IEEE 802.11

The specification defined by IEEE for wireless LAN is IEEE 802.11 - covering both the physical layer and data link layer.

Architecture:

Two kinds of services provided are:

* Basic Service Set (BSS)
* Extended Service set (ESS)

Basic Service Set:

- Building block of a wireless LAN - made up of stationary or mobile wireless station with an optional central base station (called as an access point)-AP)
- BSS without a central base station - is called as a stand-alone n/w - such n/ws cannot send data to other BSS - and architecture is called as ad hoc architecture.
- In ad-hoc n/ws - the stations form a n/w without the need for access point - they just locate one another and become a part of the BSS.
- BSS with a central base station - is called as an infrastructure network.

(Refer Fig 14.1 - Page No 422)

Extended Service Set:

- An ESS is made of / composed of two or more APs - which are connected through a distributed system.
- Stations used can be either mobile or stationary - communication b/w two stations in two different BSSs occurs through the access points.

- if the stations are within the reach of one another then the stations can communicate without the need for AP. (Refer Fig 14.2 - Page No 422)

Station Types:-

* no-transition
* BSS-transition
* ESS-transition mobility

A station with no-transition mobility - consists of stationary stations or stations moving within the BSS.

A station with BSS-transition mobility - consists of stations which can move from one BSS to another BSS.

A station with ESS-transition mobility - consists of stations which can move b/w the different ESS.

MAC Sub layer:-

Two sub layers supported by IEEE 802.11 are:

* Distributed coordination function (DCF)
* Point coordination function (PCF)

Distributed coordination Function:

- The access method used here is CSMA/CA instead of CSMA/CD for the following reasons:

* For collision detection - the data sent and collision signal must be received at the same time.
* This requires costly station and increased bandwidth
* Because of large distance b/w the stations - signal fading prevents the stations from hearing the probable collision that may have occurred.

Process Flowchart:-

- When a frame is to be sent from source to destination the channel is sensed first using the persistent strategy to make sure that the channel is idle.
- Once the channel is found idle - the station waits for a short period of time called as DIFS - distributed interframe space - after this the station sends a control frame called as Request To Send (RTS)
- On receiving the RTS and waiting for a period of time called as SIFS - Short Interframe space (SIFS) destination node returns with a control frame called as Clear To Send (CTS)
- The source sends the data - for waiting for SIFS time. and on receiving the data the receiver waits for a time duration equal to SIFS and forwards an ACK to the source station.

Network Allocation Vector: (Fig 14.5, Pg 424)

This vector is used as the means of avoiding collision occurrence by including the duration of time for which the station will be busy - either as a sender or as a receiver - with the RTS control frame.

Collision during handshaking:

Handshaking period is the period during which RTS and CTS control frames are in transition.

If two or more stations try to send RTS at the same time - it results in collision. The sender node is not specifically notified about the collision - it just waits for a certain duration - and if it does not receive a CTS frame - it assumes that collision has occurred.

Point Coordination Function (PCF):

- It is an optional access method - which can be implemented on top of DCF and is applicable for time-sensitive transmission.
- It uses centralized, contention-free polling method - by using interframe spaces like PIFS (PCF IFS) and SIFS.

Fragmentation:-

Wireless environment is more noisy in nature - so in case of frame loss it has to be retransmitted.

Frame format: is made up of nine fields

* Frame control - 2 bytes long and defines the type of frame along with the control information.
* D - this field defines the duration of transmission that is used to set the value of NAV - 2 bytes in length
* Addresses - four address fields each of 6 bytes length
* Sequence Control - defines the sequence no of the frame to be used during flow control.
* Frame body - contains information based on the type and subtype defined in FC field. - 0 to 2312 bytes long
* FCS - 4 bytes in length - and contains CRC-32 for error detection.

Frame Type:-

* Management frames
* Control frames
* Data frames

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Management frame - used for initial communication b/w stations and access points.

control frame - used for accessing the channel and acknowledging the frames.

