NITTE MEENAKSHI INSTITUTE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION, AFFILIATED TO VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM, APPROVED BY AICTE & GOVT.OF KARNATAKA

Computer Networks Lab (18CSL59)

On

Computer Networks Lab Programs

Submitted in partial fulfilment of the requirement for the award of Degree of

Bachelor of Engineering

in

Computer Science and Engineering

Submitted by:

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Submitted to:

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NITTE EDUCATION TRUST

Department of Computer Science and Engineering

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the Course Lab titled "Computer Networks Lab Programs" is an authentic work carried out by **Sanjana Honnappa (1NT18CS204)** bonafide student of **Nitte Meenakshi Institute of Technology,** Bangalore in partial fulfilment for the award of the degree of ***Bachelor of Engineering*** in COMPUTER SCIENCE AND ENGINEERING of Visvesvaraya Technological University, Belagavi during the academic year ***2020-2021***.

Internal Guide

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PART-A

Q1	**Simulate a point-to-point network with duplex link as follows: n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP agent between n1-n3. Apply relevant applications over TCP and UDP agents. Set the queue size to 5 and vary the bandwidth to find number of packets dropped and received by TCP and UDP agents using awk script and grep command.**
Answer	set ns [new Simulator] set tf [open ex1.tr w] $ns trace-all $tf set nf [open ex1.nam w] $ns namtrace-all $nf set n0 [$ns node] set n1 [$ns node] set n2 [$ns node] set n3 [$ns node] $ns duplex-link $n0 $n2 2Mb 2ms DropTail $ns duplex-link $n1 $n2 2Mb 2ms DropTail $ns duplex-link $n2 $n3 0.4Mb 10ms DropTail $ns queue-limit $n0 $n2 5 set udp1 [new Agent/UDP] $ns attach-agent $n0 $udp1 set null1 [new Agent/Null] $ns attach-agent $n3 $null1 $ns connect $udp1 $null1 set cbr1 [new Application/Traffic/CBR] $cbr1 attach-agent $udp1 $ns at 1.1 "$cbr1 start" set tcp [new Agent/TCP] $ns attach-agent $n3 $tcp set sink [new Agent/TCPSink] $ns attach-agent $n1 $sink $ns connect $tcp $sink set ftp [new Application/FTP] $ftp attach-agent $tcp $ns at 0.1 "$ftp start" $ns at 10.0 "finish" proc finish {} { global ns tf nf $ns flush-trace close $tf close $nf

```
        puts "running nam..."
        exec nam ex1.nam &
        exit 0
}
$ns run
```

