Department of

Computer Science Engineering

LAB MANUAL

Computer Networks

B.Tech–5th Semester

KCT College of Engineering & Technology

Village Fatehgarh (Distt. Sangrur)

BTCS 507 Computer Networks – II LAB

List of Experiments:

Experiment 1:

Objective: To configure the IP address for a computer connected to LAN.

Setting a Static and Dynamic IP Address in Windows XP

Theory:

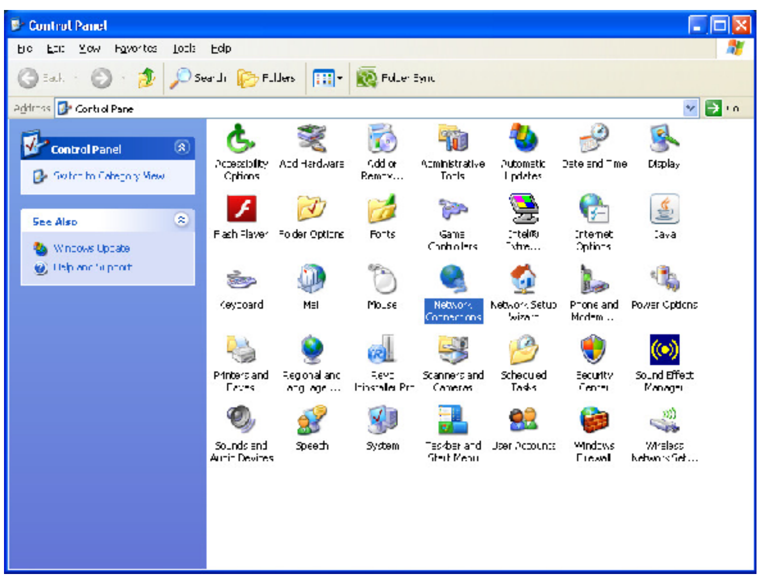
IP addresses are four sets of numbers separated by periods that allow computers to identify each other. Every computer has at least one IP address, and two computers should never have the same IP address.

As the name implies Static IP addresses are the same every time you connect. A dynamic IP is exactly that, dynamic. It could change frequently, or not change for more than 1 year. It really depends on how the DHCP server that's assigns the IPs is set up.

Setting up a Static IP for windows XP

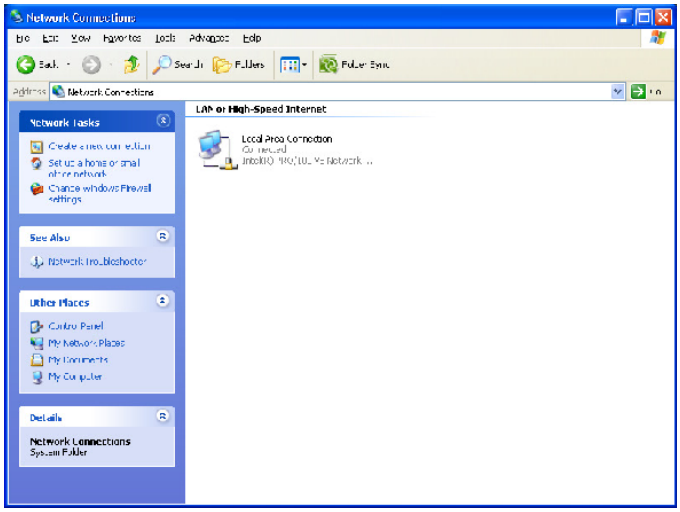
Step 1:

Open up the start menu and click **Control Panel**.



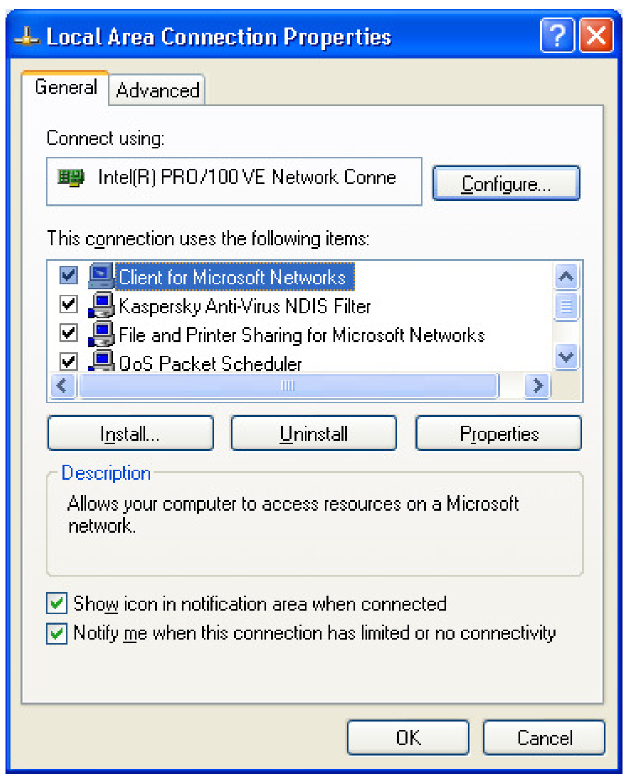
Step 2:

Double click **Network Connections**.



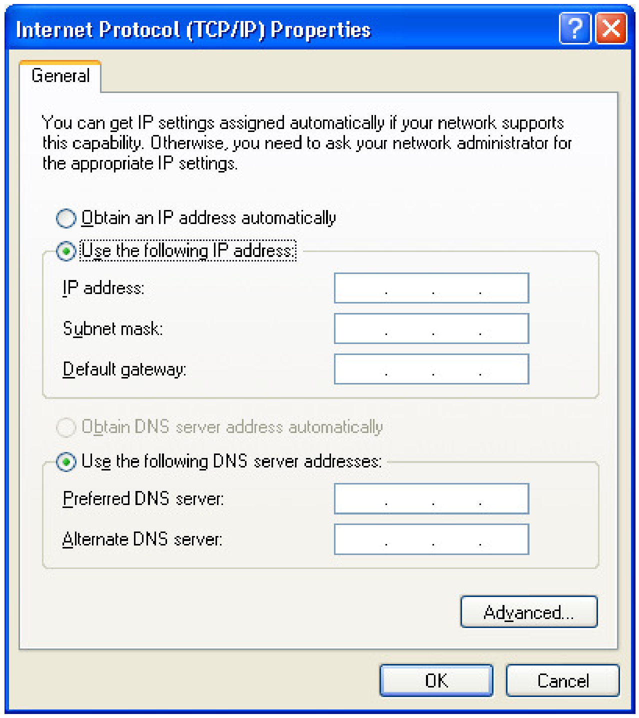
Step 3:

Right click on the Local Area Connection and then click **properties**.



Step 4:

Click **Internet Protocol (TCP/IP)** and then the **Properties** button. You will now see the following screen.



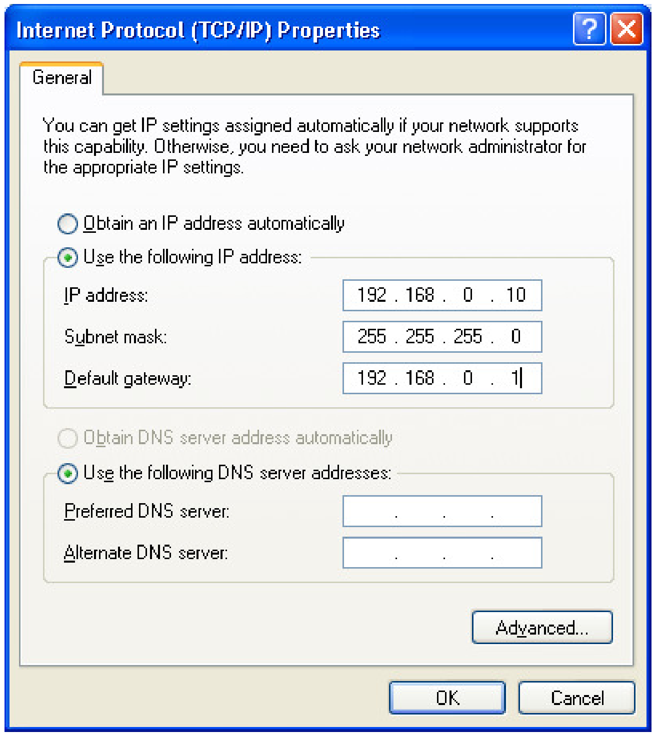
Step 5:

To specify an IP address, click **Use the following IP address**, and then, in the **IP address**, Subnet **mask**, and **Default gateway** boxes, type the IP address settings.

For Example,

A typical **IPv4 address** looks like 192.168.1.2; a typical **Subnet mask** would be 255.255.255.0.

The **Default Gateway** is generally the address of your router. Only the last number of the IP address should be different. If the router's IP address is 192.168.1.1, you may choose 192.168.1.10. The IP address you choose should end with a number between 1 and 254, and should not be the same as the router's IP address. Every device that connects to your network needs to have its own IP address.



To specify a DNS server address, click **Use the following DNS server addresses**, and then, in the **Preferred DNS server** and **Alternate DNS server** boxes, type the addresses of the primary and secondary DNS servers.

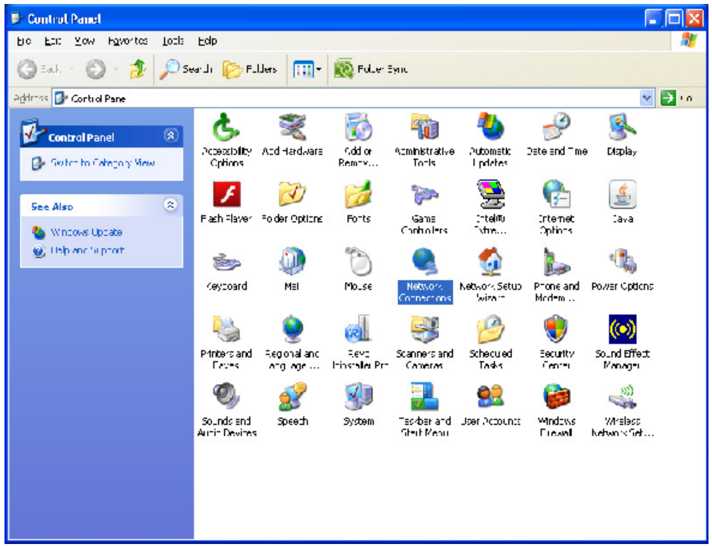
Click **OK** all the way out of this menu. Now the static IP has been set to your system.

Setting up a Dynamic IP for windows XP

DHCP automatically assigns Internet Protocol (IP) addresses to the computers on your network, if your network supports it. If you use DHCP, then you don't have to change your TCP/IP settings if you move your computer to another location, and DHCP doesn't require you to manually configure TCP/IP settings, such as Domain Name System (DNS). To enable DHCP or change other TCP/IP settings, follow these steps:

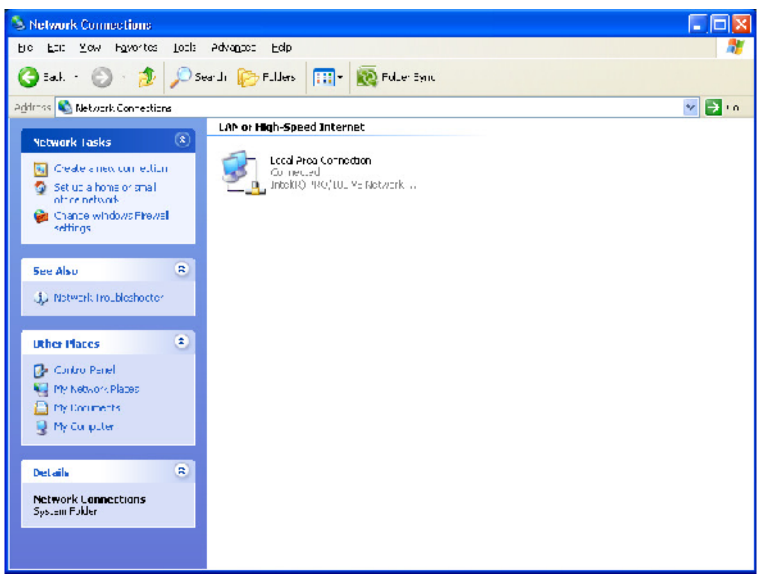
Step 1:

Open the start menu and click **Control Panel**.



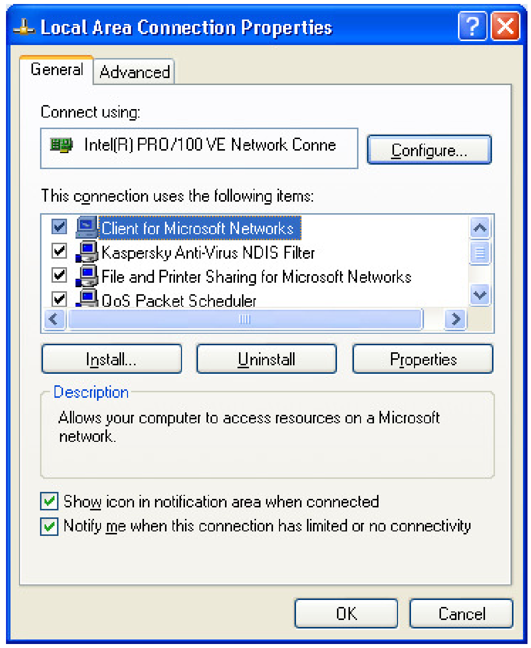
Step 2:

Double click **Network Connections**.



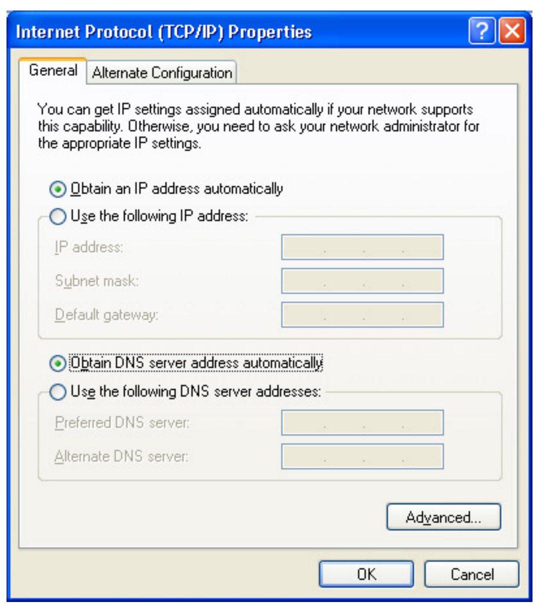
Step 3:

Right click on the Local Area Connection and then click **properties**.



