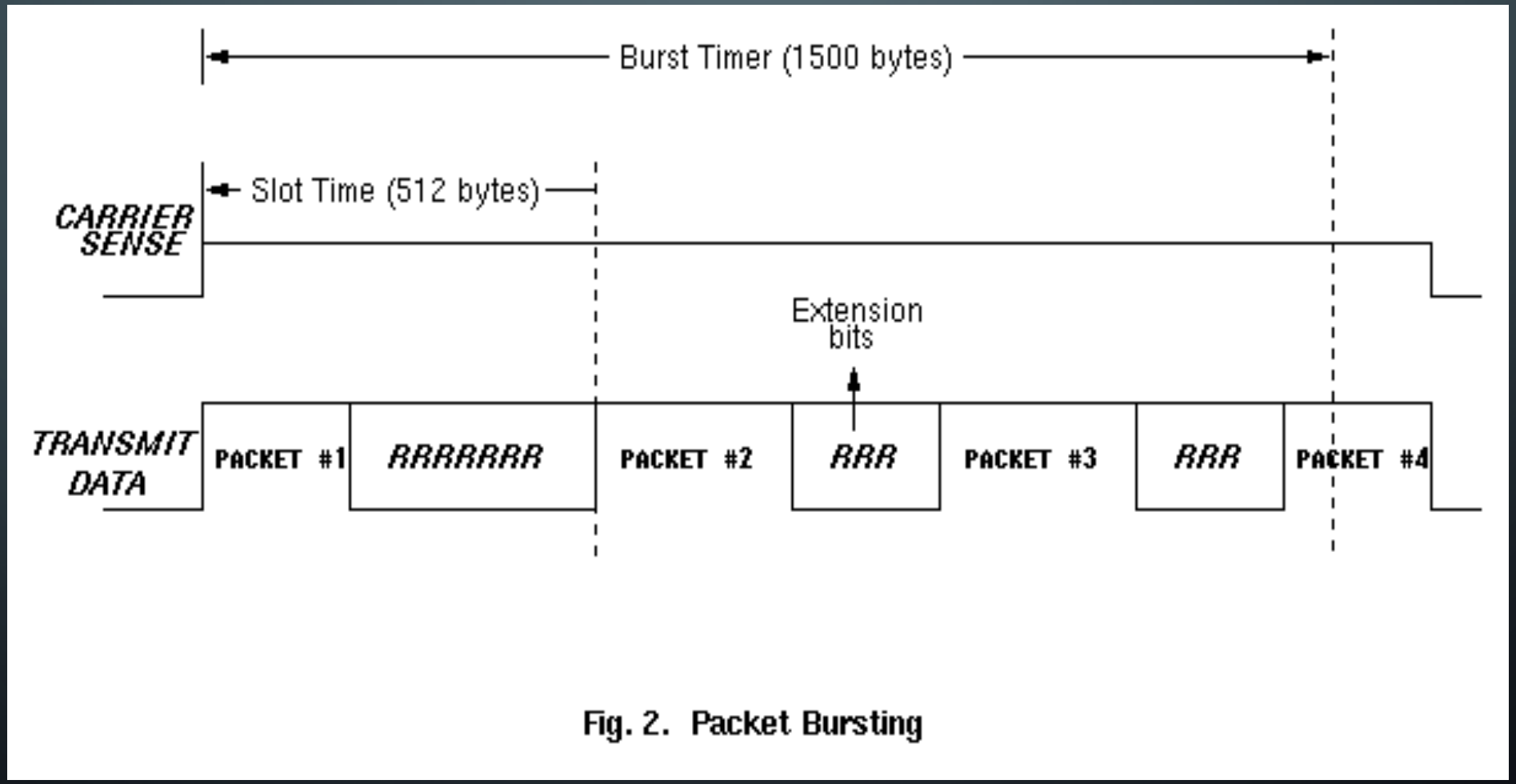


Fig. 2. Packet Bursting

ETHERNET TOPOLOGIES

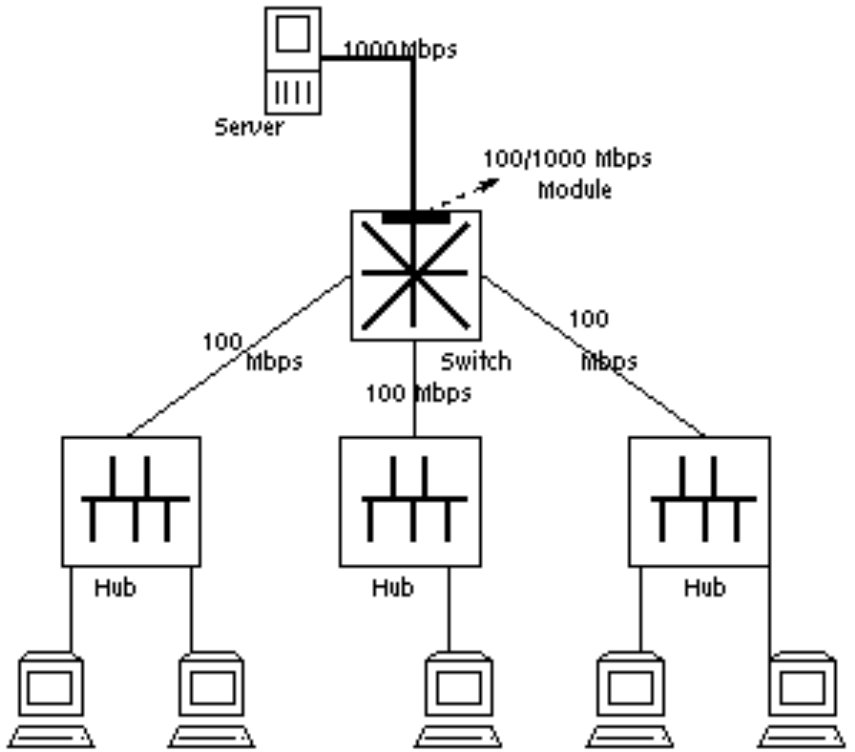


Fig. 5. Server-Switch Connection

ENCAPSULATION AND PROTOCOL HIERARCHIES