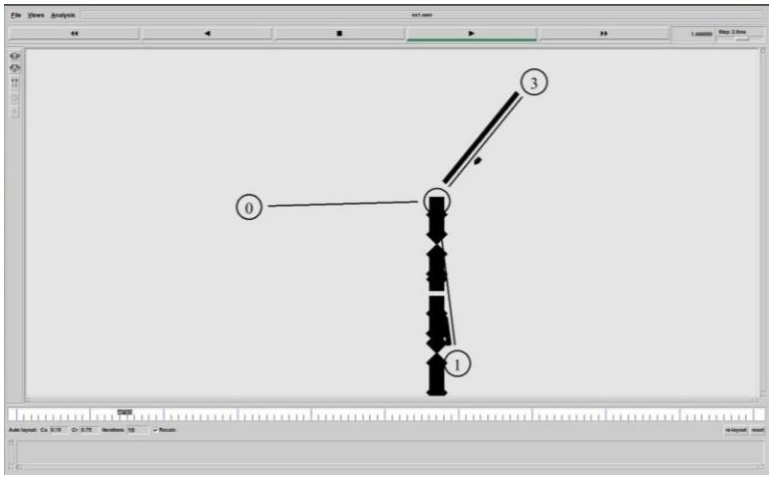
ex1.awk

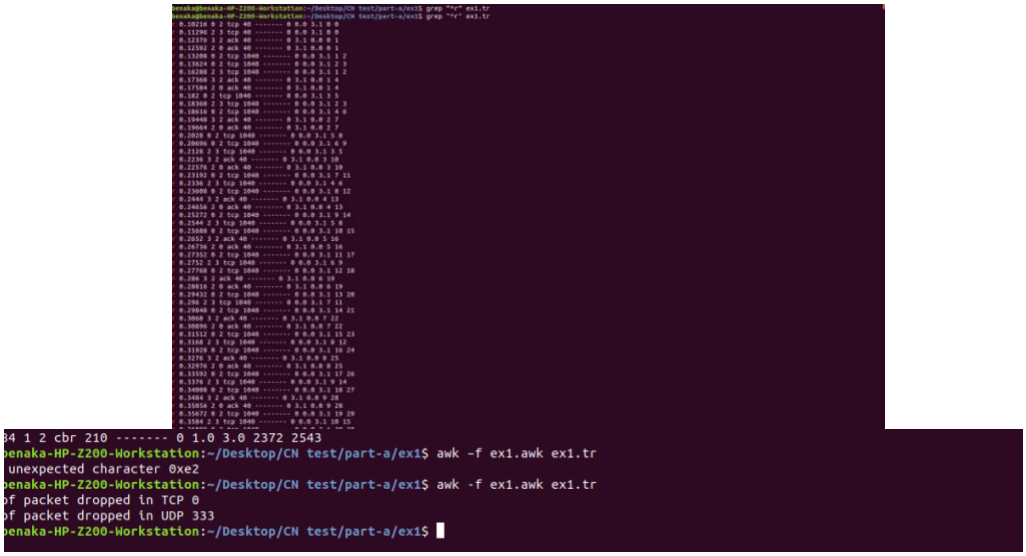
```
BEGIN {
        tcp_count=0;
        udp_count=0;
}
{
        if ( $1 == "d" && $5 == "tcp")
                tcp_count ++;

    if ( $1 == "d" && $5 == "cbr")
                udp_count ++;
}
END {
printf("Number of packet dropped in TCP     %d\n", tcp_count);
printf("Number of packet dropped in UDP     %d\n", udp_count);
}
```

To run the awk script you need to execute the command shown bellow on the terminal.

awk –f ex1.awk ex1.tr

Screenshot





Q2

Set up the network topology as shown in fig 1. Simulate different type of internet traffic Such as traffic using FTP between the nodes n1 – n6 and Telnet between the nodes n2-n5.

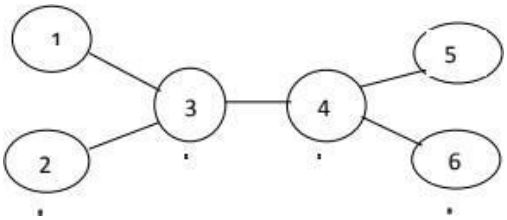


Fig. 1: Network Topology

Plot congestion window for FTP and Telnet, and analyze the throughput.