Step 4:

Click **Internet Protocol (TCP/IP)** and then the **Properties** button.



To get IP settings automatically using DHCP, click **Obtain an IP address automatically** and to get a DNS server address automatically using DHCP, click **Obtain DNS server address automatically**, and then click **OK**.

Experiment 2:

Objective: To plan IPv6 address scheme for a local area network comprising of 'n' terminals. Write a C/C++ program to implement the IPv6.

Theory:

- Like IPV4, IPV6 network can be divided into sub networks.
- A network can be divided into several smaller sub networks with each sub network has its own sub network address.
- Like IPV4 classless address, IPV6 addresses are fundamentally divided into a number of Network Id bits followed by a number of Host Id bits. The network id is called the prefix, and the number of bits used is the prefix length. The remaining bits are called as suffix
- In IPv4, the host ID can be of varying length, depending on the subnetting scheme. For currently defined unicast IPv6 addresses, the host ID is the interface ID portion of the IPv6 unicast address and is always a fixed size of 64 bits.
- Therefore, only 64 - prefix length bits can be used for subnetting. So 2^(64 - prefix length) subnets can be created in a network.
- If one wants n number of subnets for a particular network, the number of bits used for subnetting should be found. The number of bits used for subnetting can be found by using the formula: log(n)/log(2)
- Then the number of bits should be borrowed from the suffix and it will be added into prefix part. Using the number of bits, the subnetwork address of each subnet can be calculated
- For example, consider a company has the Network address: 2002:2341:30AE:0000:0000:0000:0000:0000/48 needs four subnets.
- The number of bits used for subnetting: log(4)/log(2) = 2
- 2 bits are used for subnetting. These 2 bits should be borrowed from suffix and it will be added into prefix. Using the 2 bits, following four subnets can be created
    1. 2002:2341:30AE:0000:0000:0000:0000:0000/50
    2. 2002:2341:30AE:4000:0000:0000:0000:0000/50

3. 2002:2341:30AE:8000:0000:0000:0000:0000/50
4. 2002:2341:30AE:C000:0000:0000:0000:0000/50

Algorithm:

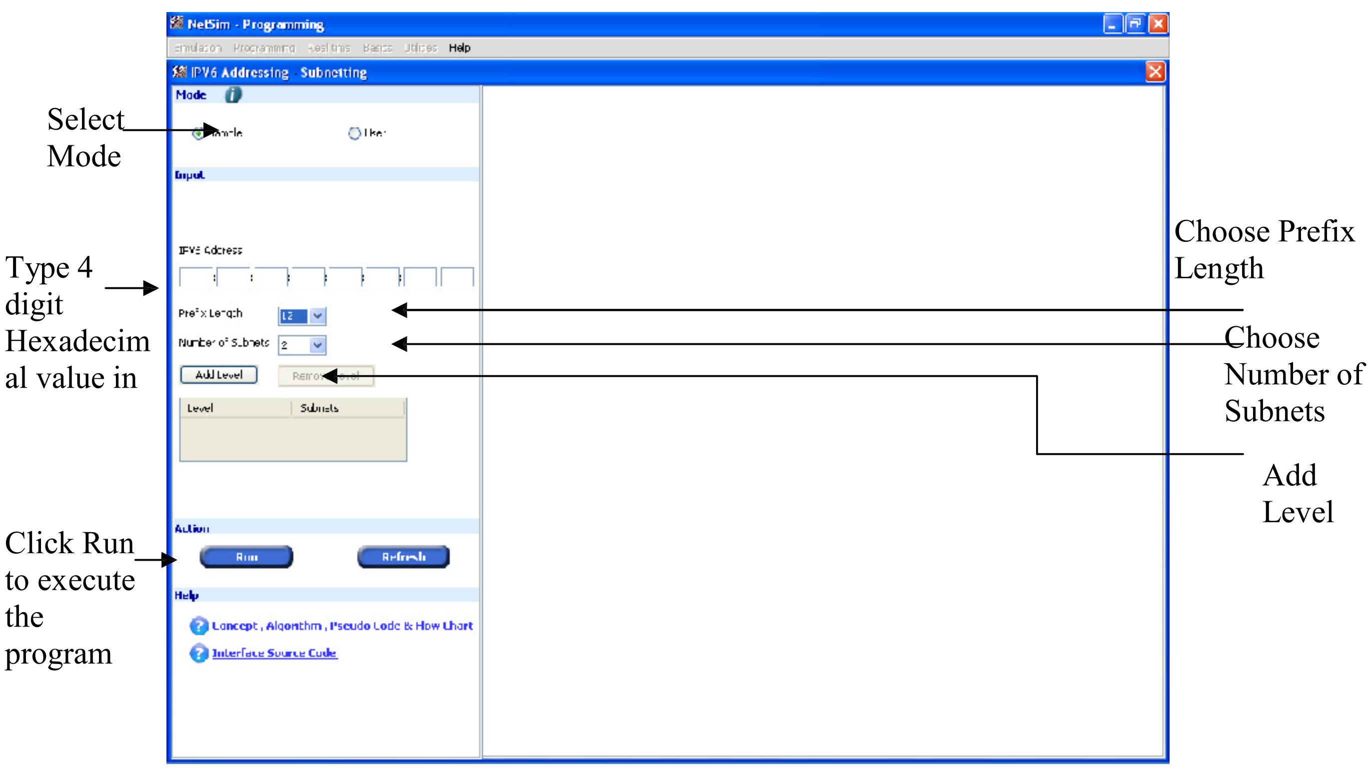
1. Get the IPV6 address and prefix length values
2. Get the number of subnets and number of levels
3. Find the number of bits used for subnetting by using the formula log(number of subnets)/log(2)
4. Using the number of bits, calculate the subnets.
5. Do the same procedure for all levels

Procedure:

To begin with the experiment, open NetSim

Click on *Programming* from the menu bar and select IPV6 Addressing Subnetting.

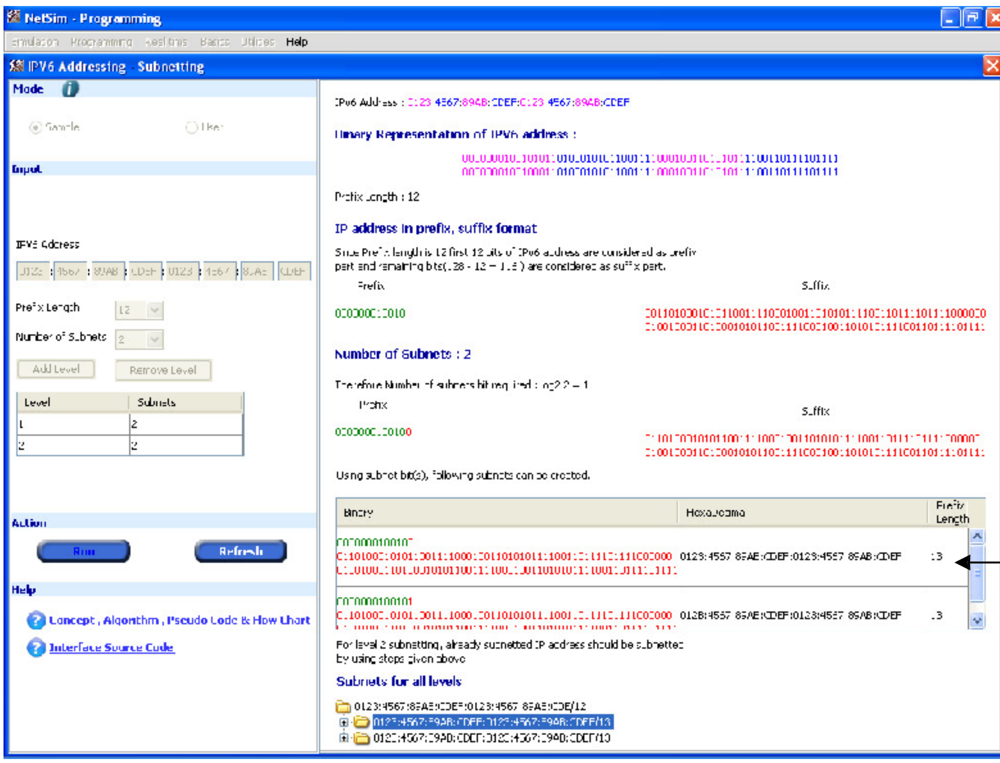
The scenario will be obtained as shown below. Follow the steps.



When you select the *User* mode, you have to write your own program in C/C++, compile and link to NetSim software for validation.

Click on F1 (Help) link for details on how to proceed with your own code.

Results (to be filled up by the students):



Subnetting details are list in the field.

Inference (to be filled up by the students):

Here, 0123456789ABCDEF0123456789ABCDEF (IPV6 Address) is divided into two sub networks

The first one is 0123:4567:89AB:CDEF:0123:4567:89AB:CDEF/13.

The second one is 012B:4567:89AB:CDEF:0123:4567:89AB:CDEF/1.

Experiment 3:

Objective: To develop programs for implementing / simulating routing algorithms for Adhoc networks. Write a C/C++ program to verify the Link state routing Algorithm.

Theory:

On wireless computer networks, **ad-hoc** mode is a method for wireless devices to directly communicate with each other. Operating in ad-hoc mode allows all wireless devices within range of each other to discover and communicate in peer-to-peer fashion without involving central access points. Each device in an Adhoc network also functions as a router and takes on the task of routing. It forms the routing table and delivers the packets depending upon the routes in the table – either directly or via an intermediate device (router).

Link state algorithm is a method used to find the shortest path between a source router and a destination router based on the distance and route the packets through that route.

Algorithm:

1. Start with the router: the root of the tree
2. Assign a cost of 0 to this router and make it the first permanent router.
3. Examine each neighbor router of the router that was the last permanent router.
4. Assign a cumulative cost to each router and make it temporary.
5. Among the list of temporary routers

    5. a. Find the router with the smallest cumulative cost and make it permanent.

    5. b. If a router can be reached from more than one direction

        5. b.1. Select the direction with the shortest cumulative cost.

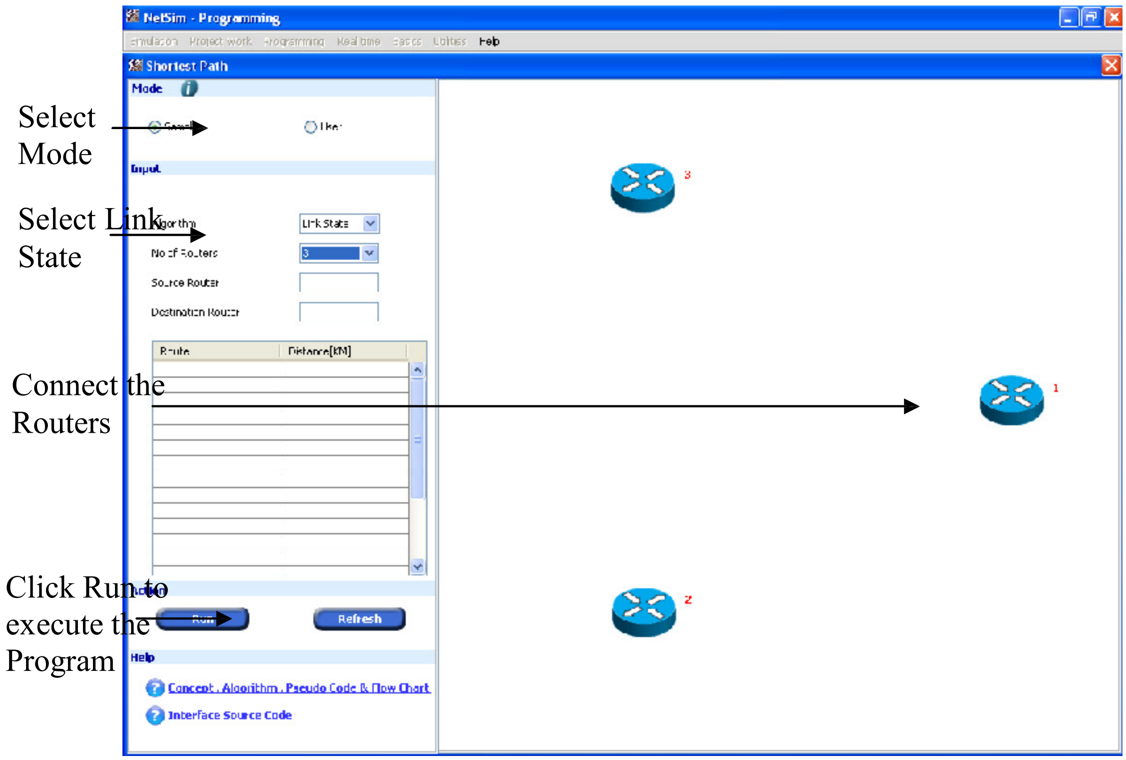
6. Repeat steps 3 to 5 until every router becomes permanent.

Procedure:

To begin with the experiment, open NetSim

Click on *Programming* from the menu bar and select Shortest Path. In shortest path select *Link State Routing algorithm.*

The scenario will be obtained as shown below. Follow the steps.

