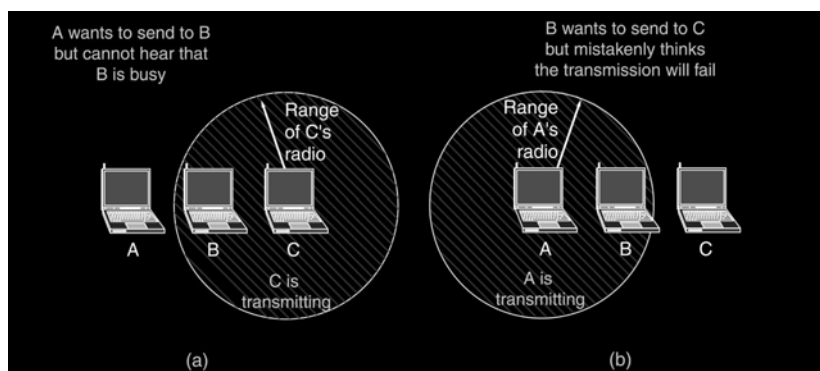


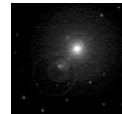
WIRELESS LAN

65

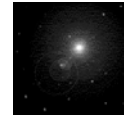
802.11 LAN



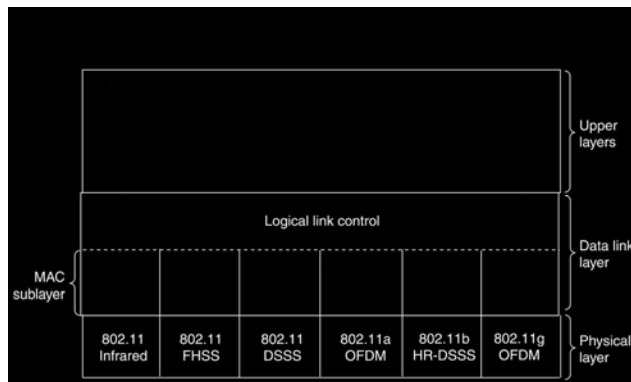
- All signal is broadcast. The signal propagates in all direction. The media is much more loss prone. Security and privacy is a concern, and stations have unequal media access.



COMPUTER
COMMUNICATION
NETWORK



COMPUTER COMMUNICATION NETWORK

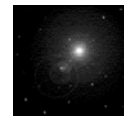
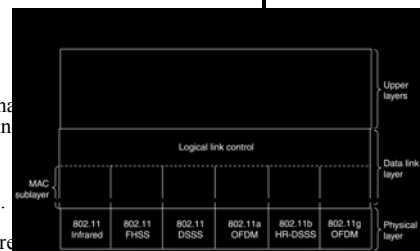


- 802.11 has a newly designed physical layer.
- It also has a new data link layer with two sub-layers.
 - Media Access Control (MAC) sub-layer determines how the channel is allocated.
 - Logical Link Control (LLC) sub-layer hides the difference between different 802 variants and makes them indistinguishable from network layer.