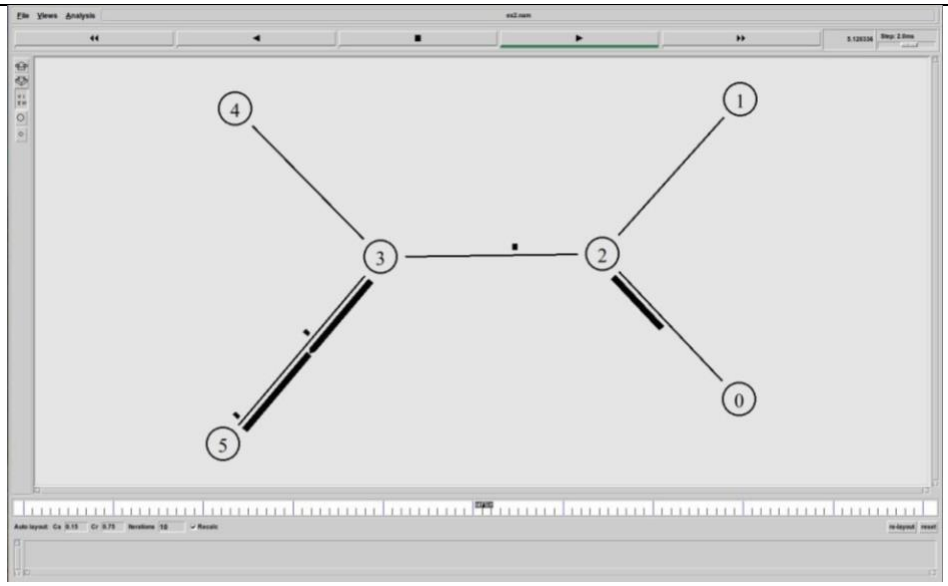
Answer

```
set ns [new Simulator]

set tf [open ex2.tr w]
$ns trace-all $tf

set nf [open ex2.nam w]
$ns namtrace-all $nf
set cwind [open win2.tr w]
set n1 [$ns node]
set n2 [$ns node]
set n3 [$ns node]
set n4 [$ns node]
set n5 [$ns node]
set n6 [$ns node]

$ns duplex-link $n1 $n3 5Mb 2ms DropTail
$ns duplex-link $n2 $n3 5Mb 2ms DropTail
$ns duplex-link $n3 $n4 5Mb 2ms DropTail
$ns duplex-link $n4 $n5 5Mb 2ms DropTail
$ns duplex-link $n4 $n6 1.5Mb 10ms DropTail
set tcp0 [new Agent/TCP]
```

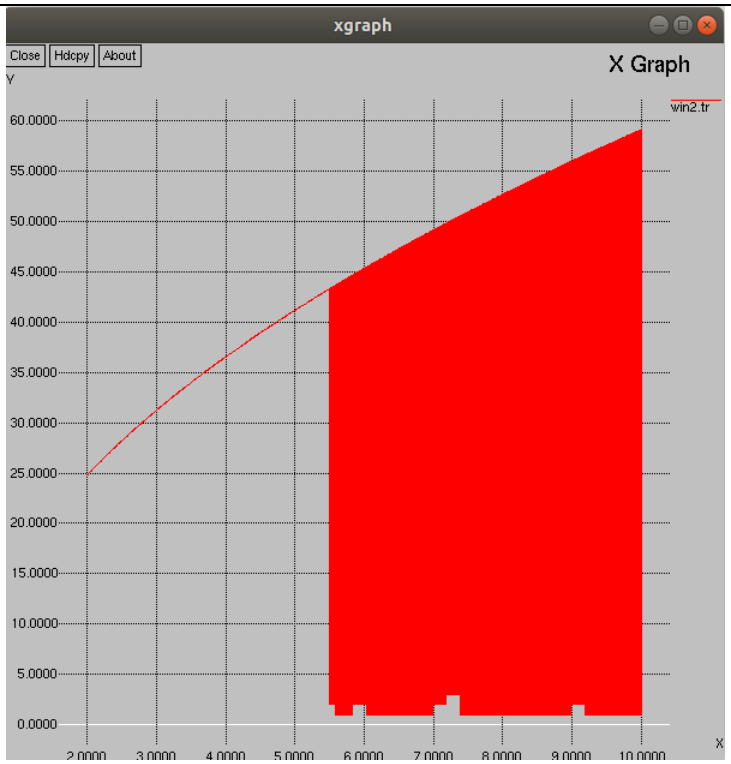
```
$ns attach-agent $n1 $tcp0
set sink0 [new Agent/TCPSink]
$ns attach-agent $n6 $sink0
$ns connect $tcp0 $sink0
set ftp [new Application/FTP]
$ftp attach-agent $tcp0

$ns at 1.2 "$ftp start"

set tcp1 [new Agent/TCP]
$ns attach-agent $n2 $tcp1
set sink1 [new Agent/TCPSink]
$ns attach-agent $n5 $sink1
$ns connect $tcp1 $sink1
set telnet [new Application/Telnet]
$telnet attach-agent $tcp1

$ns at 1.5 "$telnet start"

$ns at 10.0 "finish"

proc plotWindow {tcpSource file} {
global ns
set time 0.01
set now [$ns now]
set cwnd [$tcpSource set cwnd_]
puts $file "$now $cwnd"
$ns at [expr $now+$time] "plotWindow $tcpSource $file" }
$ns at 2.0 "plotWindow $tcp0 $cwind"
$ns at 5.5 "plotWindow $tcp1 $cwind"

proc finish {} {
        global ns tf nf cwind
        $ns flush-trace
        close $tf
        close $nf

        puts "running nam..."
        puts "FTP PACKETS.."
        puts "Telnet PACKETS.."
        exec nam ex2.nam &
      exec xgraph win2.tr &
        exit 0
}
$ns run

ex2.awk
BEGIN {
    last = 0
    tcp_sz = 0
    cbr_sz = 0
    total_sz = 0
```

