Godavari College Of Engineering, Jalgaon.

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VI SEMESTER

LAB MANUAL
COMPUTER NETWORKS LABORATORY.
[BTCOL608]

FACULTY : PROF. JAYASHRI PATIL

DEPARTMENT OF
COMPUTER ENGINEERING

Godavari Foundation's

GODAVARI COLLEGE OF ENGINEERING, JALGAON

(NAAC Accredited)

(An affiliated to Dr. Babasaheb Ambedkar Technological University)

CERTIFICATE

This is to certify that Miss. **Shweta Ravindra Patil** , Roll No: **34** of **T.Y. COMPUTER** class has satisfactorily carried out the practical work in the Subject : **Computer Networks Laboratory [BTCOL608]** as per laid down in the syllabus, in this Laboratory and that this journal represent **her** bonafide work in the year **2020-2021.**

Date :

Signature
PROF. JAYASHRI PATIL
Faculty in Charge

Signature
Prof. Pramod B. Gosavi
H.O.D.

Dr. V. H. PATIL
PRINCIPAL
Godavari Foundation's
Godavari College of Engineering, Jalgaon

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Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No : 1	**Date : 31-03-2021**

Title: Simulate and Understand IP forwarding within a LAN and across a router.

Aim : Observation of Simulation and understanding the IP forwarding within a LAN and across the router using Cisco packet tracer.

Hardware /Software requirements :
1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. Cisco Packet Tracer

Theory :

In a network architecture different layers have their own addressing scheme. This helps the different layers in being largely independent. Application layer uses host names, network layer uses IP addresses and the link layer uses MAC addresses. Whenever a source node wants to send an IP datagram to a destination node, it needs to know the address of the destination. Since there are both IP addresses and MAC addresses, there needs to be a translation between them. This translation is handled by the Address Resolution Protocol (ARP). In IP network IP routing involves the determination of suitable path for a network packet from a source to its destination. If the destination address is not on the local network, routers forward the packets to the next adjacent network.

IP Forwarding :

Every router has a forwarding table that maps the destination addresses (or portions of the destination addresses) to that router's outbound links.

1. A router forwards a packet by examining the value of a field in the arriving packet's header, and then using this header value to index into the router's forwarding table.

2. The value stored in the forwarding table entry for that header indicates the router's outgoing link interface to which packet is to be forwarded.
3. Depending on the network-layer protocol, the header value could be the destination address of the packet or an indication of the connection to which the packet belongs.
4. ARP operates when a host wants to send a datagram to another host on the same subnet.
5. When sending a Datagram off the subnet, the datagram must first be sent to the first-hop router on the path to the final destination. The MAC address of the router interface is acquired using ARP.
6. The router determines the interface on which the datagram is to be forwarded by consulting its forwarding table.
7. Router obtains the MAC address of the destination node using ARP.
8. The router sends the packet into the respective subnet from the interface that was identified using the forwarding table.

Steps of IP forwarding across router :

1) Select four PCs, two Switches and one Router
2) Connect two PCs to switch 1 and switch 1 to router
3) Connect Router to another switch 2 and next to remaining two PCs
4) Assign IP address to all PCs. For first two PCs set default gateway same and for another two PCs default gateway should be same (click on PC->Desktop->IP configuration).
5) Click on router->CLI->type n and press enter
6) Run the following commands

   en (for enable router)

   config terminal (for configuration of terminal)

   interface fa0/0 (fa0/0 is interface name of router to network 1)

   ip address 192.168.1.3 255.255.255.0

   (default gateway of network 1 with subnet mask)

   no shutdown (These commands will changed the state up of network 1)

   exit

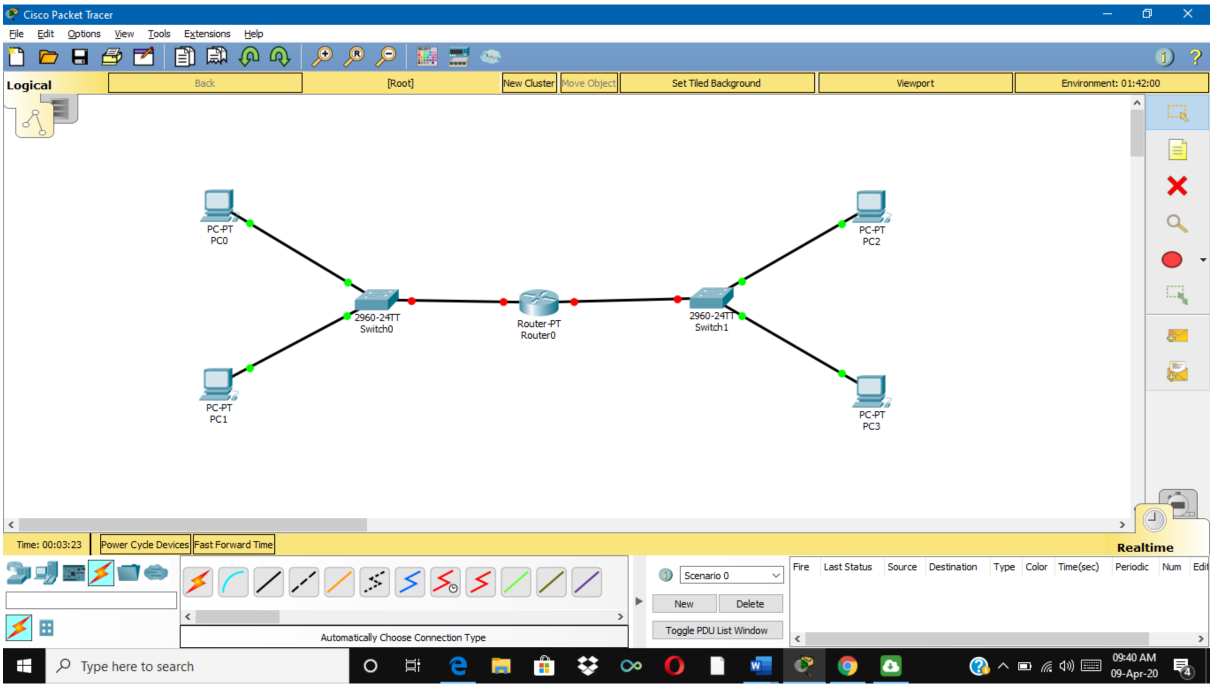
   interface fa1/0 (fa1/0 is interface name of router to network 2)

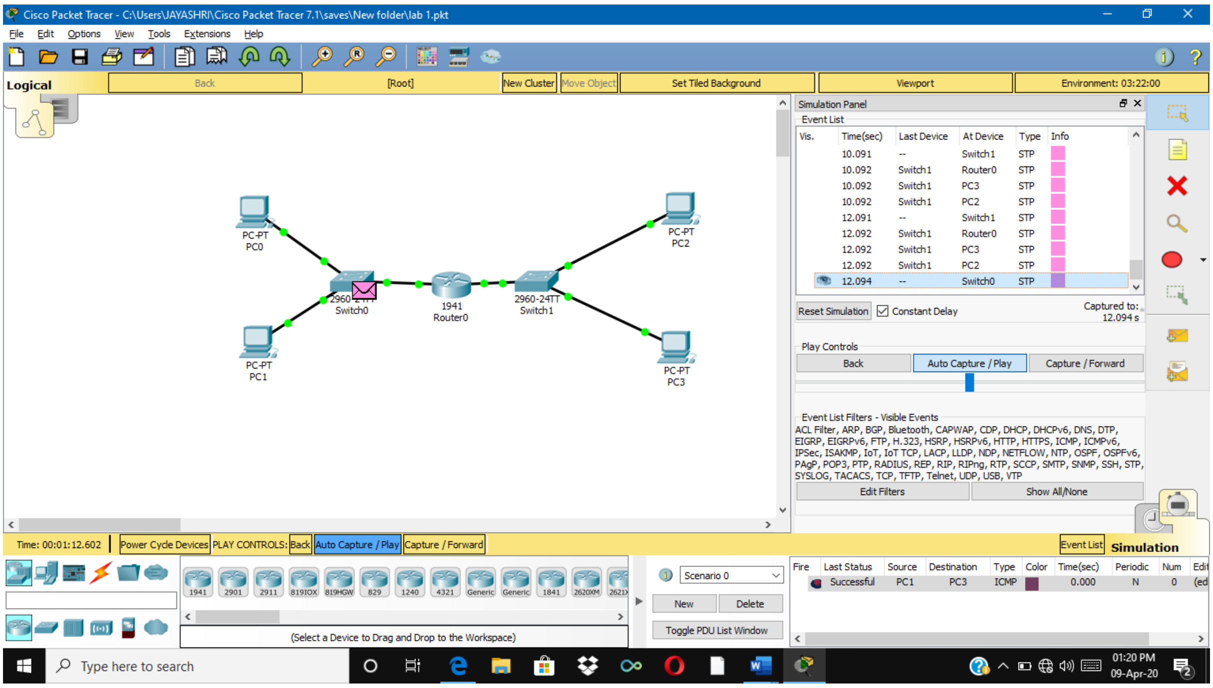
   ip address 192.168.2.3 255.255.255.0

   (default gateway of network 2 with subnet mask)

   no shutdown (now this interface is also changed to state up)
7) Check the IP forwarding in simulation mode (also cross check with ping command)

Standard INPUT and OUTPUT :





Conclusion :

In this practical, we have observed simulation and understand the IP forwarding within a LAN and across the router using Cisco packet tracer.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No : 2	**Date : 07-04-2021**

Title : Study the working of spanning tree algorithm by varying the priority among the switches.

Aim : Study and understand the working of spanning tree algorithm by varying the priority among the switches using Cisco packet tracer.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. Cisco Packet Tracer

Theory :

Spanning Tree Protocol (STP) is a link management protocol. Using the spanning tree algorithm, STP provides path redundancy while preventing undesirable loops in a network that are created by multiple active paths between stations. Loops occur when there are alternate routes between hosts. To establish path redundancy, STP creates a tree that spans all of the switches in an extended network, forcing redundant paths into a standby, or blocked state. STP allows only one active path at a time between any two network devices (this prevents the loops) but establishes the redundant links as a backup if the initial link should fail. Without spanning tree in place, it is possible that both connections may simultaneously live, which could result in an endless loop of traffic on the LAN.

Steps :

1) Select three switches and three PCs.
2) Connect all three switches with each other and each switch with one PC.
(Here one of the switch link is broken so we have to set that switch in spanning tree.)
3) We can configure spanning tree by two ways

I] Spanning tree by setting the root

II] Spanning tree by setting the priority Value

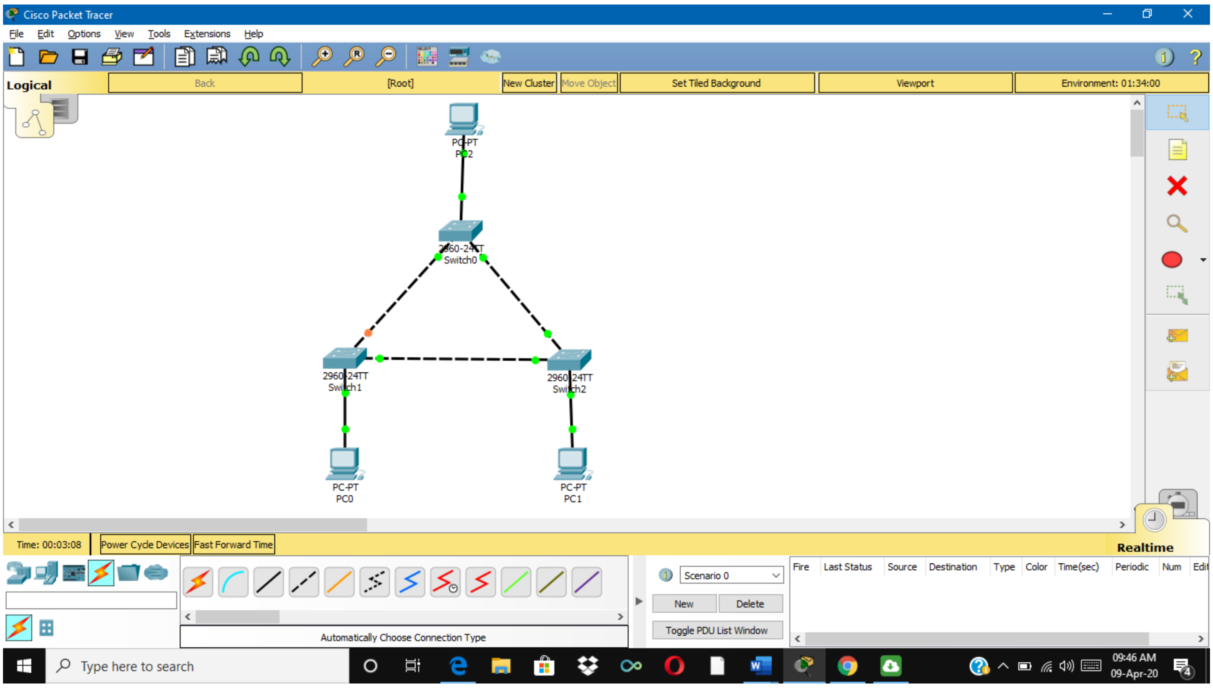
I] Spanning tree by setting the root :