LECT-5, S-67
NET98F, javed@kent.edu
Javed I. Khan@1998

802.11 Physical Layer

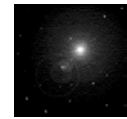
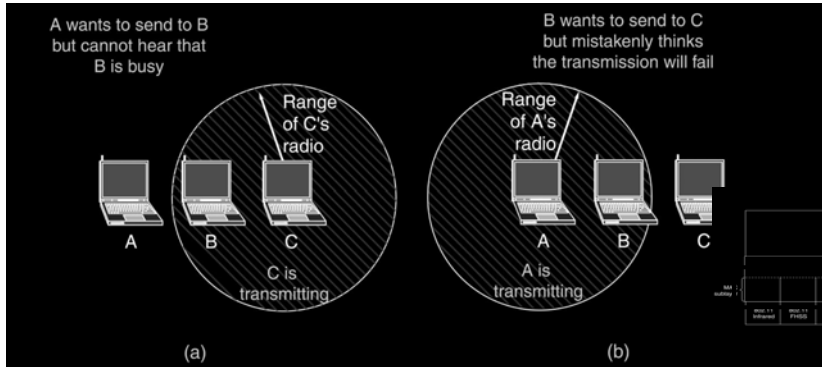
- Infrared
 - uses 85-.95 micron diffused transmission like home remote and uses Gray code.
- FHSS (Frequency hopping spread spectrum)
 - uses 79 channels. The sender/receiver channel hops (every 400 ms or less) using pseudo-random number seed.
- DSSS (Direct sequence spread spectrum)
 - Uses Barker sequence to transmit each bit.
- OFDM (Orthogonal frequency division multiplexing)
 - Known as 802.a. Supports upto 54 Mbps. Splits the signal into simultaneous multiple (84 data+ 2 sync) narrow bands for higher immunity.
- HR-DSSS (802.11b)
 - Known as 802.11b. Supports rates 1,2,5,5 and 11 Mbps. Uses Walsh/Hadamard codes. The data rate can adjust adaptively. Slower than 802.11a but has seven time more range.
- HR-OFDM (802.11g)
 - A high speed version of OFDM



COMPUTER COMMUNICATION NETWORK

LECT-5, S-68
NET98F, javed@kent.edu
Javed I. Khan@1998

802.11 MAC Sub Layer

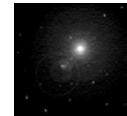
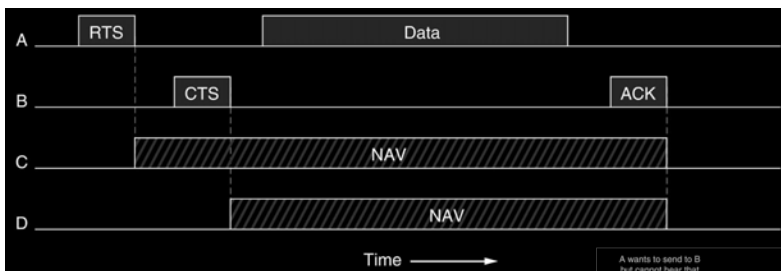


COMPUTER COMMUNICATION NETWORK

- DCF Mode: Distributed Coordination Function
 - Similar to Ethernet but with Data Link Layer ACK
- PCF Mode: Point Coordination Function
 - Centralized model.

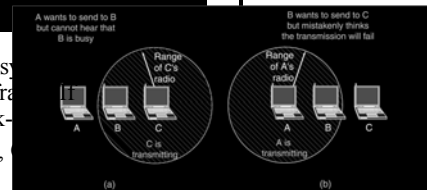
LECT-5, S-69
NET98F, javed@kent.edu
Javed I. Khan@1998

802.11 DCF Mode



COMPUTER COMMUNICATION NETWORK

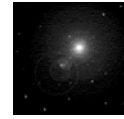
- In one mode CSMA/CA: Sender senses the channel. If busy until end of current transmission. If not transmit the entire frame at the end it senses a collision use binary exponential back-off.
- In other mode CSMA/CA with Virtual Sensing: Use RTS, CTS, ACK and NAV.
- RTS and CTS has information about the duration of sending thus C and D can determine the wait time Network Allocation Vector (NAV).



LECT-5, S-70
NET98F, javed@kent.edu
Javed I. Khan@1998

Error and Frame Size

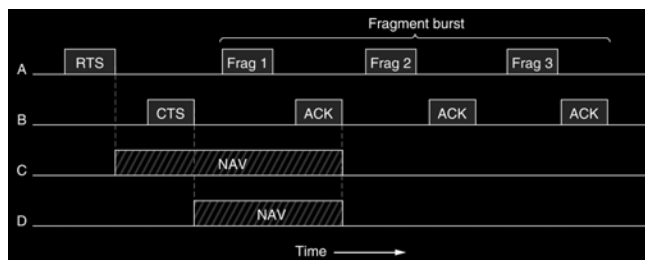
- If p is the probability of bit error. Then the probability that a frame with n bit with transmit without error is $(1-p)^n$.
- For $p=10^{-4}$, the probability that an Ethernet frame (12,144 bits) will correctly transmit is less than 30%!
- For $p=10^{-5}$, the 1 on 9 frames will be lost.
- For $p=10^{-6}$, the 1% frames will be lost.
- Solution?