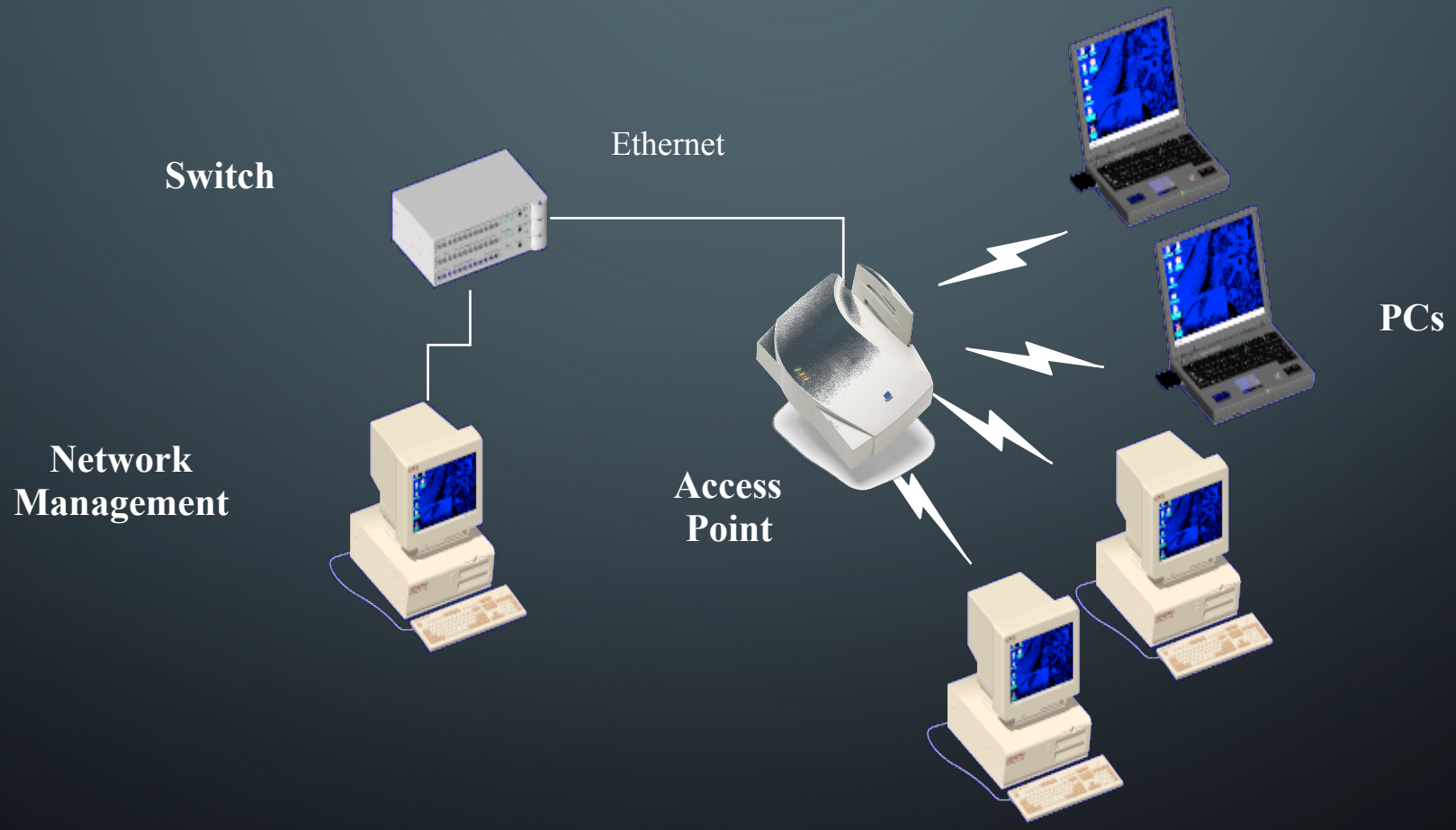
- Ethernet is layer 1 & 2 of the OSI model
- Higher layer entities build packets and provide these as a bit\byte stream to lower layer entities.
- Wrapping like Russian Dolls.