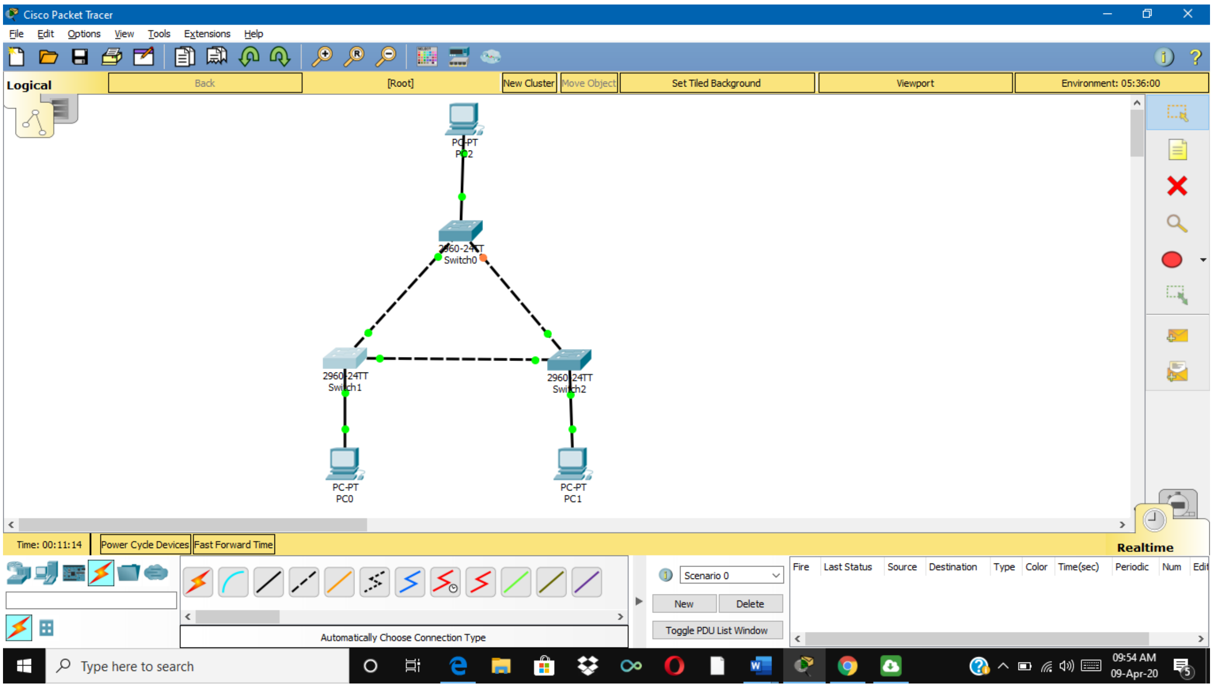
Click on switch (which has one broken link.)->CLI
Type following commands
en (for enable the switch)
config t (For configuration of terminal)
hostname s3 (for setting switch name (optional))
ctrl+z (go to switch mode)
Sh sp (shows the spanning tree routes-one interface is FWD and another is in BLK state)
config t
spanning-tree vlan 1 root primary
ctrl+z
sh sp (the interface which is in BLK state will be in LSN state and finally is in FWD state)

II] Spanning tree by setting the priority Value:

Click on switch (which has one broken link.)->CLI
Type following commands
en (for enable the switch)
config t (For configuration of terminal)
hostname s1 (for setting switch name (optional))
ctrl+z (go to switch mode)
Sh sp (shows the root priority value-one interface is FWD and another is in BLK state)
config t
spanning-tree vlan 1 priority 20480
ctrl+z
sh sp (the interface which is in BLK state will be in LSN state and finally is in FWD state)

Standard INPUT and OUTPUT :





Conclusion :

In this practical, we have Studied and understood the working of spanning tree algorithm by varying the priority among the switches using Cisco packet tracer.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 3	**Date : 21-04-2021**

Title: Understand the working of "Connection Establishment" in TCP using a network simulator.

Aim : Network setup of "Connection Establishment" in TCP using a Cisco packet tracer network simulator.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. Cisco Packet Tracer

Theory :

When two processes wish to communicate, their TCP's must first establish a connection i.e. initialize the status information on each side. Since connections must be established between unreliable hosts and over the unreliable internet communication system, a "three-way handshake" with clock based sequence numbers is the procedure used to establish a Connection. This procedure normally is initiated by one TCP and responded by another TCP. The procedure also works if two TCPs simultaneously initiate the procedure. When simultaneous attempt occurs, each TCP receives a "SYN" segment which carries no acknowledgement after it has sent a "SYN".

Three-way-handshake connection establishment :

1. SYN : The client is sending a SYN to the server. The client sets the sequence number to a random value A.
2. SYN-ACK : In response, the server replies with SYN-ACK. The

acknowledge number is set to one more than the received sequence number [A+1], and the sequence number that the server chooses for the packet is another random number B.

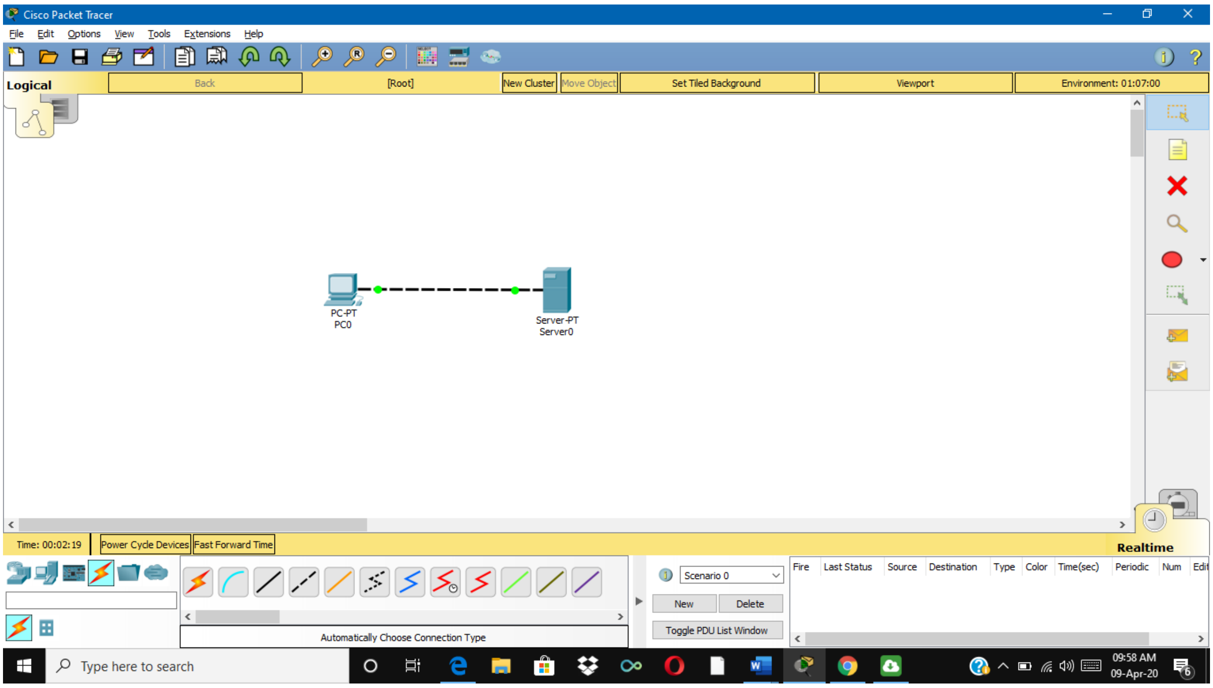
3. ACK : The client sends an ACK back to the server. The sequence number is set to the received acknowledgement number value i.e. [A+1], and the acknowledgement number is set to one more than the received sequence number i.e. B+1.

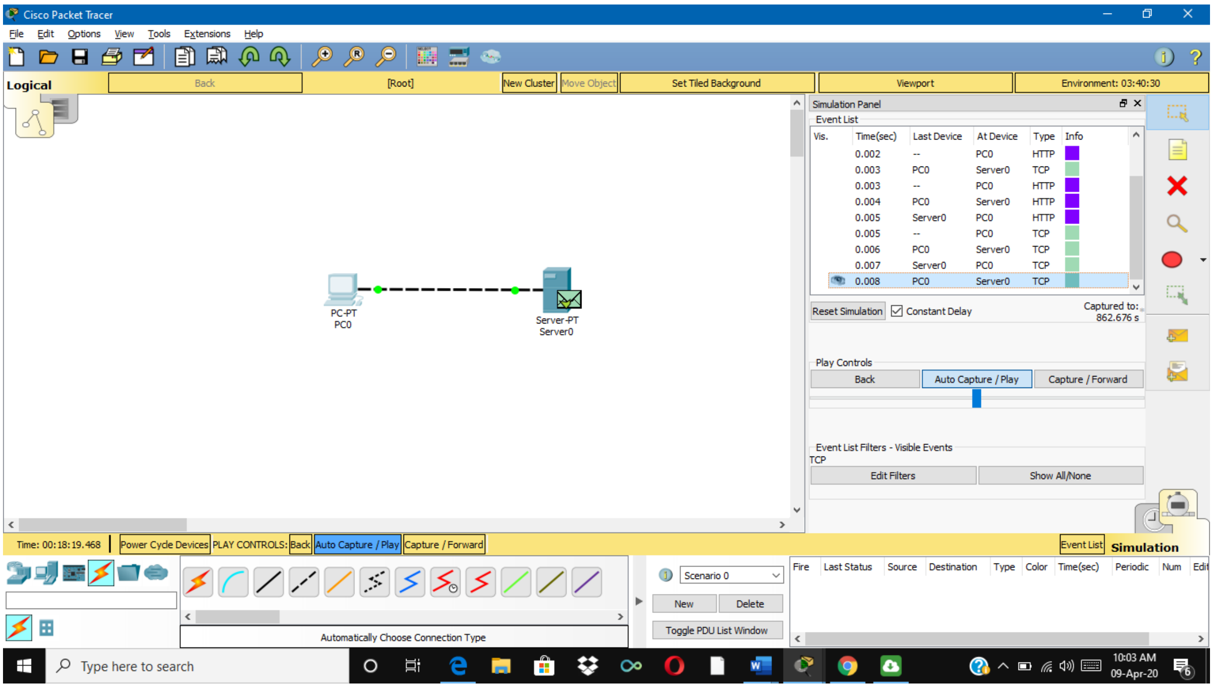
At this point, both the client and server have received an acknowledgement of the connection. The step 1,2 establish the connection parameters (sequence number) for one direction and it is acknowledged. The 2,3 establish the connection parameter (sequence number) for the other direction and it is acknowledged and full duplex communication is established.

Steps for "TCP Connection" establishment :

1. Select end device (client)
2. Select Server (server)
3. Make connection between client and server.
4. Assign IP address to client and server
5. Click on simulation mode->edit filter->select only TCP
6. Click end device(client)->desktop->web browser->address of server(in URL)
7. Observe the packet information. (info in simulation mode->PDU details)

Standard INPUT and OUTPUT :





Conclusion :

In this practical, we have Studied and understood the working of “Connection Establishment” in TCP using a Cisco packet tracer network simulator.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 4	**Date : 28-04-2021**

Title: Study how the Data Rate of a Wireless LAN (IEEE 802.11b) network varies as the distance between the Access Point and the wireless nodes is varied.

Aim : How the Data Rate of a Wireless LAN (IEEE 802.11b) network varies as the distance between the Access Point and the wireless nodes is variedin Cisco Packet tracer.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. Cisco Packet Tracer

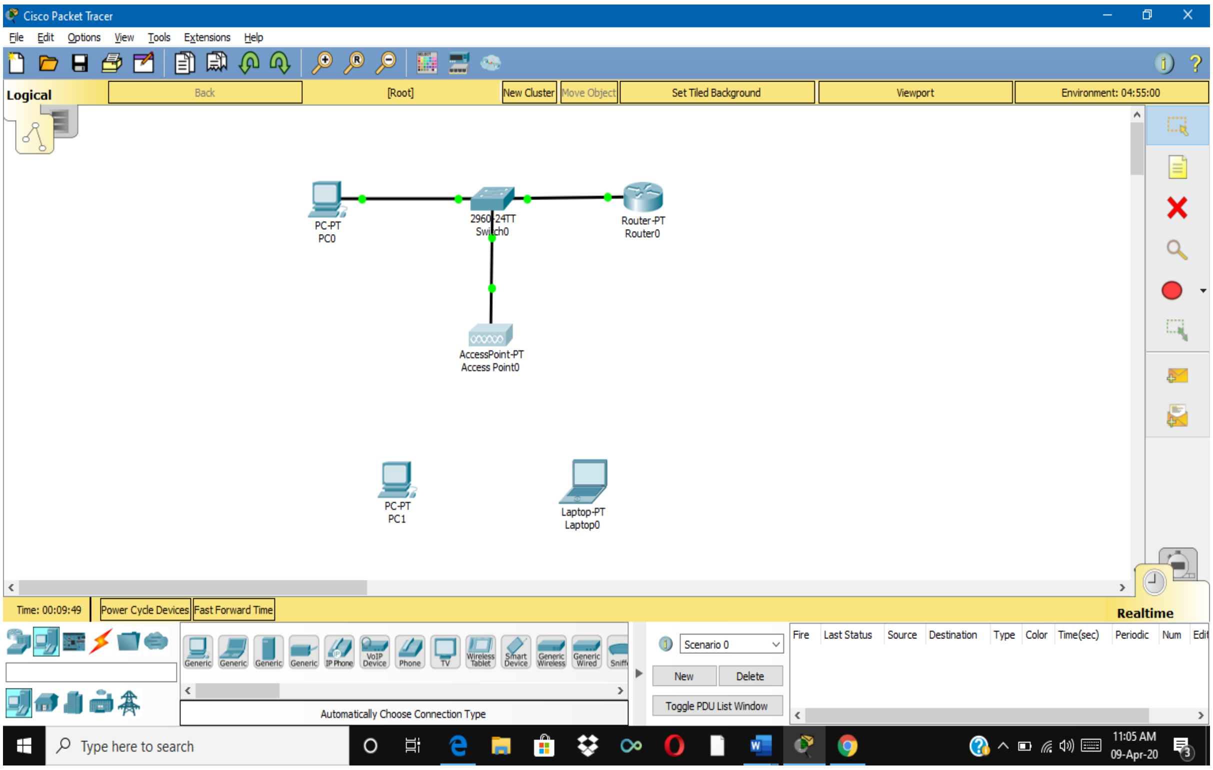
Theory :

