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CLASS BE DEPT. EE EC Engineering

SUBJECT Mobile computing

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Amrutvahini College of Engineering, Sangamner
Department of Electronics and Telecommunication Engineering
Experiment No.: 01

Date of Performance: 9/2/23

TITLE: To implement a basic function of Code Division Multiple Access (CDMA) to test the orthogonally and autocorrelation of a code to be used for CDMA operation. Write an application based on the above concept

AIM: Basic function of Code Division Multiple Access (CDMA).

OBJECTIVES: To understand function of CDMA used to test orthogonally and autocorrelation of a code.

SOFTWARE & HARDWARE REQUIREMENTS:

OS.: Unix or windows 7/8/10,

Processor: i3/i5/i7

Software: Python (Jupyter Notebook) or java

THEORY-CONCEPT

CDMA stands for Code Division Multiple Access. It is a digital cellular standard that utilizes spread Spectrum Technology. It spreads the signal over a fully available spectrum or over multiple channels through division. It is a channelization protocol for Multiple Access, where information can be sent simultaneously through several transmitters over a single communication channel.

It is achieved in below steps: A signal is generated which extends over a wide bandwidth. The code which performs this action is called spreading code. Later, a specific signal can be selected with a given code even in the presence of many other signals. It is mainly used in mobile networks like 2G and 3G. It is a more secure and private line. It has good voice and data communication capabilities.

Procedure or Working

1. The station encodes its data bit as follows.

If bit = 1 then +1

If bit = 0 then -1

no signal (interpreted as 0) if station is idle

- Each station is allocated a different orthogonal sequence (code) which is N bit long for N stations
- Each station does a scalar multiplication of its encoded data bit and code sequence.
- The resulting sequence is then stored on the channel.
- Since the channel is common, amplitudes add up and hence resultant channel sequence is the sum of sequences from all channels.
- If station 1 wants to listen to station 2, it multiplies (inner product) the channel sequence with code of station S2.
- The inner product is then divided by N to get data bit transmitted from station 2.

How does CDMA work?

To see how CDMA works, we must understand orthogonal sequences (also known as chips).

Let N be the number of stations establishing multiple access over a common channel.

Then the properties of orthogonal sequences can be stated as follows:

An orthogonal sequence can be thought of as a 1xN matrix.

Eg: $[+1 -1 +1 -1]$ for $N = 4$.

Scalar multiplication and matrix addition rules follow as usual.

Eg: $3 \times [+1 -1 +1 -1] = [+3 -3 +3 -3]$

Eg: $[+1 -1 +1 -1] + [-1 -1 -1 -1] = [0 -2 0 -2]$

Inner Product: It is evaluated by multiplying two sequences element by element and then adding all elements of the resulting list.

Inner Product of a sequence with itself is equal to N
 $[+1 -1 +1 -1] \times [+1 -1 +1 -1] = 1 \times 1 + 1 \times 1 + 1 \times 1 + 1 \times 1 = 4$

Inner Product of two distinct sequences is zero
 $[+1 -1 +1 -1] \times [+1 +1 +1 +1] = 1 \times 1 + 1 \times -1 + 1 \times 1 + 1 \times -1 = 0$

Code:

```
import numpy as np

c1=[1,1,1,1]
c2=[1,-1,1,-1]
c3=[1,1,-1,-1]
c4=[1,-1,-1,1]

rc=[]

print("Enter the data bits:")
d1=int(input("Enter D1= "))
d2=int(input("Enter D2= "))
d3=int(input("Enter D3= "))
d4=int(input("Enter D4= "))

r1=np.multiply(c1,d1)
r2=np.multiply(c2,d2)
r3=np.multiply(c3,d3)
r4=np.multiply(c4,d4)

resultant_channel=r1+r2+r3+r4

print("Resultant channel:",resultant_channel)

channel=int(input("enter the station to listen for c1=1,c2=2,c3=3,c4=4:"))

if channel==1:
    rc=c1
elif channel==2:
    rc=c2
elif channel==3:
    rc=c3
elif channel==4:
```

```

rc=c4
inner_product=np.multiply(resultant_channel,rc)
print("Inner product",inner_product)
res1=sum(inner_product)
data=res1/len(inner_product)
print("Data bit that was sent",data)

```

CONCLUSION:

In this Exp. we successfully implements a basic function of CDMA to test this orthogonally and autocorrelation of a code to be used for CDMA operation.

QUESTIONS:

1. What is CDMA?
2. Write down difference between FDMA TDMA and CDMA

Exp. No. 1

Q1 What is CDMA?

→ CDMA stands for Code division multiple access

- In CDMA more than one user is allowed to share a channel or subchannel with the help of Direct Sequence spread spectrum (DS-SS) signals.

- In CDMA each user is given a unique Code Sequence or Signature sequence.

- At the receiver the signal is received by using the same code sequence.

- CDMA signals are spread in frequency therefore the demodulation and separation of these signals at the receiver can be achieved by using the pseudorandom Code Sequence.

- CDMA is sometimes also called as spread spectrum multiple Access (SSMA)

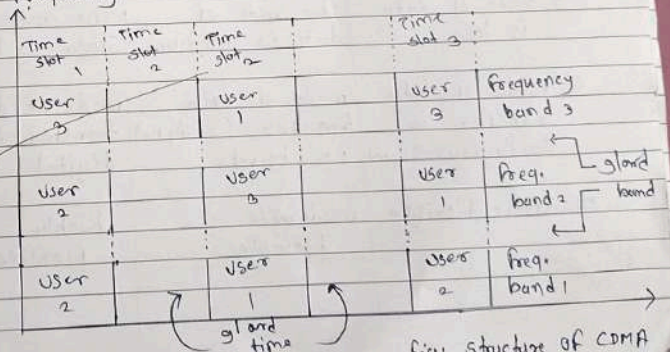


Fig:- Structure of CDMA



Amrutvahini College of Engineering, Sangamner
Department of Electronics and Telecommunication Engineering
Experiment No.: 02

Roll No

Date of Performance: 16/2/2023

Title: Study of GSM architecture and signaling techniques

AIM: Study of GSM architecture and signaling techniques

THEORY-CONCEPT

INTRODUCTION:

The development of Global System for Mobile Communication (GSM) started in 1982 when the Conference of European Posts and Telegraphs (CEPT) formed a study group called Group Special Mobile (the initial meaning of GSM) whose aim was to study and develop a pan-European public cellular system in the 900 MHz range [6]. Some of the basic criteria for their proposed system were

- Good subjective speech quality
- Low terminal and service cost
- Support for international roaming
- Ability to support handheld terminals
- Support for range of new services and facilities
- Spectral efficiency
- ISDN compatibility

Commercial operation of GSM networks started in mid-1991 in European countries. By the beginning of 1995, there were 60 countries with operational or planned GSM networks in

Europe, the Middle East, the Far East, Australia, Africa, and South America, with a total of over 5.4 million subscribers.

GSM uses a mixture of both Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) [2]. FDMA parts include the division by frequency of the 25 MHz bandwidth into 124 carrier frequencies spaced 200 KHz for GSM900. TDMA further divides each carrier frequencies into 8-time slots such that each carrier frequency is shared by 8 users. In GSM, the basic radio resource is a time slot with duration of 577 μ s. 8 Time slots of 577 μ s constitute a 4.615 ms TDMA Frame. GSM uses Gaussian Minimum Shift Keying (GMSK) modulation scheme to transmit information over Air Interface. GSM uses number of channels to carry data over air interface; these channels are broadly divided into following two categories:

- i. Physical Channels
- ii. Logical Channels

This paper is divided into five parts. Starting with an introduction (Section-I), next section covers the need of GSM (Section-II). Moving ahead, GSM architecture is discussed (Section-III). Next section is about the interfaces in between the GSM subsystems (Section-IV). After that GSM channels are discussed (Section-V). This section is about the call origination using GSM channels (Section-VI). Finally, conclusions summarize the last section (Section-VII).

NEED OF GSM:

Features of GSM that account for its popularity and wide acceptance are listed below.

