

IEEE 802.11 MAC

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MAC Layer

- MAC Layer operation
 - Contention & contention-free
 - Priority frame transmission
- MAC frame structure
 - Create MAC frame
- MAC frame Types
 - MAC management, control, and data frame

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MAC Layer Operations

- Accessing the wireless medium
- Joining the network
- Providing authentication and privacy

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Accessing the Wireless Medium

- Two operation modes:
 - Distributed Coordination Function (DCF)
 - Point Coordination Function (PCF)
- The coexist of DCF & PCF
- PCF & DCF tradeoff

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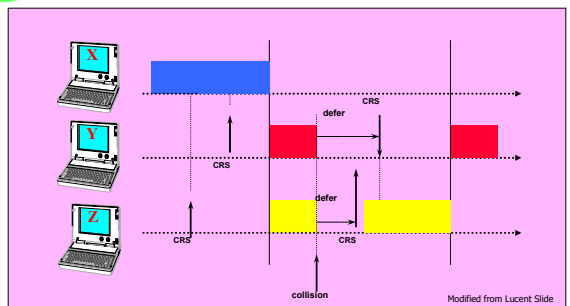
DCF

- CSMA/CA
- Carrier Sense Mechanism
- Error Recovery Mechanism
- Access Spacing

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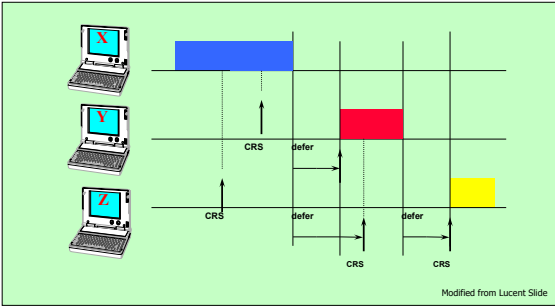
CSMA/CD



Modified from Lucent Slide

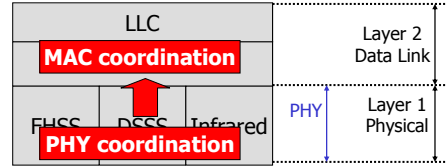
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DCF - CSMA/CA



Carrier Sense Mechanism

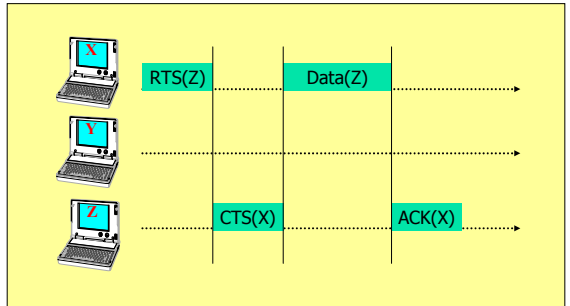
- Check for Medium status (Idle / Busy)
 - Physical Channel Assessment
 - Network Allocation Vector (NAV) [zero→clear]



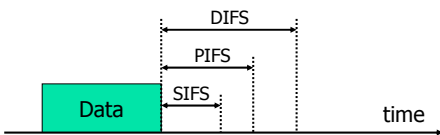
Error Recovery Mechanism

- Transmission impairments
 - Errors (interference, collision)
- Handshake mechanism
 - RTS: Request to send
 - CTS: Clear to send
 - ACK: Acknowledge
 - Data: Data Frame

Error Recovery Mechanism

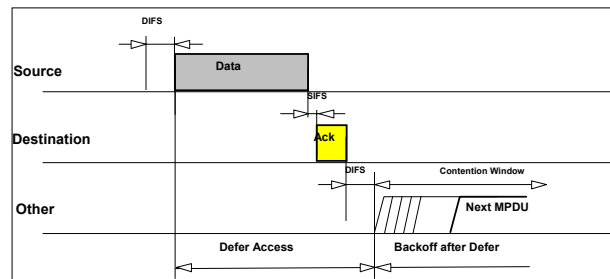


Access Spacing



IFS	Interframe Space		
SIFS	Short IFS	Highest priority	ACK, CTS, 2 nd MSDU
PIFS	PCF IFS	2 nd priority	PCF operation mode
DIFS	DCF IFS	3 rd priority	DCF operation mode
EIFS	Extended IFS	Lowest priority	Waiting period

Sending Data and Ack



Accessing the Wireless Medium

- Two operation modes:
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PCF

- Priority-based → QoS
- Contention-free frame transfer
- Optional

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PCF operation

- Point Coordinator (PC) takes control the medium
 - Sense the medium @ beginning of PCF period
 - If idle after PIFS interval, sends Beacon frame
 - Beacon includes CF parameters (CFPMaxDuration : length of CF period)
- All stations receive Beacon:
 - Update NAV with the CFPMaxDuration
 - Cannot take control the medium until CF period end

