Wireless LANs
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Physical Layer

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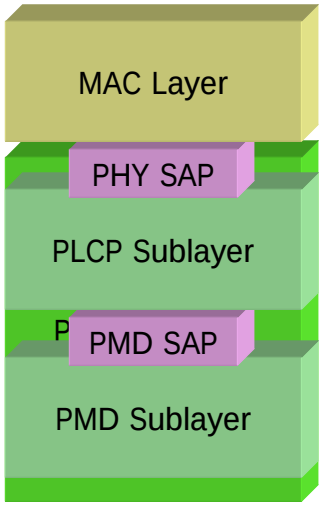
Outline

- Physical Layer Architecture
- Physical Layer Operations
- IEEE 802.11 Physical Layer
  - FHSS
  - DSSS
  - IR

Physical Layer Architecture



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PLCP Sublayer

- Physical Layer Convergence Procedure
- Communicate to MAC via primitives through Physical Layer Service Access Point (SAP)
- Prepare PLCP protocol data unit (PPDU) (append fields to MPDU)
- PPDU provides for asynchronous transfer of MPDU between stations

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PMD Sublayer

- Physical Medium Dependent
- Provide actual transmission and reception of Physical Layer entities via wireless medium
- Interface directly to the medium
- Provides modulation and demodulation of the transmission frame

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Physical Layer Operations

- 3 State machines
  - Carrier Senses: determine the state of the medium
  - Transmit: send the data frame
  - Receive: receive the data frame

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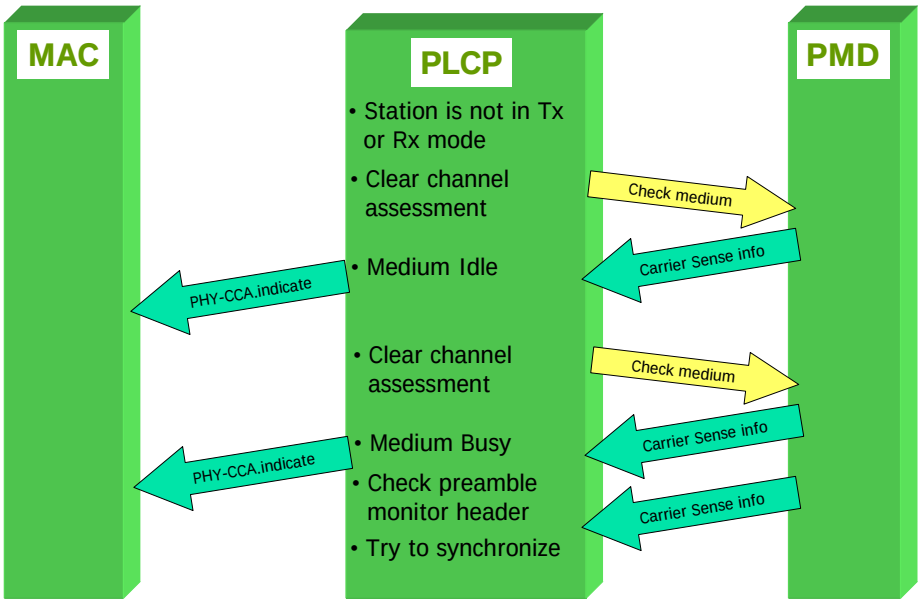
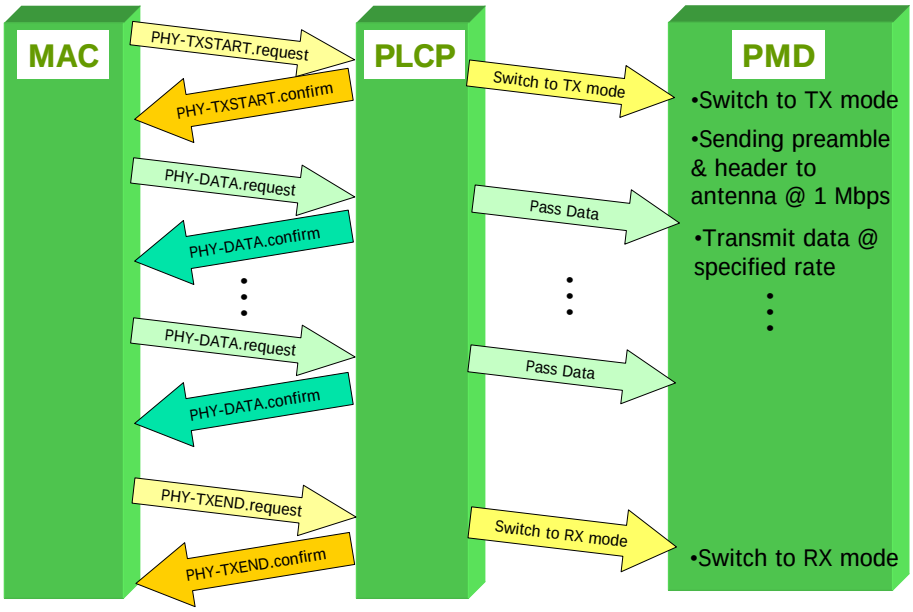
Physical Layer Service Primitives

