**Lab 3**

**WLan**

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**Problem 1:**

1) The WLAN technology started in the mid 1990s and after 10 years it became the main technology to connect computers, smartphones and tablets to the internet. It is based on LAN [802.3] standard made by IEEE for wired interconnected computers. It’s standard is [802.11].

2)WLAN application are:

* + Transporting IP packets over layer 3 of ISO protocols
  + LAN extension: saves installation of LAN cable and eases modification and reallocation of network structures.
  + Open hotspots on campuses, hotels, restaurants.

3)WLAN consists of MAC (medium access control) a sublayer of DLL (data link layer) and PHY (physical layer)

4)WLAN has two modes:

1.Ad-Hoc mode:

* + Two or more wireless devices communicate with each other directly.
  + All devices are equal and packets Exhange directly between two devices.
  + All devices share the same medium the packets are received by all stations however all station discard the package except the intended

2.infrastructure mode:

* + Suitable access to local network and internet
  + Access points (AP) used between all wireless and wire line network for all devices of basic service set (BSS).
  + If device A wants to send data packet to device B packet is first sent to AP and it resends packet to the destination address of device B.

5) The advantage of infrastructure mode is two wireless devices can connect with each other over larger distance using AP.

The disadvantage is packets that is transmitted between two wireless devices has to be transmitted twice in air.

6) To configure ad-hoc:

* + Network must have same name.
  + All users select same frequency channel.
  + All users use same ciphering key.
  + Individual IP address must be configured in every device.

7) 802.11b: uses 204GHz band. Channel bandwidth is 22MHz [20MHz + 2MHz guard band]. Available number of channels 11 in USA and 13 in Europe. Up to 3 APs can be used at close range without interfering with each other working on frequency channel. Direct sequence spread spectrum is used to limit interference from Bluetooth signals. Power up to 0.1W. modulation DBPSK/DQPSK. Max data rate 11 Mbps

802.11g: same frequency band, channel bandwidth and number of channels. Use modulation techniques BPSK/QPSK/16QAM/6AQAM. Used orthogonal frequency division multiplexing to solve multipath fading problem. Down compatible 802.11b. Max data rate 54Mbps. Can cover indoor up to 38m and outdoor up to 140m.

802.11a: used 5GHz band. Incompatible 802.11b 802.11g so it never became popular. Max data rate 54Mbps

802.11n: uses both 2.4 GHz and 5GHz. To increase throughput it can use channel bandwidth of 20/40MHz. Uses multiple input multiple output. Can cover indoor up to 20m and outdoor up to 250m.

802.11ac: 160MHz channel bandwidth. 600Mbps data rate on 2.4GHz and 1900Mbps on 5GHz. Theoretical data rate upto 6.93GHz

802.11ad: 6 different channels. It also has 1760MHz bandwidth. Theoretically they provide data rates up to 6.76Gbps frequency band 60GHz

8)802.11e introduced new power save delivery and notification mechanism. APSD (automatic power save delivery) provides two ways to start delivery: ‘scheduled APSD’ (S-APSD) and ‘unscheduled APSD’ (U-APSD). With APSD, multiple frames may be transmitted together by the access point to a power-saving device during a service period. After the end of a service period, the device enters a doze state until next service period.

802.11f provides wireless access point communications among multivendor systems.

802.11h solves problems like interference with satellites and radar using the same 5 GHz frequency band. It was originally designed to address European regulations but is now applicable in many other countries.

802.11i implemented as Wi-Fi Protected Access II (WPA2). The draft standard was ratified on 24 June 2004. This standard specifies security mechanisms for wireless networks, replacing the short Authentication and privacy clause of the original standard with a detailed Security clause. In the process, the amendment deprecated broken Wired Equivalent Privacy (WEP)

802.11w is made to increase the security of its management frames. It uses the existing security mechanisms rather than creating new security scheme or new management frame format.

9) APs have to send on different frequency and the coverage area of different APs have to overlap to avoid client losing coverage.