- i. Improved spectrum efficiency
- ii. International roaming
- iii. Low-cost mobile sets and base stations (BSs)

High-quality speech

- iv. Compatibility with Integrated Services Digital Network (ISDN) and other telephone company services
- v. Support for new services.

Architecture:

GSM architecture is classified into three subsystems i.e., BSS, NSS, and OSS.

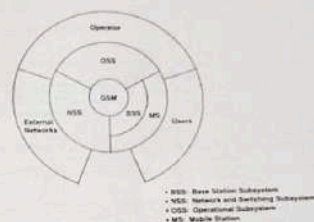


Fig : Basic Architecture

Fig : Basic Architecture

The BSS provides and manages communication paths between the MSs and the NSS. It includes management of the radio interface between MSs and the whole GSM system. The NSS has the province of managing communications and linking MSs to the relevant networks or other MS's. Neither NSS is in direct contact with the MSs, nor is the BSS in direct contact with external networks. In the GSM, interaction between the subsystems can be grouped into two main parts:

- i. **Operational:** External networks to or from NSS to or from BSS to or from MS to or from subscriber
- ii. **Control:** OSS to or from service provider

1. GSM Subsystem Entities

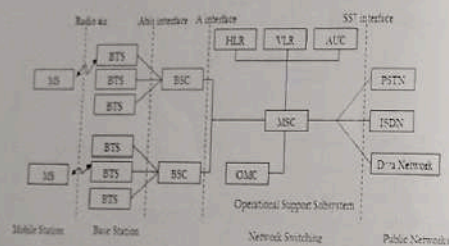


Fig: GSM Architecture

a) Mobile Station (MS):

A Mobile Station is used by a mobile subscriber to communicate with the cellular system. GSM MSs consist of:

- A mobile terminal
- A Subscriber Identity Module (SIM)

b) Base Station Subsystem (BSS):

BSS is the section which is responsible for handling and signaling traffic between a MS and the NSS. It consists of these two devices:

i. Base Transceiver System (BTS): - The BTS is the radio equipment. It handles the radio interface to the mobile station. A group of BTSs is controlled by a BSC.

ii. Base Station Controller (BSC): - The BSC is a high-capacity switch which provides all the control functions and physical links between the MSC and BTS such as handover, cell configuration data, and control of radio frequency (RF) power levels in base transceiver stations. Several BSCs are served by an MSC.

c) Network Switching Subsystem (NSS):

The NSS main role is to manage the communications between GSM and other network users. Another task of it includes the main switching functions of GSM, databases required for the subscribers, and mobility management.

i. Mobile Station Controller (MSC): The MSC is the central unit of NSS. It performs the telephony switching functions of the system. It controls the traffic among all the BSCs.

ii. Home Location Register (HLR): The HLR is the functional unit used for management of mobile subscribers. The information stored in it are subscriber's identity, location, and authentication. It acts as a permanent store for a person's subscription information until that subscription is canceled.

iii. Visitor Location Register (VLR): The VLR is the functional unit which temporarily stores subscription information so that the MSC can service all the subscribers currently visiting that MSC service area. The VLR is regarded as distributed HLR because it holds a copy of the HLR information stored about the subscriber.

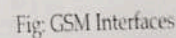
iv. Authentication Centre (AUC): The AUC is a database connected to the HLR which provides it with the authentication parameters and ciphering keys used to ensure network security.

d) Operation Support Subsystem (OSS):

The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. The implementation of OMC is called the operation support system (OSS). The OMC provides a single point for the maintenance personnel to maintain the entire system. One OMC can serve multiple MSCs.

The interfaces between various elements of the GSM network facilitates the information interchange. It also enables the case that network elements from different manufacturers can be used.

- vii. **E interface:** This interface is linking two MSCs. The E interface exchanges data related to handover between the two MSCs. It uses the MAP/E protocol, the letter "E" indicating that the protocol is used for the "E" interface.
- viii. **F interface:** This interface is linking the MSC and EIR. It uses the MAP/F protocol, the letter "F" indicating that the protocol is used for the "F" interface. The communications along this interface are used to confirm the status of the International Mobile Equipment Identity (IMEI) of the Mobile Equipment (ME) gaining access to the network [9].
- ix. **H interface:** This interface is linking the MSC and the AUC. It uses the MAP/H protocol, the letter "H" indicating that the protocol is used for the "H" interface. It transfers short messages. In a system, information flows forward, backward and sideways. This information flow is referred to as communication. Communication channels refer to the way this information flows within the system.



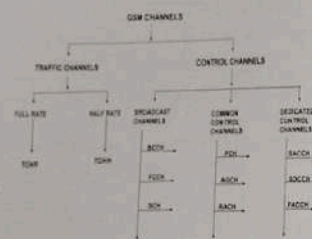


Fig : GSM Channels [1]

1. Traffic Channels (TCH): This channel carries digitally encoded user's speech or data and has identical functions and format on both the forward and reverse link.

a) Full Rate Traffic Channels (TCH/F): This channel carries information at a rate of 22.8 Kbps.

b) Half Rate Traffic Channels (TCH/H): This channel carries information at a rate of 11.4 Kbps.

2. Control Channels (CCH): This channel carries control information to enable the system to operate correctly. There are three main categories of control channels in GSM which are further divided into several categories:

i. Broadcast Channels (BCH): The broadcast channel operates on the forward link of a specific Absolute Radio Frequency Channel Number (ARFCN) within each cell, and transmits data only in the first time slot (TS0) of certain GSM frames.

a) Broadcast Control Channels (BCCH) – DOWNLINK

This channel broadcasts network and cell specific information required to identify the network and gain access.

b) Frequency Control Channels (FCCH) – DOWNLINK

This channel contains frequency correction bursts which are used by the mobiles for frequency correction. It bears information for frequency synchronization. It allows each subscriber unit to synchronize its internal frequency standard to the exact frequency of the base station.

c) Synchronization Channel (SCH) – DOWNLINK

This channel is used by the MS to learn the Base Station Information Code (BSIC) as well as the TDMA frame number (FN). There are 6 bits of BSIC which have two parts; 3 bits NCC and 3 bits BCC. NCC stands for Network Colour Code and used to identify the BTS for which measurement is made. BCC stands for Base Station Colour Code and used for a better transmission in case of interference. BSIC avoids ambiguity or interference.

ii. Common Control Channels (CCCH):

This channel is responsible for transferring control information between all mobiles and the BTS. It is necessary for call origination.

a) Paging Channel (PCH) – DOWNLINK

This channel is used for alerting to Mobile Subscribers for incoming calls, SMS, and other mobility services. Every MS in a cell periodically listens to this channel.

b) Random Access Channel (RACH) – UPLINK

This channel is used to send a request to the network for a dedicated resource to the MS. If the request is not granted within a specific time period by the network, the MS repeats the request on the RACH.

c) Access Grant Channel (AGCH) – DOWNLINK

This channel is used by a BTS to notify the MS of the assignment of a dedicated control channel.

iii. Dedicated Control Channels (DCCH):

Like traffic channels, they are bidirectional and have the same format and function on both the forward and reverse links.

a) Standalone Dedicated Control Channel (SDCCH) – UPLINK/DOWNLINK

In response of RACH, the network allocates SDCCH over AGCH for further communication between MS and BTS. This channel is used for the Location Update, Voice Call Setup and SMS.

b) Fast Associated Control Channel (FACCH) – UPLINK/DOWNLINK

This channel is used to convey Handover information. There is no time slot and frame allocation dedicated to this channel. This channel can be associated with SDCCH or TCH and works on the principle of stealing. The burst of TCH is replaced by FACCH signaling when required.

c) Slow Associated Control Channel (SACCH) – UPLINK/DOWNLINK

This channel is always associated with TCH or SDCCH used for control and supervision of signals associated with the traffic channels.