MAC → PLCP	PLCP → MAC	Description
	PHY-CCA.indication	(busy/idle : send every channel changes state)
PHY-TXSTART.request	PHY-TXSTART.confirm	Start TX
PHY-DATA.request	PHY-DATA.confirm	Transfer Data
PHY-TXEND.request	PHY-TXEND.confirm	End TX
PHY-CCARESET.request	PHY-CCARESET.confirm	Reset Clear Channel Assessment state machine
	PHY-DATA.indication	Transfer Data
	PHY-RXSTART.indication PHY-RXEND.indication	Received a valid start frame/PLCP header

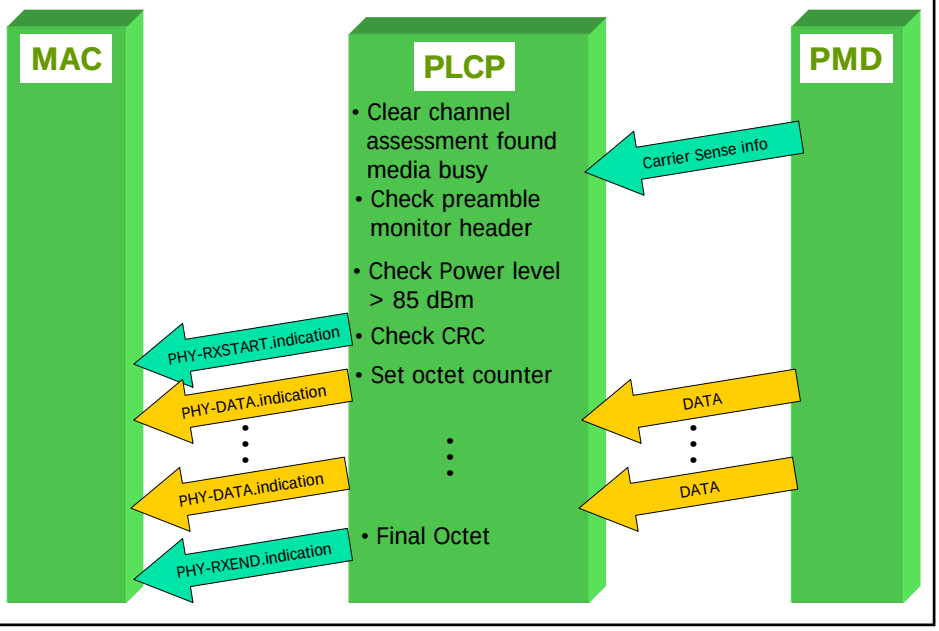
Carrier Sense Function



Transmit Function



Receive Function



Multiple Antenna Diversities

- Receive function will operate with
  - Single Antenna
  - Multiple Antennas
- Signal Degradation Factors
  - Distance
  - Atmosphere
  - Barrier
- Multiple-path propagation
  - Decrease the signal strength
  - Use multiple antennas (diversity) to improve the received signal