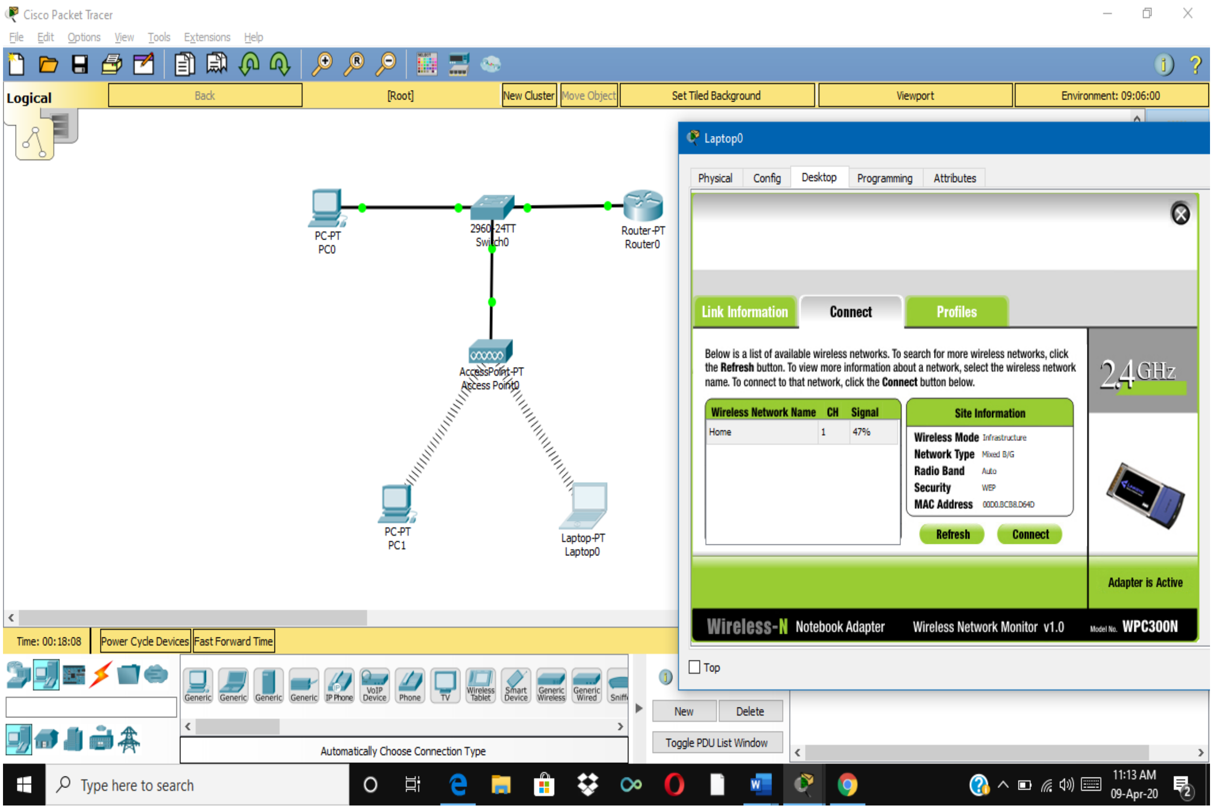
In most of the WLAN products on the market based on the IEEE 802.11b technology the transmitter is designed as a Direct Sequence Spread Spectrum Phase Shift Keying (DSSS PSK) modulator, which is capable of handling data rates of up to 11 Mbps. The system implements various modulation modes for every 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. The 802.11b IEEE standard provides four data rates, 1 Mbps, 2 Mbps, 5.5 Mbps, and 11 Mbps. The rate is decided based on the received power and the errors in the channel. Note a higher data rate does not necessarily yield a higher throughput since packets may get errored. Only when the channel conditions are good, does a higher data rate give a higher throughput. In a realistic WLAN environment, the channel condition can vary due to path loss, fading, and shadowing.

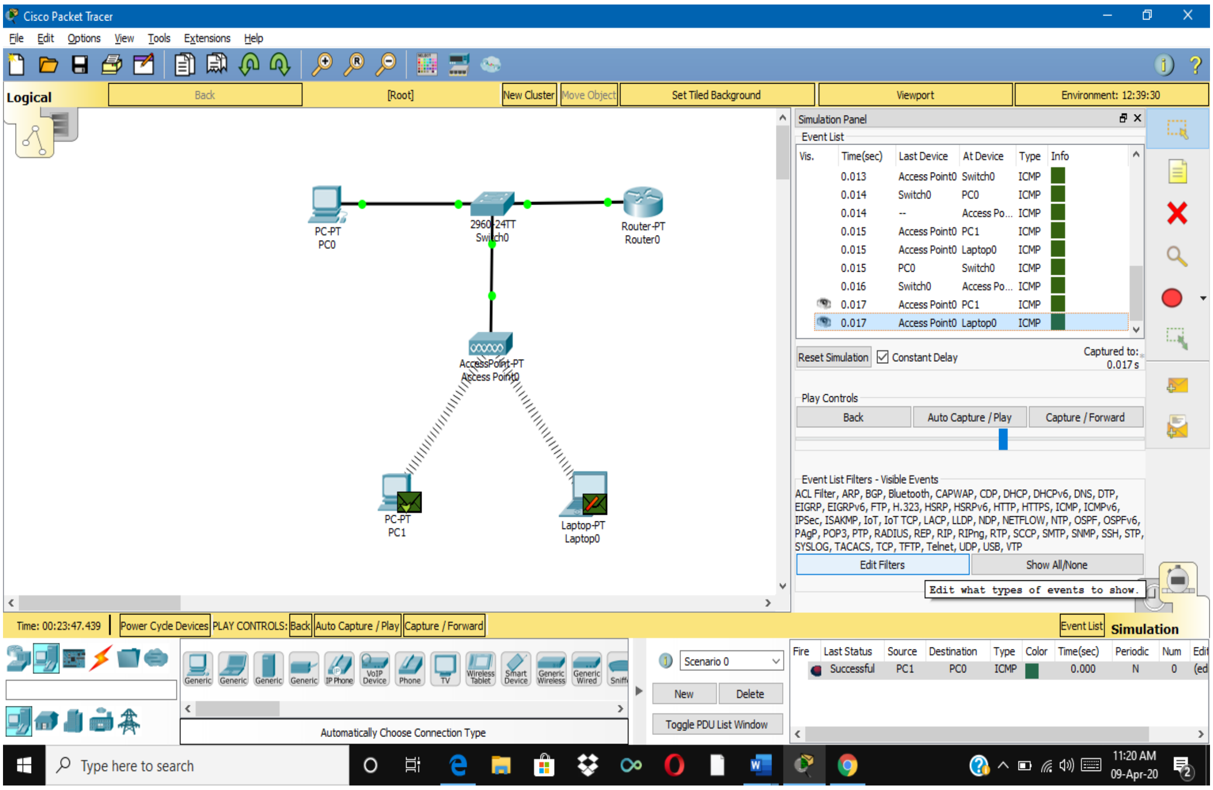
Steps to configure wireless LAN network :

1. Select 1 Router, 1 switch and 1 PC as end device.
2. Make the connection between router to switch to PC.
3. Assign the IP address to router (config->interface(ethernet0/0)->port status->on)
4. Assign the IP address to end device (PC) (desktop->IP configuration->IP address, default gateway)
5. Check the connection establishment by sending packet between router and end device.
6. Select Access Point-PT
7. Connect Access point to switch
8. Click on access point->Config tab->port 1->WEP->set WEP keys (10 digit number)->set network name[SSID]->close
9. Select another PC and laptop as wireless nodes
10. Click on wireless node-PC->physical->turn off PC->first remove linksys->then insert linksys->WMP 300N for making wireless connection with access point->turn on pc->close the tab.
11. Assign IP address and default gateway to Wireless node-PC.
12. Click on wireless node-PC->desktop->PC wireless->connect->refresh->Select network SSID->connect->put WEP key->connect (This will connect PC to wirelessly).
13. Repeat the step 12 for laptop configuration, this will connect laptop wirelessly.
14. Send packets between different end devices and observe the network performance.
15. Vary the distance between access point and nodes and observe the data rate.

Standard INPUT and OUTPUT :







Conclusion :

In this practical, we have Studied and observed the data Rate of a Wireless LAN (IEEE 802.11b) network varies as the distance between the Access Point and the wireless nodes is varied.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 5	**Date : 05-05-2021**

Title: Study the working and routing table formation of Interior routing protocols, i.e. Routing Information Protocol (RIP) and Open Shortest Path First (OSPF).

Aim : Working and routing table formation of Interior routing protocols, i.e. Routing Information Protocol (RIP) and Open Shortest Path First (OSPF) in Cisco Packet Tracer.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. Cisco Packet Tracer

Theory :

RIP is intended to allow hosts and gateways to exchange information for computing routes through an IP-based network. RIP is a distance vector protocol which is based on Bellman-Ford algorithm. This algorithm has been used for routing computation in the network. Distance vector algorithms are based on the exchange of only a small amount of information using RIP messages.

Each entity (router or host) that participates in the routing protocol is assumed to keep information about all of the destinations within the system. Generally, information about all entities connected to one network is summarized by a single entry, which describes the route to all destinations on that network. This summarization is possible because as far as IP is concerned, routing within a network is invisible. Each entry in this routing database includes the next router to which datagram’s destined for the entity should be sent. In addition, it includes a "metric" measuring the total distance to the entity.

Distance is a somewhat generalized concept, which may cover the time delay in getting messages to the entity, the dollar cost of sending messages to it, etc.

Distance vector algorithms get their name from the fact that it is possible to compute optimal routes when the only information exchanged is the list of these distances. Furthermore, information is only exchanged among entities that are adjacent, that is, entities that share a common network.

OSPF :

In OSPF, the Packets are transmitted through the shortest path between the source and destination.

Shortest path:

OSPF allows administrator to assign a cost for passing through a link. The total cost of a particular route is equal to the sum of the costs of all links that comprise the route. A router chooses the route with the shortest (smallest) cost.
In OSPF, each router has a link state database which is tabular representation of the topology of the network (including cost). Using Dijkstra algorithm each router finds the shortest path between source and destination.

Formation of OSPF Routing Table :

1. OSPF-speaking routers send Hello packets out all OSPF-enabled interfaces. If two routers sharing a common data link agree on certain parameters specified in their respective Hello packets, they will become neighbors.
2. Adjacencies, which can be thought of as virtual point-to-point links, are formed between some neighbors. OSPF defines several network types and several router types. The establishment of an adjacency is determined by the types of routers exchanging Hellos and the type of network over which the Hellos are exchanged.
3. Each router sends link-state advertisements (LSAs) over all adjacencies. The LSAs describe all of the router's links, or interfaces, the router's neighbors, and the state of the links. These links might be to stub networks (networks with no other router attached), to other OSPF routers, or to external networks (networks learned from another routing process). Because of the varying types of link-state information, OSPF defines multiple LSA types.
4. Each router receiving an LSA from a neighbor records the LSA in its link-state database and sends a copy of the LSA to all of its other neighbors.
5. By flooding LSAs throughout an area, all routers will build identical link-state databases.
6. When the databases are complete, each router uses the SPF algorithm to

calculate a loop-free graph describing the shortest (lowest cost) path to every known destination, with itself as the root. This graph is the SPF tree.