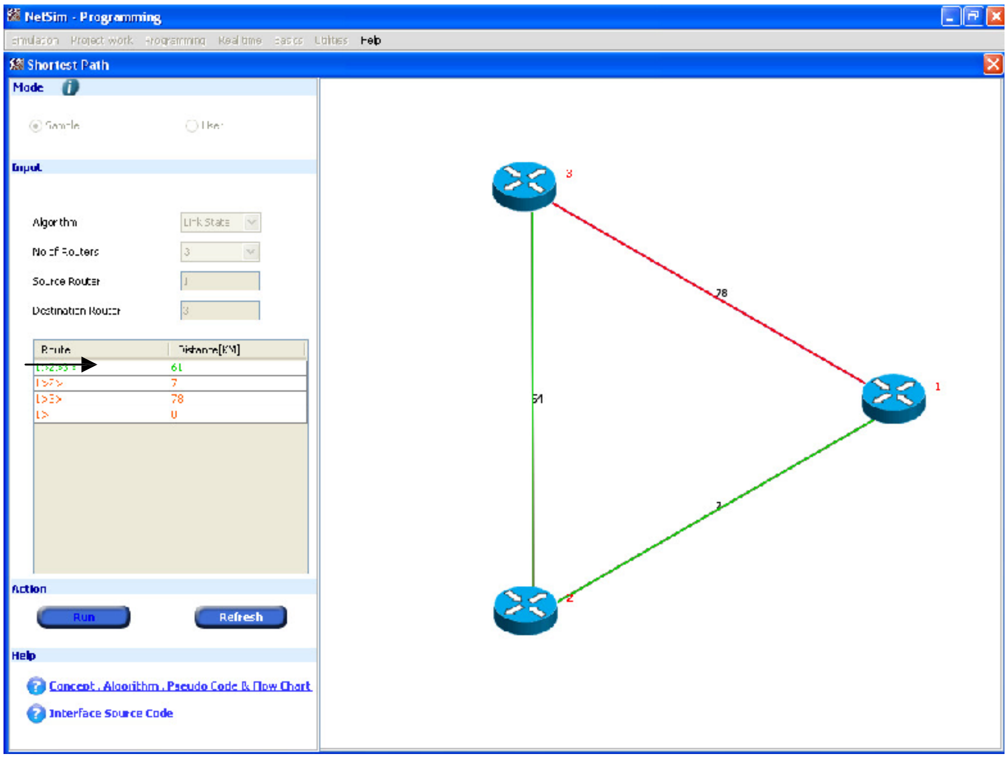


When you select the *User* mode, you have to write your own program in C/C++, compile and link to NetSim software for validation.

Click on F1 (Help) link for details on how to proceed with your own code.

Results (to be filled up by the students):

Output table



Inference (to be filled up by the students):

Here, Router 1 is taken as the source and Router 3 as the destination. The paths are connected with input as the distance. The figure indicated in green line shows the shortest path.

Experiment 4:

Objective:

To install any one open source packet capture software like wireshark etc. Monitor the traffic using Frames capture.

Description:

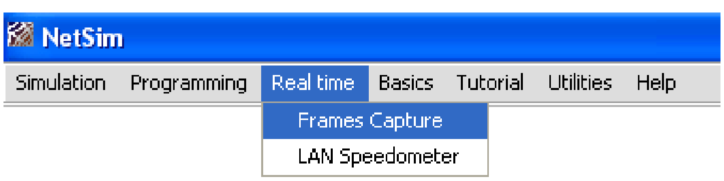
To analyze the packet capture in network we require active systems connected through network and a network monitoring tool. The network monitoring tool observes the network for data movement, as the tool recognizes data movement it will copy the data (even if it is not for itself) and analyses the data. The analyses of data include the correctness of the data, the data payload, overheads, the time of capture and also the protocols involved. Based on the data analyses the tool calculates the utilization and effective utilization of the network observed.

Procedure:

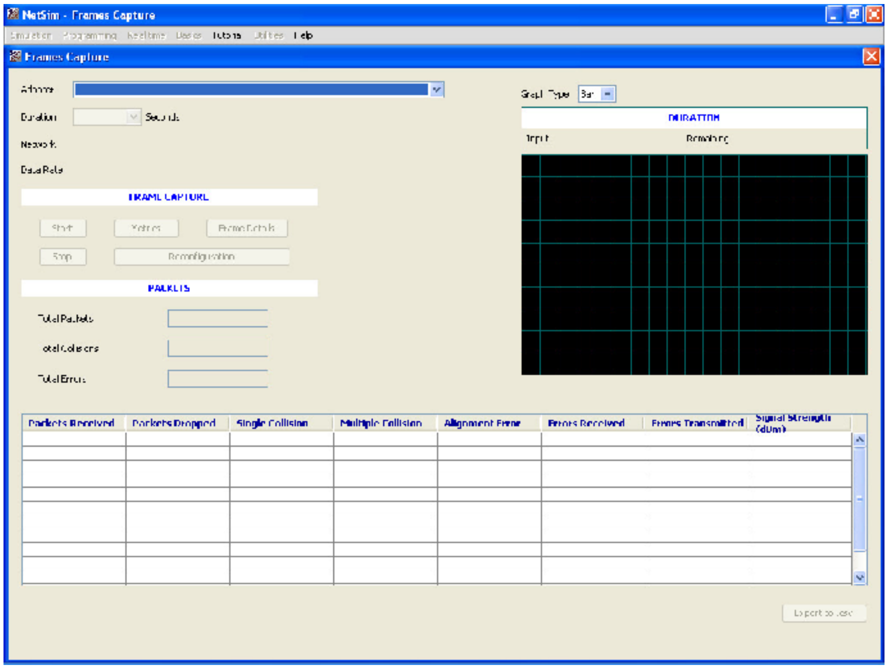
(1) Connect two systems by using a hub (Single broadcast domain).

(2) To begin with the experiment, open NetSim

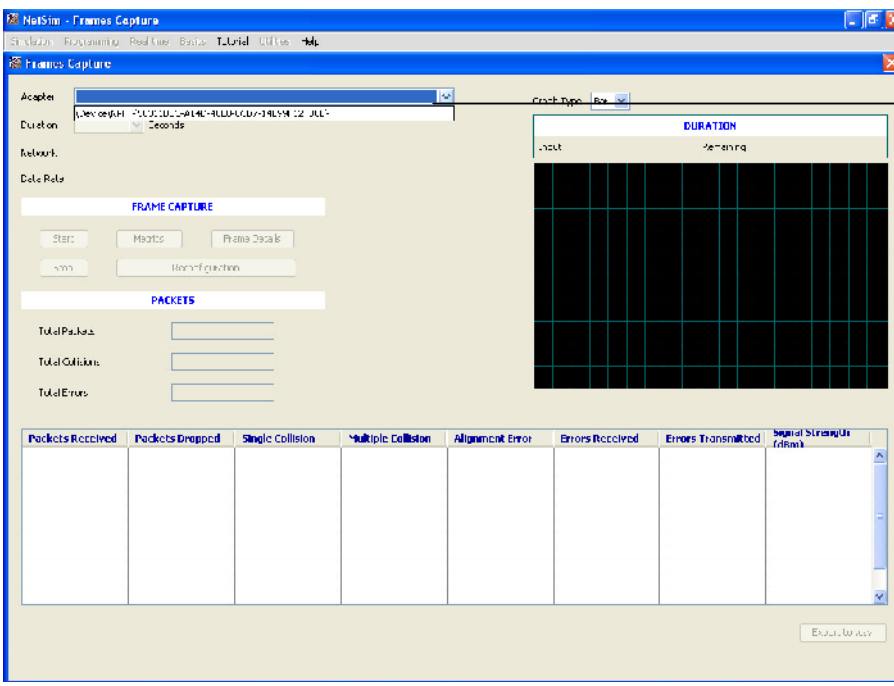
(3) Click on Real Time, select Frame Capture. The frame capture environment is now open.



The below figure shows the NetSim frame capture environment

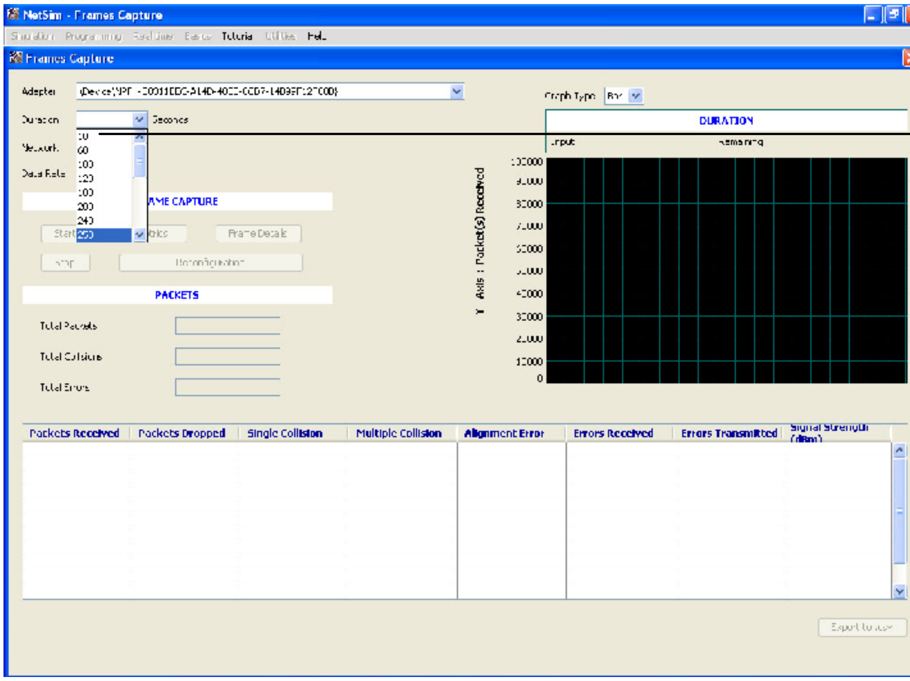


(4) Select the adapter



Select the network adaptor

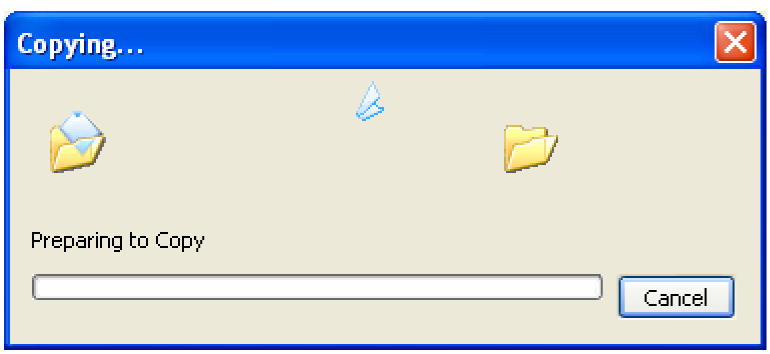
(5) Fix the time to how long user need to monitor the traffic.



Select the frame capture duration

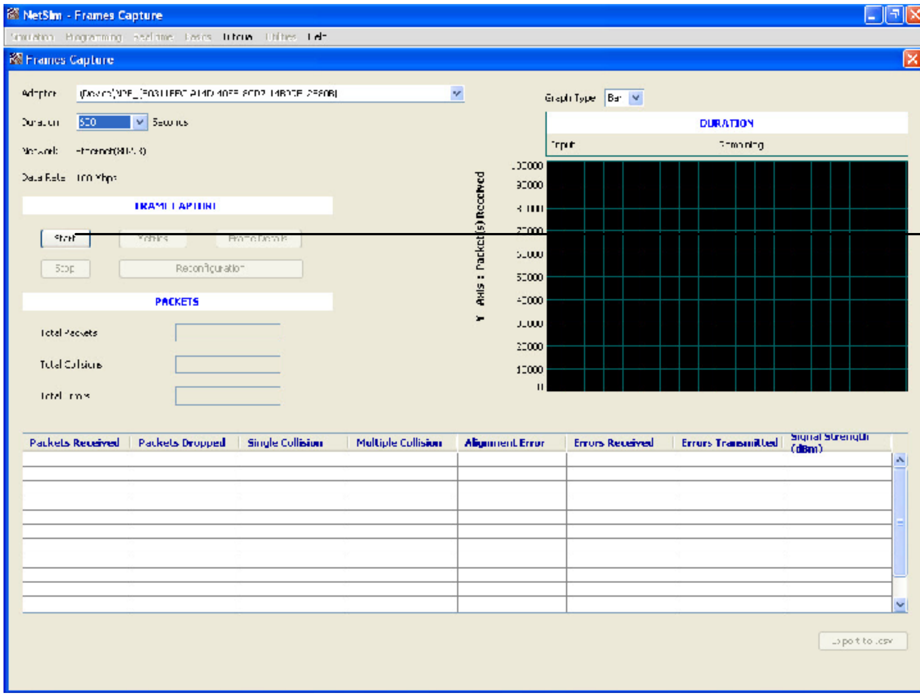
(6) Out of the two systems connected in hub copy a substantial big file from one system and paste it on to the other system.

Note: The file copying should happen for a longer time period for the tool to analyze the network.

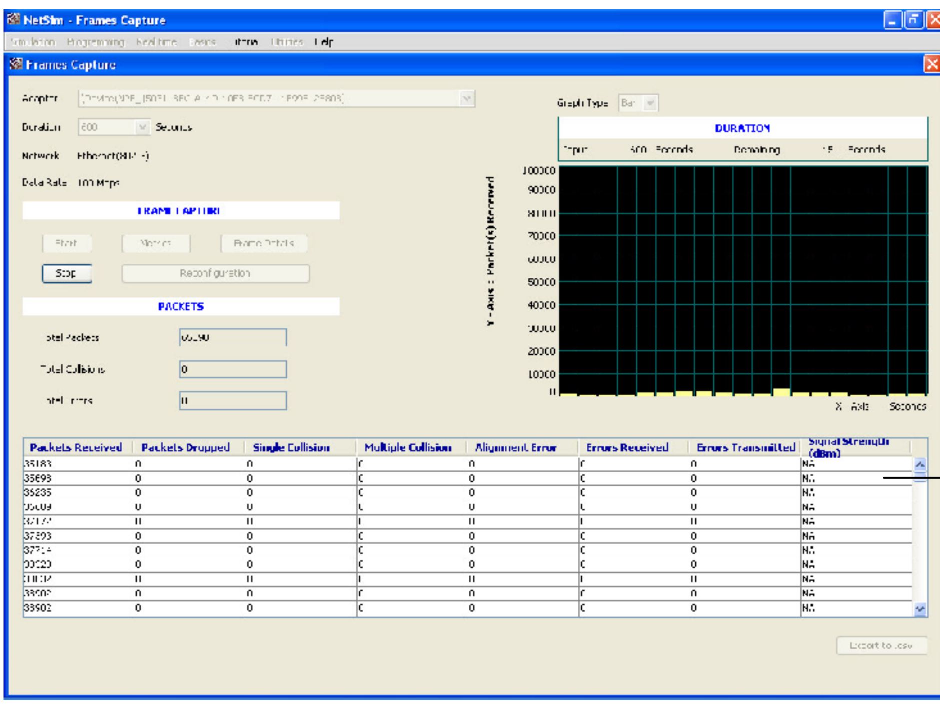


Transfer data from one machine to another

(7) As the file is getting transferred between systems start the traffic monitor by clicking the 'Start' button.