II. CALL FLOW USING CHANNELS

The call origination made by the Mobile Station (MS) is a multi-step process on the network side. First of all, broadcast channels are already being transmitted by the BTS continuously. When a number is dialed by the MS, Random Access Channels (RACH) is sent to the BSC for allocation of the channel. In response to that Access Grant Channel (AGCH) is sent by BSC as a confirmation. Standalone Dedicated Control Channel (SDCCH) can be used for both downlinks as well as uplink. Hence, it is used for multiple purposes in this flow. It is sent by the MS to MSC with its location update information.

Through SDCCH MSC request for the International Mobile Subscriber Identity (IMSI) number and then this information is sent back to MSC by MS by SDCCH [2]. Along with IMSI to MSC, SDCCH gives location update to ULA and information about equipment to Equipment Identity Register (EIR) which is a part of Authentication Centre (AUC). Using the same channel security and ciphering of call is done. After all, this process connection is established and ringing begins [6]. Also, the Traffic Channel (TCH) is allocated for the call. Hence, the conversation starts between the two MS's.

Conclusion:

In this expt. we studied about the GSM architecture, its need and signaling technique. Also learnt about GSM interface & call flow using channels.

QUESTIONS:

1. What is GSM and architecture?
2. What is GSM Signalling?
3. What is GSM technique?



Sangamner College of Engineering, Sangamner
Department of Electronics and Telecommunication Engineering
Experiment No.: 03

Date of Performance: 2/3/2023

Title: Study of GPRS services.

AIM: Study of GPRS services.

OBJECTIVES: To understand function of GPRS services.

INTRODUCTION:

GPRS is an expansion Global System for Mobile Communication. It is basically a packet-oriented mobile data standard on the 2G and 3G cellular communication network's global system for mobile communication. GPRS was built up by European Telecommunications Standards Institute (ETSI) because of the prior CDPD, and I-mode packet switched cell advances. GPRS overrides the wired associations, as this framework has streamlined access to the packet information's network like the web. The packet radio standard is utilized by GPRS to transport client information packets in a structured route between GSM versatile stations and external packet information networks. These packets can be straightforwardly directed to the packet changed systems from the GPRS portable stations

History Of GPRS

GPRS was one of the main advances that empowered a cell system to interface with Internet Protocol systems, accomplishing across the board reception in the mid-2000s. The capacity to peruse the web from a telephone whenever through "dependably on" data network, while underestimated in a great part of the world today, was yet an oddity when it was introduced. Indeed, even now, GPRS keeps on being utilized in parts of the world where it has been too expensive even to consider upgrading cell organize framework to move up to newer alternatives. According to a study on the history of GPRS development Bernhard Walke and his student, Peter Decker, are the inventors of GPRS – the first system providing universal mobile Internet access.

Goals Of GPRS:

1. Consistent IP services
2. Leverage industry investment in IP
3. Open Architecture
4. Service innovation independent of infrastructure

Services Offered:

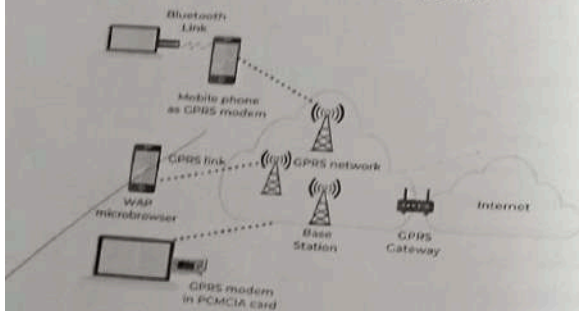
1. SMS messaging and broadcasting
2. Push-to-talk over cellular
3. Instant messaging and presence
4. Multimedia messaging service
5. Point-to-Point and Point-to-Multipoint services

Protocols supported:

1. Internet Protocol (IP)
2. Point-To-Point Protocol (PPP)

spiceworks

HOW DOES GPRS WORK?



Benefits Of GPRS:

• Mobility:

The capacity to keep up consistent voice and information interchanges while moving.

• Cost Efficient:

Communication via GPRS is cheaper than through the regular GSM network.

• Immediacy:

Allows customers to obtain connectivity when needed, regardless of location and without a lengthy login session.

• Localization:

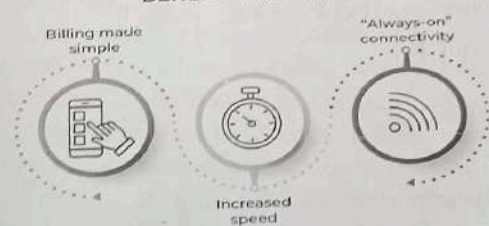
Enables customers to acquire data applicable to their present area.

• Easy Billing:

GPRS packet transmission offers an easier to use billing than that offered by circuit switched administrations. GPRS is an innovation that numerous GPS beacons are using to get up to the minute data with tracking. When the GPS gadget records the information, it would then be able to be transmitted through GPRS to another central location, for example, a PC or through an email. It is the GPRS innovation that takes into consideration ongoing updates to GPS following frameworks. It is this direct GPRS association that gives the client of the GPS system the most reliable information available today.

spiceworks

BENEFITS OF GPRS



GPRS wireless packet data has three main characteristics:

1. An always-online function that eliminates the need for dial-up, enabling programs accessible with just one click.
2. The upgraded usual systems mean that carriers do not have to update their equipment; instead, GPRS is put on top of the current equipment.
3. An essential part of future 3G networks, meaning the packet data core network for 3G systems EDGE and WCDMA, GPRS is a necessary foundation for the future.

GPRS provides the services listed below:

1. Broadcasting and SMS messaging
2. Cellular-based push-to-talk
3. Presence and instant messaging
4. Service for multimedia messaging
5. Services such as point-to-point and point-to-multipoint

Conclusion:

In this expt. we studied about the GPRS. Services, its history, goals and services offered. Also the protocols and benefits.

QUESTION:

1. What is GPRS?
2. What are features of GPRS?
3. Difference between GSM and GPRS

Exp. No. 3

Q.1) What is GPRS?

→ GPRS - GPRS is General packet Radio Services For wireless. It is a best effort packet switching protocol for wireless and cellular Network Communication Services.
- GPRS was one of the main advances that empowered a cell system to interface with
- GPRS the first system providing universal mobile internet access.

Q.2) What are the features of GPRS?

→ Feature of GPRS

- 1) mobility: The capacity to keep up consistent voice and information interchanges while moving.
- 2) Cost efficient - Communication via GSM N/w cheaper than through the regular GSM N/w.
- 3) Immediacy: Allows customers to obtain in connectivity when needed regardless of location & without a lengthy log in sessions.
- 4) Localization:- Enable customers to acquire data application to their present area.
- 5) Easy Billing - GPRS transmission packet offers an easier to use billing than offered by circuit switched communications. These are the features of GPRS.

Date of Performance: 9/3/2023

TITLE: Simulate BER Performance over Rayleigh Fading wireless channel with BPSK Transmission

AIM: Simulate BER Performance over Rayleigh Fading wireless channel with BPSK Transmission for SNR 0 to 60 db..

OBJECTIVES:

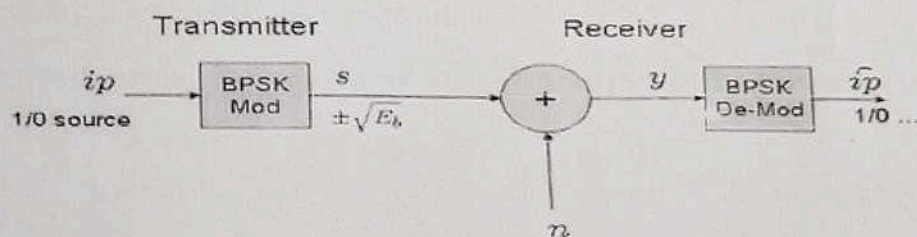
- What is a Rayleigh Fading
- Study of BPSK transmission

SOFTWARE & HARDWARE REQUIREMENTS:

- Windows 7/10/11
- Matlab

THEORY-CONCEPT

In this experiment, we will derive the theoretical equation for bit error rate (BER) with Binary Phase Shift Keying (BPSK) modulation scheme in Additive White Gaussian Noise (AWGN) channel. The BER results obtained using Matlab/Octave simulation scripts show good agreement with the derived theoretical results. With Binary Phase Shift Keying (BPSK), the binary digits 1 and 0 may be represented by the analog levels and respectively. The system model is as shown in the Figure below.