7. Each router builds its route table from its SPF tree

Steps of OSPF and RIP network :

1. Select 4 Routers and 2 PCs
2. Change the names of router and PC as R1, R2, R3, R4 and PC1, PC2 respectively.
3. Make connection from PC1-R1-R2-R3-R4-PC2
4. Click on router R2->physical->OFF router->insert PT-ROUTER-NM-1S into original size slot->ON router.
5. Make connection from router R2 (serial DTE) ->router R4.
6. Assign IP address and default gateway to both PCs
   (PC1 – 192.168.1.1 , 192.168.1.2, PC2 – 192.168.6.2, 192.168.6.1)
7. Configure all 4 routers as follows –
   R1 : click on R1->config->Interface-> Fa0/0->192.168.1.2->port status ON
   click on R1->config->Interface-> S2/0->192.168.2.1->port status ON
   R1->CLI->exit
   Run the following commands
   Router rip
   Network 192.168.1.0
   Network 192.168.2.0
   Exit
   Router ospf 1
   Network 192.168.2.0 0.0.0.255 area 0
   exit
   R2 :click on R2->config->Interface-> S2/0->192.168.2.2->port status ON
   click on R2->config->Interface-> S3/0->192.168.3.1->port status ON
   click on R2->config->Interface-> S6/0->192.168.4.1->port status ON
   R2->CLI->exit
   Run the following commands
   Router rip
   Network 192.168.2.0
   Network 192.168.3.0
   Network 192.168.4.0

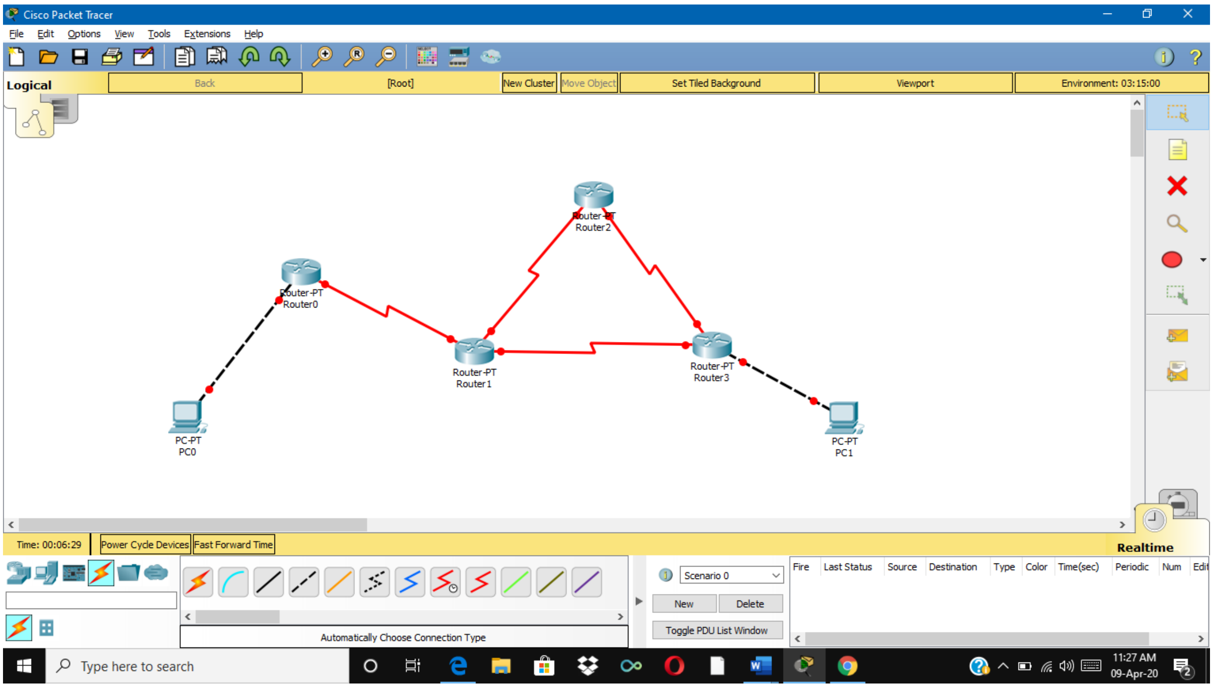
Exit
Router ospf 1
Network 192.168.2.0 0.0.0.255 area 0
Network 192.168.3.0 0.0.0.255 area 0
Network 192.168.4.0 0.0.0.255 area 0
exit

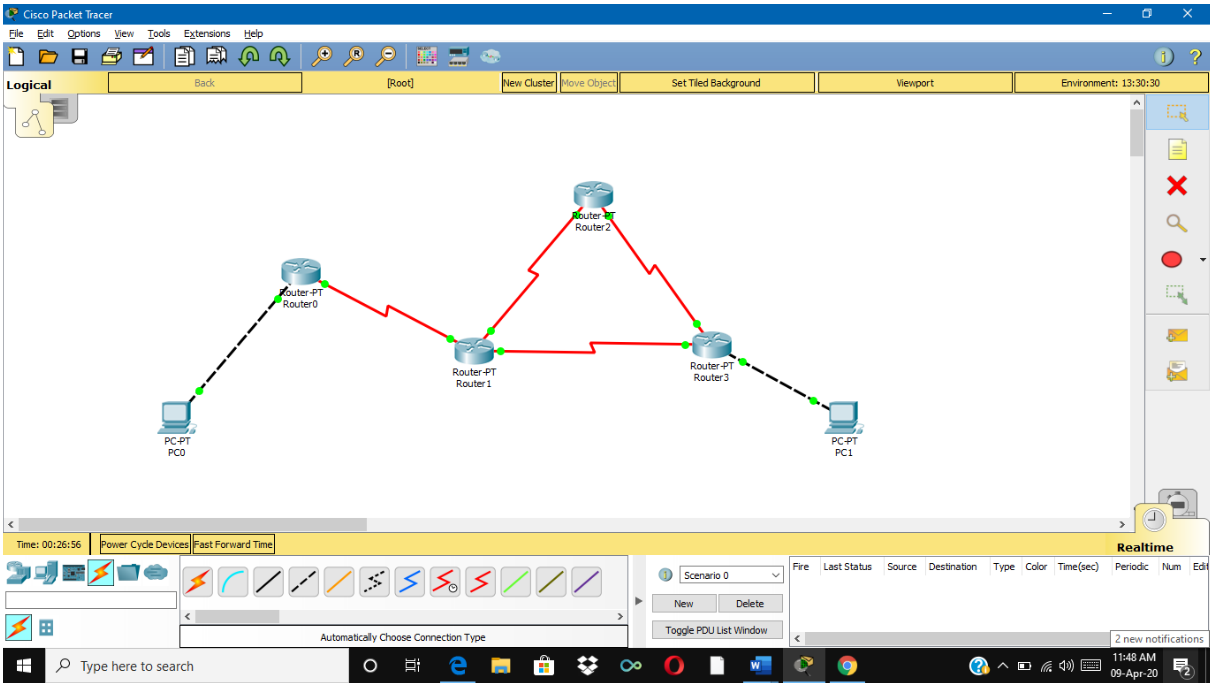
R3 :click on R3->config->Interface-> S2/0->192.168.3.2->port status ON
click on R3->config->Interface-> S3/0->192.168.5.1->port status ON
R3->CLI->exit
Run the following commands
Router rip
Network 192.168.3.0
Network 192.168.5.0
Exit
Router ospf 1
Network 192.168.3.0 0.0.0.255 area 0
Network 192.168.5.0 0.0.0.255 area 0
exit

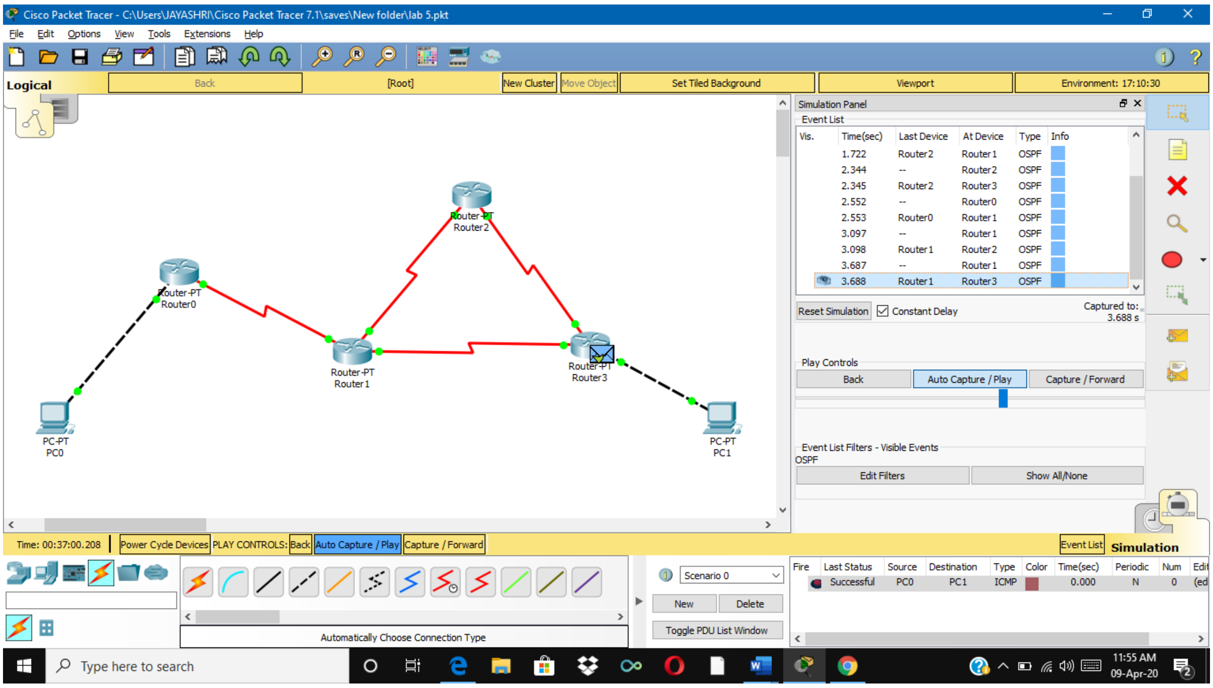
R4 :click on R4->config->Interface-> fa0/0->192.168.6.1->port status ON
click on R4->config->Interface-> S2/0->192.168.5.2->port status ON
click on R4->config->Interface-> S3/0->192.168.4.2->port status ON
R4->CLI->exit
Run the following commands
Router rip
Network 192.168.4.0
Network 192.168.5.0
Network 192.168.6.0
exit
Router ospf 1
Network 192.168.4.0 0.0.0.255 area 0
Network 192.168.5.0 0.0.0.255 area 0
exit

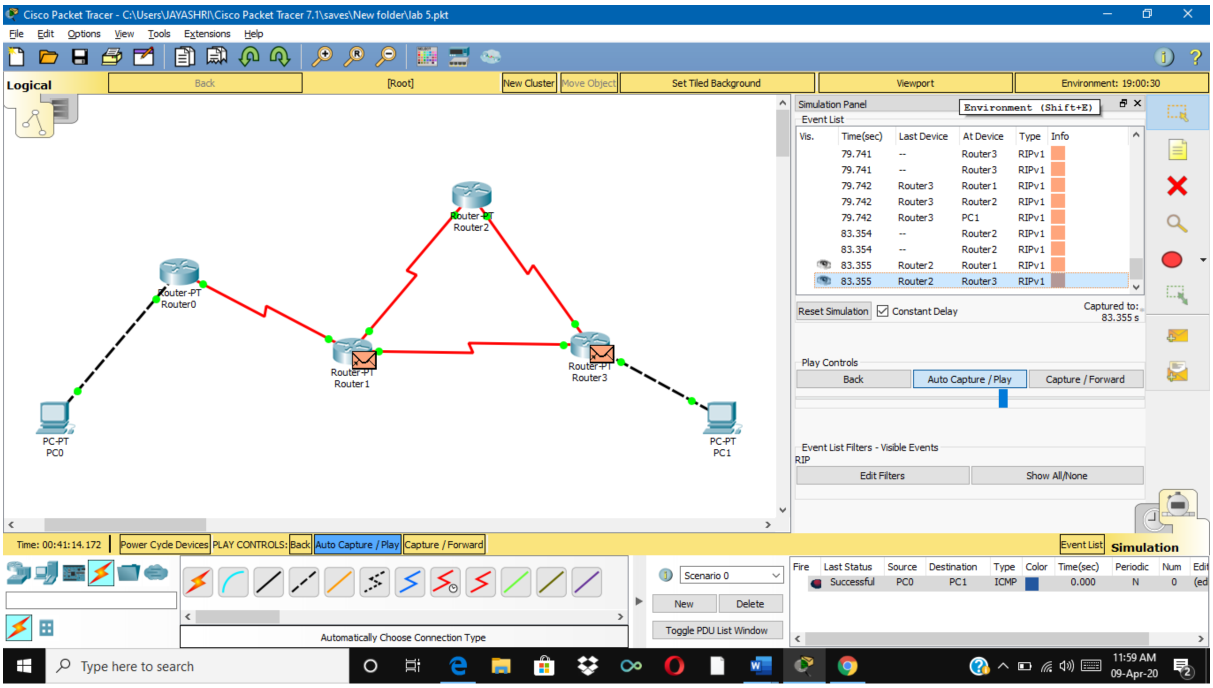
8. Send the packets between PC1 and PC2 and observe the working of RIP and OSPF.

Standard INPUT and OUTPUT :









Conclusion :

In this practical, we have studied the working and routing table formation of Interior routing protocols, i.e. Routing Information Protocol (RIP) and Open Shortest Path First (OSPF) in Cisco Packet Tracer.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 6	**Date : 12-05-2021**

Title: Plot the characteristic curve throughput versus offered traffic for a Slotted ALOHA system**.**

Aim : Generate the multiple traffic between nodes in NS2 and Plot the characteristic curve throughput versus offered traffic for a Slotted ALOHA system.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. NS2

Theory :

Slotted ALOHA :

In slotted Aloha, time is divided up into discrete intervals, each interval corresponding to one frame. In Slotted ALOHA, a computer is required to wait for the beginning of the next slot in order to send the next packet. The probability of no other traffic being initiated during the entire vulnerable period is given by e^{-G} which leads to S = $G * e^{-G}$ where, S (frames per frame time) is the mean of the Poisson distribution with which frames are being generated. For reasonable throughput S should lie between 0 and 1.

G is the mean of the Poisson distribution followed by the transmission attempts per frame time, old and new combined. Old frames mean those frames that have previously suffered collisions.

It is easy to note that Slotted ALOHA peaks at G=1, with a throughput of $S = {}^{1}/_{e}$ or about 0.368. It means that if the system is operating at G=1, the probability of an empty slot is 0.368.

Calculations to obtain the plot between S and G :

The attempts per packet time (G) can be calculated as:

$$G = \frac{\textit{Number of packet transmitted} * PT}{ST * 1000}$$

Where,	G	=	Attempts per packet time
	ST	=	Simulation time (in second)
	PT	=	Packet time(in second)

The throughput (in Mbps) per packet time can be obtained as follows:

$$S = \frac{\textit{Throughput (in Mbps)} * 1000 * PT}{PS * 8}$$

Where,	S	=	Throughput per packet time
	PS	=	Packet size (in bytes)
	PT	=	Packet time (in millisecond)

In the following code, we have taken packet size=1472 (Data Size) + 28 (Overheads) = 1500 bytes

Bandwidth is 10 Mbps and hence, packet time comes as 1.2 milliseconds.