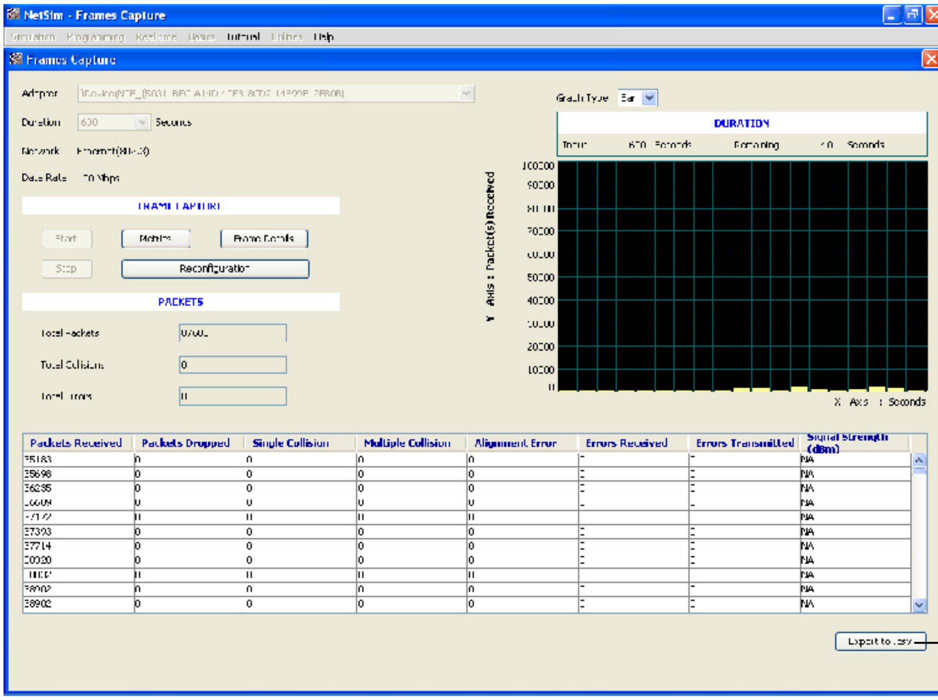


Click the Start button



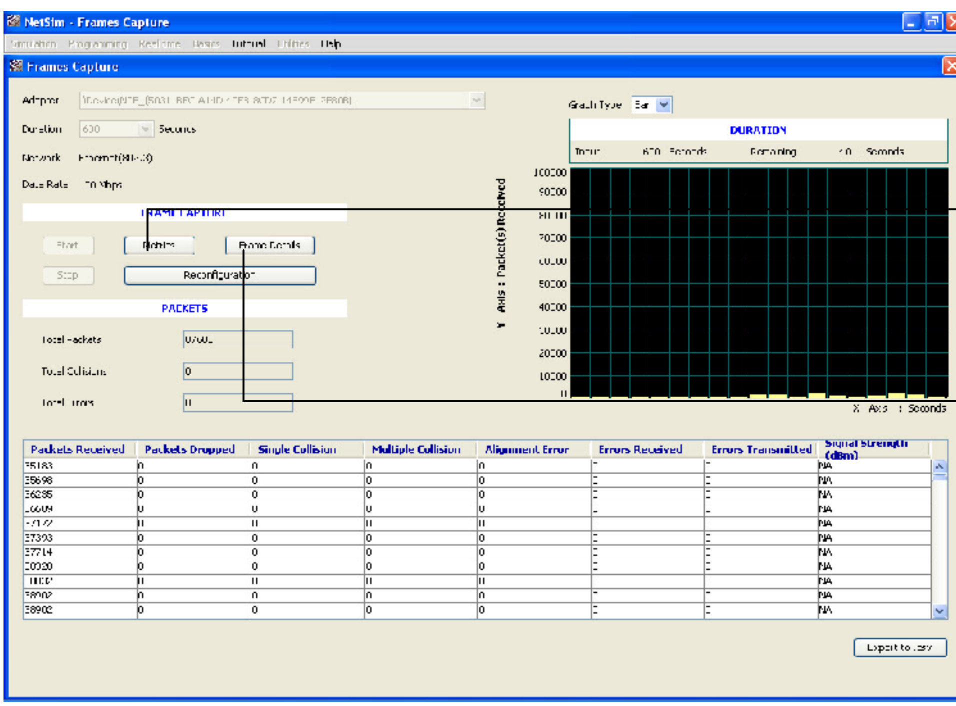
Data from the network getting captured

(8) After the duration time end click 'Export to .csv' button and note the values.



Click Export to .CSV

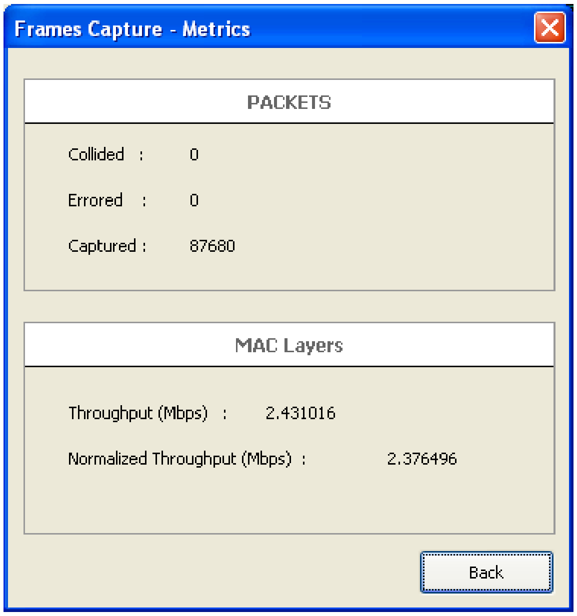
The details of the frame and the performance of the network can be viewed by clicking ‘Metrics’ and ‘Frame Details’ button.



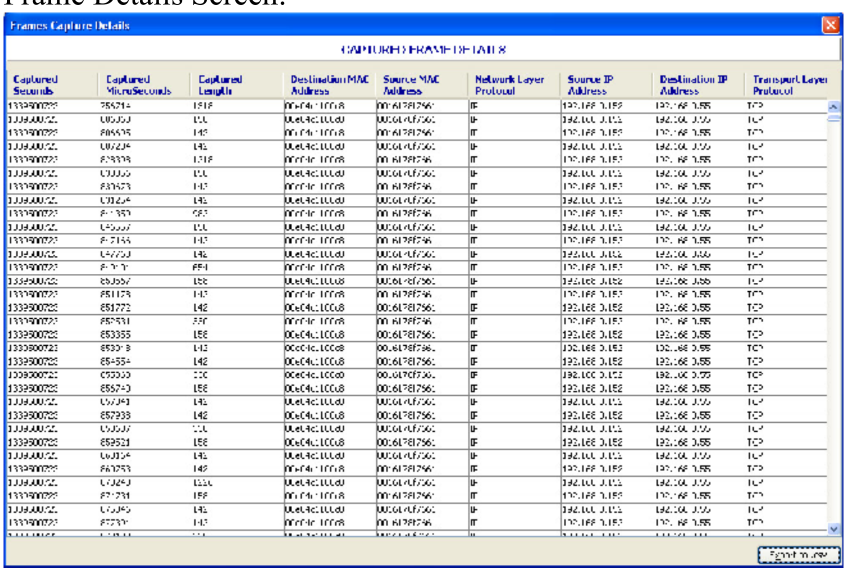
Click Metrics to view the metrics screen

Click Frame Details to view the frame details screen

Metrics Screen:



Frame Details Screen:



(9) Repeat the same procedure by increasing the number of systems in the network, and also increase the number of node transferring data in the network.

Inference:

Using Netpatrol one can analyze the through of the file transfer in the network. Furthermore you can drill down to each packet and get information relating to packet length, source IP address, Destination IP address, Source MAC Address, Destination MA Address etc.

Experiment 5:

Objective: To configure Wireless Local Loop and study how the number of channels increases and the Call blocking probability decreases as the Voice activity factor of a CDMA network is decreased.

Theory:

In traditional telephone networks, phone would be connected to the nearest exchange through a pair of copper wires. Wireless local loop (WLL) technology simply means that the subscriber is connected to the nearest exchange through a radio link instead of through these copper wires. Local loop refers to the circuit terminating at the subscriber's premises connecting the subscriber equipment to the switch of the telecommunications provider.

There are various technologies like frequency division multiple access (FDMA), time division multiple access (TDMA) and code division multiple access (CDMA) used for WLL. The one that is being used in India is CDMA. This is a full-fledged cellular mobile technology. In fact, it is the most dominant technology for mobile phone services in countries like the US and Korea.

Procedure:

How to Create Scenario & Generate Traffic:

Please navigate through the below given path to,

- **Create Scenario:** "Help NetSim Help F1 Simulation New Cellular CDMA Create Scenario".

Inputs

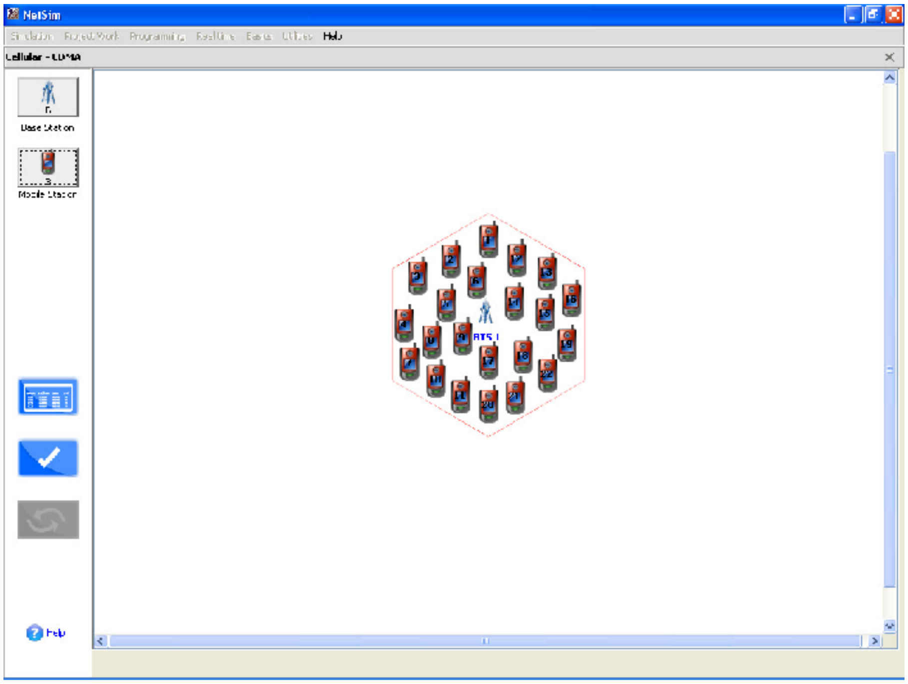
Follow the steps given in the different samples to arrive at the objective.

In all Samples,

- Total no of BTS used: 1
- Total no of MS used: 22

The devices are inter connected as given below,

- All the MS is placed in the range of BTS1



Set the properties of BTS and MS by following the tables for each sample,

MS Properties	MS 1	MS 3	MS 5	MS 7	MS 9
Destination	MS 2	MS 4	MS 6	MS 8	MS 10
Transmission Type	Point to Point	Point to Point	Point to Point	Point to Point	Point to Point
Traffic Type	Voice	Voice	Voice	Voice	Voice
``Call Details					
Distribution	Exponential	Exponential	Exponential	Exponential	Exponential
Mean Call Interval Time (sec)	300	300	300	300	300
Distribution	Exponential	Exponential	Exponential	Exponential	Exponential
Call Duration	60	60	60	60	60
Codec					
Codec	GSM-FR	GSM-FR	GSM-FR	GSM-FR	GSM-FR
Packet Size	33	33	33	33	33
Inter Arrival Time (micro sec)	20000	20000	20000	20000	20000
Service Type	CBR	CBR	CBR	CBR	CBR
Generation rate	0.0132	0.0132	0.0132	0.0132	0.0132
Mobility Model	No Mobility	No Mobility	No Mobility	No Mobility	No Mobility

Likewise, MS 11 to MS 12, MS 13 to MS 14, MS 15 to MS 17 and MS 19 to MS 20.

Inputs for Sample 1

BTS Properties	BTS
Standards	IS95A/B
Total bandwidth	1.25 MHz
Chip rate	1.2288 McPS
Voice Activity factor	**1.0**
Transmitter power	20 W
Path loss exponent	3
Fading figure	0.5
Standard deviation	11

Change the voice activity factor from 1.0, 0.9, 0.8, 0.7…. to 0.1.

Simulation Time – 1000 sec

Output

To view the output by using NetSim Sample experiments need to be added onto the Analytics interface. Given below is the navigation for analytics -

“Simulation Analytics”.

Select the experiments by selecting

Cellular Protocols

Select the Experiments (Note**:** Click one experiment after another to compare the experiments in the Analytics interface).