Channel Model

The transmitted waveform gets corrupted by noise, typically referred to as Additive Gaussian Noise (AWGN).

Additive: As the noise gets 'added' (and not multiplied) to the received signal.

White: The spectrum of the noise is flat for all frequencies.

Gaussian: The values of the noise follows the Gaussian probability distribution function.

$$p(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \text{ with } \mu = 0 \text{ and } \sigma^2 = \frac{N_0}{2}$$

Computing the probability of error

Using the derivation provided

The received signal

$$y = s_1 + n, \quad \text{when bit 1 is transmitted and}$$

$$y = s_0 + n, \quad \text{when bit 0 is transmitted.}$$

$$p(y/s_0) = \frac{1}{\sqrt{\pi N_0}} e^{-\frac{(y+\sqrt{E_b})^2}{N_0}}$$

$$p(y/s_1) = \frac{1}{\sqrt{\pi N_0}} e^{-\frac{(y-\sqrt{E_b})^2}{N_0}}$$

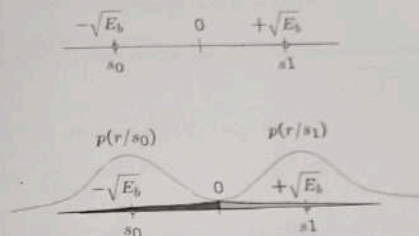


Figure: Conditional probability density function with BPSK modulation

The conditional probability distribution function (PDF) of for the two cases are

Assuming that s_1 and s_0 are equally probable i.e. $p(s_1) = p(s_0) = 1/2$ the threshold 0 forms the optimal decision boundary

- If the received signal is greater than 0, then the receiver assumes s_1 was transmitted.
- If the received signal is less than or equal to 0, then the receiver assumes s_0 was transmitted.

i.e.

$$y > 0 \Rightarrow s_1 \text{ and}$$

$$y \leq 0 \Rightarrow s_0$$

Probability of error given was transmitted

With this threshold, the probability of error given is transmitted is (the area in blue region).

$$P(e|s_0) = \frac{1}{\sqrt{\pi N_0}} \int_0^{\infty} e^{-\frac{(y+\sqrt{E_b})^2}{N_0}} dy = \frac{1}{\sqrt{\pi}} \int_{\frac{\sqrt{E_b}}{\sqrt{N_0}}}^{\infty} e^{-z^2} dz = \frac{1}{2} \operatorname{erfc}\left(\sqrt{\frac{E_b}{N_0}}\right)$$

$$P_b = P(s_1)P(e|s_1) + P(s_0)P(e|s_0).$$

Given that we assumed that S_1 and S_0 are equally probable i.e. $P(s_1) = P(s_0) = 1/2$, the bit error probability is

$$P_b = \frac{1}{2} \operatorname{erfc} \left(\sqrt{\frac{E_b}{N_0}} \right).$$

Simulation model

Matlab/Octave source code for computing the bit error rate with BPSK modulation from theory and simulation. The code performs the following:

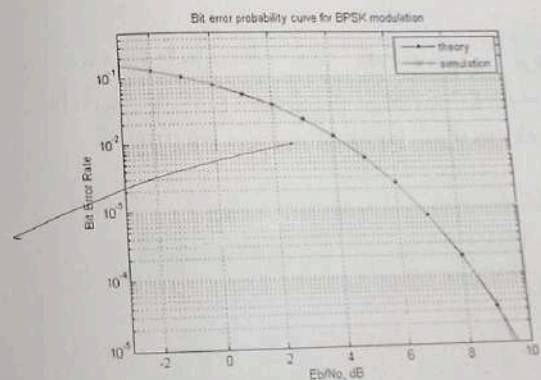
- Generation of random BPSK modulated symbols +1's and -1's
- Passing them through Additive White Gaussian Noise channel
- Demodulation of the received symbol based on the location in the constellation
- Counting the number of errors
- Repeating the same for multiple E_b/N_0 value

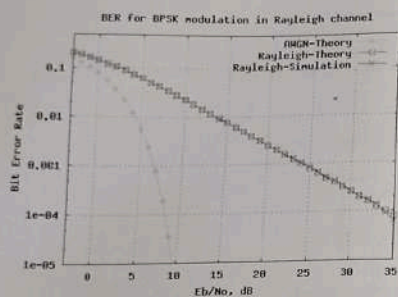
MATLAB CODE:

```
clear
N = 10^6 % number of bits or symbols
rand('state',100); % initializing the rand() function
randn('state',200); % initializing the randn() function
% Transmitter
ip = rand(1,N)>0.5; % generating 0,1 with equal probability
s = 2*ip-1; % BPSK modulation 0 -> -1; 1 -> 1
n = 1/sqrt(2)*randn(1,N) + j*randn(1,N); % white gaussian noise, 0dB variance
Eb_N0_dB = [-3:10]; % multiple Eb/N0 values
for ii = 1:length(Eb_N0_dB)
    % Noise addition
    y = s + 10^(-Eb_N0_dB(ii)/20)*n; % additive white gaussian noise
    % receiver - hard decision decoding
    ipHat = real(y)>0;
    % counting the errors
```

```
nErr(ii) = size(find([ip- ipHat]),2);
end
simBer = nErr/N; % simulated ber
theoryBer = 0.5*erfc(sqrt(10.^(Eb_N0_dB/10))); % theoretical ber
% plot
close all
figure
semilogy(Eb_N0_dB,theoryBer,b.-');
hold on
semilogy(Eb_N0_dB,simBer,'mx-');
axis([-3 10 10^-5 0.5])
grid on
legend('theory', 'simulation');
xlabel('Eb/No, dB');
ylabel('Bit Error Rate');
title('Bit error probability curve for BPSK modulation')
```

Result:





CONCLUSION:

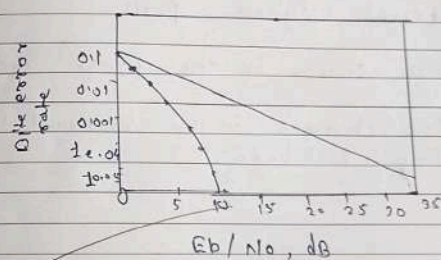
In this experiment we simulated the BER performance over Rayleigh fading wireless channel with BPSK using MATLAB.

QUESTIONS:

1. What is BER Performance in fading channel in wireless communication?
2. What are the characteristics of fading channel?

Exp. No. 4

1. What is BER Performance in fading channel in wireless communication?
- BER Performance in fading channel.
- The BER fading function returns the bit error rate (BER) & symbol error rate (SER) over a Rayleigh or Rician fading channel for uncoded data using a specified modulation scheme.



The first input argument E_b/N_0 is the energy per bit to noise power spectral density ratio (E_b/N_0) in dB.

Date of Performance: 23/3/2023

TITLE: Configure a Cisco Router as a DHCP Server

AIM: Configure a Cisco Router as a DHCP Server

Objectives:

What is a DORA PROCESS?
Benefits of DHCP
How it works?

Outcome:

Deploy Client-Server architectures and prototypes by the means of correct standards and technology to assign IP address.

Software Requirements:

Open-source Linux operating system, Cisco Packet Tracer.

THEORY:

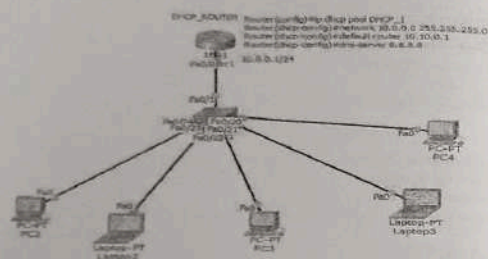
Dynamic Host Configuration Protocol (DHCP) is a standardized client/server network protocol that dynamically assigns IP addresses and other related configuration information to network devices. Every device on a TCP/IP-based network must have a unique unicast IP address to access the network and its resources. Without DHCP, IP addresses for new computers or computers that are moved from one subnet to another must be configured manually.