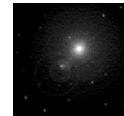
COMPUTER
COMMUNICATION
NETWORK

LECT-5, S-71
NET98F, javed@kent.edu
Javed I. Khan@1998

802.11 Fragmentation



- Fragments are individually numbered and acknowledged. Once a channel has been grabbed by CTS+RTS, multiple fragments can be sent in a row. Others are kept from jumping in by NAV.
- Only lost fragments are retransmitted.
- Fragment size is variable.

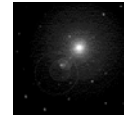


COMPUTER
COMMUNICATION
NETWORK

LECT-5, S-72
NET98F, javed@kent.edu
Javed I. Khan@1998

802.11 PCF Mode

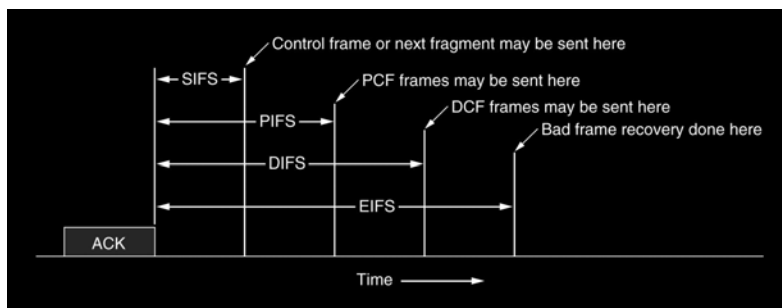
- Base station polls other stations asking if they have any frame to send.
- It sends a beacon signal periodically 10-100 times a second.
- Beacon contains information such as hopping sequence, dwell times, clock synch, etc.
- Base station allocates times for every station.
- Base station can direct a station to sleep mode.
- Can PCF and DCF co-exists?



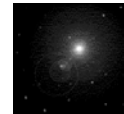
COMPUTER
COMMUNICATION
NETWORK

LECT-5, S-73
NET98F, javed@kent.edu
Javed I. Khan@1998

Inter Frame Spacing



- SIFS-PIFS: Parties in a single dialogue to go first. **Receiver** can send RTS, ACK for next segment. **Sender** of a burst send the next fragment. By design just one station may answer between SIFS and PIFS.
- PIFS-DIFS: If no one talks, after PIFS a PCF **base station** can grab the channel and send a beacon.
- DIFS-EIFS: If base station has nothing to say, and time DIFS elapses, then any other **station** can grab the channel and initiate a DCF frame.
- EIFS: If there is no such contender and time EIFS elapses then any **station** which has received a bad frame can begin recovering it.

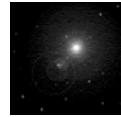


COMPUTER
COMMUNICATION
NETWORK

LECT-5, S-74
NET98F, javed@kent.edu
Javed I. Khan@1998

Distribution Services

- Association
 - A mobile station attaches itself to a base station. This is used when it moves into the radio range. Upon arrival it announces its identity and capabilities (data rate, need to PCF, power requirements etc.). Base station can accept or reject it. If accepted it moves to authentication phase.
- Disassociation
 - A station or base station can tear up association.
- Reassociation
 - A station changes its base station, during handoff or when choice is available.
- Distribution
 - Some routing preference is decided- such as allowing stations to communicate directly without the base when within reach.
- Integration
 - Tunneling type support when a non 802.11 foreign frame type has to be carried.