Data frame - used for carrying data and control information

Hidden and Exposed Station Problems

* Hidden station problem -

Consider three stations - station A, station B and station C. Each station has its own transmission range within which other stations can hear the signals transmitted

- So here, lets assume that station C is outside the transmission range of station B, similarly station B is outside the transmission range of station C.
- However station A is present in the area covered by both station B and station C.
- Assume that station B is transmitting data to station A & in b/w if station C wants to communicate with station A - station C thinks that the medium is free as it is unaware of communication going on b/w station A and station B.
- So station C starts sending data to station A resulting in collision - this problem is called as the hidden station problem - station B and C are hidden from each other
- This problem reduces the capacity of the n/w due to its high probability of collision.
- Solution:- use of handshake frames (RTS and CTS) before data transmission.

(Dia on Page 430 - Fig 14.10 & Fig 14.11)

* Exposed station problem -

Consider four stations - A, B, C and D

- Station A is transmitting data to station B, smilly station C

is transmitting data to station D.

- But station C is exposed to transmission from station A as it is within the transmitting range of station C.
- Because of this station C may refrain from sending any data frame. — exposed station problem.
- The handshake messages used are also of no use - as one station remains exposed - until another station is still sending the data

(Refer Fig 14.12 & 14.13 - Page No 431)

Physical Layer:-

Six different variations are:

* IEEE 802.11 FHSS
  uses frequency-hopping spread spectrum method (FHSS)
* IEEE 802.11 DSSS
  uses direct sequence spread spectrum method (DSSS)
* IEEE 802.11 Infrared
  uses infrared light in range of 800 to 950 nm - uses pulse position modulation technique
* IEEE 802.11a OFDM
  uses orthogonal frequency-division multiplexing (OFDM) method
* IEEE 802.11b OFDM
  uses high-rate direct sequence spread spectrum (HR-DSSS) method.
* IEEE 802.11g
  uses OFDM method with forward error correction technique.

Bluetooth

- wireless LAN technology used to connect devices - ad hoc network - spontaneous formation of network.
- originally introduced by Ericsson company - implementation is defined by 802.15 (IEEE) standard.

Architecture:

Bluetooth is composed of two types of networks:

* Piconet (Ref pg 435, Fig 14.19)
* Scatternet (Ref pg 436, Fig 14.20)

Piconet:-

- limited upto 8 stations with one primary station & 7 other secondary stations.
- Secondaries synchronize the clock and hopping sequence with primary & then communicate with each other.
- communication b/w primary and secondary can be one-to-one or one-to-many.
- Parked state - additional station which is waiting to be a part of the piconet - just because there are already 7 secondaries.

Scatternet:-

- combination of piconets.
- secondary station in one piconet - can be primary in another piconet.
- A station can be a member of two piconets.

Bluetooth Layers: (Pg. 436, Fig 14.21)

- Radio Layer
- Baseband layer
- L2CAP Layer
- Applications

Radio Layer :-

- equal to physical layer of the internet model.
- low power - with an range of 10m.

Band -
uses 2.4GHz ISM - divided into 79 channels

FHSS -
- uses frequency - hopping spread spectrum (FHSS) - to avoid interference from other devices or other networks

Modulation -
- uses Gaussian frequency shift keying (GFSK) - to transform bits to signals.

Baseband Layer:

- equal to MAC sublayer.
- TDMA access method - primary and secondary communicate with each other using time slots.
- length of each time slot is - 625 μs.

TDMA

- uses TDD-TDMA (time division duplex-TDMA) - half duplex communication

Single-secondary communication -
If the piconet has only one secondary, TDMA operation is as follows:
- Time is divided into slots of 625 μs.
- primary uses even-numbered slots
- secondary uses odd-numbered slots
- in slot 0 primary sends & secondary receives.
- in slot 1 secondary sends & primary receives.

Multiple-secondary communication:

- primary uses even-numbered slots and secondary uses odd-numbered slots.
- all secondaries listen to even-numbered slots, but only one secondary sends in any odd-numbered slots.
- follows poll/select method along with reservations ie when a primary selects a secondary - it polls - so the next time slot is reserved for polled station to send its frame.
- If the polled secondary has no frame to send — channel is silent.

Physical link: Two types:

SCO - synchronous connection oriented links - used to avoid latency than compared to error-free delivery.
→ physical link is created b/w the primary and secondo -ry by reserving specific slots at regular intervals
→ used in real time audio transmissions.