Configuring the DHCP server

The DHCP server uses address pools when responding to DHCP client requests. Address pools contains specific IP configuration details that the DHCP server can allocate to a client. You can configure multiple address pools on the device for different networks. To configure an address pool, you must:

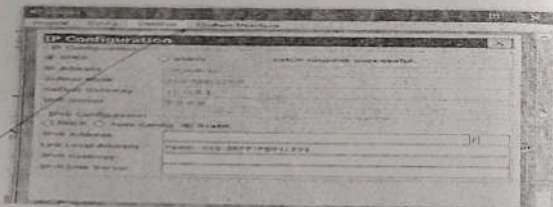
1. Create the pool and enter its configuration mode.
2. Define the network the pool applies to.
3. Define the range of IP addresses that the server can allocate to clients. You can specify multiple address ranges for each pool.

4. Set the lease for the clients. This defines whether the clients receive a dynamic, permanent, or static IP address.
5. Set the options (standard and user-defined) that the clients of a pool require when configuring their IP details.
6. After configuring the address pools, enable the DHCP server by using the command



On Client Side:

Select IP allocation as a Dynamic allocation.



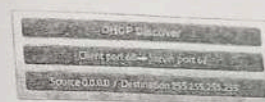
DORA Process

The following diagram shows the changing port numbers and the source and destination addresses used during the DHCP transaction. UDP port 68 is reserved for DHCP clients, and UDP port 67 is reserved for DHCP servers.

Step 1

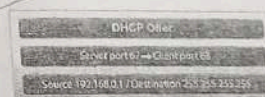
DHCP Discover

Sent by the client looking for the IP address. The source IP is 0.0.0.0 because the client doesn't have an IP address. The destination is 255.255.255.255, which is the broadcast address, as the client doesn't know where the DHCP server is located, so it broadcasts to all devices on the network.



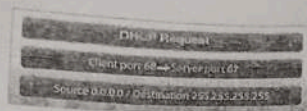
Step 2 DHCP Offer

Sent by the DHCP server offering an IP address to the client. The source address is the DHCP server address. The DHCP server doesn't know the client address yet, so it broadcasts the offer to all devices on the network.



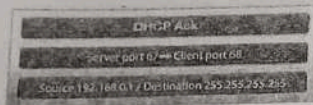
Step 3 DHCP Request

Sent by the client to the DHCP server to say "I will take that IP address, thanks." The client IP address is still 0.0.0.0 and it is again broadcast to all so that any other servers on the network that may have offered an IP address will know to stop communicating with the client for now.



Step 4 DHCP Acknowledgment

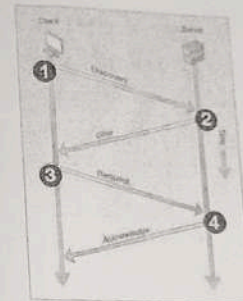
Sent by the DHCP server to the client. It confirms the IP address and other details such as subnet mask, default gateway, and lease time with the client. The source address is the DHCP server and the destination is still the broadcast address.



The DHCP process

There are four basic steps the DHCP process follows when a client connects to the network:

1. The client broadcasts a DHCP Discover message to say "I need an IP address, are there any DHCP servers out there?"
2. Multiple DHCP servers may respond (via broadcast) with an OFFER for a leased IP address back to the client.
3. The client will choose a DHCP server offer and then broadcast a DHCP REQUEST back to the DHCP server(s) to say "Thanks, I have selected an offer from this DHCP server." All servers will see which offer the client selected.
4. Finally, the selected DHCP server will send (broadcast) an ACKNOWLEDGEMENT back to the client to confirm the IP address, lease time, and other details



Conclusion:

In this experiment we have studied & configured a cisco Router as a DHCP server using open-source linux os, and cisco packet tracer.

QUESTIONS:-

1. Explain DORA Process?
2. What are benefits of DHCP Process?
3. Why DORA works on UDP...



Amrutvahini College of Engineering, Sangamner
Department of Electronics and Telecommunication Engineering
Experiment No.: 06

Roll No. 8

Date of Performance: 13/4/2023

TITLE: To understand the handover mechanism.

Aim: To understand the handover mechanism.

OBJECTIVES: To study the effect of handover threshold and margin on SINR and call drop probability and handover probability

SOFTWARE & HARDWARE REQUIREMENTS:

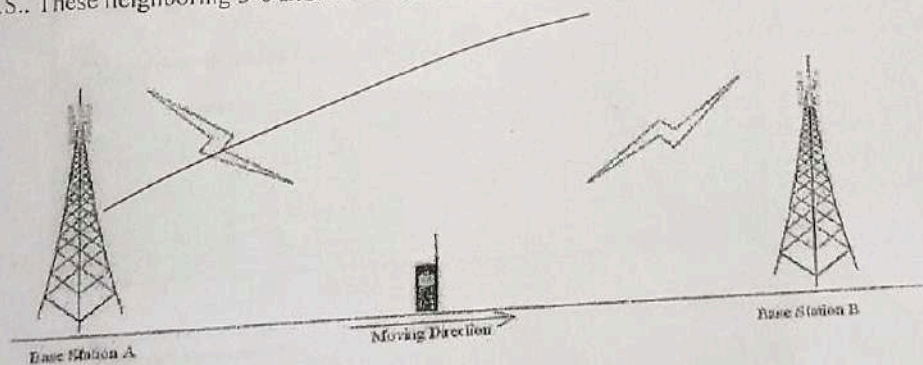
Operating System: Windows 7

Java Version: 6 only

Mozilla Firefox: version: 47.0.1

THEORY-CONCEPT

Theory: Handoff Consider the figure below Initially say the mobile M is quite close to the base station A and hence receives signal strength from A $P_{Arx} > P_{Brx}$. As the mobile moves away from the base station A and goes towards B then the signal strength from A keeps falling (pathloss increases). Let there be a minimum sensibility level P_{0rx0} for the mobile, i.e. if the signal from the B.S. to which the mobile is connected falls below P_{0rx0} then the call drops. In order to prevent call drop the mobile monitors receive signal strength from the neighboring 3-6 B.S.. These neighboring 3-6 B.S. also monitor Rx signal strength from the M.S.



The mobile should get connected to B.S. which has the highest signal strength. However, if the MS continuously attaches itself to the B.S. with instantaneous height signal strength then the h/o rate may vary high in server condition.

Thus, some hysteresis condition is used for h. If $P_{Tx}(T = \text{target B.S.}) > P_{Max}h$ higher h/o threshold and $P_{Tx}(C = \text{current B.S.}) < P_{Min}h$ minimum h/o threshold the execute h/o to B.S.T from B.Sc. Thus, it is threshold impeditive to study in part of the handoff process.

$$\Delta\gamma = P_{Max} - P_{Min} \Delta = h$$

A successful handoff is one where the call gets from and continuous without call or in other words the occurs before h/o P_{Tx} becomes $< P_{Min}$. If $P_{Tx} < P_{Min}$ then call drop event occurs. One would like to minimize the no of handoff events as well as minimize call drop probability. The experiment provides opportunity to study the inherent of these three parameters on h/o. Further the averaging window for calculating P_{Tx} and P_{Tx} also plays a role in the process. In the experiment small scale fading is not considered and hence the averaging considered only shadowing.

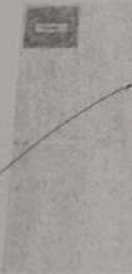
Students conducting the experiment is expected to study the impact of these on h/o. He/She is encouraged to respect the experiment for several sets of values of these parameters these draw conclusion

Instruction

Follow the instructions given below to perform the experiments.

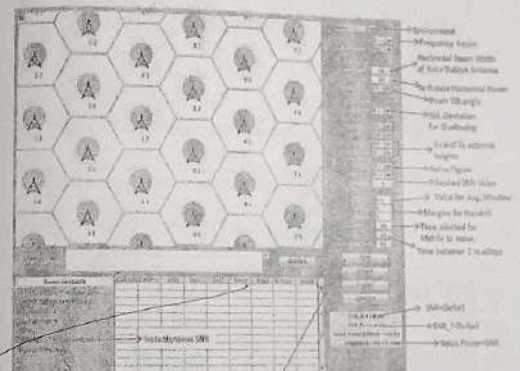
1.1 Starting the Experiments: -

- Step1: Click on START button to start experiment.