WIFI

WIRELESS TECHNOLOGIES

PAN	LAN	MAN	WAN
"Personal Area Network"	"Local Area Network"	"Metropolitan Area Network"	"Wide Area Network"
Bluetooth	802.11b 802.11a HiperLAN2	802.11 MMDS LMDS	GSM GPRS CDMA 2.5-3 G
Low Data Rates Short Distances Notebook/PC to Devices/ Printer/Keyboard/Phone	Higher Data Rates Medium Distances Computer-Computer and to Internet	Higher Data Rates Med-longer Distances Fixed, last mile access	Lower Data Rates Longer Distances PDA Devices and Handhelds to Internet
< 1 Mbps	2 to 54+ Mbps	22+ Mbps	10 to 384 Kbps

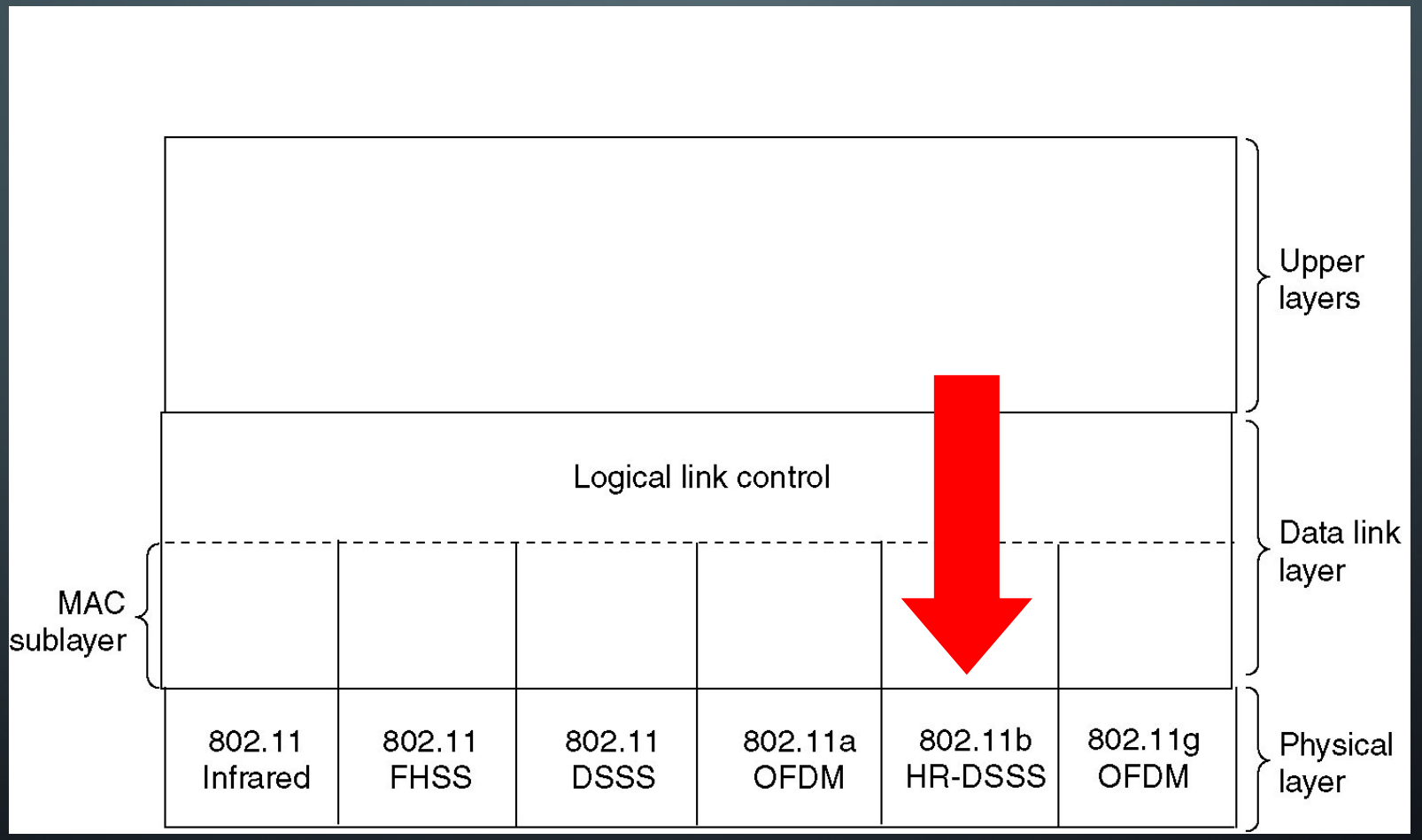
802.11B WIFI



WIRELESS LANS

- The 802.11 Protocol Stack
- The 802.11 Physical Layer
- The 802.11 MAC Sublayer Protocol
- The 802.11 Frame Structure