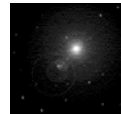


**COMPUTER
COMMUNICATION
NETWORK**

LECT-5, S-75
NET98F, javed@kent.edu
Javed I. Khan@1998

Station Services

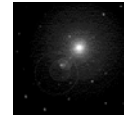
- Authentication
 - After association, the base sends a challenge frame to newcomer. Newcomer must encrypt the frame with public key of the base.
- Deauthentication
- Privacy
- Data Delivery



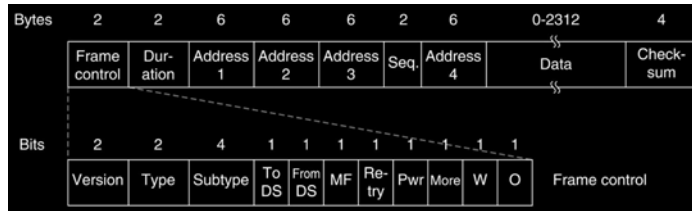
**COMPUTER
COMMUNICATION
NETWORK**

LECT-5, S-76
NET98F, javed@kent.edu
Javed I. Khan@1998

802.11 Data Frame



COMPUTER
COMMUNICATION
NETWORK



Type: (data, control, or management)
 Subtype: (RTS, CTS)
 MF: (fragment?)
 Retry:(if it is retransmitted frame)
 Pwr: (used to put to sleep, wakeup)
 W: (WEP encrypted)
 O: (process strictly in order)

Duration: how long data and ack will take
 Address1 & 2: source and destination
 Address3 & 4: source and destination base stations
 Sequence: 12 bit frame # and 4 bit fragment #
 Data: 0-2312 bytes
 Management frames don't have address 4, it is for single cell.
 Control frames have only 1 or 2 address fields. No data.

LECT-5, S-77
 NET98F, javed@kent.edu
 Javed I. Khan@1998

BROADBAND WIRELESS

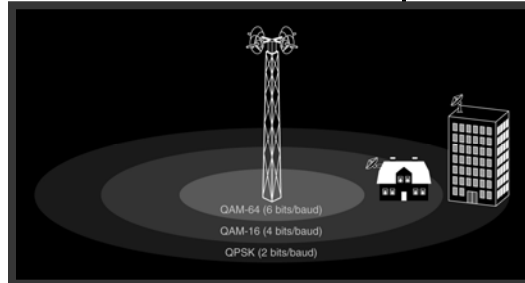
802.16

Why a New Standard?

- It is for outdoor (error handling is important)
- Connect buildings.
- Connects longer distance.
- Buildings are not mobile.
- Connects more than one computers at its end-points.
- Can be costly.
- Needs quality of service.

Quiz 103: How many nodes can participate in one piconet?

COMPUTER
COMMUNICATION
NETWORK

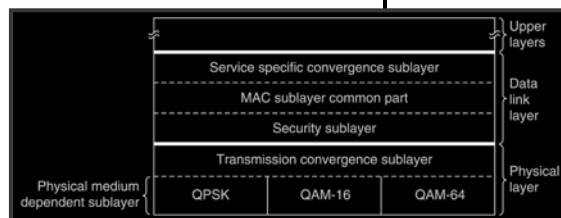


LECT-5, S-79
NET98F, javed@kent.edu
Javed I. Khan@1998

802.16 Physical Layer

- Frames use both Frequency Division (FDM) and Time Division (TDM) Multiplexing.
- The downstream and upstream bandwidths can be adjusted.
- Multiple MAC frames can be loaded back-to-back saving physical layer headers.
- Uses hamming code to do forward error correction.

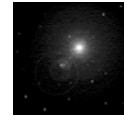
COMPUTER
COMMUNICATION
NETWORK



Quiz 101: what is the main difference? Why slotted ALOHA is better than pure ALOHA?