Step2: Enter your name then click OK button

- Step3: Select the parameters (e.g.: Reuse, Environment, Beamwidth, Carrier frequency etc.



Time duration of mobile during which mobile has no connectivity

Click this "OK" button to apply any change made to the screen parameters.

Step9: To redo experiment click on RESET button.

Observation Table:

Reuse No	No of Hand Off	Mobile Speed	Outage	Outage Percentag
1				
3				

Keep reuse ratio 3 and set mobile speed to 50 mps and 100 mps and record the below data. What do we observe after increasing the speed of the mobile station.

Reuse No	Mobile Speed	No of Hand Off	Outage	Outage Percentag %
3	50	9.0	1008.0	5.04%
3	100	59.0	756.0	3.98%

Conclusion:

In this expt. we studied the handover mechanism. Also studied the effect of threshold handover and margin on SINR call drop prob, etc.

Question:

1. What is handoff?
2. What is the condition for handoff?
3. Explain Handoff and its types

Exp 8: Handoff Name: ROHINI

Input Parameters

Reuse: 3, Model: Urban Micro	Pf(dBm): 41
f _c (GHz): 2.5	Beam Width(deg): 70
Rotate(deg): 20	Cell Radius(mi): 116
h _t (m): 10	h _m (m): 1.5
Sigma(dB): 4	Vertical Tilt(deg): 12
SNR(dB): 5	Band Width(MHz): 5
Noise Figure(dB): 7	Noise Power(dBm): 100.01
Pr0(dBm): -95.01	Time Slot(s): 200

Exp. Results

SNR	No. Call dr ops	No. Hand offs	Delta1	Delta2	Reading Time(ms)	Outage Time(ms)	% Outage	Alpha
5.0	0.0	15.0	3.0	3.0	200704.0	6272.0	3.12	0.1

Observation

Observation not entered

Signature of ROHINI)

Date of Performance: 20/4/2023

TITLE: To study the outage probability, LCR & ADF in SISO for Selection Combining and MRC.

AIM: To study the outage probability, LCR & ADF in SISO for Selection Combining and MRC.

OBJECTIVES: To understand function of CDMA used to test orthogonally and autocorrelation of a code.

SOFTWARE & HARDWARE REQUIREMENTS:

OS: Unix or windows 7/8/10,

Processor: i3/i5/i7

Software: Python (Jupyter Notebook) or java

THEORY-CONCEPT

Small scale fading characterizes the fluctuation of signal (strength) over a spatial distance of fraction of wavelength. The fluctuation is also observed in both time and frequency domain at a gain location. The variation of signal (strength) at the receiver is due to random interference between the different copies of the transmitted signal. The interference is sometimes constructive and sometimes destructive. The multiple copies of the transmitted signal are generated due to scattering, reflection, and diffraction due to obstacle present in the path of radio signal between the Tx and Rx movement of the Tx and Rx or the obstacle cause time domain variation of the signal (strength) and the phenomenon is called Doppler effect. Since each path of the radio wave may exhibit difference doppler its cumulative effect results in spread of the carrier/ frequency content of the signal and hence is also known as Doppler spread.

If v is the maximum velocity (m/s) then the maximum Doppler shift is given by

$$f_m = v(m/s) / c =$$

Where,

- $c = \text{velocity of light} = 3 \times 10^8 \text{ m/s} = 3 \times 10^8$
- $f_c = \text{carrier frequency}$.

Coherence time is defined as interval in time over which the signal remains correlated. It is defined as

$$T_c = 9/16f_m \text{ (s)}$$

If symbol duration $T_s \ll T_c$ it experience slow fading while if $T_s > T_c$ it experience fast fading. The enveloped level crossing rate is defined as the rate at which the signal envelope crosses a specified level

R in the positive (or negative) going direction.

It requires the joint pdf $f(u, a)$ of the enveloped level $a = |r|$ and enveloped slope $a = |r|$

$LR = \sqrt{2\pi}(k+1)f_m p_c - k - (k+1)p_2 10(2p\sqrt{k(k+1)})p = R\sqrt{\Omega_p} = RR_{rms}$ $R_{rms} = \sqrt{\Omega_p}$ is the enveloped level

Rayleigh fading ($k=0$) and isotropic scattering $LR = \sqrt{2\pi}f_m p_c - p^2$

Level Crossing Rate For Selection Combining

$$L_r = f_m \sqrt{2\pi} M \gamma \sqrt{\exp(-\gamma^2/2)} [1 - \exp(-\gamma^2/2)]^{M-1}$$

Where,

- f_m is the Maximum doppler frequency.
- σ is the r.m.s value of the received signal voltage.
- γ is the threshold voltage.
- $M = \text{No. of channels}$

21 Average enveloped fade duration

2023-19-49 on the enveloped remains below a specified level R .

$$F = (NR/P)[r \leq R]$$

Average fade duration For Selection Combining

$$ADF = \sqrt{p} \exp(\gamma^2/2) \sqrt{2\pi} f_m M \gamma$$

For Rayleigh distribution fading

$$Pr(r \leq R) = \int_0^R 0Pr(dr) = 1 - \exp(-p/2)$$

$$1 - \exp(-p/2) = 1 - p f_m \sqrt{2\pi}$$

In case of flat fading the plot of signal enveloped of transmitting Y is given as

$$p(r) = r \sigma^2 \exp(-r^2/2\sigma^2) (0 \leq r < \infty)$$

$$= 0 (r < 0)$$

Where,

- σ is the r.m.s value of the received voltage signal before detection.
- σ^2 is the time average power of the received signal before enveloped detection.

Probability of outage is defined as

$$P(R) = Pr(r \leq R) = \int_0^R 0p(r)dr = 1 - \exp(-R^2/2\sigma^2)$$

The mean value r_{mean} of rayleigh distribution is given by

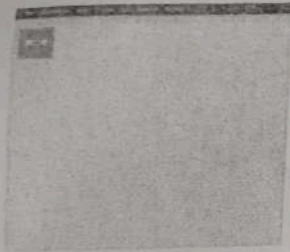
$$r_{mean} = E[r] = \int_0^\infty 0r p(r)dr = \sigma \sqrt{\pi/2} = 1.2533\sigma = 1.2533$$

$$\sigma^2 r = E[r^2] - E^2[r] = \int_0^\infty 0r^2 p(r)dr - \sigma^2 \pi/2$$

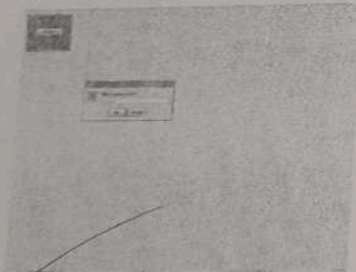
$$= \sigma^2 (2 - \pi/2) = 0.4292\sigma^2$$

Instructions for Experiment: - Flat Fading

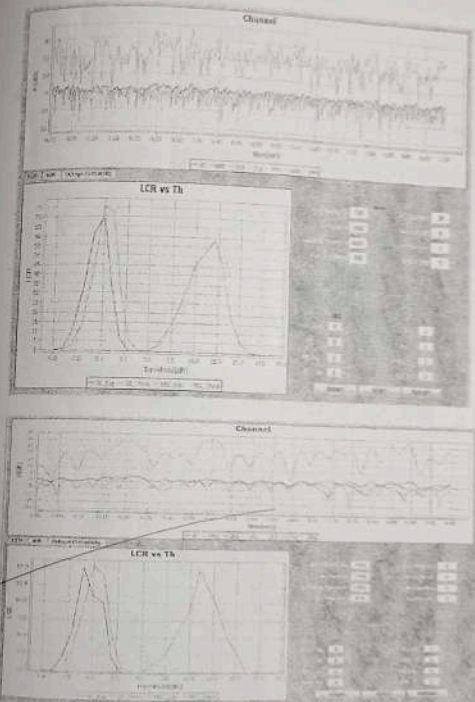
Step1:- Click on the button START. A page appears with a dialogue box asking for your name