PART OF THE 802.11 SET OF PROTOCOLS



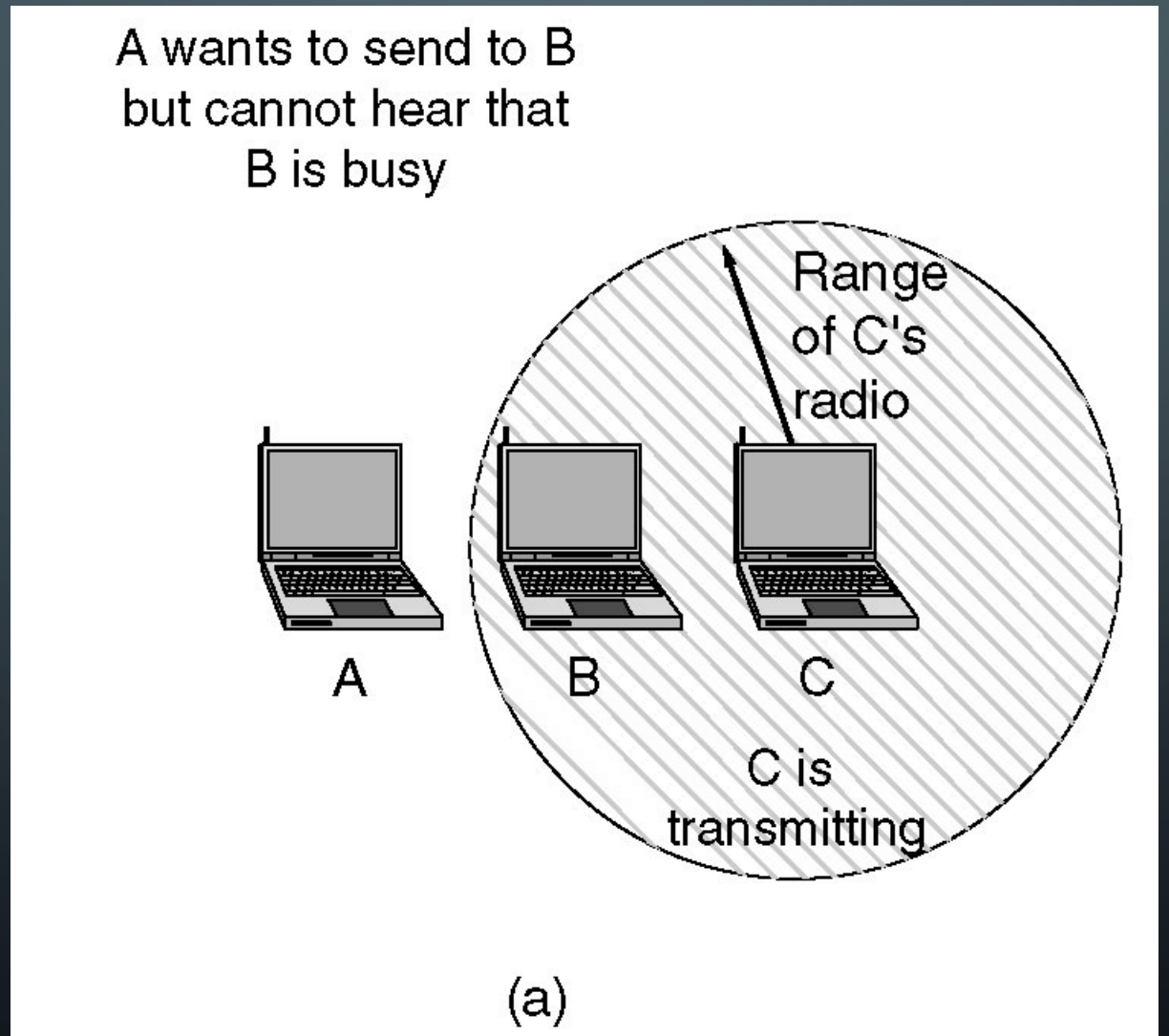
802.11 HR-DSS

- High Rate - Direct Sequence Spread Spectrum (HR-DSSS)
- Speeds
- 1, 2, 5.5, 11 Mbps
- Dynamic speed adaptation
- Same bandwidth as cordless phones, Bluetooth and microwave ovens
- ISM Band
  - Usually reserved for science, but we can use the 2.4 GHz band