Select the Metric: Call Blocking probability & Number of channel

Comparison Charts and Inference:

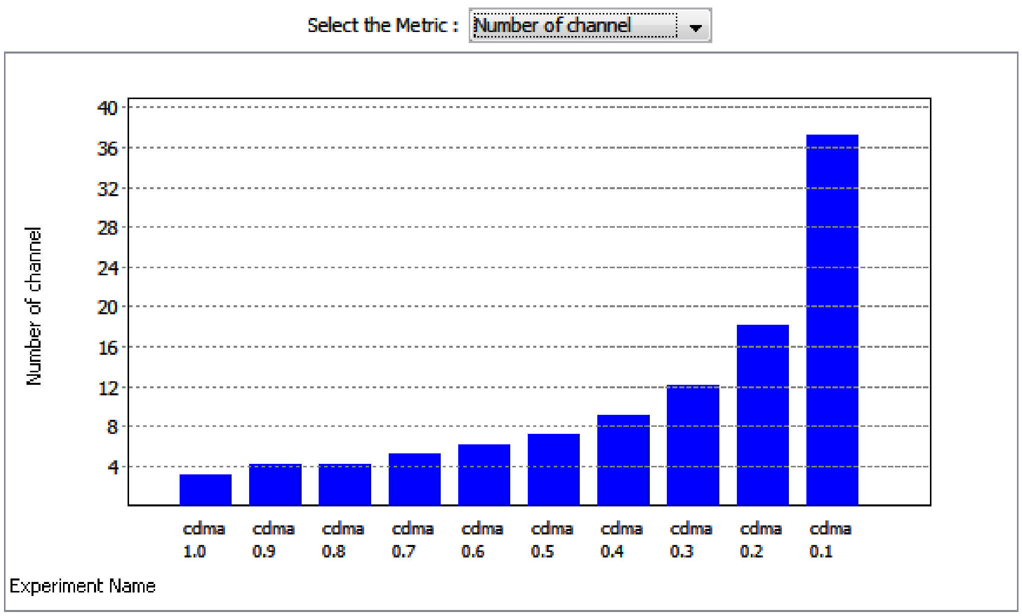


Chart 1

When the system Voice activity factor decreases from 1.0 to 0.1, the number of channels increases from 3 to 37. (Note: All other parameters like Bandwidth 1.25 MHz, chip rate 1.2288McPS, target SNR 6, Path loss exponent 3, Fading figure 0, and standard deviation 11, are constant in all the samples taken.)

In CDMA network, the number of channels is inversely proportional to the voice activity factor.

$$\text{Number of channels} \;\alpha\; \frac{1}{\text{Voice activity factor}}$$

Chart 1 is a mirrored form of the $y = \frac{1}{x}$ graph. (This is because VAF is decreasing along + ve X)

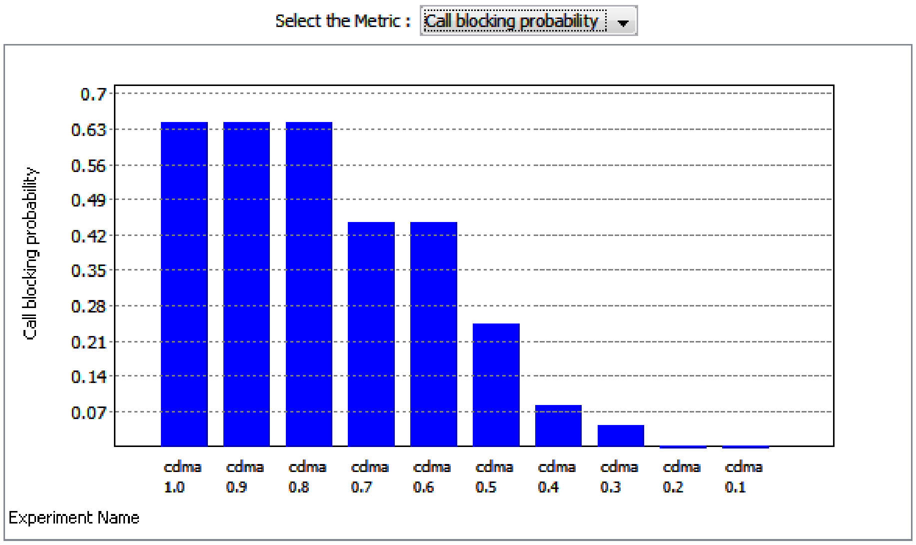


Chart 2

When voice activity factor is decreased the number of channels available increases. Thus the system has more number of channels to handle the same number of calls (Note - Number of MS is constant and their properties are same across all experiments. So, they generate approximately same number of calls throughout).

Let us also understand why the call blocking probability of Sample1, Sample2, Sample3 is equal and again is equal for Sample4, sample5. In this experiment, all the mobile stations are placed on only BS: base station1. One call requires 2 channel (One is for caller party and another is for called party). So, even if base station 1 has one free channel, the also the call is blocked.

For Sample1,

Total number of channel = 3.

Number of traffic channel = 3-1 = 2.

Means BTS can handle only 1 call at a time.

For Sample2,

Total number of channel = 4

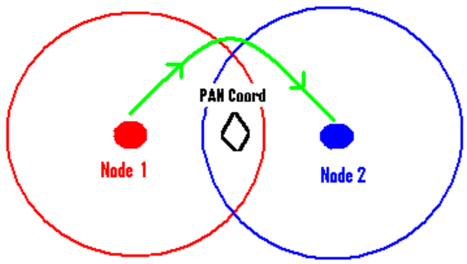
Number of traffic channel = 4-1 = 3.

So, here also in this particular scenario where caller and called party are in BTS1, BTS1 can handle only 1 call at a time. The 1 extra channel that is not available in sample1 is wasted throughout. So, number of blocked calls or call blocking probability is same as sample1.

Experiment 6:

Objective:

To plan Personal Area Network and analyze the scenario shown, where Node 1 transmits data to Node 2, with no path loss and obtain the theoretical throughput based on IEEE 802.15.4 standard. Compare this with the simulation result.



Introduction:

IEEE Standard 802.15.4 defines the protocol and compatible interconnections for data communication devices using low-data-rate, low-power, and low-complexity short-range radio frequency (RF) transmissions in a wireless personal area network (WPAN). In Wireless sensor network IEEE 802.15.4 standard is used in MAC and PHY layers.

IEEE 802.15.4 PHYs provide the capability to perform CCA in its CSMA-CA mechanism. The PHYs require at least one of the following three CCA methods: Energy Detection over a certain threshold, detection of a signal with IEEE 802.15.4 characteristics, or a combination of these methods.

Theory:

- A packet transmission begins with a random backoff (in number of slots, each slot of 20 T_s duration) which is sampled uniformly from 0 to $2^{macminBE} - 1$ followed by a CCA.
- A CCA failure starts a new backoff process with the backoff exponent raised by one, i.e., to macminBE+1, provided it is lesser than the maximum backoff value given by macmaxBE.
- Maximum number of successive CCA failures for the same packet is governed by macMaxCSMABackoffs, exceeding which the packet is discarded at the MAC layer.
- A successful CCA is followed by the radio turnaround time and packet transmission.

- If the receiver successfully receives the packet i.e., without any collision or corruption due to PHY layer noise, the receiver sends an ACK after the radio turnaround time.
- A failed packet reception causes no ACK generation.
- The transmitter infers that the packet has failed after waiting for macAckWaitDuration and retransmits the packet for a maximum of aMaxFrameRetries times before discarding it at the MAC layer.

Note:
In NetSim the radio turnaround time after a CCA success is not considered.

Simulation:

How to plan Personal Area Network in NetSim:

In the **Simulation** menu select **Simulation** **New** **PAN**

To perform experiments in **ZigBee**, the following steps should be followed,

- **Create Scenario**
- **Set Node Properties**
- **Set PAN Coordinator Properties**
- **Set Environment Properties**
- **Remove Devices**
- **Simulate**

Create Scenario

Adding Node -

- **Click** on the **Node** icon and **drag** and **drop** it inside the **Environment** (i.e. **Visibility Range** - The systems can move and communicate in this range only).

A Node cannot be placed on another Node. A Node cannot float outside the **Environment**. It has to be dragged and placed inside the **Visibility Range**.

Adding PAN Coordinator - Click on the **PAN Coordinator** icon and **drag** and **drop** it onto the environment builder.

Set Node Properties

Right Click on the appropriate node to select Properties. Inside the properties' window clicks on Application 1 to modify its properties.

Transmission Type

This indicates the type of transmission made by this session, Point to Point.

Destination

This property indicates the Destination Node.

Traffic Type

This property indicates the type of traffic. The traffic can either be Voice or Data.

Voice

Codec

Codec is the component of any voice system that translates between analog speech and the bits used to transmit them. Every codec transmits a burst of data in a packet that can be reconstructed into voice. Three different standards of voice codec's are given which can be selected depending on the variations required.

Service Type

- **CBR** - CBR stands for Constant Bit Rate. Packets of constant size are generated at constant inter arrival times.
- **VBR** - VBR stands for Variable Bit Rate. The two types of Suppression Model that can be selected are,
  - **Deterministic**
  - **Markov Chain**
  - **Success Ratio (%)**

Click **OK** to accept the user entered values. Click on the close button at the top right corner to exit the screen.

Data

Packet Size

Distribution: The options available for distribution are,

- **Constant**
- **Exponential**

Mean Packet Size (Bytes): Sets the size of the packets being generated by the Constant distribution. The ranges of values that can be entered are between 10 to 10000 bytes. By default 1472 bytes is entered.

Inter Arrival Time

This indicates the time gap between packets.

Distribution : The options available for distribution are,

- **Exponential**
- **Uniform**
- **Constant**

Mean Inter Arrival Time: Enter the average inter-arrival time between packets. A lower inter-arrival time would lead to a higher generation rate and the vice versa. The ranges of values that can be entered are between 1000 to 20000 Micro Sec. By default 20000 Micro Sec is entered.

Data Link Layer

Protocol – IEEE 802.15.4 is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs).

Mac Address - A **Media Access Control address** (MAC address) is a unique identifier assigned to network interfaces for communications on the physical network segment.

Device Type- Full Function Device is one of the devices in IEEE 802.15.4 wireless networks. By **default** the device type is **FFD**.

Retry Limit - Indicate the number of attempts that can be made by a frame. This **varies** from **1** to **7**. By **default** the **Retry Limit** value is **7**.

Ack request – Frame transmitted with the Acknowledgment Request subfield of its frame control field set to one shall be acknowledged by the recipient. It can be enabled or disabled. By **default** it is **enabled.**

Physical Layer

Protocol – IEEE 802.15.4 is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs).

Transmitter Power (milli watts) - This property defines the power level of the **Node**. By **default** the value for **Transmitter Power** is **100 milli watts**.

Transmitter Range (meters) - This property defines the Range of Transmitter. By **default** the value for **Transmitter Range** is **100 meters**.

This **View** button is enabled once the **Accept** Button is clicked. To view the given values, click on the **View** button.

Click **OK** to accept the user entered values. Click on the close button at the top right corner to exit the screen.

Modifying/Viewing/Accepting Properties

On opening an already configured properties of an application the input fields will be frozen (i.e. the input cannot be changed).To modify these values click on the **Modify** button in the screen. Now the input value can be changed. Click on the **Accept** button, the modified values will be saved.

This **View** button is enabled once the **Accept** Button is clicked. To view the given values, click on the **View** button.

Set PAN Coordinator Properties

Right Click on the **PAN Coordinator** and **click Properties**. Options available are,

PAN Coordinator Properties

Data Link Layer - The options available under this property is,

Protocol – IEEE 802.15.4 is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs).

Beacon Mode – Beacon Mode defines synchronization and reliability of the transmission mechanism, whereas beaconless networks adopt a simple lightweight protocol based on CSMA-CA. There are two options available, Enable/Disable**. Default** is set as **enable**

Beacon Order – Beacon Order, describes the interval at which the coordinator shall transmit its beacon frames. **15** denote that **beacon mode is disabled**; if **Beacon mode is enabled** then the **Beacon Order value** can range from **0 to 14. Default Beacon Order** value is **15.**

Superframe Order – Superframe Order describes the length of the active portion of the superframe, which includes the beacon frame**.** This property will be there, only in case of beacon mode is enabled. The value of Superframe Order should be less than **15**. **Default** value is **15.**

GTS Mode - GTS (Guaranteed Time Slot) allows a device to operate on the channel within a portion of the superframe that is dedicated (on the PAN) exclusively to that device. This property will be there, only if beacon mode is enabled. By **default** the **GTS Mode** is **enabled.**

Superframe Duration – The Superframe Duration (SD) is divided into 16 equally sized time slots, during which data transmission is allowed. The SD can be further divided into a Contention Access Period (CAP)and an optional Contention Free Period (CFP) composed of Guaranteed Time Slots. A **default** value has been coded in; hence no change can be made. The fixed value is **15.36 ms.**

Battery Life Extension – The Battery Life Extension (BLE) subfield is 1 bit in length and shall be set to one if frames transmitted to the beaconing device during its CAP(Contention Access Period) are required to start on or before macBattLifeExtPeriods full backoff periods after the IFS (inter frame space or spacing) period following the beacon. Otherwise, the **BLE** subfield shall be set to **0**. The options available are **True/False**. This property will be there, only in case of beacon mode is **enabled**. By **default** the **Battery Life Extension mode** is **true.**

Maximum Backoff Exponent – The maximum value of the backoff exponent (BE) in the CSMA-CA algorithm. The Maximum Backoff Exponent value ranges from **3 to 8. Default** value is **5.**

Minimum Backoff Exponent – The minimum value of the backoff exponent (BE) in the CSMA-CA algorithm. The Minimum Backoff Exponent value rangse from **0 to Max BE. Default** value is **5.**

Max Frame retries – The maximum number of retries allowed after a transmission failure. The Max Frame retries value ranges from **0 to 7.** By **default** the **Max Frame retries** value is **3.**

MAX CSMA Backoff - The maximum number of backoffs the CSMA-CA algorithm will attempt before declaring a channel access failure. The MAX CSMA Backoff value ranges from **0 to 5. Default** value is **4.**

Unit Backoff Period - The number of symbols forming the basic time period used by the CSMA-CA algorithm. A **default** value has been coded in; hence no change can be made. The value is **20 Symbols.**

Min CAP length - The minimum number of symbols forming the CAP (contention access period).This ensures that MAC commands can still be transferred to devices when GTSs (Guaranteed Time Slot) are being used. A **default** value has been coded in; hence no change can be made. The value is **440 Symbols**

GTS descriptor Persistent Time - A default value has been coded in; hence no change can be made. The **GTS descriptor Persistent Time** is 4 s.

Physical Layer - The options available under this property is,

Protocol – IEEE 802.15.4 Phy - IEEE 802.15.4 is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs).

Frequency Band - Frequency bands are groupings of radio frequencies that are used by mobile networks to communicate with mobile phones. **A default** value has been coded in; hence no change can be made. The value is **2.4 GHz**.

Data Rate - Data rate or bit rate is the number of bits that are conveyed or processed per unit of time. **A default** value has been coded in; hence no change can be made. The value is **250 kbps**.