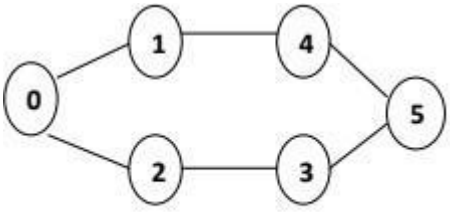
```
}
{
  action = $1;
  time = $2;
  from = $3;
  to = $4;
  type = $5;
  pktsize  =  $6;
  flow_id = $8;
  src = $9;
  dst = $10;
  seq_no = $11;
  packet_id = $12;

        if (type == "tcp" && action == "r" && to == "3" )
        tcp_sz += pktsize

if (type == "cbr" && action == "r" && to == "3" )
        cbr_sz += pktsize

 total_sz += pktsize
 }
END {
    print time, ( tcp_sz * 8 / 1000000)
   print time , (tcp_sz * 8 / 1000000 ), ( total_sz * 8 / 1000000)
 }
```

Screenshot

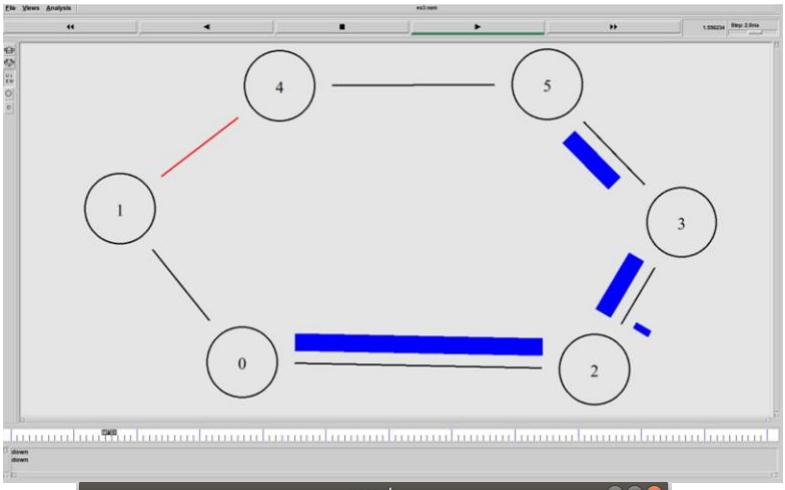
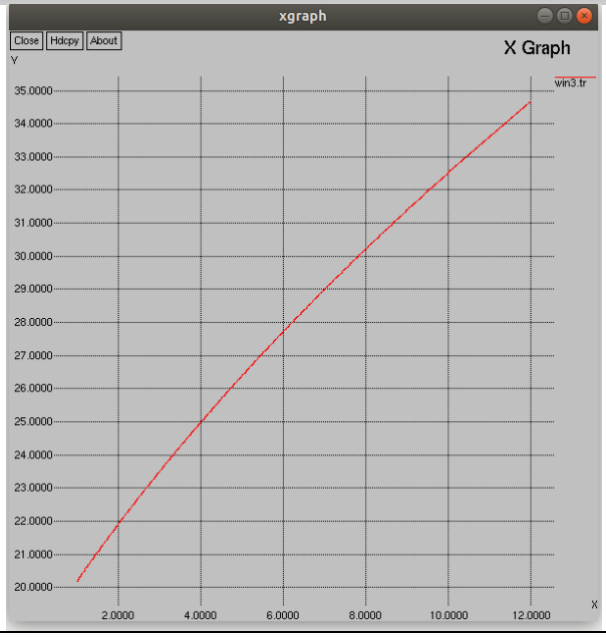



```
benaka@benaka-HP-Z200-Workstation:~/Desktop/CN test/part-a/ex2$ awk -f ex2.awk ex2.tr
9.998677 13.271
9.998677 13.271 123.805
benaka@benaka-HP-Z200-Workstation:~/Desktop/CN test/part-a/ex2$
```