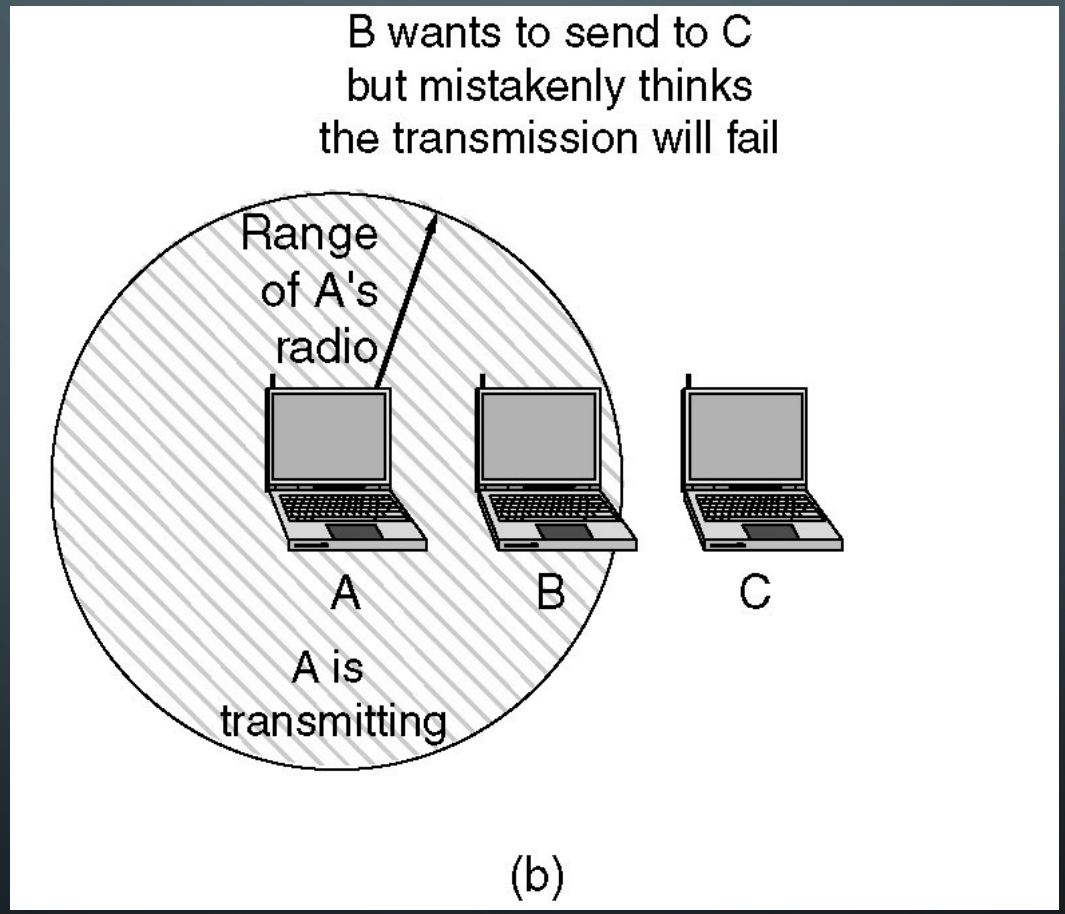
802.11 MAC PROBLEMS

- The hidden station problem.
- The exposed station problem.

HIDDEN STATION PROBLEM



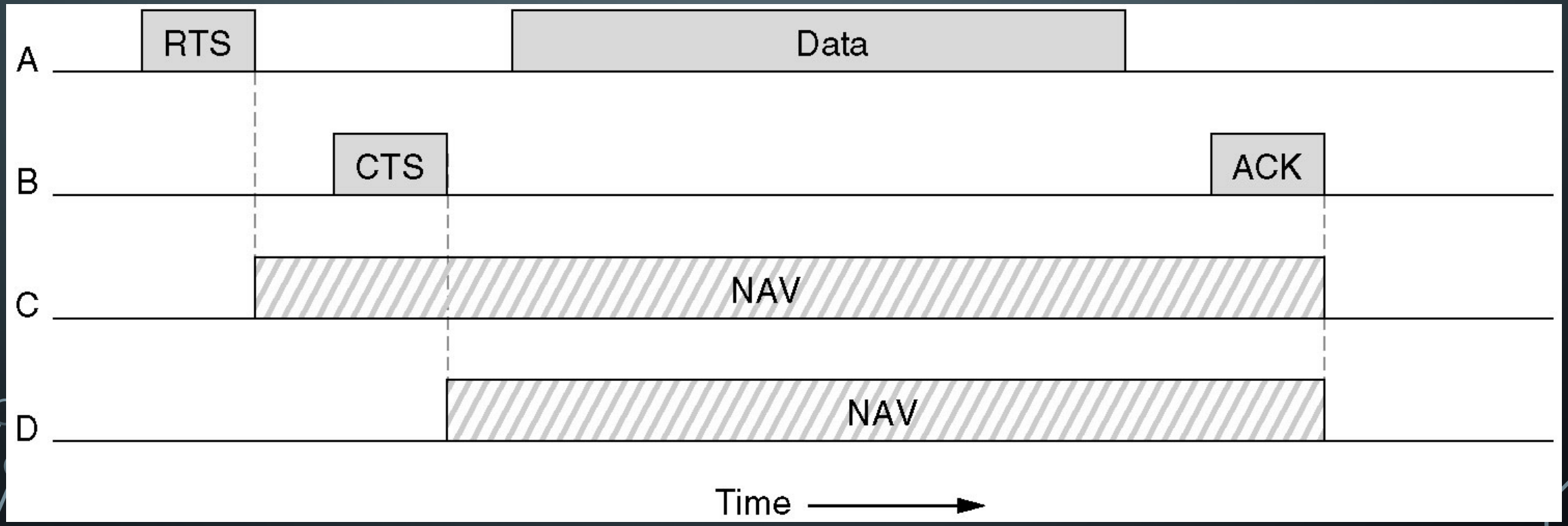
EXPOSED STATION PROBLEM



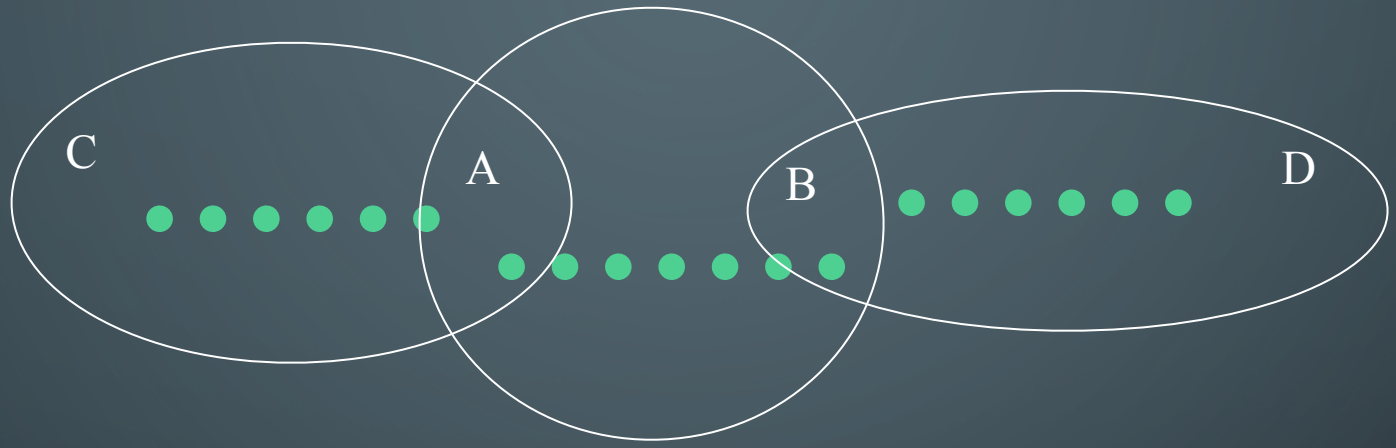
HOW DO WE OVERCOME THESE PROBLEMS?