10) Carrier dense multiple access with collision avoidance. Before node transmission data it checks or listen to the medium. When medium is free node sends a signal when medium is empty waits for random time and try again. To avoid hidden terminal problem we use rts/cts signals. If terminal sense idle medium It sends RTS signal. If AP sees that no other terminal is transmitting it send CTS signal to terminal. If AP was busy the terminal waits random time, then send another RTS signal to the AP and so on.

11) Beacon frame is one of the management frames in IEEE 802.11 based WLANs. It contains all the information about the network. Beacon frames are transmitted periodically, they serve to announce the presence of a wireless LAN and to synchronize the members of the service set. Beacon frames are transmitted by the access point (AP) in an infrastructure basic service set (BSS).

12) DSSS combines a data signal at the sending station with a higher data rate bit sequence, which many refer to as a chipping code. Direct sequence spread spectrum sends a specific string of bits for each data bit sent. A chipping code is assigned to represent logic 1 and 0 data bits. As the data stream is transmitted, the corresponding code is actually sent. For example, the transmission of a data bit equal to 1 would result in the sequence 00010011100 being sent.

13) orthogonal frequency-division multiplexing (OFDM) is a type of digital transmission and a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication, used in applications such as digital television and audio broadcasting, DSL internet access, wireless networks, power line networks, and 4G/5G mobile communications. It is used to combat multipath fading by breaking signals into multiple low rate streams each stream suffer from almost flat narrow bandwidth channel. Each is modulated over orthogonal frequency then simply equalize.

14) MIMO (multiple input multiple output) use of multiple antennas in both Tx, Rx. Spatial multiplexing splits data across antennas each antenna sends different data which increase data rate. Diversity multiplexing send multiple copies of same data each antenna sends same data to insure correct reception lower BER

**Problem 2:**

1) The MRF24WB0MA RF transceiver module contains integrated PCB antenna with range up to **400m**.

2) char strSSID[13] = "Ahmed50";

3) char channels[11] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11};

4) Run this command:

netsh wlan set profileparameter “ssid” ConnectionType=ibss

**Problem 3:**

clc; clear all; close all;

%% Initialization

Frames = 1000; %Number of Frames

fft\_size = 128; %FFT Size (Number of subcarriers)

M = 16; %16-QAM Modulation

delta = 312.5\*10^(3); %Carrier Separation

delay\_spread = 0.2\*10^(-6); %Delay Spread

SNRdb = 0:3:30; %SNR Range in dB

delay\_spread\_max = delay\_spread\*fft\_size\*delta; %Max delay spread

msg\_size\_bits = log2(M)\*fft\_size; %number of bits

BER = zeros(length(SNRdb),Frames); %initialization for BER

BER\_avg = zeros(length(SNRdb),1); %initialization for BER average values

%%

for i = 1:length(SNRdb)

for k = 1:Frames

%% Message Generation

msg\_bits=randi([0,1],msg\_size\_bits/4,4);

msg = bi2de(msg\_bits,'left-msb')';

%% Modulation and Normalization

X = qammod(msg,M);

%% OFDM Modulation

x = (1/sqrt(128)) \* (ifft(X));

%% Cyclic Prefix

CP = x(1:32);

msg\_CP = [x CP];

%% Channel (fading + noise)

[fadedSamples, gain] =ApplyFading(msg\_CP,1,delay\_spread\_max);

y=awgn(fadedSamples,SNRdb(i),'measured');

%% Cyclix prefix exclusion

y = y(1:128);

%% OFDM Demodulation

y\_demod = fft(y\*(sqrt(128)));

%% Equalization

z = y\_demod ./ (fft(gain,128));

%% Demodulation and Denormalization

msg\_demodulated\_symbols = qamdemod(z,M);

msg\_demodullated\_bits = de2bi(msg\_demodulated\_symbols,'left-msb');

%% BER calculation

[~,BER(i,k)] = biterr(msg\_demodulated\_symbols,msg);

BER\_avg(i) = sum(BER(i,:))./Frames;

end

end

%% Plotting BER vs. SNR

semilogy(SNRdb',BER\_avg)

xlabel('SNR(dB)')

ylabel('BER')

title('OFDM BER vs. SNR for 16-QAM')

Output :