Chip Rate - The chip rate of a code is the number of pulses per second (chips per second) at which the code is transmitted (or received). The chip rate is larger than the symbol rate, meaning that one symbol is represented by multiple chips. **A default** value has been coded in; hence no change can be made. The value is **2000 McPs**.

Symbol Rate - In digital communications, symbol rate (also known as baud or modulation rate) is the number of symbol changes (waveform changes or signaling events) made to the transmission medium per second using a digitally modulated signal or a line code. **A default** value has been coded in; hence no change can be made. The value is **62.5 KSymbolsPS**.

Modulation Technique - Offset quadrature phase-shift keying (OQPSK) is a variant of phase-shift keying modulation using 4 different values of the phase to transmit. It is sometimes called staggered quadrature phase-shift keying (SQPSK).

Min LIFS period - The minimum number of symbols forming a LIFS (Long Inter Frame Spacing) period. **A default** value has been coded in; hence no change can be made. The value is **40 Symbols**.

Min SIFS period - The minimum number of symbols forming a SIFS (Short Inter Frame Spacing) period. **A default** value has been coded in; hence no change can be made. The value is **20 Symbols**.

Unit Backoff Time - The number of symbols forming the basic time period used by the CSMA-CA algorithm. **A default** value has been coded in; hence no change can be made. The value is **20 Symbols**.

Turn Around Time - The TX-to-RX turnaround time is defined as the shortest time possible at the air interface from the trailing edge of the last chip (of the last symbol) of a transmitted PPDU to the leading edge of the first chip (of the first symbol) of the next received PPDU. The RX-to-TX turnaround time is defined as the shortest time possible at the air interface from the trailing edge of the last chip (of the last symbol) of a received PPDU to the leading edge of the first chip (of the first symbol) of the next transmitted PPDU. **A default** value has been coded in; hence no change can be made. The value is **12 Symbols**.

Phy SHR Duration – The duration of the synchronization header (SHR) in symbols for the current PHY. The Values available are **3, 7, 10, and 40.** By default Phy SHR Duration is **3.**

Phy Symbol Per Octet - The number of symbols per octet for the current PHY. The Values available are **0.4, 1.6, 2, 8.** By **default** phy symbol per octet is **0.4.**

CCA mode

The following are the available options under CCA mode,

- **Carrier Sense Only (by default this options is selected).**
  CCA (Clear Channel Assessment) shall report a busy medium only upon the detection of a signal compliant with this standard with the same modulation and spreading characteristics of the PHY that is currently in use by the device. This signal may be above or below the ED threshold.
- **Energy Detection**
  CCA shall report a busy medium upon detecting any energy above the ED threshold.
- **Carrier Sense with Energy Detection**
  CCA shall report a busy medium using a logical combination of Detection of a signal with the modulation and spreading characteristics of this standard and Energy above the ED threshold, where the logical operator may be AND/OR.

Receiver Sensitivity –Threshold input signal power that yields a specified PER (packet error rate) conditions PSDU (PHY service data unit) length = 20 octets PER less than 1% Power measured at antenna terminals. Interference not present The Receiver Sensitivity Value should be less than **0**. **Default** value is **-85 dbm**.

ED threshold - The receiver ED threshold is intended for use by a network layer as part of a channel selection algorithm. It is an estimate of the received signal power within the bandwidth of the channel. No attempt is made to identify or decode signals on the channel. If the receive signal power is greater than the ED threshold value then the channel selection algorithm will return false. The **ED threshold** Value should be **less than 0**. **Default** value is **-95 dbm**.

Set Environment Properties

Right click in side of the on the Environment and **click Properties.**

Channels - There are sixteen non-overlapping channel numbered from **11 to 26 for 2450** MHz band in **802.15.4** standard. **Default** value is **11**.

Frequency (MHz) - This property defines the **frequency** allotted for the channel selected. By **default Frequency** (**MHz**) used is **2405 MHz**, since the **Channel** value is **11**.

Channel Characteristics - This property defines the **Channel Characteristics** for the **Agent**. It consists of the following options.

- **Fading and Shadowing** (default option).
- **Fading only**
- **Line of Sight**
- **No Path Loss**

Path loss Exponent – Path loss exponent indicates the rate at which the path loss increases with distance. The value depends on the specific propagation environment. The value varies range from 2 to 5. The **default** value is **3.5.** This property will be enabled only for **Fading and Shadowing, Fading only, and Line of Sight**.

Fading Figure m (0.5 to 5) - The parameter 'm', the "fading figure", is defined as the ratio of moments, and the **default** value is **1.0**. The value of m = 1 corresponds to Rayleigh fading, and m > 1 indicates better fading conditions than Rayleigh and usually indicates Line of Sight available between agent. This value varies from **0.5 to 5.** This property will be enabled only for **Fading and Shadowing, and Fading only.**

Standard Deviation - Shadowing is caused mainly by terrain features of the radio propagation environment. The mathematical model for shadowing is a log-normal distribution with standard deviation of **5 to 12 dB**. This has been found to be the best available data to be taken. The **default** value is **12 db**. This property will be enabled only for **Fading and Shadowing.**

Remove Devices (or) Links

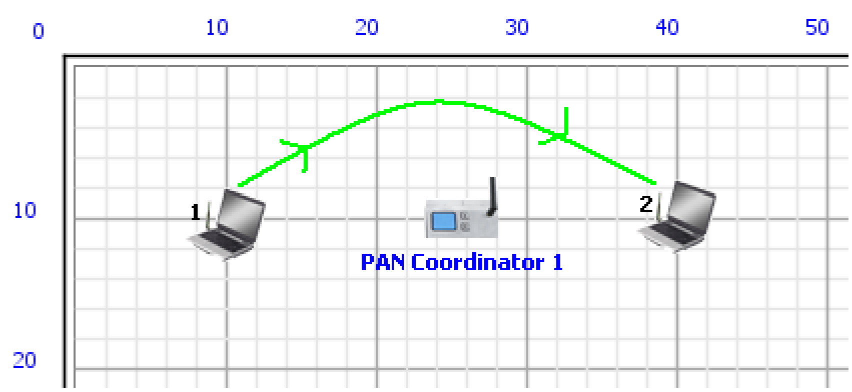
Remove Node - Right click on the appropriate **Node** and **click Remove**.

Remove PAN Coordinator - Right click on the appropriate **PAN Coordinator** and **click Remove**.

Simulate - After creating the **Scenario** the following steps need to be followed,

- **Click** on **Validate** button.
- **Click** on **Simulate** button.
- **Select** the **Simulation End Time** and then **click** on "**OK"** button to start the **Simulation**.

Analyze the scenario shown below:



Create the scenario as shown using drag and drop.

Node 1 Properties:

Node Properties	Node - 1

Transmission	Point-to-Point
Destination	Node2
Traffic Type	Data
Distribution	Constant
Application Data Size (Bytes)	501
Distribution	Constant
Mean Inter Arrival Time(µs)	16000
ACK Request	Enable
Retry Limit	7
Transmitter power (mW)	100
Transmitter Range	100

PAN Co-ordinator Properties: Accept default properties.

Environment Properties: Accept default properties.

Simulation Time: **50 Seconds**

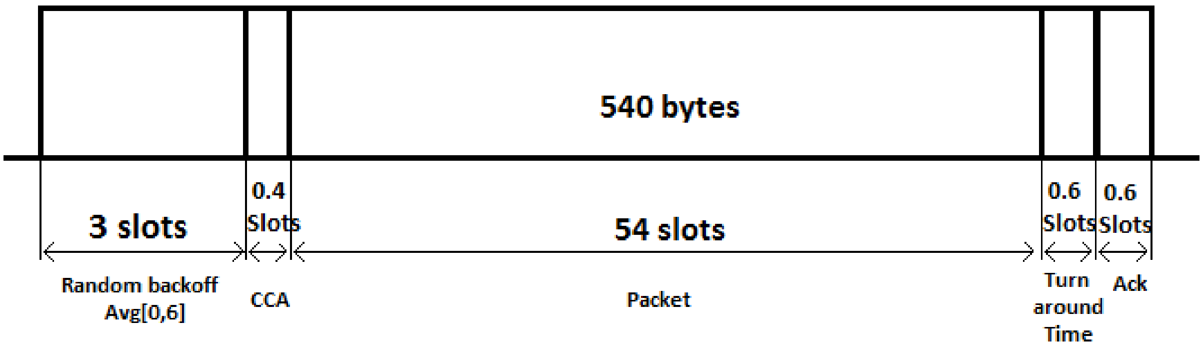
Throughput obtained from the simulation is **206.492 kbps**

Theoretical Analysis:

We have set the Application layer payload as 501 bytes in the Node1 properties and when the packet reaches the physical layer various other headers gets added like

App layer Payload	501 Bytes
IP Header	20 Bytes
MAC Header	13 Bytes
PHY Header	6 Bytes
Packet Size	540 Bytes

In simulation, by default NetSim uses Unslotted CSMA/CA and so a packet transmission happens after a random backoff, CCA and is followed by turn-around-time and ACK packet and each of them occupies specific time set by the IEEE 802.15.4 standard as per the timing diagram shown below.



From standard each slot has 20 Symbols in it and each symbol takes 16µs for transmission

Symbol	T_s	16 µs
$\boldsymbol{Slots}$	20 * T_s	0.32 ms
Random Backoff Average	3.5 *	1.12 ms
CCA	0.4 *	0.128 ms
Packet Transmission Time	54 *	17.28 ms
Turn-around-Time	0.6 *	0.192 ms
ACK Packet Time	0.6 *	0.192 ms
Total Time	59.6 * $Slots$	18.912ms

$$Throughput = \frac{501(bytes)\ in\ App\ layer}{18.912\ ms} = 211.92$$

Inference:

Throughput from simulation	206.492 kbps
Throughput from analysis	211.92 kbps

Throughput from theoretical analysis matches the results of NetSim's discrete event simulation.

Note: The slight difference in throughput is due to fact that the average of random numbers generated for backoff need not be exactly 3 as the simulation is run for short time and also in Network layer DSR protocol is running so, route setup process will take some time.

Experiment 7:

Objective: To configure WLAN (IEEE 802.11b) network, and study how the loss, utilization and transmission time varies as the distance between the Access Point and the wireless nodes is varied.

Theory:

Please navigate through the below given path to,

- **Theory:** Basics LAN Protocols Wireless LAN IEEE 802.11 PHY.

In most of the WLAN products on the market based on the IEEE 802.11b technology the transmitter is designed as a Direct Sequence Spectrum Phase Shift Keying (DSSS PSK) modulator, which is capable of handling data rates of up to 11 Mbps. The system implements various modulation modes for every transmission rate, which are Different Binary Phase Shift Keying (DPSK) for 1 Mbps, Different Quaternary Phase Shift Keying (DQPSK) for 2 Mbps and Complementary Code Keying (CCK) for 5.5 Mbps and 11 Mbps.

Large Scale Fading represents Receiver Signal Strength or path loss over a large area as a function of distance. The statistics of large scale fading provides a way of computing estimated signal power or path loss as a function of distance and modulation modes vary depends on the Receiver Signal Strength.

How to configure WLAN in NetSim:

New Experiments

In the **Simulation** menu select **New LAN Wireless LAN 802.11b.**

To perform experiments in **Wireless LAN**, the following steps should be followed,

- **Create Scenario**
- **Set Node Properties**
- **Set Access Point (AP) Properties**
- **Remove Devices (or) Links**
- **Simulate**

Create Scenario

Adding Wireless AP - Click on the **Wireless AP** icon and **drag** it onto the environment builder.

Adding Switch - Click on the **Switch** icon and **drag** it onto the environment builder. By default a **Switch** consists of eight ports.

Adding Node -

- **Click** on the **Node** icon and **drag** and **drop** it on the **Wireless AP**.
- **Nodes** cannot be connected directly to each other because an intermediate connecting component (such as **Switch**) is required.
- A **Node** cannot be placed on another **Node**. It has to be dragged and placed on any connecting component.

Establishing Connections between Switch, Wireless AP and Nodes - Click the **two devices** to connect them**.** These two devices are connected via a **Link**

Set Node Properties

Right Click on the appropriate node to select Properties. Inside the property window click on Application 1 to modify its properties.

Transmission Type

This indicates the type of transmission made by this session, either Broadcast or Point to Point.

Destination

This property indicates the Destination Node.

Traffic Type

This property indicates the type of traffic. The traffic can either be Voice or Data.

Voice

Codec

Codec is the component of any voice system that translates between analog speech and the bits used to transmit them. Every codec transmits a burst of data in a packet that can be reconstructed into voice. Five different standards of voice codec's are given which can be selected depending on the variations required.

Service Type

- **CBR** - CBR stands for Constant Bit Rate. Packets of constant size are generated at constant inter arrival times.
- **VBR** - VBR stands for Variable Bit Rate. The two types of Suppression Model that can be selected are,
    - **Deterministic**
    - **Markov Chain**

Click **OK** to accept the user entered values. Click on the close button at the top right corner to exit the screen.

Data

Packet Size

Distribution: The options available for distribution are,

- **Constant**
- **Exponential**

Mean Packet Size (Bytes): Sets the size of the packets being generated by the chosen distribution. The range of values that can be entered are between 65 to 1500 bytes. By default 1500 bytes is entered.

Inter Arrival Time

This indicates the time gap between packets.

Distribution : The options available for distribution are,

- **Constant**
- **Exponential**
- **Uniform**

Mean Inter Arrival Time: Enter the average inter-arrival time between packets. A lower inter-arrival time would lead to a higher generation rate and the vice versa. The range of values that can be entered are between 1000 to 20000 Micro Sec. By default 20000 Micro Sec is entered.

Click **OK** to accept the user entered values. Click on the close button at the top right corner to exit the screen.

RTS Threshold (Bytes)

This is to allow the node to enable/disable the RTS/CTS mechanism. The valid value ranges from "0 to 2347". Default values are 0 bytes.

Retry Limit

This indicates the number of attempts that can be made by a frame. The option varies from 1 to 7.

Modifying/Viewing/Accepting Properties

On opening an already configured properties of an application the input fields will be frozen (i.e. the input cannot be changed).To modify these values click on the **Modify** button in the screen. Now the input value can be changed. Click on the **Accept** button, the modified values will be saved.

This **View** button is enabled once the **Accept** Button is clicked. To view the given values, click on the **View** button.