ACL - asynchronous connectionless link
→ used when data integrity is more important than latency.

Frame Format:

A frame in baseband layer can be 3 three types:

* one slot
* three slot
* five slot.

(frame format - refer Page 440 - Fig 14.24 with explanation)

L2CAP (Logical link control and adaptation Protocol) 5-b

- equivalent to LLC sublayer.
- used for data exchange on an ACL link only
- its ~~same~~ functionalities are multiplexing, segmentation and reassembly, quality of Service and group management. (data packet format - on Pg 441 Fig 14.25)

* Multiplexing

Sender site - accepts data from one of the upper-layer protocols, frames them and delivers them to baseband layer
Receiver site - accepts a frame from baseband layer - extract the data & delivers them to appropriate protocol layer.

* Segmentation and Reassembly:

- L2CAP divides the large packets into segments and adds extra information to define the location of segments in original packet.
- segments packets at the source and reassembles at the destination.

* QoS

provides best-effort service

* Group management

- provides facilities for logical addressing - which is similar to multicasting.

Connecting Devices:

1. Passive Hubs - operates below the physical layer.
2. Repeater or active Hubs - operates at the physical layer.
3. Bridge or two-layer switch - operates at both physical and data link layer.
4. Router or three-layer switch - operates at physical, data link and n/w layer.
5. Gateway - operates in all 5 layers.

(Fig 15.1 - Page 445)

Passive Hubs :-

- used as a connector - connects wires coming from different branches
- its a part of the media which is present below the physical layer.

Repeaters :-

- operates in the physical layer
- it is used to regenerate the original signal - it is used to extend the physical length of the LAN
- Repeater is not same as an amplifier
- Amplifier - cannot discriminate b/w the intended signal & noise
- But a repeater regenerates the signal - ie it creates a copy - bit for bit - at original strength
- A repeater must be placed such that the signal is clear without any noise interference.

(or before)

Active Hubs

- multipoint repeater
- used to create connections b/w stations in a physical

star topology.

Bridges :-

- Operates in both physical and data link layer.
- physical layer - it regenerate the signal received.
- Data link layer - checks the source and destination address contained in the frame.
- A bridge maintains a table - which has filtering capacity: ie checks the destination address and decides if the frame is to be forwarded or discarded if corrupted.

Transparent bridges :-

A bridge in which the stations are completely unaware of the existence of a bridge are called as transparent bridges.

The activities performed by transparent bridges are:

* Forwarding
* Learning
* Loop problem

- A transparent bridge must correctly forward the frames - by the use of dynamically maintained table which maps addresses to ports automatically.
- Destination address is used for forwarding decision & source address is used to add entries to the table and for further updations.

Loop problem :-

In case of redundant bridges in the network - it results in creation of loops in the system - which is an undesirable condition.

Spanning Trees are used to overcome this problem - ie a spanning tree is a graph with no loop.

- physical topology of the s/m cannot be changed - so a logical topology is used to overlay and overcome the looping problem.

Source Routing Bridges :-

Source routing bridges are used to overcome the loops in the system caused by redundant bridges - a source routing bridge performs the duties of filtering frames forwarding and blocking activities.

- In such s/w source station defines the bridges that must be visited by the frame on its way to reach the destination.

Two-layer switches :-

- performs at physical and data link layers.
- switch makes the filtering decision based on the MAC address of the frame received.
- it can act as a buffer for processing the frames.

Routers :-

- three-layer device.
- routes packets based on their logical addresses
- connects LAN and WAN.
- maintains routing table for decide choosing the feasible paths.

Gateway :-

- a computer which operates in all the five layers of Internet or seven layers of OSI model.
- it accepts an application message, reads it and interprets it.
- it is used as the connecting device b/w two internetworks which use different models.