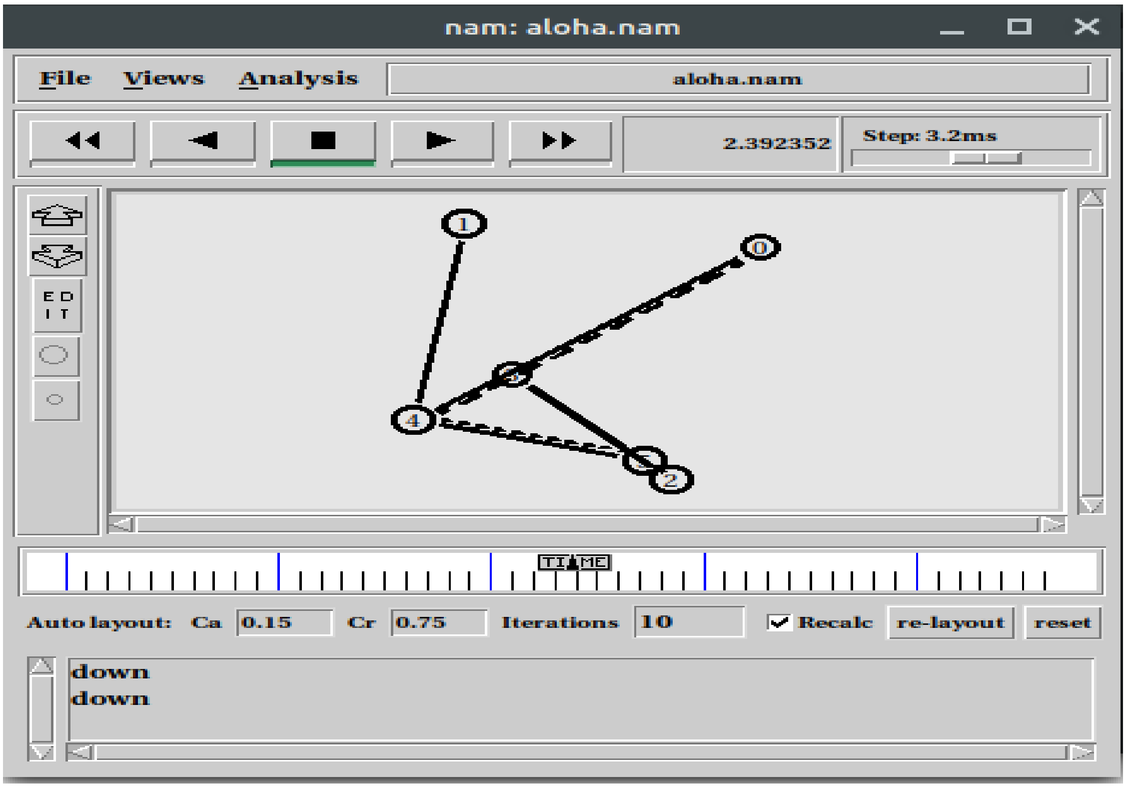
Source Code:

```
set ns [new Simulator]
#Tell the simulator to use dynamic routing
$ns rtproto DV
$ns macType Mac/Sat/SlottedAloha
#Open the nam trace file
set nf [open aloha.nam w]
$ns namtrace-all $nf
```

```
#Open the output files
set f0 [open aloha.tr w]
$ns trace-all $f0
#Define a finish procedure
proc finish {} {
global ns f0 nf
$ns flush-trace
#Close the trace file
close $f0
close $nf
exec nam aloha.nam &
exit 0
}
# Create six nodes
set n0 [$ns node]
set n1 [$ns node]
set n2 [$ns node]
set n3 [$ns node]
set n4 [$ns node]
set n5 [$ns node]
# Create duplex links between nodes with bandwidth and distance
$ns duplex-link $n0 $n4 1Mb 50ms DropTail
$ns duplex-link $n1 $n4 1Mb 50ms DropTail
$ns duplex-link $n2 $n5 1Mb 1ms DropTail
$ns duplex-link $n3 $n5 1Mb 1ms DropTail
$ns duplex-link $n4 $n5 1Mb 50ms DropTail
$ns duplex-link $n2 $n3 1Mb 50ms DropTail
# Create a duplex link between nodes 4 and 5 as queue position
$ns duplex-link-op $n4 $n5 queuePos 0.5
#Create a UDP agent and attach it to node n(0)
set udp0 [new Agent/UDP]
$ns attach-agent $n0 $udp0
# Create a CBR traffic source and attach it to udp0
set cbr0 [new Application/Traffic/CBR]
$cbr0 set packetSize_ 1472
$cbr0 set interval_ 0.005
$cbr0 attach-agent $udp0
```

```
#Create a Null agent (a traffic sink) and attach it to node n(3)
set null0 [new Agent/Null]
$ns attach-agent $n2 $null0
#Connect the traffic source with the traffic sink
$ns connect $udp0 $null0
#Schedule events for the CBR agent and the network dynamics
$ns at 0.5 "$cbr0 start"
$ns rtmodel-at 1.0 down $n5 $n2
$ns rtmodel-at 2.0 up $n5 $n2
$ns at 4.5 "$cbr0 stop"
#Call the finish procedure after 5 seconds of simulation time
$ns at 5.0 "finish"
#Run the simulation
$ns run
```

Output Topology:

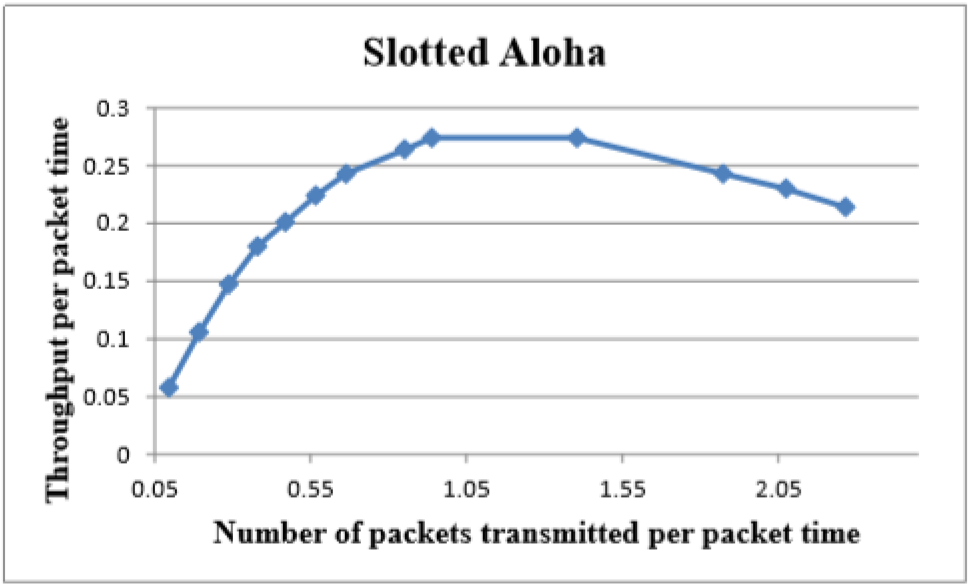


Comparison Table:

The values of Throughput and Total Number of Packets Transmitted obtained from the network statistics after running NS2 simulation code are as follows. Throughput per packet time and Number of Packets Transmitted per packet time calculated from the above mentioned formulae are tabulated as below:

Number of nodes generating traffic	Throughput (in mbps)	Total number of packets Transmitted	Throughput per packet time	Number of packets transmitted per packet time
1	0.58	793	0.058	0.095
2	1.06	1602	0.106	0.192
3	1.47	2394	0.147	0.287
4	1.8	3164	0.18	0.379
5	2.01	3913	0.201	0.469

Plot for the Slotted ALOHA :



Conclusion :

In this practical, we have generated the multiple traffic between nodes using NS2 simulation and Plot the characteristic curve throughput versus offered traffic for a Slotted ALOHA system.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 7	**Date : 19-05-2021**

Title: Understand the impact of bit error rate on packet error and investigate the impact of error of a simple hub based CSMA / CD network**.**

Aim : Observe the impact of bit error rate on packet error and investigate the impact of error of a simple hub based CSMA / CD network using NS2.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. NS2

Theory :

Bit error rate (BER): The bit error rate or bit error ratio is the number of bit errors divided by the total number of transferred bits during a studied time interval i.e. For example, a transmission might have a BER of 10-5, meaning that on average, 1 out of every of 100,000 bits transmitted exhibits an error. The BER is an indication of how often a packet or other data unit has to be retransmitted because of an error. Unlike many other forms of assessment, bit error rate, BER assesses the full end to end performance of a system including the transmitter, receiver and the medium between the two. In this way, bit error rate, BER enables the actual performance of a system in operation to be tested.

Bit error probability (pe): The bit error probability is the expectation value of the BER. The BER can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors.

Packet Error Rate (PER): The PER is the number of incorrectly received data packets divided by the total number of received packets. A packet is declared incorrect if at least one bit is erroneous. The expectation of the PER is denoted as packet error probability pp, which for a data packet length of N bits can be expressed as,

$$P_p = 1 - (1 - p_e)^N$$

It is based on the assumption that the bit errors are independent of each other.

Derivation of the packet error probability: Suppose packet size is N bits.

p_e is the bit error probability then probability of no bit error=1- p_e

As packet size is N bits and it is the assumption that the bit errors are independent. Hence,

Probability of a packet with no errors = $(1 - p_e)^N$

A packet is erroneous if at least there is one bit error, hence

Probability of packet error=1- $(1 - p_e)^N$

Ethernet is a LAN (Local area Network) protocol operating at the MAC (Medium Access Control) layer. Ethernet has been standardized as per IEEE 802.3. The underlying protocol in Ethernet is known as the CSMA / CD – Carrier Sense Multiple Access / Collision Detection. The working of the Ethernet protocol is as explained below, A node which has data to transmit senses the channel. If the channel is idle then, the data is transmitted. If the channel is busy then, the station defers transmission until the channel is sensed to be idle and then immediately transmitted. If more than one node starts data transmission at the same time, the data collides. This collision is heard by the transmitting nodes which enter into contention phase. The contending nodes resolve contention using an algorithm called Truncated binary exponential back off.

Algorithm :

1. Create a simulator object
2. Define different colors for different data flows
3. Open a nam trace file and define finish procedure then close the trace file, and execute nam on trace file.
4. Create six nodes that forms a network numbered from 0 to 5

5. Create duplex links between the nodes and add Orientation to the nodes for setting a LAN topology
6. Setup TCP Connection between n(0) and n(4)
7. Apply FTP Traffic over TCP
8. Setup UDP Connection between n(1) and n(5)
9. Apply CBR Traffic over UDP.
10. Apply CSMA/CA and CSMA/CD mechanisms and study their performance
11. Schedule events and run the program.

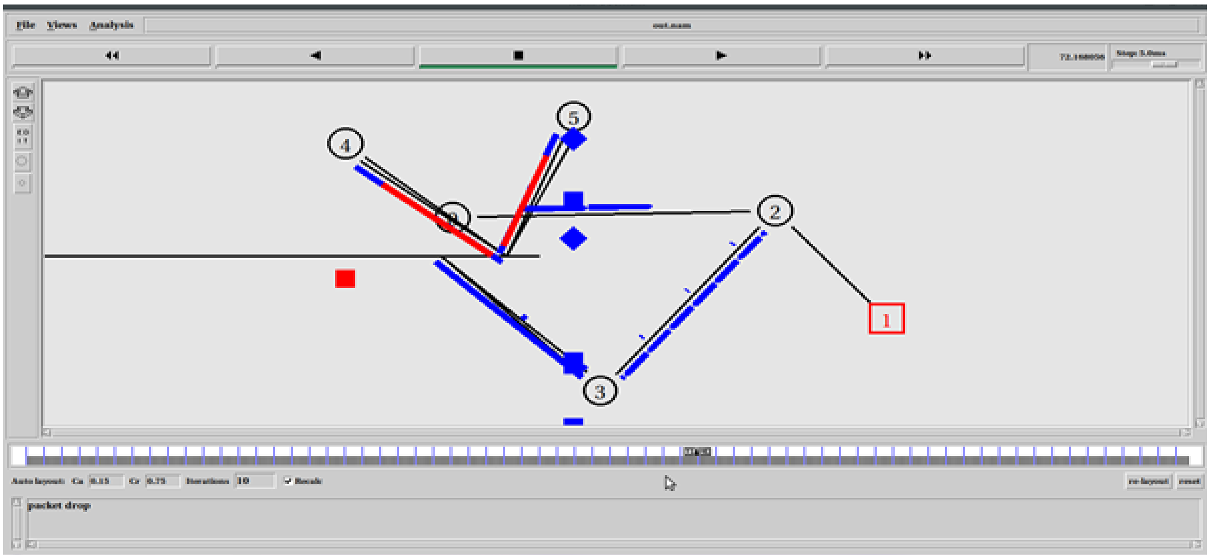
Source Code :

```
set ns [new Simulator]
#Define different colors for data flows (for NAM)
$ns color 1 Blue
$ns color 2 Red
#Open the Trace files
set file1 [open out.tr w]
set winfile [open WinFile w]
$ns trace-all $file1
#Open the NAM trace file
set file2 [open out.nam w]
$ns namtrace-all $file2
#Define a 'finish' procedure
proc finish {} {
global ns file1 file2
$ns flush-trace
close $file1
close $file2
exec nam out.nam &
exit 0
}
#Create six nodes
set n0 [$ns node]
set n1 [$ns node]
set n2 [$ns node]
set n3 [$ns node]
set n4 [$ns node]
set n5 [$ns node]
$n1 color red
```

```
$n1 shape box
#Create links between the nodes
$ns duplex-link $n0 $n2 2Mb 10ms DropTail
$ns duplex-link $n1 $n2 2Mb 10ms DropTail
$ns simplex-link $n2 $n3 0.3Mb 100ms DropTail
$ns simplex-link $n3 $n2 0.3Mb 100ms DropTail
set lan [$ns newLan "$n3 $n4 $n5" 0.5Mb 40ms LL Queue/DropTail
MAC/Csma/Cd Channel]
#Setup a TCP connection
set tcp [new Agent/TCP/Newreno]
$ns attach-agent $n0 $tcp
set sink [new Agent/TCPSink/DelAck]
$ns attach-agent $n4 $sink
$ns connect $tcp $sink
$tcp set fid_ 1
$tcp set window_ 8000
$tcp set packetSize_ 552
#Setup a FTP over TCP connection
set ftp [new Application/FTP]
$ftp attach-agent $tcp
$ftp set type_ FTP
#Setup a UDP connection
set udp [new Agent/UDP]
$ns attach-agent $n1 $udp
set null [new Agent/Null]
$ns attach-agent $n5 $null
$ns connect $udp $null
$udp set fid_ 2
#Setup a CBR over UDP connection
set cbr [new Application/Traffic/CBR]
$cbr attach-agent $udp
$cbr set type_ CBR
$cbr set packet_size_ 1000
$cbr set rate_ 0.01mb
$cbr set random_ false
$ns at 0.1 "$cbr start"
$ns at 1.0 "$ftp start"
```

```
$ns at 124.0 "$ftp stop"
$ns at 124.5 "$cbr stop"
# next procedure gets two arguments: the name of the
# tcp source node, will be called here "tcp",
# and the name of output file.
proc plotWindow {tcpSource file} {
global ns
set time 0.1
set now [$ns now]
set cwnd [$tcpSource set cwnd_]
set wnd [$tcpSource set window_]
puts $file "$now $cwnd"
$ns at [expr $now+$time] "plotWindow $tcpSource $file" }
$ns at 0.1 "plotWindow $tcp $winfile"
$ns at 5 "$ns trace-annotate \"packet drop\""
# PPP
$ns at 125.0 "finish"
$ns run
```