Set Access Point (AP) Properties

Right click on the appropriate **Access Point** (**AP**) and **click Properties**. Options available are,

Wireless Properties - Under **Wireless Properties** tab the options available are,

> **Connected To** - This property defines the **Wireless** medium connected to the **Access Point** (**AP**). A **default** value is already entered; hence no changes can be done.

Communication - This property defines the **Communication** mode of the network. By **default**, a **Wireless LAN** network works in **Half Duplex**. This property cannot be changed.

Data Link Layer - Under **Data Link Layer** the sub-options available are,

MAC Address - A **default** value has been coded in, hence no change can be made.

Buffer Size (MB) - This property defines the buffer capacity of the **Wireless Port**. Options available are **"1, 2, 3, 4 and 5". Default** value is **5MB**.

Retry Limit - Indicate the number of attempts that can be made by a frame. This **varies** from **1** to **7**. By **default** the **Retry Limit** value is **7**.

RTS Threshold (Bytes) - This property is to allow the node to **enable/disable** the **RTS/CTS** mechanism. By **default** the value that is available is **2347 Bytes**. **Limit** ranges from **0** to **2347 Bytes**.

Physical Layer - Under **Physical Layer** the sub-options available are,

Standard - This property gives the **standard** that is followed for modeling **Physical Layer**. By **default** the **standard** is **IEEE 802.11b** can be found next to this property.

Transmission type - This property specifies that the **DSSS**. DSSS is used as a **Transmission** technology.

Channels - The **Channels** that are allowed for the **Access Points** (**AP**) to operate are 1, 6, and 11. By **default** the value entered is 1.

Frequency (MHz) - This property defines the **frequency** allotted for the channel selected. By **default Frequency** (**MHz**) found is **2412 MHz**, since the **Channel** value is **1**. Refer the table for further details,

Channels	Frequency (MHz)
1	2412
6	2437

11	2462

Transmitter Power (milli watts) - This property defines the power level of the **Access Points** (**AP**). It ranges from **1** to **100 milli watts**. By **default** the value for **Transmitter Power** is **100 milli watts**.

Channel Characteristics - This property defines the **Channel Characteristics** for **Access Point**. It consists of the following options,

- **Without Fading**
- **With Fading**
- **With Shadowing** (by default this option is displayed)

Ethernet Port Properties - To set the properties of the **Ethernet Port** of **access point** select the **Ethernet Port Properties** tab. Options available are,

Connected To - This property gives the **Port** number and the **Switch** number that the **Access Point** (**AP**) is connected.

For E.g.: If the **Port** number is P**ort1** and the **Switch** number is **Switch1**, then, **Connected To** **Port1** of **Switch1**.

Communication - This property defines the **Communication** mode of the network. By **default**, the **Switch** to **Wireless AP** connectivity works in **Full Duplex**, hence the user cannot change this property.

Data Link Layer - Under **Data Link Layer** the following sub-options are,

MAC Address - This field is filled up with a **default** value. Changes cannot be made.

Buffer Size (MB) - This property defines the **Buffer** Capacity of the **Wireless Port**. Options available are **"1, 2, 3, 4 and 5". Default** value is **1MB**.

Data Rate (Mbps) - This property defines the rate at which the link transmits data. By **default** the **Data Rate** (**Mbps**) is **100**. **100 Mbps** means 100 Mega Bits per Second. Changes cannot be made.

Error Rate (BER) - This property defines the rate at which the data is affected by error in the network. By **default** the **Error Rate** (**BER**) is **No Error**. Changes cannot be made.

Physical Medium - This property defines the type of **Physical Medium** that is used in the network. By **default** the **Physical Medium** is **Twisted Pair**.

Remove Devices (or) Links

Remove Link - **Right click** on the appropriate **Link** and **click Remove**.

Remove Node - Right click on the appropriate **Node** and **click Remove**.

Remove Switch - Right click on the appropriate **Switch** and **click Remove**.

Remove Wireless AP - Right click on the appropriate **Wireless AP** and **click Remove**.

Note:

- If a **Node** transmitting data is removed, all traffic originating from this **Node** is also deleted.
- In cases where the **Switch/Wireless AP** is in a network (connected to each other), firstly the connection need to be removed. Subsequently the **Switch/Wireless AP** can be removed.

Simulate - After creating the **Scenario** the following steps need to be followed,

- **Click** on **Validate** button.
- **Click** on **Simulate** button.
- **Select** the **Simulation End Time** and then **click** on **"OK"** button to start the **Simulation**.

Study how the loss, utilization and transmission time varies as the distance between the Access Point and the wireless nodes is varied:

Sample Inputs:

In this Sample experiment, required number of Nodes (Node1, Node2) needs to be dragged & dropped onto the Wireless AP. Upon completion of the experiment "Save" them for comparisons that can be carried out in the "Analytics" section.

The follow these steps, Node 1 transmits data to Node 2

- Experiment 1: Distance between Node1 and Node2 to Access Point is 5m.
- Experiment 2: Distance between Node1 and Node2 to Access Point is 10m.
- Experiment 3: Distance between Node1 and Node2 to Access Point is 15m.
- ……. And so on till all 100 meter distance.

Inputs for the Sample experiment, where Node 1 is transmitting which is given below:

How to Set Node Properties:

Please navigate through the below given path to,

Set Node Properties: "Help NetSim Help Simulation New LAN Wireless LAN 802.11b Set Node Properties".

Sample Input - Transmitting Node 1:

Node Properties	**Node - 1**
Transmission	Point-to-Point
Destination	Node2
Traffic Type	Data
Distribution	Constant
Application Data Size (Bytes)	1375
Distribution	Constant
Mean Inter Arrival Time(Micro sec)	1000
RTS Threshold(Bytes)	2347
Retry Limit	7
Generation Rate Mbps	11

How to Set Node Properties:

Please navigate through the below given path to,

Set Access Point Properties: "Help NetSim Help Simulation New LAN Wireless LAN 802.11b Set Access Point (AP) Properties".

Sample Input - Access Point 1:

Access Point Properties	Access Point - 1
Communication	Half Duplex
Buffer Size (MB)	5
Retry Limit	7
RTS Threshold (Bytes)	2347
Transmission	DSSS
Channel	1
Frequency (MHZ)	2412
Transmitter power (Milli Watts)	100
Channel Characteristics	Fading only
Path Loss Exponent	3.5
Fading Figure	1.0

Simulation Time - 10 Sec

(**Note:** *The Simulation Time can be selected only after the following two tasks,*

- *Set the properties for the Nodes & The AP*
- *Click on the Validate & Simulate button*).

Output:

To view the output by using NetSim the Sample experiments need to be added onto the Analytics interface. Given below is the navigation for analytics -"Simulation Analytics".

Select the experiments by selecting

Wireless LAN Protocols

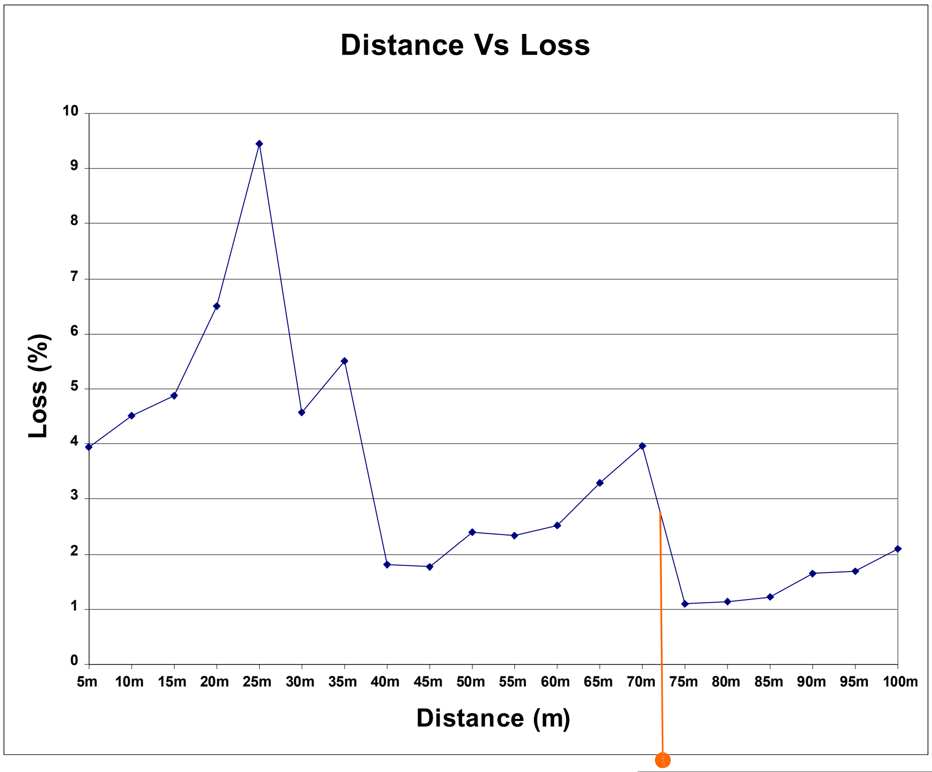
Select the Experiments (Note**:** Click on one experiment after the other to add multiple experiments need to be added onto the Analytics interface).

Click on "Export to .csv"

Comparison Chart:

To draw these graphs by using Excel "Insert Chart" option and then select chart type as "Line chart".

Graph I

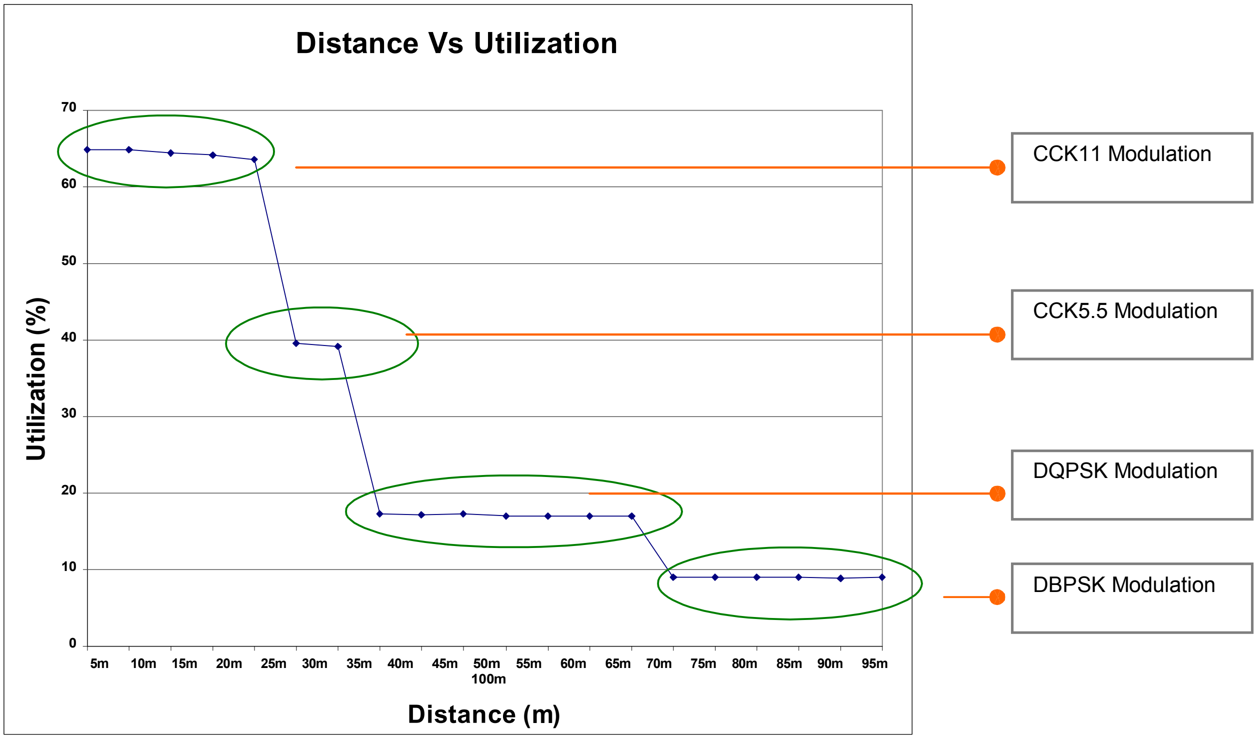


Data Rate changes from 2Mbps DQPSK to 1Mbps DBPSK modulation

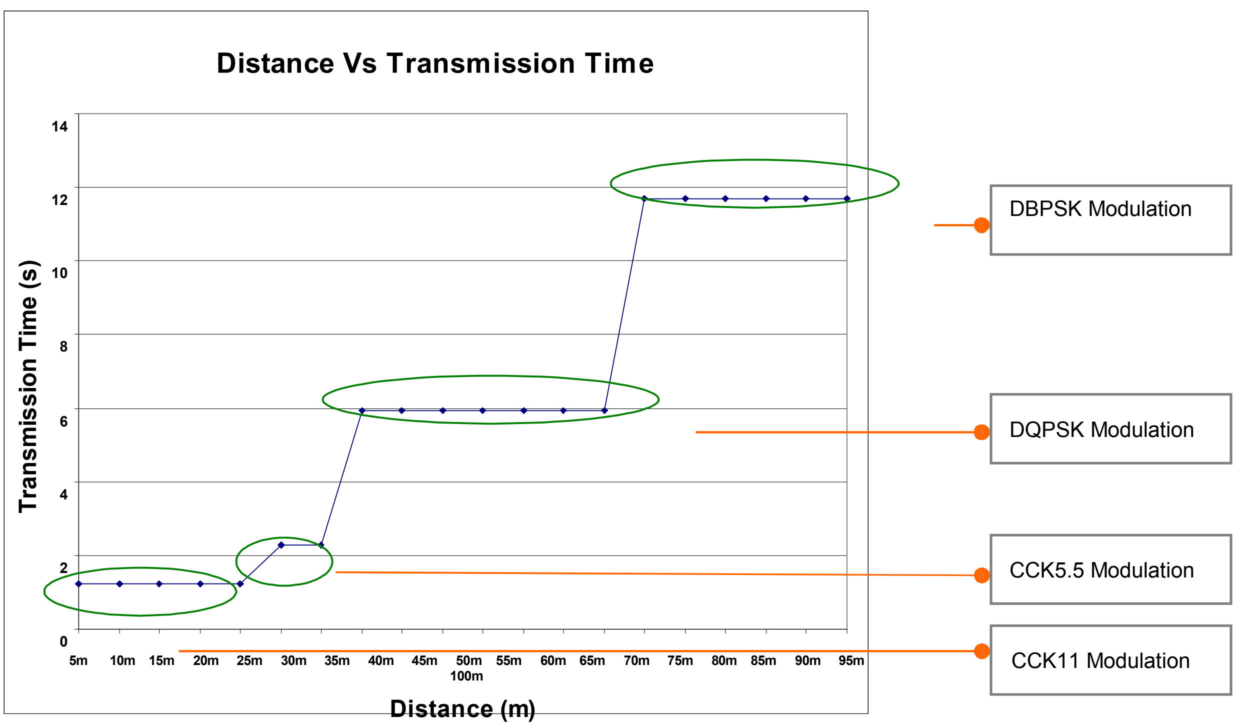
Data Rate changes from 5.5 Mbps CCK5.5 to 2Mbps DQPSK modulation

Data Rate changes from 11Mbps CCK11 to 5.5Mbps CCK5.5 modulation

Graph II



Graph III



Inference:

Graph I

Sl. No	Approx Range (m)	Data Rate (Mbps)	Modulation	Loss (%)
1.	1 – 26 *	11	CCK11	Exponential Increases.
2.	26 – 36 *	5.5	CCK5.5	The loss percentage first falls as the data rate drops. Then it starts to exponential increase.
3.	36 - 75 *	2	DQPSK	The loss percentage first falls as the data rate drops. Then it starts to exponential increase.
4.	75 – 100 *	1	DBPSK	The loss percentage first falls as the data rate drops. Then it starts to exponential increase.
* denotes the modulation ranges affected by fading effect.				