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IEEE 802.11 PHY Layer

- FHSS Physical Layer
- DSSS Physical Layer
- Infrared (IR) Physical Layer

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FHSS Physical Layer

- Low cost
- Low power consumption
- Most tolerant to noise
- Low potential data rate
- Medium range (< DSSS)

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FHSS Architecture

- FHSS PLCP Sublayer
- FHSS PMD Sublayer
- Primitives

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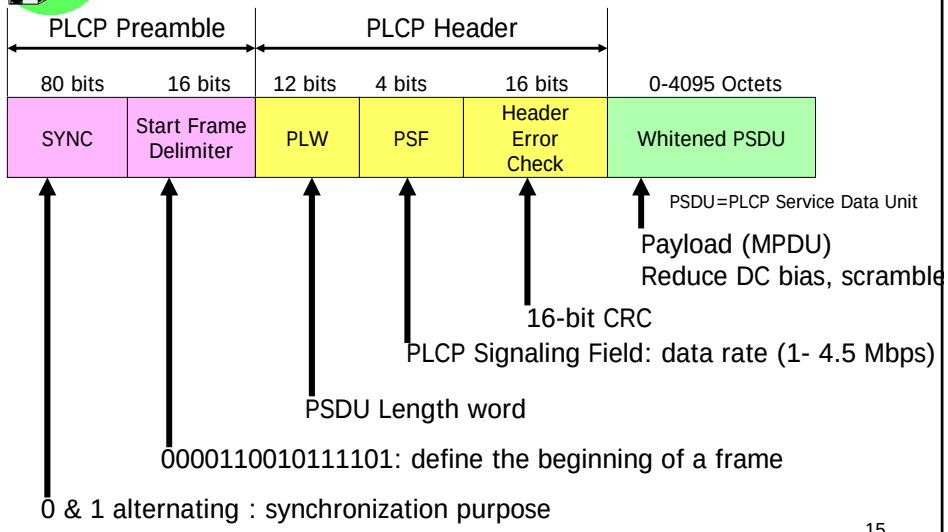
FHSS PLCP frame



FHSS PMD

- Perform actual Tx/Rx of PPDU by hopping between channel (hopping sequence)
- Provides FHSS modulation/demodulation

FHSS PMD Service Primitives

PLCP → PMD	PMD → PLCP	Description
PMD_DATA.request	PMD_DATA.indicate	Transfer Data
PMD_TXRX.request		Set Tx/Rx mode
PMD_PA_RAMP.request		Set Ramp up/down Tx power
PMD_ANTSEL.request		Select antenna (1..N)
PMD_PWRMGMT.request		Put radio in sleep mode
PMD_TXPWRLVL.request PMD_FREQ.request		Select power level Tx Freq (channel ID)
	PMD_RSSI.indication	Signal Strength (0-15)

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DSSS Physical Layer

- High cost
- High power consumption
- High potential data rate
- More range

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DSSS Architecture

- DSSS PLCP Sublayer
- DSSS PMD Sublayer
- Primitives

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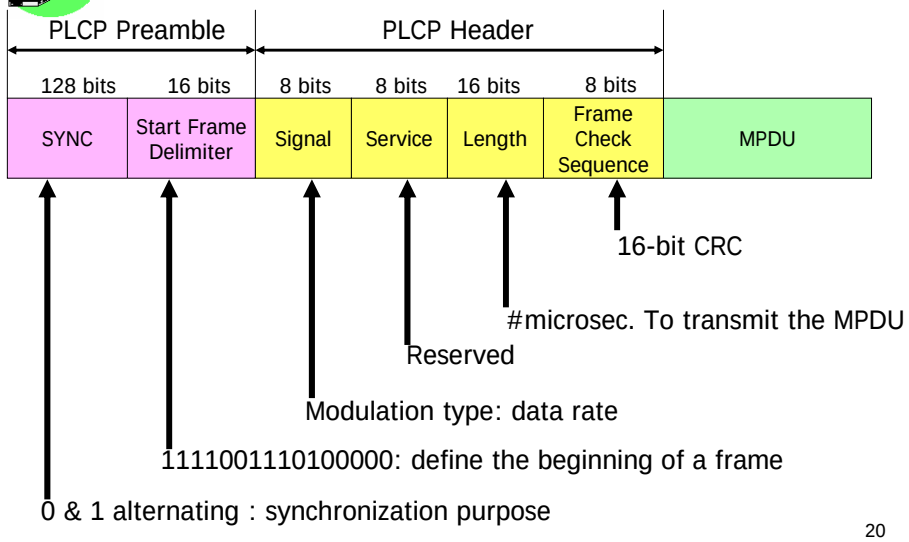
DSSS PLCP frame