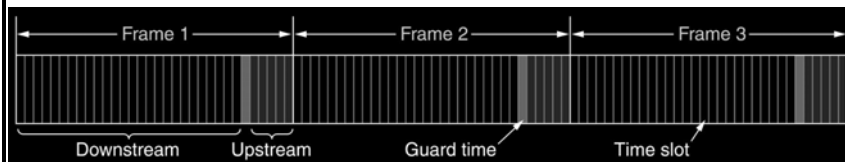
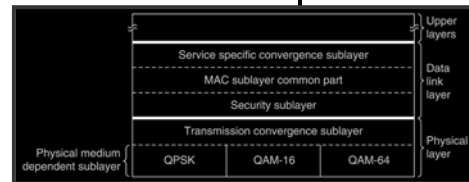
LECT-5, S-80
NET98F, javed@kent.edu
Javed I. Khan@1998

802.16 Physical Layer



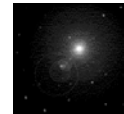
COMPUTER
COMMUNICATION
NETWORK

- Frames use both Frequency Division (FDM) and Time Division (TDM) Multiplexing.
- The downstream and upstream bandwidths can be adjusted.
- Multiple MAC frames can be loaded back-to-back saving physical layer headers.
- Error is part of life. It uses hamming code to do forward error correction.



LECT-5, S-81
NET98F, javed@kent.edu
Javed I. Khan@1998

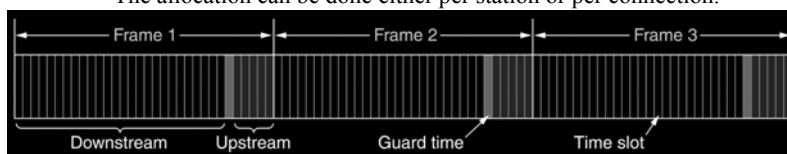
802.16 MAC Sub Layer



COMPUTER
COMMUNICATION
NETWORK

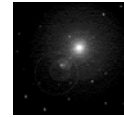
- Security and Privacy: All communication is mutually authenticated and frames are encrypted.
- QoS: all service is connection oriented.
 - Constant-bit rate service: (intended for uncompressed voice) pre-determined slots are allocated to each connection.
 - Real-time VBR: (compressed multimedia) base station regularly at fixed interval polls senders for rate requirement and the slots are allocated accordingly.
 - Non-real-time VBR (large files): base station polls at non-periodic interval. A CBR customer can request a poll by a flag bit in frame.
 - Best Efforts Service: (everything else): not polled and uses remaining slots.
 - The allocation can be done either per station or per connection.

Quiz 102: what is the advantage of go-back-n flow control over selective repeat?



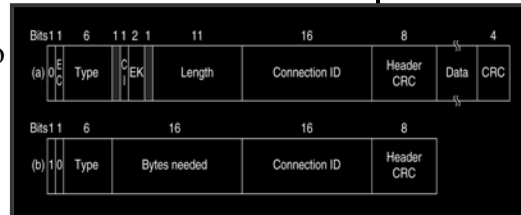
LECT-5, S-82
NET98F, javed@kent.edu
Javed I. Khan@1998

802.16 Frame



COMPUTER
COMMUNICATION
NETWORK

- All MAC frame start with a generic header.
- CRC is optional (unlike most others, since there is no retransmission and there is physical layer correction, so why bother CRC?)!



A Generic Frame

EC: Encrypted or not.
Type: fragmentation present?
CI: If checksum is present?
EK: If encrypted then what type of key.
Len: data+header
CID: identifies each connection.

A Bandwidth Request Frame

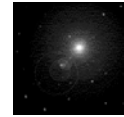
Starts with 1
Bytes needed: a 16 bit specification of bandwidth requirements.

Quiz 104: Who can talk between SIFS-and PIFS interval in 802.11?

Javed I. Khan@1998

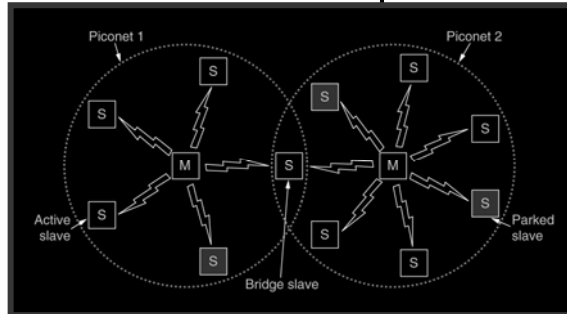
Blue Tooth (PAN)