Step 2:- Enter your name then Click Ok



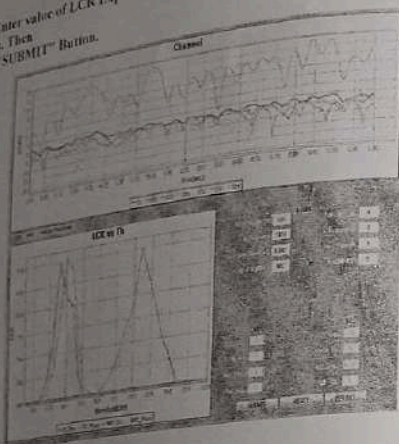
Step3:- Enter the input parameters value. Then click on "RESET" Button. Observed the waveform



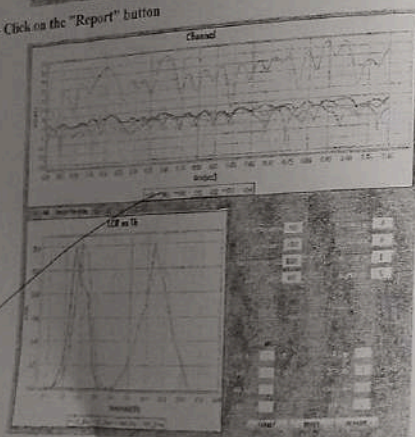
vivo V21

May 25, 2023, 19:49

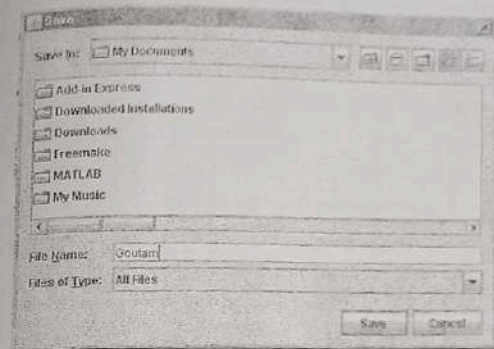
Step4:- Enter value of LCR Exp and ADF Exp in both MRC and SC from the waveform. Then Click on "SUBMIT" Button.



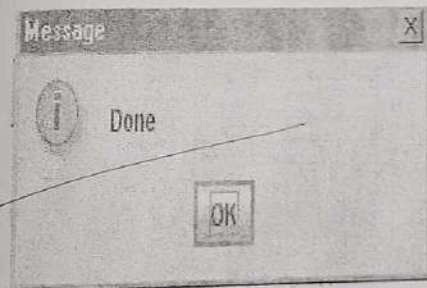
Step5:- Click on the "Report" button



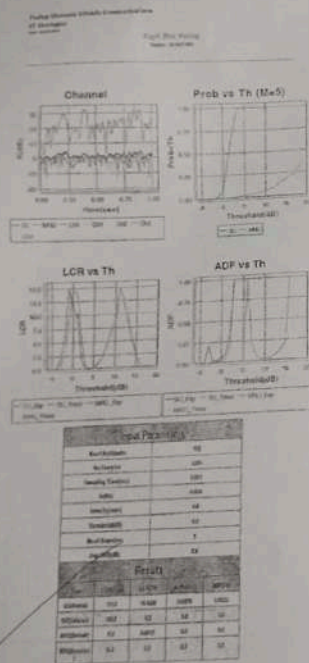
Step6:- PDF report of the experiment is generated



Step7:-After generation of the Report you will get following message



Step8:- Click on the "Ok" and you will get your Report



Step9:- To Redo the experiment click on "RESET" button

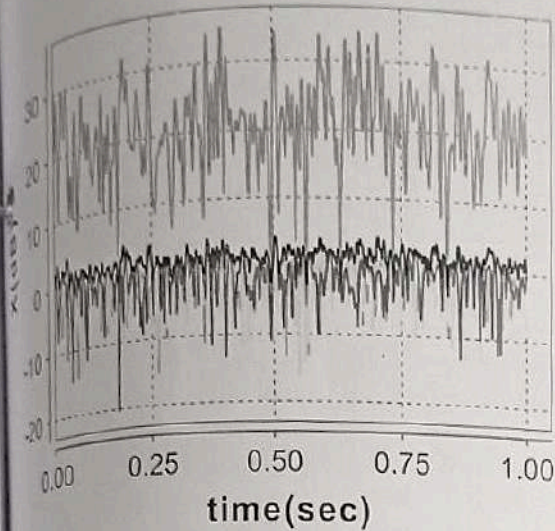
Conclusion:
In this expt. we studied the outage Probability LCR and ADF in GISO for Selection combining and MRC. using Python (Jupyter) Notebook. using unix or windows 10.

QUESTIONS:

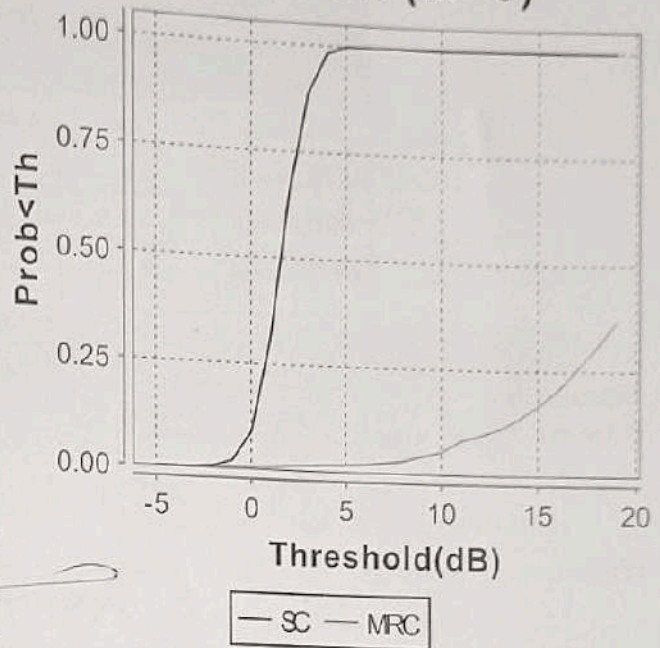
1. What is Flat Fading?
2. What is the difference between flat and selective fading?
3. What are the types of fading?

Exp9: Flat Fading
 Name: BE ETC

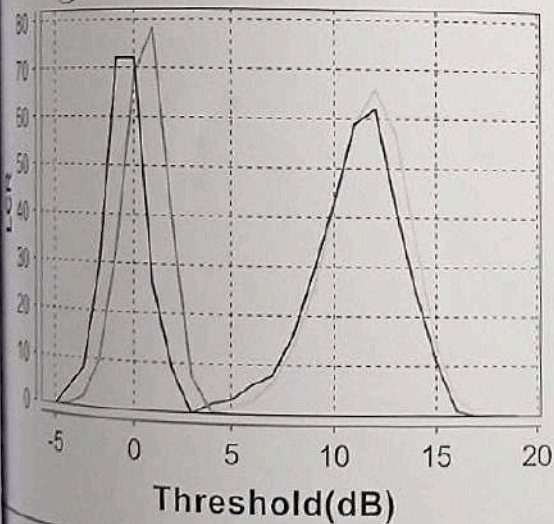
Channel



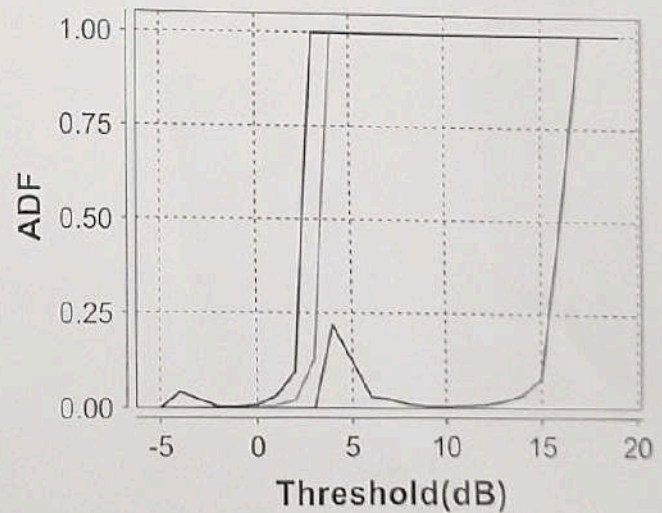
Prob vs Th (M=5)