Output :



Conclusion :

In this practical, we have observed the impact of bit error rate on packet error and investigate the impact of error of a simple hub based CSMA / CD network using NS2.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 8	**Date : 02-06-2021**

Title: Study the performance of networks based on Star, Bus and Ring topologies**.**

Aim : Observe and understand the performance of networks based on Star, Bus and Ring topologies in Cisco Packet Tracer.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. Cisco Packet Tracer

Theory :

Network topology is the schematic description of network arrangement, connecting various node (sender and receiver) through lines of connection. There are various types of topologies like Bus, Ring, Star, Mesh and Hybrid.

Star Topology :

In this type of topology all the computers are connected to a single hub through a cable. This Hub is the central node and all other nodes are connected to the central node.

Advantages of Star topology :

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and install.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

Disadvantages of Star topology :

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.

Steps to create star topology :

1. Select switch
2. Select 5-6 end devices
3. Click on switch->physical tab->Turn it OFF->click on PT-switch-NM-1CFE (in order to add number of ports) and add ports according to requirements->Turn it ON.
4. Assign the IP address to each end device (192.168.1.1 and so on)
5. Set the common default gateway for all end device (192.168.2.1)
6. Make the connection between switch and end devices with automatic connection type in star topology.
7. Send the data between switch and end devices.

Bus Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two end points, then it is called linear bus topology.

Features of Bus Topology :

1. It transmits data only in one direction.
2. Every device is connected to a single cable.

Advantages of Bus topology :

1. It is cost effective
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

Disadvantage of Bus Topology :

1. Cable fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.

3. Cable has a limited length.
4. It is slower than ring topology.

Steps to create Bus Topology :

1. Select four switches.
2. Select 4 end devices.
3. Assign IP address to 4 end devices.
4. Make the connection with switch.
5. Send the data between end devices and switch.

Ring Topology :

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbors for each device.

Advantages of Ring Topology :

1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand.

Disadvantages of Ring Topology :

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

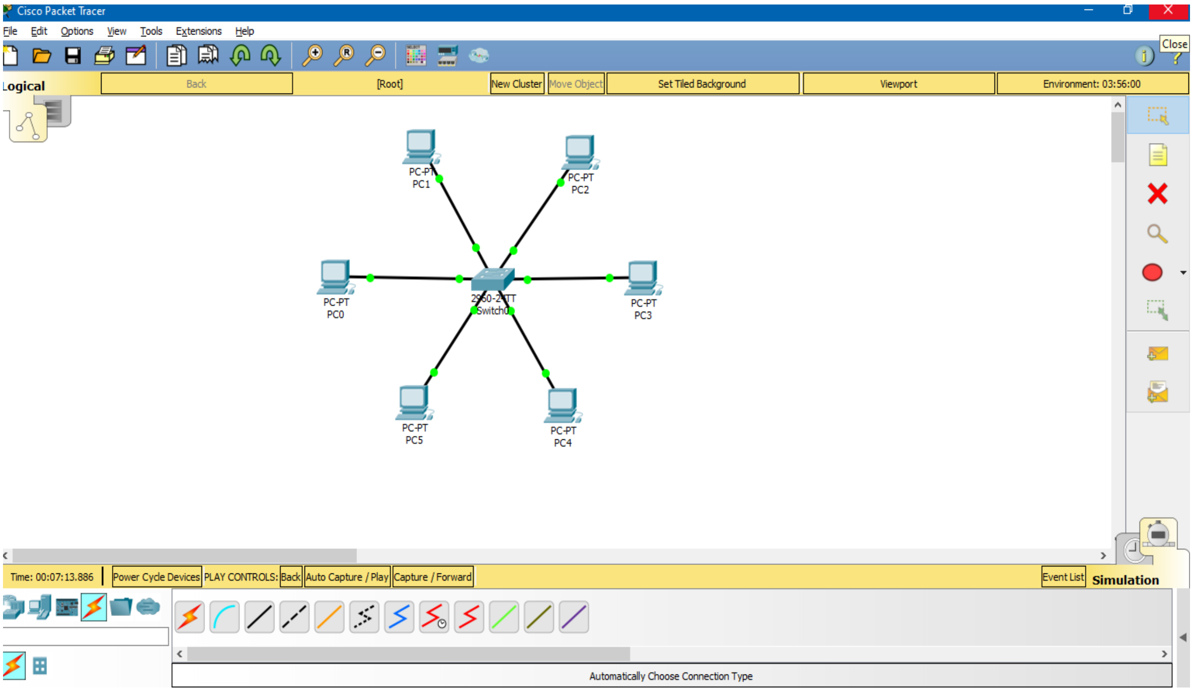
Steps to create Ring Topology :

1. Select some nodes.
2. Select 4 switches and design in ring like structure.
3. Assign IP address to each node.
4. Make the connection between nodes and switches.
5. Transfer the data between the nodes.

After the creation of all the topologies observe the performance of network by ping command.

Standard INPUT and OUTPUT :

Star Topology :



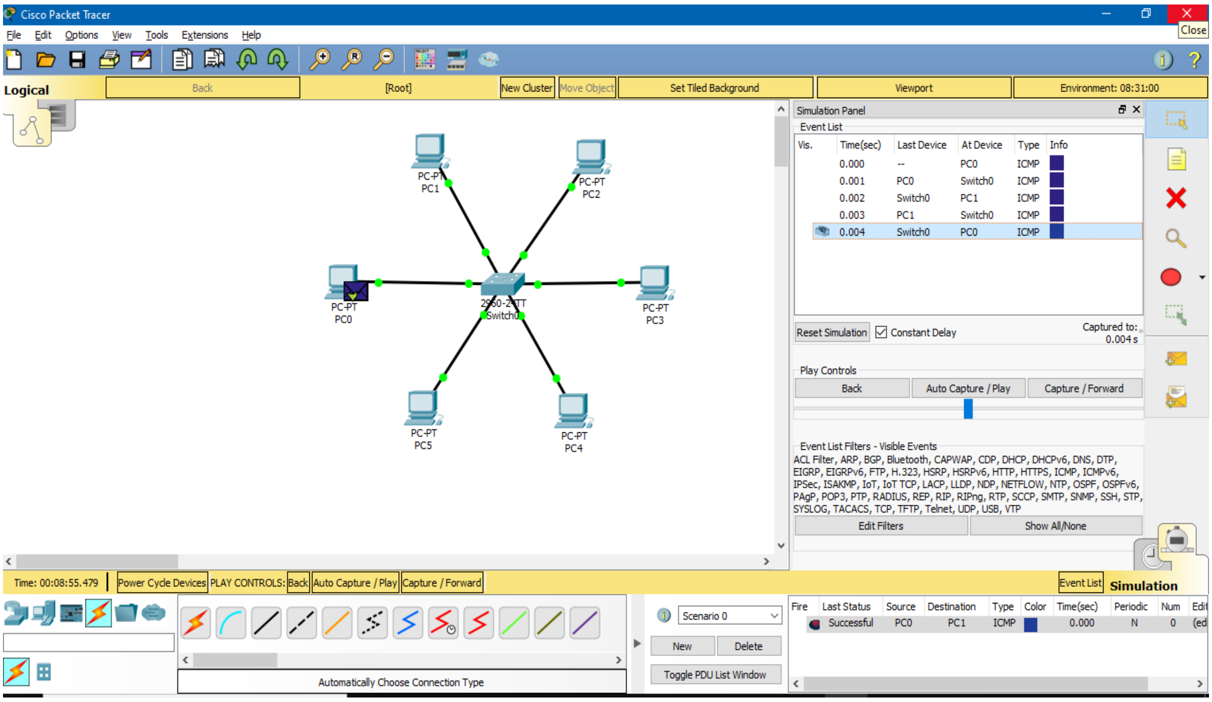
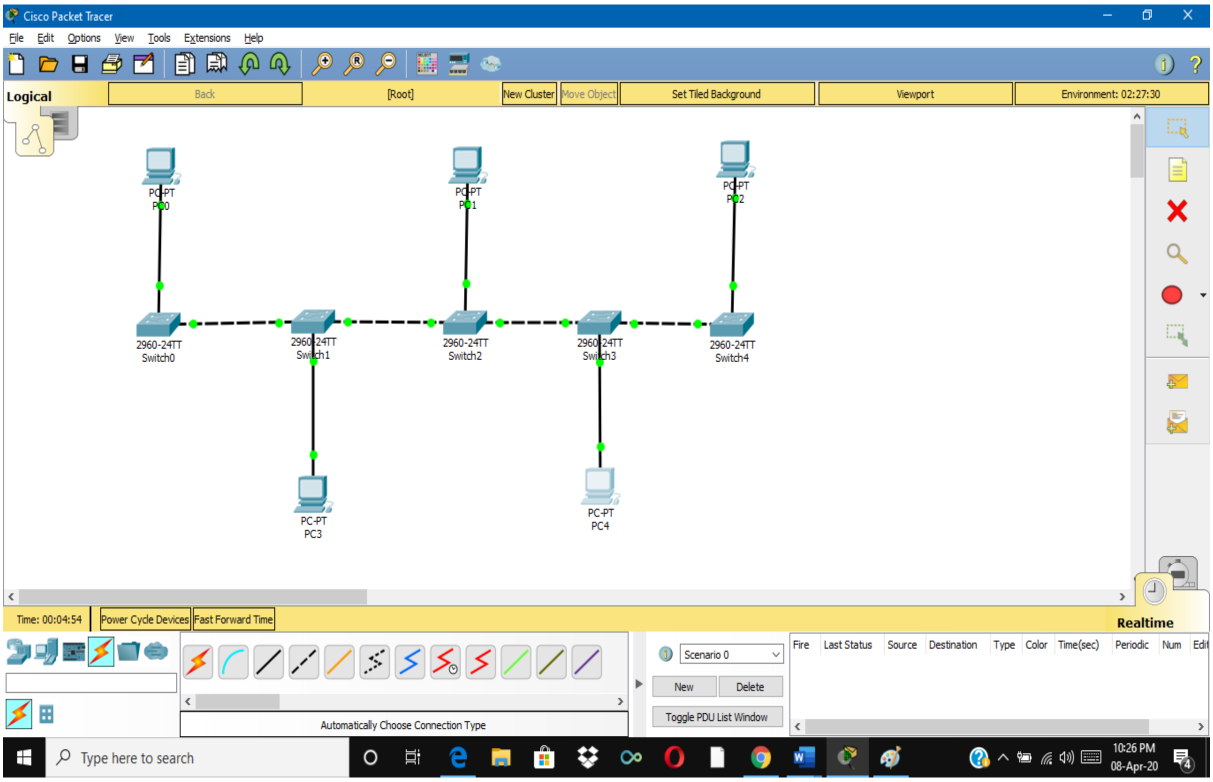


Fig. Star Topology

Bus Topology:



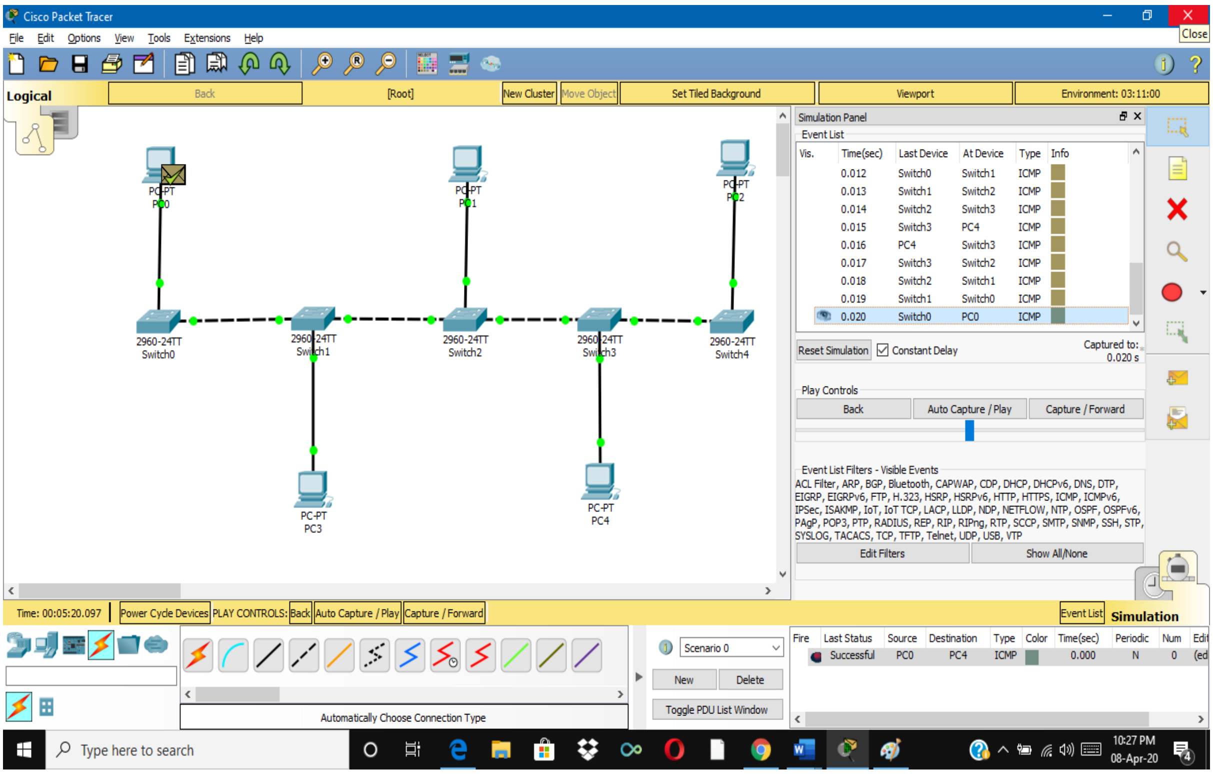
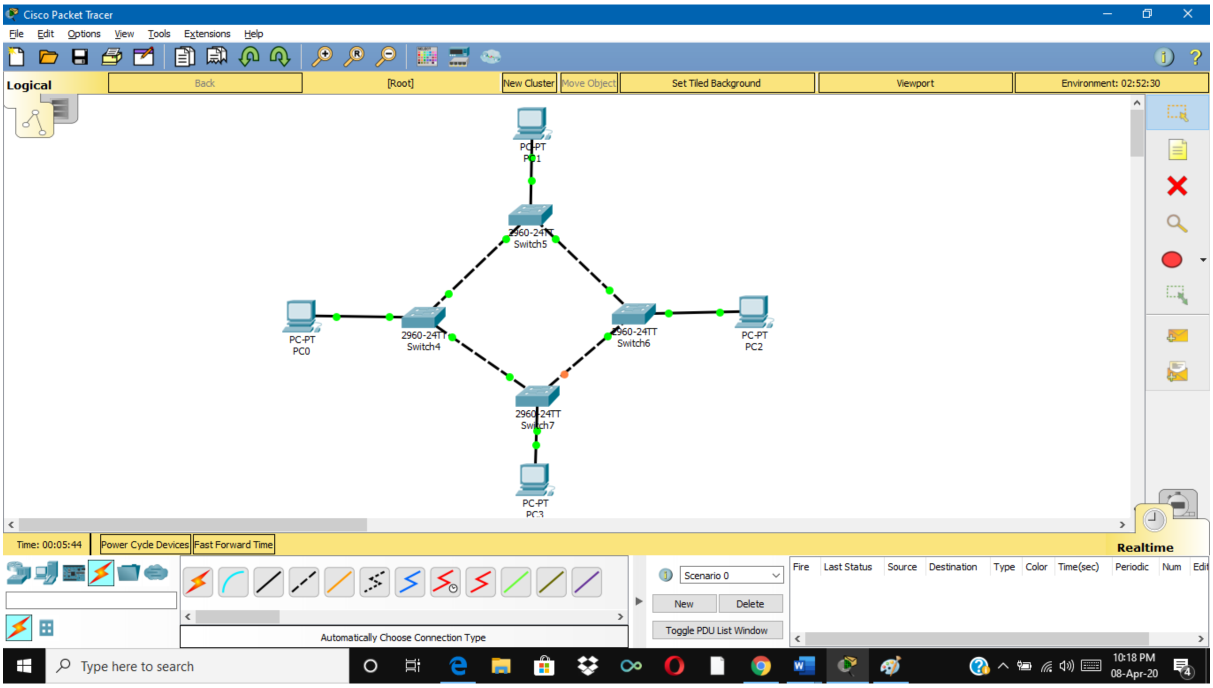


Fig. Bus Topology

Ring Topology :



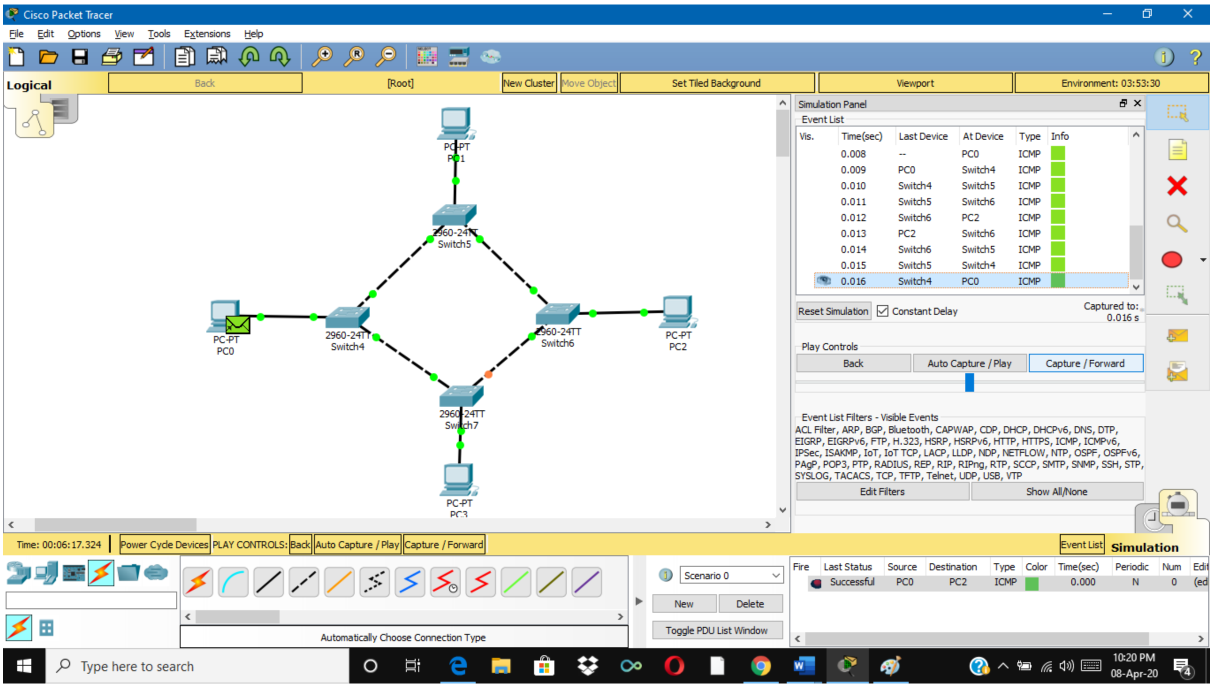


Fig. Ring Topology

Conclusion :

In this practical, we have studied the performance of networks based on Star, Bus and Ring topologies in Cisco Packet Tracer.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 9	**Date : 09-06-2021**

Title: TCP/IP Sockets: Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present.

Aim : Write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. Java

Theory :

TCP Socket :

TCP is a connection-oriented protocol. This means that before the client and server can start to send data to each other, they first need to handshake and establish a TCP connection. One end of the TCP connection is attached to the client socket and the other end is attached to a server socket. When creating the TCP connection, we associate with it the client socket address (IPaddress and port number) and the server socket address (IPaddress and port number). With the TCP connection established, when one side wants to send data to the other side, it just drops the data into the TCP connection via its socket.

With the server process running, the client process can initiate a TCP connection to the server. This is done in the client program by creating a TCP socket. When the client creates its TCP socket, it specifies the address of the welcoming socket in the server, namely, the IP address of the server host and the port number of the socket. After creating its socket, the client initiates a three-way handshake and establishes a TCP connection with the server.

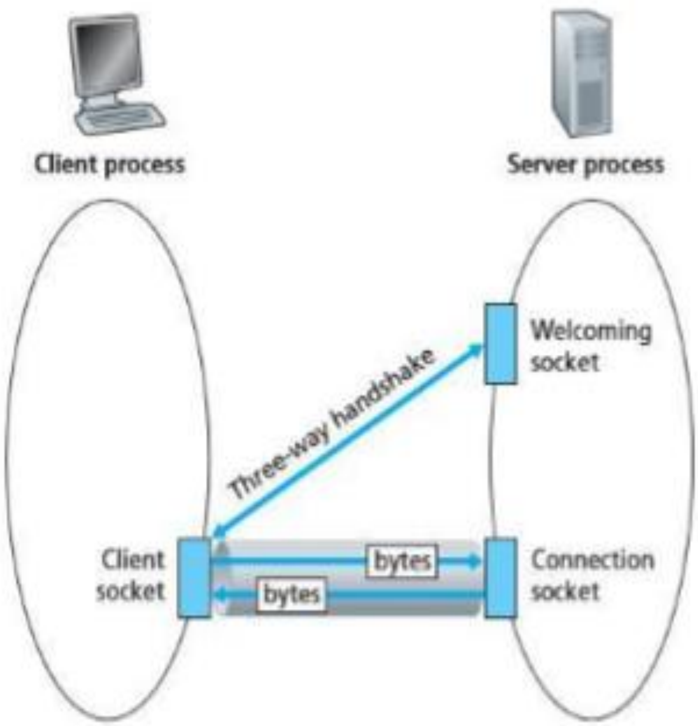


Fig. TCP server process

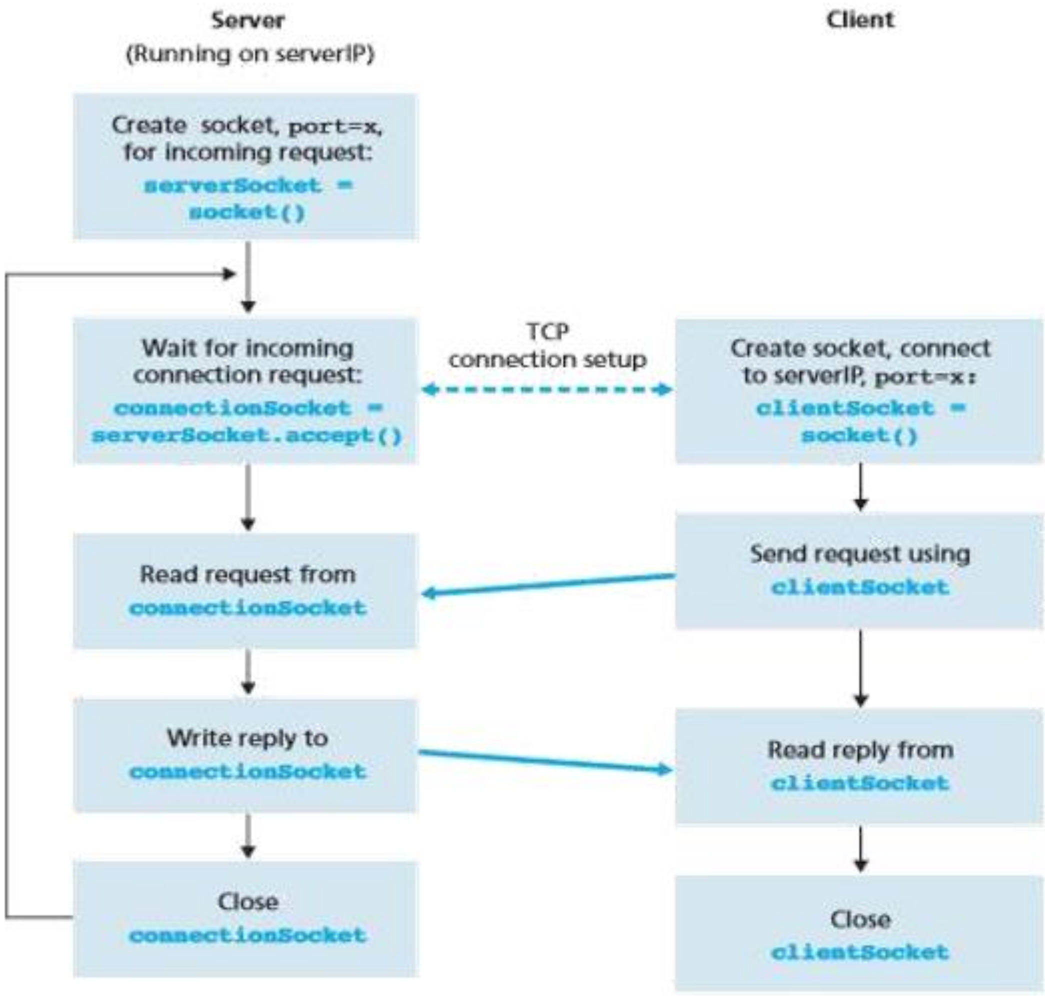


Fig. The Client-server application using TCP

Socket creates an endpoint for communication and returns a descriptor. The domain parameter specifies a common domain this selects the protocol family which will be used for communication.