- Some new protocols
- CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance)
- Some terminology
- RTS = Request to send
- CTS = Clear to send
- ACK = Acknowledgement

CSMA/CA



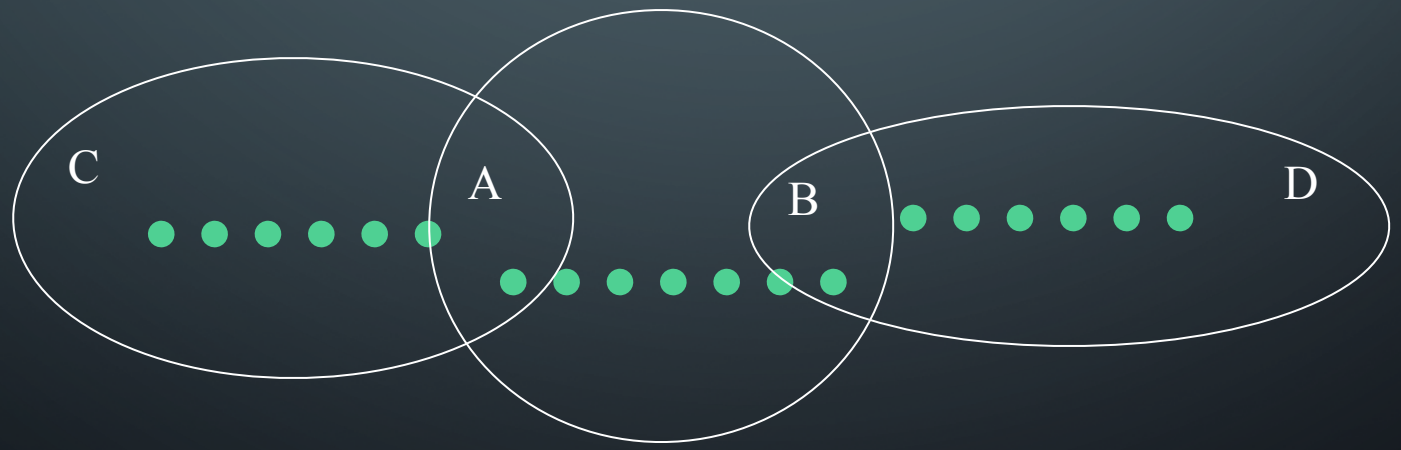
CSMA/CA EX - 1



- Example…
  - A wants to send to B, sends RTS
  - B says Ok with a CTS frame
  - A sends its frame & starts ACK timer.
  - B gets frame Ok and sends ACK frame.
  - If A's ACK timer expires, start again

OTHER STATIONS

- C within range of A… may receive RTS, if so Hush. This is Network Allocation Vector **NAV**
- D doesn't hear RTS but hears CTS… assert NAV
- All fine & dandy!