Q3	**Design networks that demonstrate the working of Distance vector routing protocol. The link between node 1 and 4 breaks at 1.0 ms and comes up at 3.0ms. Assume that the source node 0 transmits packets to node 4. Plot the congestion window when TCP sends packets via other nodes. Assume your own parameters for bandwidth and delay.**  **Fig 2: Network Topology**
Answer	set tf [open ex4.tr w] $ns trace-all $tf set nf [open ex4.nam w] $ns namtrace-all $nf set cwind [open win4.tr w] $ns color 1 Blue $ns color 2 Red $ns rtproto DV set n0 [$ns node] set n1 [$ns node] set n2 [$ns node] set n3 [$ns node]

```
set n4 [$ns node]
set n5 [$ns node]

$ns duplex-link $n0 $n1 0.3Mb 10ms DropTail
$ns duplex-link $n1 $n2 0.3Mb 10ms DropTail
$ns duplex-link $n2 $n3 0.3Mb 10ms DropTail
$ns duplex-link $n1 $n4 0.3Mb 10ms DropTail
$ns duplex-link $n3 $n5 0.5Mb 10ms DropTail
$ns duplex-link $n4 $n5 0.5Mb 10ms DropTail

$ns duplex-link-op $n0 $n1 orient right
$ns duplex-link-op $n1 $n2 orient right
$ns duplex-link-op $n2 $n3 orient up
$ns duplex-link-op $n1 $n4 orient up-left
$ns duplex-link-op $n3 $n5 orient up-left
$ns duplex-link-op $n4 $n5 orient right-up



set tcp [new Agent/TCP]
$ns attach-agent $n0 $tcp
set sink [new Agent/TCPSink]
$ns attach-agent $n5 $sink
$ns connect $tcp $sink
$tcp set fid_ 1

set ftp [new Application/FTP]
$ftp attach-agent $tcp

$ns rtmodel-at 1.0 down $n1 $n4
$ns rtmodel-at 3.0 up $n1 $n4

$ns at 0.1 "$ftp start"

$ns at 12.0 "finish"

proc plotWindow {tcpSource file} {
global ns
set time 0.01
set now [$ns now]
set cwnd [$tcpSource set cwnd_]
puts $file "$now $cwnd"
$ns at [expr $now+$time] "plotWindow $tcpSource $file" }
$ns at 1.0 "plotWindow $tcp $cwind"

proc finish {} {
        global ns tf nf cwind
        $ns flush-trace
        close $tf
        close $nf
        exec nam ex4.nam &
      exec xgraph win4.tr &
        exit 0
```