Blue Tooth



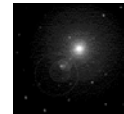
COMPUTER
COMMUNICATION
NETWORK

- Designed to form close Personal Area Network (PAN) for devices in very close proximity (10m).
- A group of up to 8 devices forms a Piconet. Only one device becomes master and seven becomes slave.
- Master controls all communication and all communication between devices is via the master.
- The slaves are dumb. Just follows masters order. Slaves has active, hold and sniff states to conserve power.
- Master used simple TDM to co-ordinate.



LECT-5, S-85
NET98F, javed@kent.edu
Javed I. Khan@1998

Blue Tooth Profiles



COMPUTER
COMMUNICATION
NETWORK

Name	Description
Generic access	Procedures for link management
Service discovery	Protocol for discovering offered services
Serial port	Replacement for a serial port cable
Generic object exchange	Defines client-server relationship for object movement
LAN access	Protocol between a mobile computer and a fixed LAN
Dial-up networking	Allows a notebook computer to call via a mobile phone
Fax	Allows a mobile fax machine to talk to a mobile phone
Cordless telephony	Connects a handset and its local base station
Intercom	Digital walkie-talkie
Headset	Allows hands-free voice communication
Object push	Provides a way to exchange simple objects
File transfer	Provides a more general file transfer facility
Synchronization	Permits a PDA to synchronize with another computer

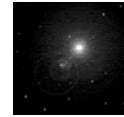
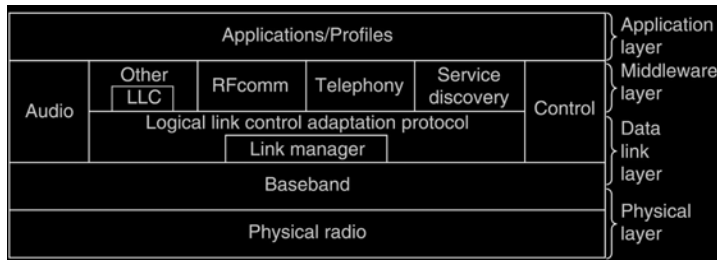
- A particular device may support just few of these profiles.

Quiz 105: Why
there is a
minimum frame
length
requirement in
Ethernet?

16
du
Javed I. Khan@1998

Layers of Blue Tooth

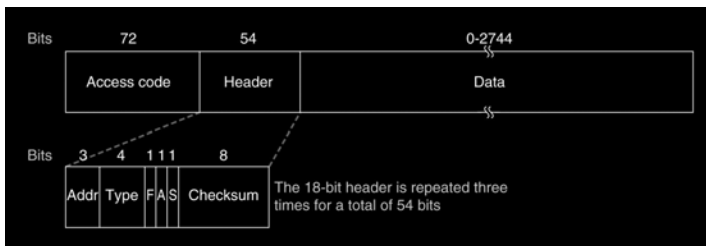
- Except for the physical layer rest does not correspond to OSI or TCP/IP.



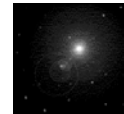
COMPUTER
COMMUNICATION
NETWORK

LECT-5, S-87
NET98F, javed@kent.edu
Javed I. Khan@1998

Frame



- Access code: identifies the master device (or the piconet).
- Data: can be 0-2744 bits. Takes up to 5 time slots.
- Address: which if the 8 devices is it.
- Type: Frame type (ACL, SCO, Poll, or null)
- Flow (F): slaves tells that its buffer is full.
- A: is used to piggyback an acknowledgment onto a frame.
- S: is used as a 1 bit sequence number (uses stop-and-go).
- Checksum:
- This 18 bit header is repeated 3 times in that 54 bit header. In case of error the majority wins! This is done to achieve error tolerance at low power cost-very little computation is needed.



COMPUTER
COMMUNICATION
NETWORK

LECT-5, S-88
NET98F, javed@kent.edu
Javed I. Khan@1998