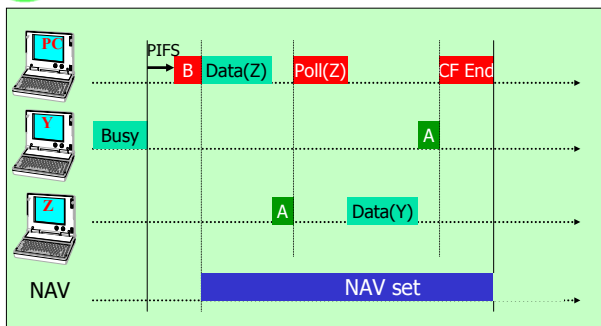
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PCF operation

- After SIFS interval, PC transmits may transmit
 - Data frame (PC → station)
 - Individual, broadcast, multicast
 - Immediate retransmit is allowed (PIFS)
 - CF Poll frame
 - Grants permission to stations
 - Can transmit to any destination
 - Only single frame allowed per poll
 - Data + CF Poll frame (piggyback)
 - CF End frame
 - Announce the end of CF period

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PCF operation



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Accessing the Wireless Medium

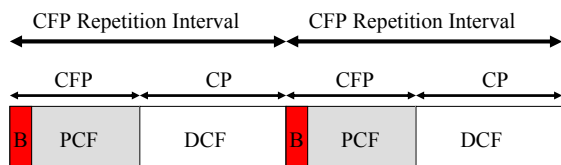
- Two operation modes:
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 - Point Coordination Function (PCF)
- The coexist of DCF & PCF
- PCF & DCF tradeoff

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Accessing the Wireless Medium

- Two operation modes:
 - Distributed Coordination Function (DCF)
 - Point Coordination Function (PCF)
- The coexist of DCF & PCF
- **PCF & DCF tradeoff**

The coexist of DCF & PCF



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Startup/Join the network

- Turn on → discovery phase
 - determine AP or other stations exist
- If exist → joint the network, get the following:
 - Service Set Id (SSID)
 - Timing Synchronization Function (TSF)
 - Timer Value
 - PHY setup parameters
- Negotiate for connection
 - Authentication & Association

PCF & DCF tradeoff

- DCF by default, PCF is optional
- DCF cannot guarantee the transmission delay
- PCF is more suitable for QoS
- PCF needs to pay for the overhead (Poll)

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Authentication

- Open system authentication
 - Default mode
- Shared key authentication
 - Higher degree of security
 - More rigorous frame exchange
 - Need to implement WEP

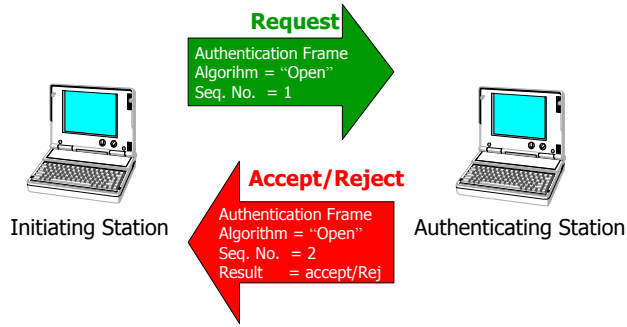
Discovery Phase

- Enter scanning mode
 - Passive / Active scanning mode
- Passive
 - Listen for a Beacon for ChannelTime period
 - In Beacon → get the SSID & parameters
- Active
 - Transmit a probe frame (including the SSID that wishes to join)
 - Wait for a period responded by AP or other stations

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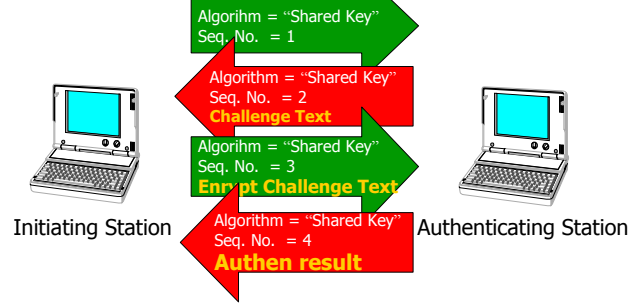
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Open System Authentication



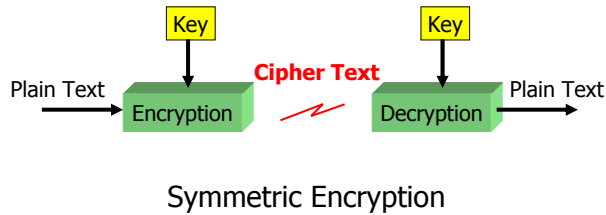
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Shared Key Authentication