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Cellular Telephony :-

- used to communicate b/w two mobile (moving) devices or b/w one mobile unit and one stationary unit (the stationary unit is called as the land unit)
- A service provider is used to locate and track a caller, assign a channel to the call and transfer the channel from one base station to another base station. 4 to make sure ~~caller~~ caller does not move out of range.
- The cellular n/w is divided into cellular service areas called as cells — each cell is composed of an antenna, solar or AC powered n/w station called as the Base station
- Each Base station is controlled by a switching office called as Mobile service center (MSC) - MSC coordinate communication b/w all the base stations and telephone central office.

Frequency - reuse principal :

- Same set of frequency cannot be used for comm^n as it results in interference for the users located near the cell boundaries.
- also the set of available frequencies is limited & it has to be reused.
- the frequencies can be reused based on a reuse pattern for a configuration of N cells called as the reuse factor - where each cell uses a unique set of frequencies - and when the pattern is repeated - frequencies can be reused.

Transmitting and receiving:

- A caller has to enter either a 7 or 10 digit number & press the send button - after this mobile station scans the frequency band - seeking a set up channel with a strong signal & sends the data to the closest base station.
- Base station forwards this to the nearest MSC - this forwards the data to the telephone central office.
- If the called party is available - a connection is set up and this is relayed back to MSC - assigning an unused channel and a connection is established.
- when a mobile phone is called - telephone central office sends the number to the MSC - MSC searches for the location of the mobile - this is done by sending a query signal to each cell ~~in the~~ (this process is called as paging).
- MSC transmits a ringing signal once the station is found

Handoff

As the mobile station moves from one cell to another cell - the communicating signal strength may become weak.

- MSC is responsible for managing the levels of signals ie if the signal becomes weak - MSC seeks a new cell which can better accomodate communication.
- Two types of handoff's

* Hard handoff
* Soft Handoff

Hard handoff - communication of a mobile station is restricted to only one base station.

Soft handoff - mobile station can communicate with two base stations at the same time.

Roaming :-

Roaming is the ability of a user to have access to communication or to be reached where there is a coverage.

- If the service provider has restricted coverage - then neighboring service providers can provide extended coverage based on the roaming contract.

Generations of Cellular Telephony :-

* First Generation
  - introduced in North America as AMPS - Advanced Mobile Phone System
  - Analog cellular s/m
  - FDMA to separate channels in a link.
  - Bands used is ISM (Industrial Scientific Medical) 800-MHz band.
  - Two separate analog channels - one to for foorward communication and another for reverse communication.
  - Forward communication range is 869 - 894 MHz (base station to mobile station)
  - Reverse communication range is 824 - 849 MHz (mobile station to base station)
  - Transmission - uses FM and FSK for modulation.

Second Generation :

- higher quality mobile voice communication.
- use of digitized voice instead of analog.

Three categories are:

* D-AMPS (digital - AMPS)
  - backward compatible to AMPS
  - same bands and channels as of AMPS

Transmission:
  - uses PCM and compression technique

* GSM - Global System for Mobile Communication
  - European standard.

Bands

- uses duplex communication - where each band is 25MHz in width - to 900MHz.
- each band is divided into 24 channels of 200kHz ea

Transmission:
- uses TDMA
- uses a reuse factor of 3.

* IS-95 (Interim Standard 95)
  - introduced in North America.
  - based on CDMA and DSSS

Bands and channels
- uses two bands for duplex communication.
- ISM 800-MHz band or ISM 1900-MHz band.

Synchronization -
all base channels need to be synchronized to use CDMA technique - use of GPS (Global

positioning System)
- use of soft hand off
- offers short message service (SMS) and limited internet access.

Third Generation:
- both digital data and voice communication
- introduced in 1992 and called as International Mobile Communication (IMT-2000)
- supports data rate of 144 kbps for accessing in a mobile device, 384 kbps for pedestrians, 2 Mbps for stationary users.
- supports packet-switched and circuit-switched data services.
- Bandwidth of 2 MHz and band of 2 GHz
- Interface of Internet

Variants are:

* IMT-DS → uses wideband CDMA (W-CDMA) & 5 MHz bandwidth - introduced in Europe
* IMT-MC → uses CDMA 2000 - introduced in North America. 2 Mbps data rate.
* IMT-TC → uses W-CDMA and TDMA
* IMT-SC → used TDMA
* IMT-FT → uses a combination of FDMA and TDMA