	} $ns run
Screenshot	 
Q4.	**Consider a client and a server. The server is running an FTP application over TCP. The client sends a request to download a file of size 10 MB from the server. Write a TCL script to simulate this scenario. Let node n0 be the server and node n1 be the client. TCP packet size is 1500 Bytes.**
Answer	#Create a ns simulator set ns [new Simulator] #Open the NS trace file set tracefile [open ex5.tr w] $ns trace-all $tracefile #Open the NAM trace file set namfile [open ex5.nam w] $ns namtrace-all $namfile #Create 2 nodes set s [$ns node]

```
set c [$ns node]
$ns color 1 Blue
#Create labels for nodes
$s label "Server"
$c label "Client"

#Create links between nodes
$ns duplex-link $s $c 10Mb 22ms DropTail

#Give node position (for NAM)
$ns duplex-link-op $s $c orient right


#Setup a TCP connection for node s(server)
set tcp0 [new Agent/TCP]
$ns attach-agent $s $tcp0
$tcp0 set packetSize_ 1500

#Setup a TCPSink connection for node c(client)
set sink0 [new Agent/TCPSink]
$ns attach-agent $c $sink0

$ns connect $tcp0 $sink0

#Setup a FTP Application over TCP connection
set ftp0 [new Application/FTP]
$ftp0 attach-agent $tcp0
$tcp0 set fid_ 1
proc finish { } {
        global ns tracefile namfile
        $ns  flush-trace
        close $tracefile
        close $namfile
        exec nam ex5.nam &
        exec awk -f ex5transfer.awk ex5.tr &
        exec awk -f ex5convert.awk ex5.tr > convert.tr &
        exec xgraph convert.tr -geometry 800*400 -t "bytes_received_at_client" -x
"time_in_secs" -y "bytes_in_bps" &
                }

$ns at 0.01 "$ftp0 start"
$ns at 15.0 "$ftp0 stop"
$ns at 15.1 "finish"
$ns run
```

ex5transfer.awk

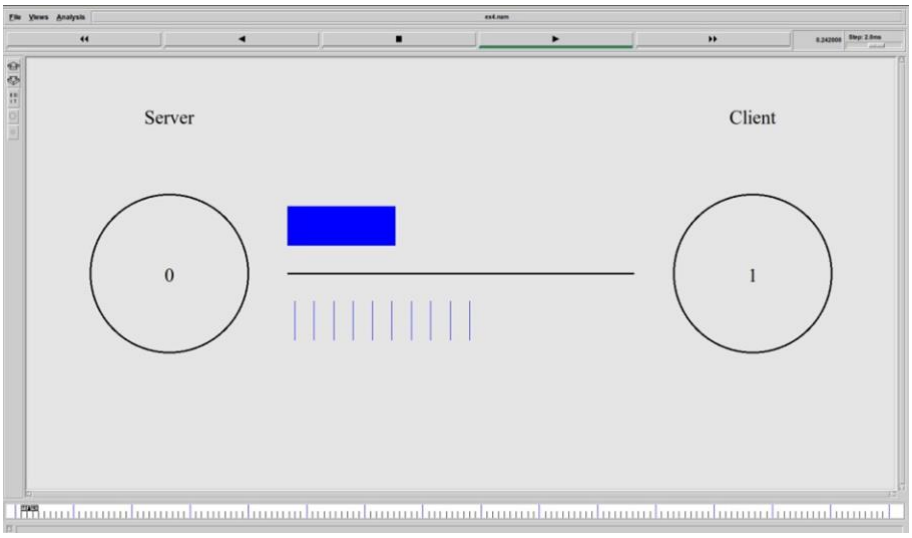
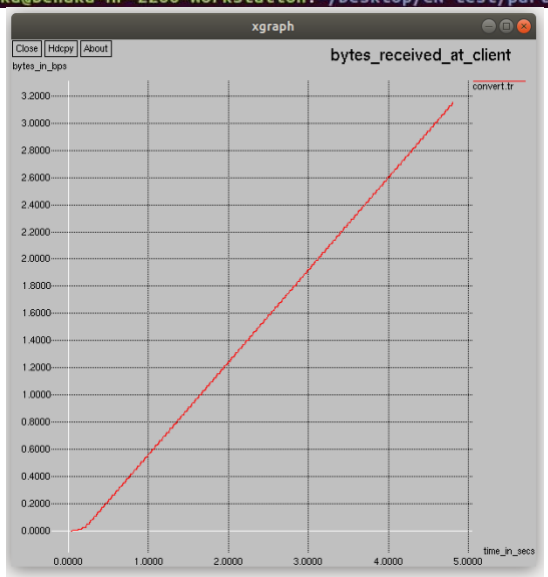
```
# AWK script to calulate the time required to transfer the 10 MB file from the
```