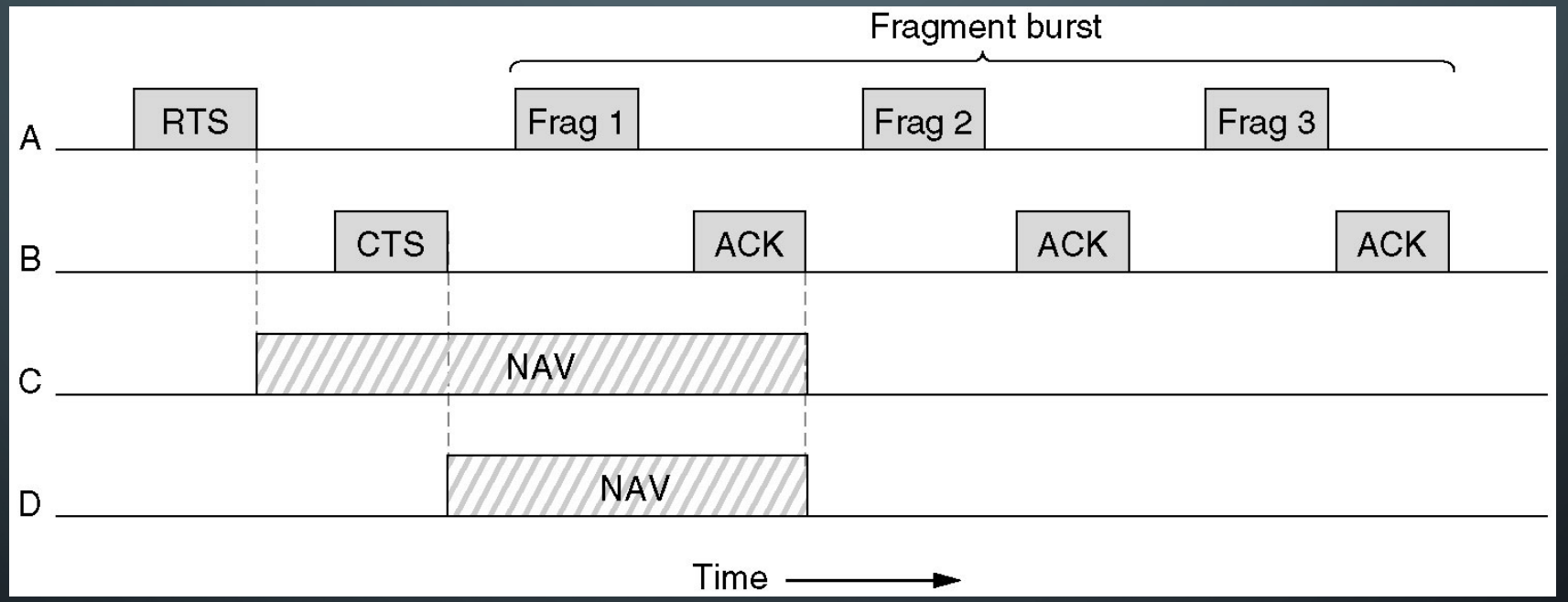
BUT ISM IS NOISY

- Probability of 1 bit error is p
- Probability of n bit frame arriving uncorrupted is $(1-p)^n$
- So, for $P = 10^{-4}$, 12144 bit frame has <30% probability of arriving correct.
- If 10^{-5}, roughly 1:9 will be damaged.
- If 10^{-6}, roughly >1:100 will be damaged.
- Bigger frames more susceptible to damage!

DEALING WITH NOISE

- Smaller frames have less change of being corrupted
- Solution:
- Break large frames into fragments and send them

FRAGMENT BURSTS



DEALING WITH NOISY CHANNELS

Fragment frames, use checksums & number

Acknowledge using Stop & Wait

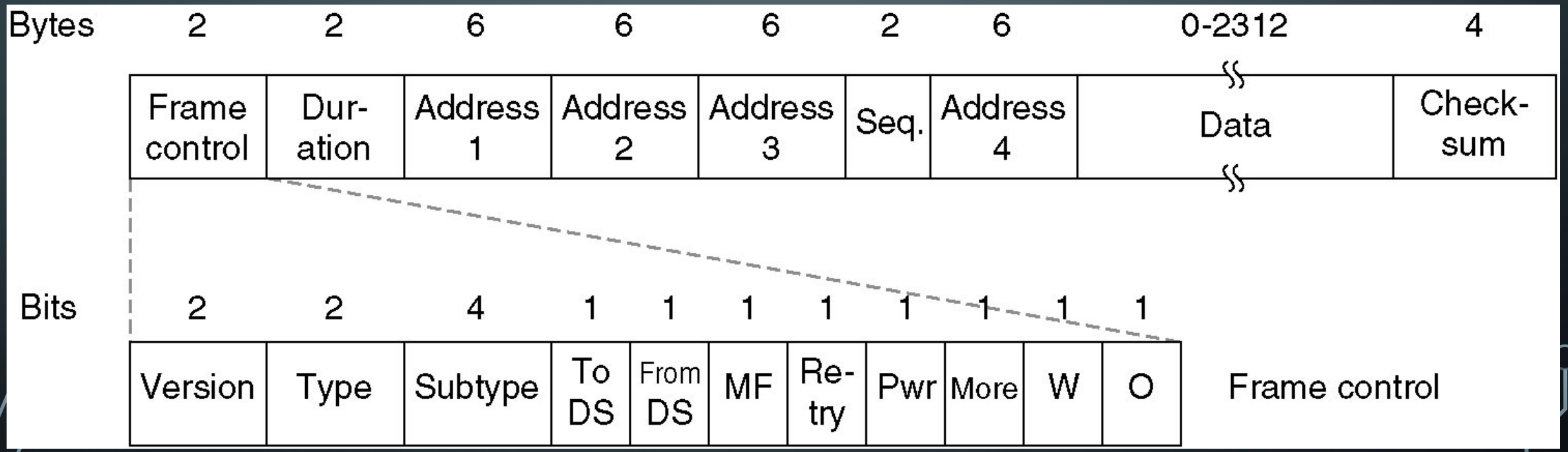
Once channel is acquired (RTS & CTS), send fragment burst, ACK each fragment.

This is what is called Distributed Coordination Function (DCF) Mode

POINT COORDINATION FUNCTION - PCF

- Sits on access point
- Monitors network
- Base station polls... central control.
- Beacon frame transmitted periodically.
- There cannot be any collisions.
- Beacon frame contains system parameters.
- PCF and DCF (Distributed Coordination function) may coexist

802.11 FRAME STRUCTURE



FRAME STRUCTURE

- Data Control & Management Frames
- Control has 11 Fields
- protocol version [PCF | DCF]
- Type - [Data | Control | Management]
- Subtype [RTS | CTS]
- To DS and From DS indicate to\from intercell distribution system (e.g. Ethernet)
- MF More Fragments
- Retry - this is a retransmission
- Pwr - power management [go asleep | wake up]
- W - encrypted with WEP
- O - process this frame sequence in order

FRAME STRUCTURE

- Duration field says how long frame & acknowledgement will occupy channel.
- 4 addresses - Source & Dest, also Source & Dest. Base stations for intercell traffic.
- Sequence is for fragment numbering, 12 bits for frame, 4 for fragment
- Data contains payload, up to 2312 bytes
- Checksum is CRC
- Mgmt frames operate within single cell
- Control frames are RTS, CTS and ACK

802.11 DISTRIBUTION SERVICES

- Association
- Disassociation
- Reassociation (roaming)
- Distribution (wired or wireless)
- Integration (protocol translation)