*** All the above plots highly depend upon the placement of Node in the simulation environment. So, note that even if the placement is slightly different the same set of values will not be got but one would notice a similar trend.

Graph II

The distance between the Access Point and the wireless nodes increases, the Utilization decreases because received power is directly proportional to 1 / (Distance ^{2}). Note that utilization is directly proportional to received power.

Graph III

The transmission time between the Access Point and the wireless nodes increases. This is because transmission time is directly proportional to (1 / Data Rate).

Experiment 8:

Objective:

To configure Adhoc networks and study the performance of a mobile adhoc network using NetSim simulation.

Introduction:

In Random waypoint model, nodes will move freely, and remain in the same position for some time, which is called "Pause Time", and then it will choose another random position and it will move towards that position with a given velocity. For further details refer Basics Advanced Wireless Networks MANET Mobility.

How to Configure Adhoc networks in NetSim:

New Experiments

In the **Simulation** menu select **New** **LAN** **MANET**

To perform experiments in **MANET**, the following steps should be followed,

- **Create Scenario**
- **Set Node Properties**
- **Remove Devices**
- **Simulate**

Create Scenario

Adding Node -

- **Click** on the **Node** icon and **drag** and **drop** it in side the **Environment** (i.e. **Visibility Range** - The systems can move and communicate in this range only).
- **Node**s are needed to find the Route to data, and then it starts its transmission through path.

A Node cannot be placed on another Node. A Node cannot float outside the **Environment**. It has to be dragged and placed inside the **Visibility Range**.

Set Node Properties

Right Click on the appropriate node to select Properties. Inside the properties' window click on Application 1 to modify its properties.

Transmission Type

This indicates the type of transmission made by this session, Point to Point.

Destination

This property indicates the Destination Node.

Traffic Type

This property indicates the type of traffic. The traffic can either be Voice or Data.

Voice

Codec

Codec is the component of any voice system that translates between analog speech and the bits used to transmit them. Every codec transmits a burst of data in a packet that can be reconstructed into voice. Three different standards of voice codec's are given which can be selected depending on the variations required.

Service Type

- **CBR** - CBR stands for Constant Bit Rate. Packets of constant size are generated at constant inter arrival times.
- **VBR** - VBR stands for Variable Bit Rate. The two types of Suppression Model that can be selected are,
  - **Deterministic**
  - **Markov Chain**
  - **Success Ratio (%)**

Click **OK** to accept the user entered values. Click on the close button at the top right corner to exit the screen.

Data

Packet Size

Distribution: The options available for distribution are,

- **Constant**
- **Exponential**

Mean Packet Size (Bytes): Sets the size of the packets being generated by the Constant distribution. The ranges of values that can be entered are between 10 to 10000 bytes. By default 1472 bytes is entered.

Inter Arrival Time

This indicates the time gap between packets.

Distribution : The options available for distribution are,

- **Exponential**
- **Uniform**
- **Constant**

Mean Inter Arrival Time: Enter the average inter-arrival time between packets. A lower inter-arrival time would lead to a higher generation rate and the vice versa. The ranges of values that can be entered are between 1000 to 20000 Micro Sec. By default 20000 Micro Sec is entered.

Data Link Layer

Protocol- A **default** value has been coded in; hence no change can be made.

MAC Address - A **default** value has been coded in, hence no change can be made.

RTS Threshold (Bytes) - This property is to allow the node to **enable/disable** the **RTS/CTS** mechanism. By **default** the value that is available is **2347 Bytes**. **Limit** ranges from **0** to **2347 Bytes**.

Retry Limit - Indicate the number of attempts that can be made by a frame. This **varies** from **1** to **7**. By **default** the **Retry Limit** value is **7**.

MTU- A **default** value has been coded in, hence no change can be made.

Physical Layer

Transmitter Power (milli watts) - This property defines the power level of the **Node**. By **default** the value for **Transmitter Power** is **100 milli watts**.

This **View** button is enabled once the **Accept** Button is clicked. To view the given values, click on the **View** button.

Click **OK** to accept the user entered values. Click on the close button at the top right corner to exit the screen.

Modifying/Viewing/Accepting Properties

On opening an already configured properties of an application the input fields will be frozen (i.e. the input cannot be changed).To modify these values click on the **Modify** button in the screen. Now the input value can be changed. Click on the **Accept** button, the modified values will be saved.

This **View** button is enabled once the **Accept** Button is clicked. To view the given values, click on the **View** button.

Set Environment Properties

Right click in side of the on the Environment and **click Properties**.

Mobility model

Mobility - A **default** value has been coded in; hence no change can be made.

Velocity (m/s) - This property defines movement speed of the nodes. **Default** value is **20 m/s**.

Pause Time (sec) – This property specifies that the **"Pause Time"**. Nodes will remain the same position for this time period.

Physical Layer

Transmission type - This property specifies that the **Direct Sequence Spread Spectrum** (**DSSS**) is used as a **Transmission** technology.

Channels - The **Channels** that are allowed for the **Nodes** to operate are **1**, **6** and **11**. By **default** the value entered is **1**.

Frequency (MHz) - This property defines the **frequency** allotted for the channel selected. By **default Frequency** (**MHz**) found is **2412 MHz**, since the **Channel** value is **1**. Refer the table for further details,

Channels	Frequency (MHz)
1	2412
6	2437
11	2462

Channel Characteristics - This property defines the **Channel Characteristics** for **Nodes**. It consists of the option **With Shadowing** (by default this option is displayed).

Remove Devices

Remove Node - Right click on the appropriate **Node** and **click Remove**.

Note -

- If a **Node** transmitting data is removed, all traffic originating from this **Node** is also **deleted**.

Simulate - After creating the **Scenario** the following steps need to be followed,

- **Click** on **Validate** button.
- **Click** on **Simulate** button.
- **Select** the **Simulation End Time.**
- Select the **Mobility Animation.**
    1. "**On**" – User can view the Mobility animation at the end of the simulation.
    2. "**Off**"- Mobility animation will not be shown at the end of the simulation.
- **Click** on "**OK"** button to start the **Simulation**.
- **Click** on "**Stop Simulation"** to stop the **Simulation**.

Study the performance of a Mobile Adhoc Network:

Sample Inputs:

In this Sample experiment, required number of Nodes needs to be dragged & dropped onto the Simulation Environment. Upon completion of the experiment "Save" them for comparisons that can be carried out in the "Analytics" section.

First create a scenario with 10 nodes. Then follow these steps

- Experiment 1: Node 1 transmits data to Node 6, Node 2 -> Node 7, and Node 3 -> Node 8 ……. And so on in a circular fashion till all 10 nodes transmit. Set pause time as 1.
- Experiment 2: Repeat the experiment 1 with pause time 2 in environment property.
- Experiment 3: Repeat the experiment 1 with pause time 3 in environment property.
- ……. And so on increase the pause time up to 10 in environment property.

Inputs for the Sample experiment, where 5 nodes are transmitting is given below:

Node Properties	Node - 1	Node - 2	Node - 3	Node - 4	Node - 5
Transmission	Point-to-Point	Point-to-Point	Point-to-Point	Point-to-Point	Point-to-Point
Destination	Node6	Node7	Node8	Node9	Node10
Traffic Type	Data	Data	Data	Data	Data
Application Data Size					
Distribution	Constant	Constant	Constant	Constant	Constant
Application Data Size (Bytes)	1472	1472	1472	1472	1472
Inter Arrival Time					
Distribution	Constant	Constant	Constant	Constant	Constant
Mean Inter Arrival Time(Micro sec)	20000	20000	20000	20000	20000
RTS Threshold(Bytes)	0	0	0	0	0

Retry Limit	7	7	7	7	7
Transmitter power (Milli Watts)	100	100	100	100	100

Environment Properties:

Environment Properties	Values
Mobility Model	Random Way Point model
Velocity (m/sec)	50
Pause Time	1
Transmission	DSSS
Channel Number	1
Frequency (MHz)	2412
Channel Characteristics	No Path Loss

Simulation Time - 10 Sec.

Note: The Simulation Time can be selected only after doing the following two tasks,

- Set the properties of Node & Environment.
- Click on the Validate & Simulate button and save the experiment.

Increase the pause time and continue the above procedure up to 10 pause time.

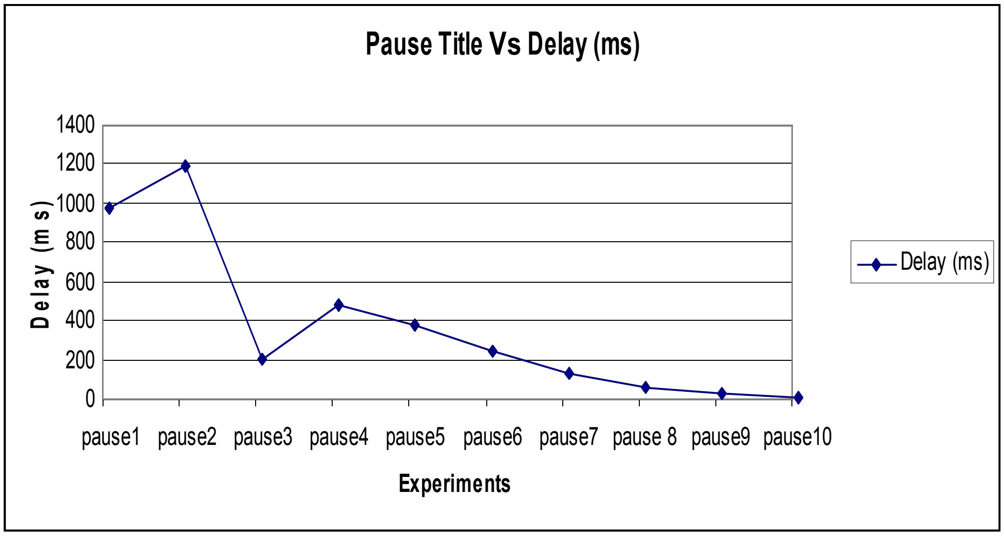
Output:

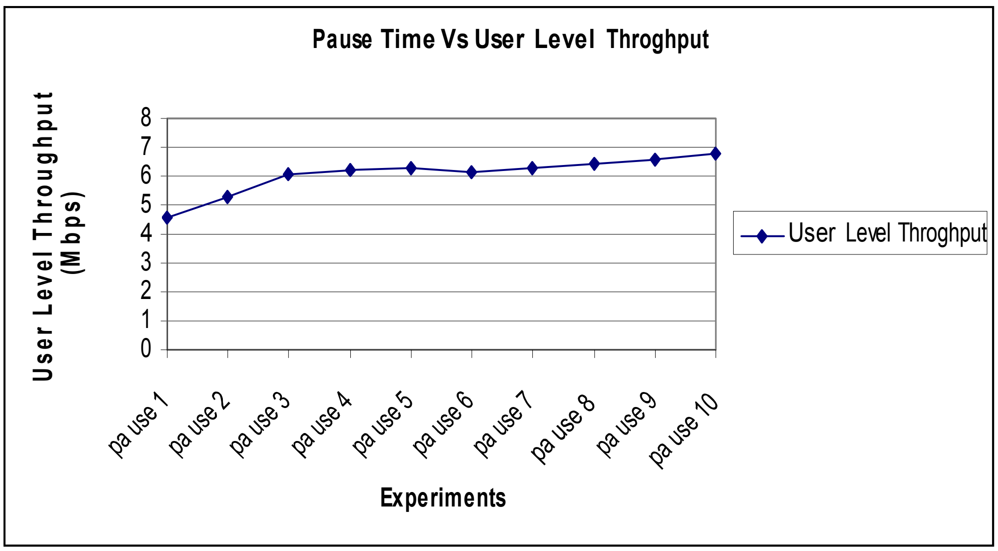
1. For User level Throughput- Get the User level throughput value from Network Statistics - Performance metrics window for all experiments and draw the graph.
2. For Delay- Get the Delay value from Network - Performance metrics window for all experiments and draw the graph.

Note:

User level Throughput and Delay values can be exported to Excel sheet using "Export to .CSV" Option. Then the required graph can be drawn in the Excel sheet

Comparison Chart:





*** All the above plots highly depend upon the placement of Node in the simulation environment. So, note that even if the placement is slightly different the same set of values will not be got but one would notice a similar trend.

Inference:

As the pause time increases, user level throughput will increase because of lower mobility. There is a lower probability of route errors. This leads to increased number of packets transmitted. It also results in reduced packet waiting time in the queue.