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DSSS PMD

- Perform actual Tx/Rx of PPDU
- Provides DSSS modulation/demodulation

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DSSS PMD Service Primitives

PLCP → PMD	PMD → PLCP	Description
PMD_DATA.request	PMD_DATA.indicate	Transfer Data
PMD_TXSTART.request PMD_TXEND.request PMD_TXPWRLVL.request		Start Tx End Tx Select power level
PMD_ANTSEL.request	PMD_ANTSEL.indicate	Select antenna (1..N)
PMD_RATE.request	PMD_RATE.indicate	Select data rate
PMD_ED.request	PMD_ED.indicate	Energy > Threshold
	PMD_RSSI.indication PMD_SQ.indicate PMD_CS.indicate PMD_CAA.indicate	Signal Strength (0-15) Signal Quality (PN code) Valid 802.11 DS Detect RF as CCA algo.

IR Physical Layer

- Lowest cost
- Highest tolerant to RF noise
- Lowest range
- Need ceiling
- More secure
- No frequency regulating
- No product ?
- IrDA: Infrared Data Association Standard

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IR Architecture

- IR PLCP Sublayer
- IR PMD Sublayer

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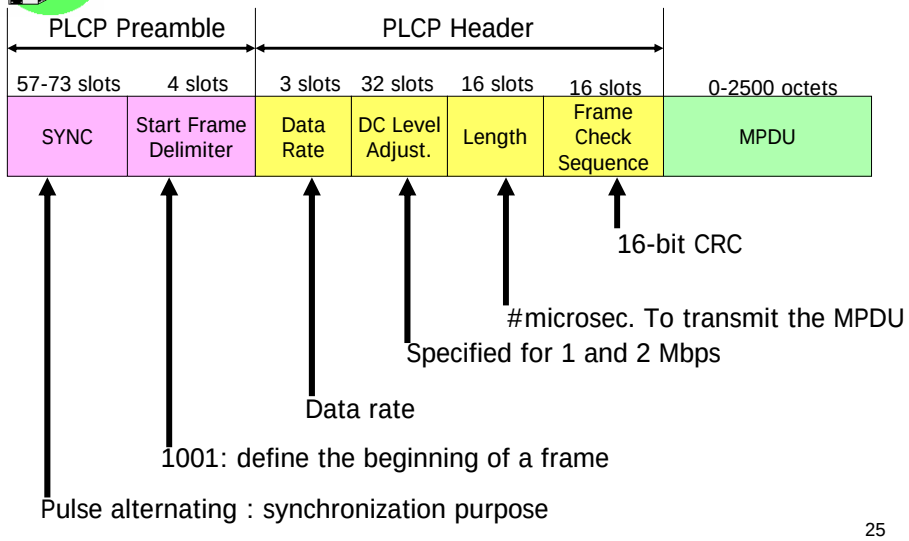
IR PLCP frame



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IR PMD

- Mostly use diffused infrared
- Perform actual Tx/Rx of PPDU, translate binary to infrared light
- Provides IR modulation/demodulation

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IR PMD

- Noise affects amplitude (not phase)
  ➔ Pulse position reduces interference
- Pulse position modulation :PPM
  - Vary position of pulse
- For 1 Mbps → 16 PPM
- For 2 Mbps → 4 PPM

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Pulse Position Modulation

Data bits	16-PPM signal
0000	0000 0000 0000 0001
0001	0000 0000 0000 0010
…	…
1000	1000 0000 0000 0000

Data bits	4-PPM signal
00	0001
01	0010
10	0100
11	1000

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