LCR vs Th



ADF vs Th



SC_Exp — SC_Theor — MRC_Exp
 MRC_Theor

SC_Exp — SC_Theor — MRC_Exp
 MRC_Theor

Input Parameters				
No of Multipaths				100
No Samples				1000
Sampling Time(sec)				0.0010
f_c (Hz)				9.0E8
Velocity(mps)				20.0
Threshold(dB)				0.0
No of Branches				5
Avg SNR(dB)				5.0
Results				
Type	LCR(Exp)	LCR(Th)	ADF(Exp)	ADF(Th)
SC(Actual)	72.0	68.8016	0.0081	0.0033
SC(Entered)	0.0	0.0	0.0	0.0
MRC(Actual)	0.0	0.0073	0.0	-
MRC(Entered)	0.0	0.0	0.0	-

Discussion:

Enter your discussion here...

(Signature of BE ETC)

(Signature of Faculty)

Fading Channels & Mobile Communications
 IT Kharagpur
 Date: 13 May 2023

Exp 8: Handoff
 Name: BE ETC

Input Parameters	
Reuse: 3, Model: Urban Micro	PrdBm: 41
f_c (GHz): 2.5	Beam Width(deg): 70
Rotate(deg): 30	Cell Radius(m): 118
hT (m): 10	hM (m): 1.5
Sigma(dB): 4	Vertical Tilt(deg): 12
SNR(dB): 5	Band Width(MHz): 5
Noise Figure(dB): 7	Noise Power(dBm): -100.01
PrO(dBm): -95.01	Time Slots: 1000

Exp. Results							
SNR	No. Call dr ops	No. Hand offs	Delta1	Delta2	Reading Time(ms)	Outage Time(ms)	% Outage
5.0	0.0	70.0	3.0	3.0	1000384.0	6272.0	0.63

Observation	
Observation not entered	

(Signature of BE ETC)

(Signature of Faculty)



Date of Performance: 27/4/2023

TITLE: File sharing by using TCP Protocol

AIM: File sharing by using TCP Protocol

OBJECTIVES:

What is a socket?

- The client-server model.
- Remote Communication

SOFTWARE & HARDWARE REQUIREMENTS:

- Python, Open-source Linux operating system.

THEORY-CONCEPT

The basics

What is mean by Socket

Sockets allow communication between two different processes on the same or different machines. To be more precise, it's a way to talk to other computers using standard Unix file descriptors. In Unix, every I/O action is done by writing or reading a file descriptor. A file descriptor is just an integer associated with an open file and it can be a network connection, a text file, a terminal, or something else.

To a programmer, a socket looks and behaves much like a low-level file descriptor. This is because commands such as `read()` and `write()` work with sockets in the same way they do with files and pipes.

Types of Socket

A Unix Socket is used in a client-server application framework. A server is a process that performs some functions on request from a client. Most of the application-level protocols like FTP, SMTP, and POP3 make use of sockets to establish connection between client and server and then for exchanging data.

Socket Types

There are four types of sockets available to the users. The first two are most commonly used and the last two are rarely used.

Processes are presumed to communicate only between sockets of the same type but there is no restriction that prevents communication between sockets of different types.

Stream Sockets -

Delivery in a networked environment is guaranteed. If you send through the stream socket three items "A, B, C", they will arrive in the same order - "A, B, C". These sockets use TCP (Transmission Control Protocol) for data transmission. If delivery is impossible, the sender receives an error indicator. Data records do not have any boundaries.

Datagram Sockets -

Delivery in a networked environment is not guaranteed. They're connectionless because you don't need to have an open connection as in Stream Sockets - you build a packet with the destination information and send it out. They use UDP (User Datagram Protocol).

Raw Sockets - These provide users access to the underlying communication protocols, which support socket abstractions. These sockets are normally datagram oriented, though their exact characteristics are dependent on the interface provided by the protocol. Raw sockets are not intended for the general user; they have been provided mainly for those interested in developing new communication protocols, or for gaining access to some of the more cryptic facilities of an existing protocol.

Sequenced Packet Sockets -

They are similar to a stream socket, with the exception that record boundaries are preserved. This interface is provided only as a part of the Network Systems (NS) socket abstraction, and is very important in most serious NS applications. Sequenced-packet sockets allow the user to manipulate the Sequence Packet Protocol (SPP) or Internet Datagram Protocol (IDP) headers on a packet or a group of packets, either by writing a prototype header along with whatever data is to be sent, or by specifying a default header to be used with all outgoing data, and allows the user to receive the headers on incoming packets.

The client-server model

The client-server model is one of the most commonly used communication paradigms in networked systems. Clients normally communicate with one server at a time. From a server's perspective, at any point in time, it is not unusual for a server to be communicating with multiple clients. Client need to

know of the existence of and the address of the server, but the server does not need to know the address of (or even the existence of) the client prior to the connection being established. The

client and the server on the same local network (usually called LAN, Local Area Network), the client and the server may be in different LANs, with both LANs connected to a Wide Area Network (WAN) by means of routers.

Transmission Control Protocol (TCP)

TCP provides a connection oriented service, since it is based on connections between clients and servers. TCP provides reliability. When a TCP client sends data to the server, it requires an acknowledgement in return. If an acknowledgement is not received, TCP automatically retransmits the data and waits for a longer period of time for acknowledgement.

TCP Socket API

The sequence of function calls for the client and a server participating in a TCP connection is presented in following Figure

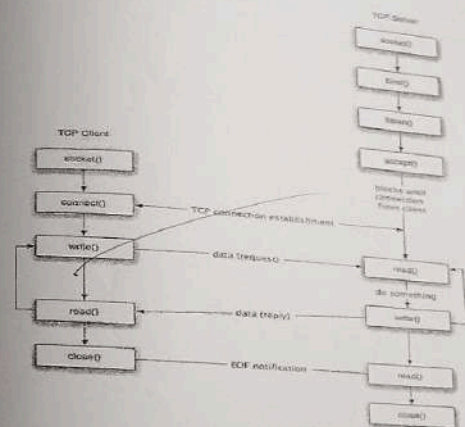


Figure: TCP client-server

CONCLUSION:

In this expt. we learnt the File Sharing by using TCP Protocol using Python. ALSO studied the socket, As type. client-server model, TCP, TCP Socket, API, etc.

QUESTIONS:

1. Explain Transaction oriented TCP
2. What is mobile TCP
3. Snoop TCP
4. Fast retransmission System

client code (3)

```
import socket
server_ip="localhost"
server_host=8002
FORMAT="utf-8"
CS=socket.socket(socket.AF_INET,socket.SOCK_STREAM)
CS.connect((Server_ip,Server_host))
file = open("data/abc.txt","r")
data=file.read()
CS.send("abc.txt".encode(FORMAT))
msg=CS.recv(1024)
print(msg)
CS.send(data.encode(FORMAT))
msg=CS.recv(1024)
print(msg)
```



```
import socket
server_ip="localhost"
server_host=8002
FORMAT="utf-8"
ss=socket.socket(socket.AF_INET,socket.SOCK_STREAM)
ss.bind((Server_ip,Server_host))
ss.listen(5)
s1, addr=ss.accept()
file_name= s1.recv(1024).decode(FORMAT)
print(file_name)
file=open(file_name,"w")
s1.send("File name received")
data=s1.recv(1024).decode(FORMAT)
print("File data received")
s1.send("File data received")
file.write(data)
file.close()
```

server code (3)