Algorithm :

1. Create a server socket.
2. Then create a client socket.
3. DataInputStream and DataOutputStream is to abstract different ways to input and output whether the stream is a file, a web page.
4. Specify the IP address and port number for socket.
5. Close all streams.
6. Close server and client socket.
7. stop

Source Code:

1. Server.java

```
import java.io.*;
import java.net.*;
public class Server
{
public static void main(String[] args) throws Exception
{
ServerSocket sersock = new ServerSocket(3000);
System.out.println("Server ready for chatting");
Socket sock = sersock.accept( );
// reading from keyboard (keyRead object)
BufferedReader keyRead = new BufferedReader(new
InputStreamReader(System.in));
// sending to client (pwrite object)
OutputStream ostream = sock.getOutputStream();
PrintWriter pwrite = new PrintWriter(ostream, true);
// receiving from server ( receiveRead object)
InputStream istream = sock.getInputStream();
BufferedReader receiveRead = new BufferedReader(new
InputStreamReader(istream));
String receiveMessage, sendMessage;
while(true)
{
if((receiveMessage = receiveRead.readLine()) != null)
{
System.out.println(receiveMessage);
}
sendMessage = keyRead.readLine();
pwrite.println(sendMessage);
pwrite.flush();
}
}
}
```

2. Client.java

```
import java.io.*;
import java.net.*;
public class client
{
public static void main(String[] args) throws Exception
{
Socket sock = new Socket("127.0.0.1", 3000);
// reading from keyboard (keyRead object)
BufferedReader keyRead = new BufferedReader(new
InputStreamReader(System.in));
// sending to client (pwrite object)
OutputStream ostream = sock.getOutputStream();
PrintWriter pwrite = new PrintWriter(ostream, true);
// receiving from server ( receiveRead object)
InputStream istream = sock.getInputStream();
BufferedReader receiveRead = new BufferedReader(new
InputStreamReader(istream));
System.out.println("Start the chitchat, type and press Enter key");
String receiveMessage, sendMessage;
while(true)
{
sendMessage = keyRead.readLine(); // keyboard reading
pwrite.println(sendMessage); // sending to server
pwrite.flush(); // flush the data
if((receiveMessage = receiveRead.readLine()) != null) //receive from server
{
System.out.println(receiveMessage); // displaying at DOS prompt
} } } }
```

Procedure :

run both Server.java & Client.java files

Client side

run:

hi, good Morning ,are you fine?

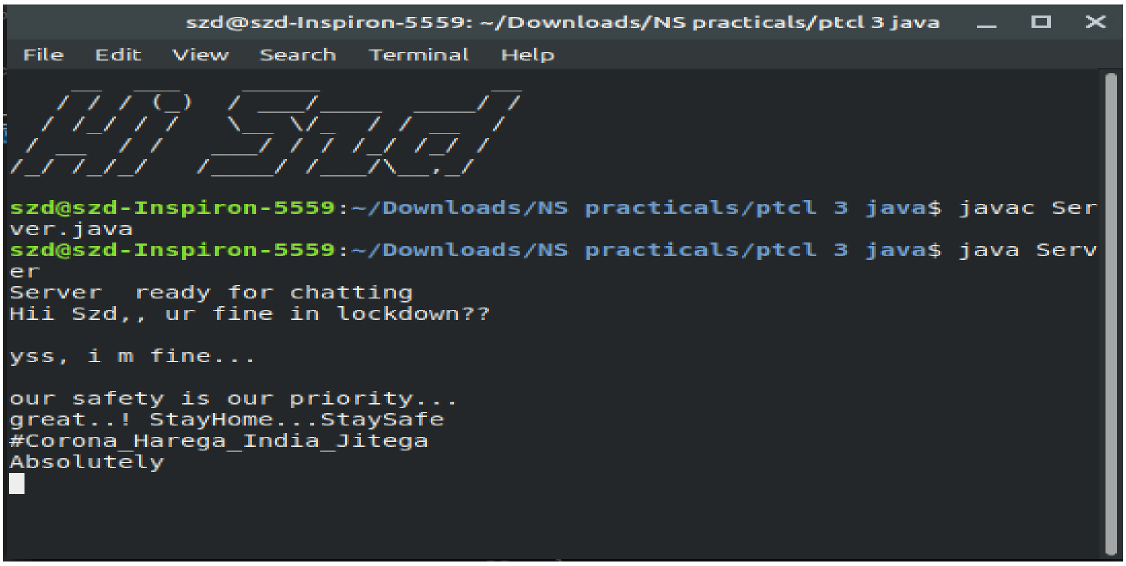
FROM SERVER: HI, GOOD MORNING ,ARE YOU FINE?

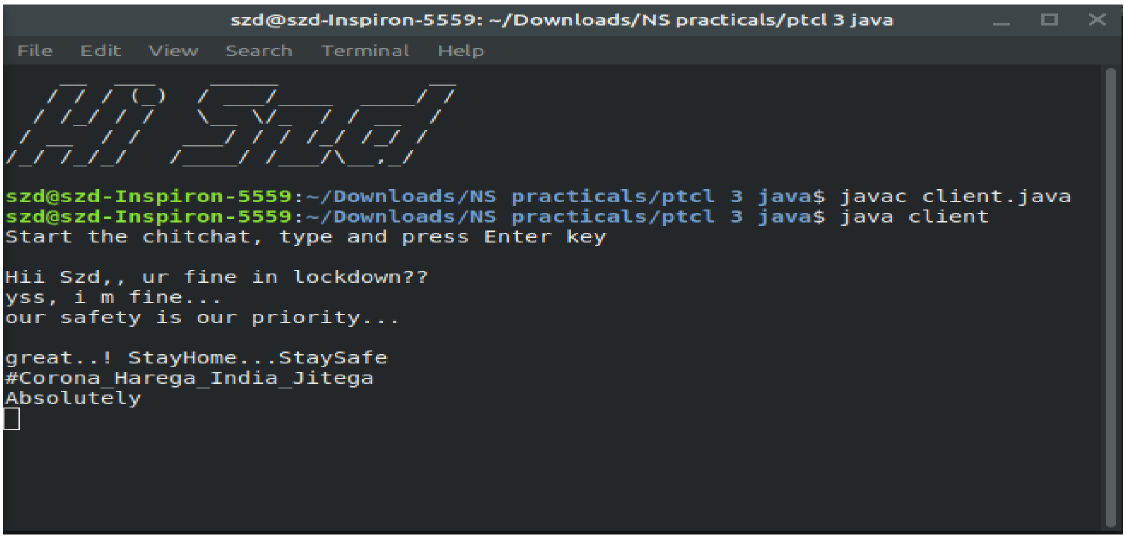
Server side

run:

Received: hi, good Morning ,are you fine?

Output :





Conclusion : In this practical, we have studied client – server program to make the client send the file name and to make the server send back the contents of the requested file if present.

Subject : Computer Network	**Class : T.Y. BTech (Comp)**
Practical No. : 10	**Date : 16-06-2021**

Title: Write a program for calculating the shortest path using Link State Routing Algorithms.

Aim : Write a program for calculating the shortest path using Link State Routing Algorithms in NS2.

Hardware /Software requirements :

1. Processor – 1.5GHz or more
2. RAM – 512 MB minimum
3. HDD – Minimum 900MB free space
4. Standard I/O Devices
5. Operating System – Windows XP or later
6. NS2

Theory :

In link state routing, each router shares its knowledge of its neighborhood with every other router in the internet work.

(i) Knowledge about Neighborhood: Instead of sending its entire routing table a router sends info about its neighborhood only.

(ii) To all Routers: each router sends this information to every other router on the internet work not just to its neighbor. It does so by a process called flooding.

(iii) Information sharing when there is a change: Each router sends out information about the neighbors when there is change.

Procedure :

The Dijkstra algorithm follows four steps to discover what is called the shortest path tree(routing table) for each router: The algorithm begins to build the tree by identifying its roots. The root router's trees the router itself. The algorithm then attaches all nodes that can be reached from the root. The algorithm compares the tree's temporary arcs and identifies the arc with the lowest cumulative cost. This arc and the node to which it connects are now a permanent part of the shortest path tree. The algorithm examines the database and identifies every node that can be reached from its chosen node. These nodes and their arcs are added temporarily to the tree. The last two steps are repeated until every node in the network has become a permanent part of the tree.

Algorithm :

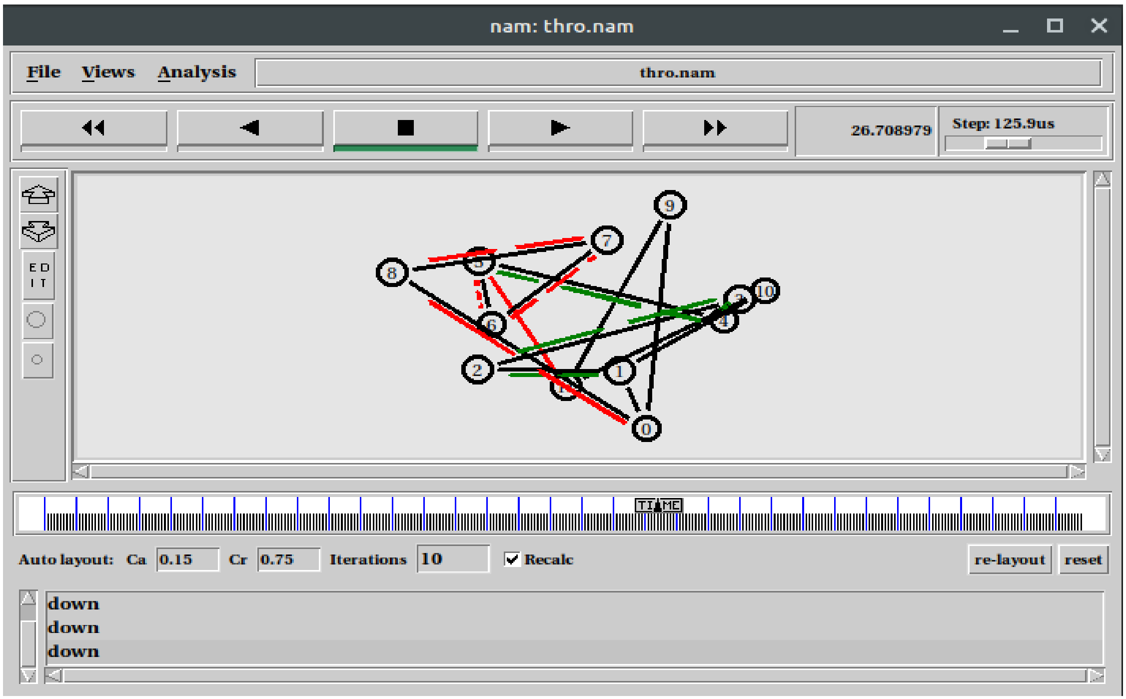
1. Create a simulator object
2. Define different colors for different data flows
3. Open a nam trace file and define finish procedure then close the trace file, and execute nam on trace file.
4. Create n number of nodes using for loop
5. Create duplex links between the nodes
6. Setup UDP Connection between n(0) and n(5)
7. Setup another UDP connection between n(1) and n(5)
8. Apply CBR Traffic over both UDP connections
9. Choose Link state routing protocol to transmit data from sender to receiver.
10. Schedule events and run the program.

Source Code:

```
set ns [new Simulator]
set nr [open thro.tr w]
$ns trace-all $nr
set nf [open thro.nam w]
$ns namtrace-all $nf
proc finish { } {
global ns nr nf
$ns flush-trace
close $nf
close $nr
exec nam thro.nam &
exit 0
}
for { set i 0 } { $i < 12} { incr i 1 } {
set n($i) [$ns node]}
for {set i 0} {$i < 8} {incr i} {
$ns duplex-link $n($i) $n([expr $i+1]) 1Mb 10ms DropTail }
```

```
$ns duplex-link $n(0) $n(8) 1Mb 10ms DropTail
$ns duplex-link $n(1) $n(10) 1Mb 10ms DropTail
$ns duplex-link $n(0) $n(9) 1Mb 10ms DropTail
$ns duplex-link $n(9) $n(11) 1Mb 10ms DropTail
$ns duplex-link $n(10) $n(11) 1Mb 10ms DropTail
$ns duplex-link $n(11) $n(5) 1Mb 10ms DropTail
set udp0 [new Agent/UDP]
$ns attach-agent $n(0) $udp0
set cbr0 [new Application/Traffic/CBR]
$cbr0 set packetSize_ 500
$cbr0 set interval_ 0.005
$cbr0 attach-agent $udp0
set null0 [new Agent/Null]
$ns attach-agent $n(5) $null0
$ns connect $udp0 $null0
set udp1 [new Agent/UDP]
$ns attach-agent $n(1) $udp1
set cbr1 [new Application/Traffic/CBR]
$cbr1 set packetSize_ 500
$cbr1 set interval_ 0.005
$cbr1 attach-agent $udp1
set null0 [new Agent/Null]
$ns attach-agent $n(5) $null0
$ns connect $udp1 $null0
$ns rtproto LS
$ns rtmodel-at 10.0 down $n(11) $n(5)
$ns rtmodel-at 15.0 down $n(7) $n(6)
$ns rtmodel-at 30.0 up $n(11) $n(5)
$ns rtmodel-at 20.0 up $n(7) $n(6)
$udp0 set fid_ 1
$udp1 set fid_ 2
$ns color 1 Red
$ns color 2 Green
$ns at 1.0 "$cbr0 start"
$ns at 2.0 "$cbr1 start"
$ns at 45 "finish"
$ns run
```

Output :



Conclusion :

In this practical, we have studied how to write a program for calculating the shortest path using Link State Routing Algorithms in NS2.