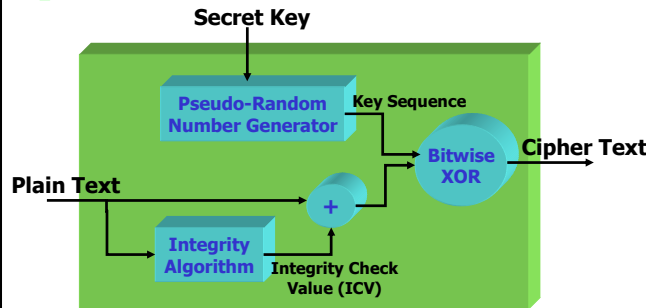
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Wired Equivalent Privacy



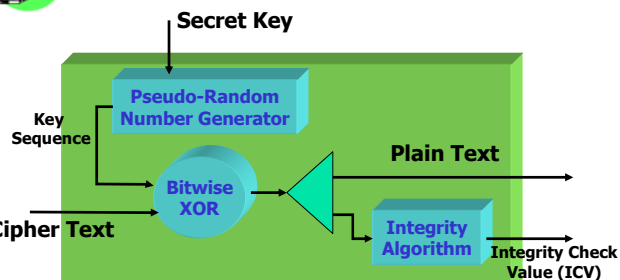
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WEP - Encryption



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WEP - Decryption



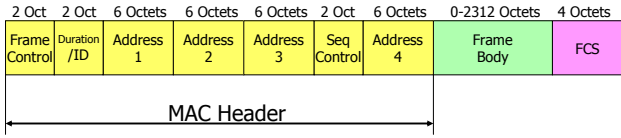
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MAC Layer

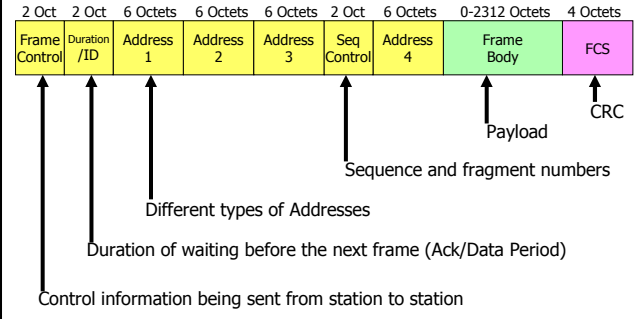
- MAC Layer operation
 - Contention & contention-free
 - Priority frame transmission
- MAC frame structure/Types
 - MAC management, control, and data frame
- Basic process revisit

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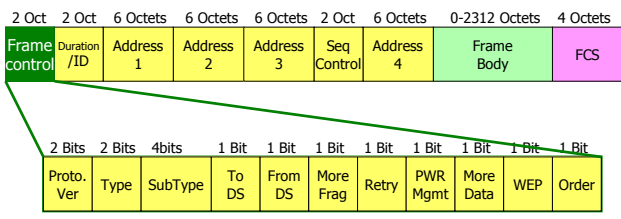
MAC Frame Structure



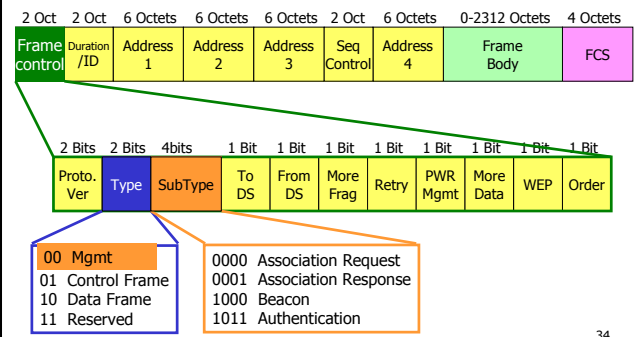
MAC Frame Structure



Frame Control Fields

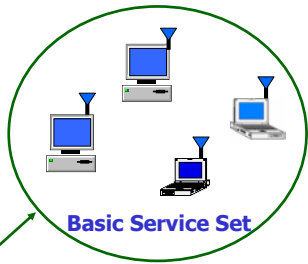


Frame Control – Type/subtype



Independent Basic Service Set (IBSS)

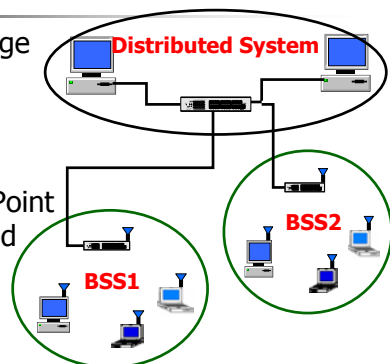
- Stand-alone BSS
- No backbone infrastructure
- At least 2 stations
- **Ad hoc** Network
- Small area