802.11G – HIGH SPEED WIRELESS

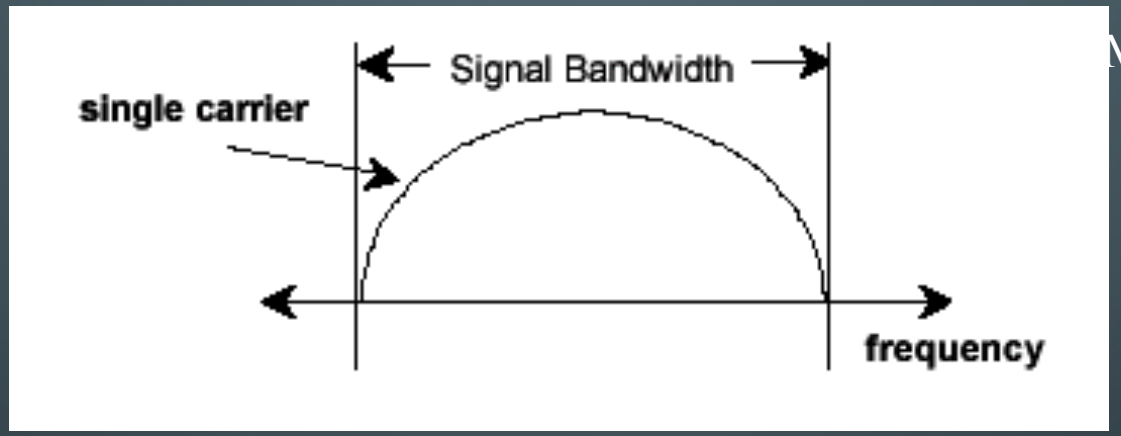
- 2.4GHz is still the frequency band with 54Mbps
- Compulsory…
  - Orthogonal Frequency Division Multiplexing (OFDM) used for rates > 20Mbps.
  - Complementary Code Keying (CCK) required for backward compatibility.
- Optional
  - CCK\OFDM Hybrid Header\Payload
  - PBCC Hybrid Header\Payload (Texas Instruments)

802.11G PACKET PREAMBLE AND PAYLOAD

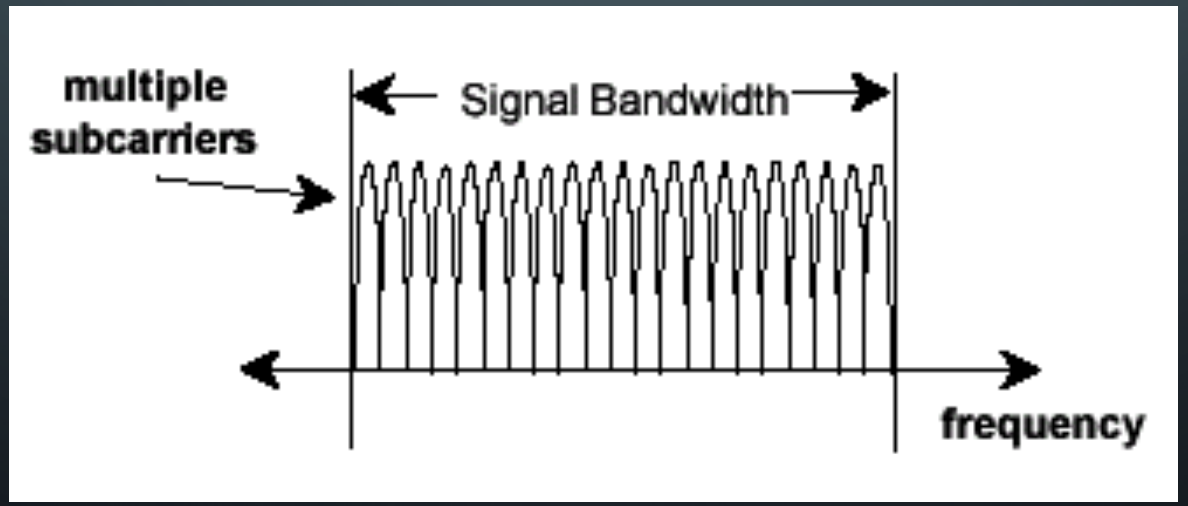
Preamble/Header	Payload

- Preamble warns of forthcoming packet
- Header contains length of packet.
- Payloads vary from 64Byte to 1500Byte.
- Generally CCK used to transmit header and payload, usually!

CCK & OFDM



Max. 11Mbps



Max. 54Mbps

WIFI INTEROPERABILITY

- CSMA\CA will be used again.
- RTS\CTS will be used
- Headers may be transmitter using CCK and payloads may use OFDM

802.11G SECURITY

- Wired Equivalent Privacy (WEP)
  - Garbage
- Service Set Identifier (SSID)
  - Disable broadcasts
- WiFi Protected Access (WPA)
  - Stronger than WEP
- MAC Address Authentication
- 802.1x Network Authentication
  - EAP

COMPARING WIRELESS TECHNOLOGIES

	Infrared	Bluetooth	802.11b
Frequency	10^{13} - 10^{14} Hz	2.4 GHz	2.4 GHz
Transmission Method	Line-of-sight	Frequency Hopping	Direct Sequence Spread-Spectrum
Speed	4 Mbps	1 Mbps	11 Mbps
Range	1 meters	30 meters	100 meters
Network	PAN	PAN/LAN/WAN	LAN
Signal	Data or Voice	Data & Voice	Data
Security	None	Authentication, Encryption	Authentication, Encryption

Security? - RUBBISH !