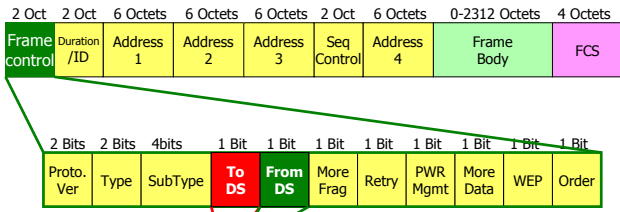
Cell Boundary

Extended Service Set (ESS)

- Extending range
- Arbitrary size
- Multiple cells interconnect
- Need Access Point and Distributed system



Frame Control – Address Fields

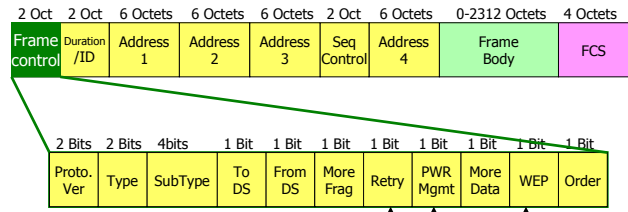


DS: Distribution System
 DA: Destination Addr
 SA: Source Addr
 BSSID: BSS ID same as AP
 TA: Transmitter Addr
 RA: Receiver Addr

	Add 1	Add 2	Add 3	Add 4
0 0	DA	SA	BSSID	N/A
0 1	DA	BSSID	SA	N/A
1 0	BSSID	SA	DA	N/A
1 1	RA	TA	DA	SA

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Frame Control Fields



1 = retransmit
 0 = regular

1 = Data encrypted
 0 = Other Tx

Sender gonna be 1=Sleep (power saving) mode
 0=Full active mode

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IEEE 802.11 Basic process

- Authentication
- Association
- Starting an IBSS
 - One station is configured to be “initiating station”
 - Starter send beacons

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Traffic Flow

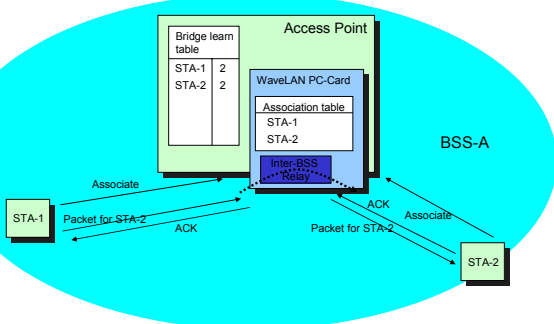
	Add 1	Add 2	Add 3	Add 4
0 0	DA	SA	BSSID	N/A
0 1	DA	BSSID	SA	N/A
1 0	BSSID	SA	DA	N/A
1 1	RA	TA	DA	SA

MAC filters frames based on “Addr1”

- In IBSS:
 - Traffic is sent directly to the destination in BSS
 - Add1 = MAC add of the destination station
 - Add2 = MAC add of the source station
 - Add3 = BSSID (= MAC add of the initiator of the IBSS)
- In ESS:
 - Outgoing traffic is sent to Access-Point in BSS
 - Add1 = MAC add of the Access-Point
 - Add2 = MAC add of the source station
 - Add3 = MAC add of the destination station

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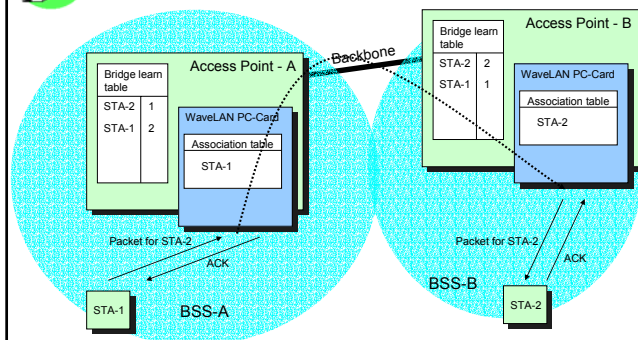
Traffic flow inside BSS



From WaveLAN Slide

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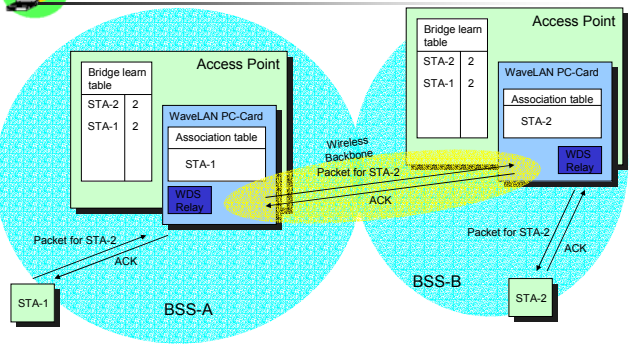
Traffic flow in ESS



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Traffic flow in WDS



Control Frame : RTS-CTS-ACK