server to client

```
BEGIN {
        count=0;
        time=0;
      total_bytes_sent =0;
      total_bytes_received=0;

}
{
        if ( $1 == "r" && $4 == 1 && $5 == "tcp")
                                total_bytes_received += $6;

      if($1 == "+" && $3 == 0 && $5 == "tcp")
                                total_bytes_sent += $6;
}
END {
     system("clear");
     printf("\n Transmission time required to transfer the file is %f",$2);
     printf("\n Actual data sent from the server is %f
Mbps",(total_bytes_sent)/1000000);
     printf("\n Data Received by the client is %f
Mbps\n",(total_bytes_received)/1000000);
}
```

ex5convert.awk

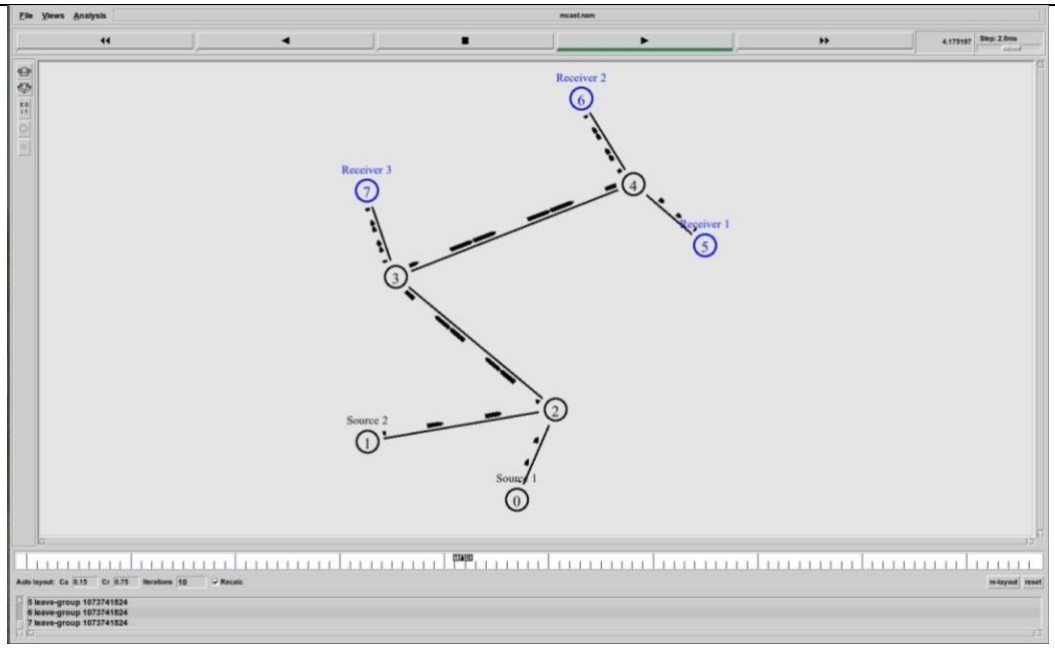
```
# AWK Script to convert the downloaded file into MB
BEGIN {
        count=0;
        time=0;
}
{
        if ( $1 == "r" && $4 == 1 && $5 == "tcp")
        {
                count += $6;
                time=$2;
                printf("\n%f\t%f",time,(count)/1000000);
        }
}
END {
}
```

Screenshot	  

Q5.	**Demonstrate the working of multicast routing protocol. Assume your own parameters for bandwidth and delay.**
Answer	#Create an event scheduler wit multicast turned on set ns [new Simulator -multicast on] #$ns multicast #Turn on Tracing set tf [open mcast.tr w] $ns trace-all $tf # Turn on nam Tracing set fd [open mcast.nam w] $ns namtrace-all $fd

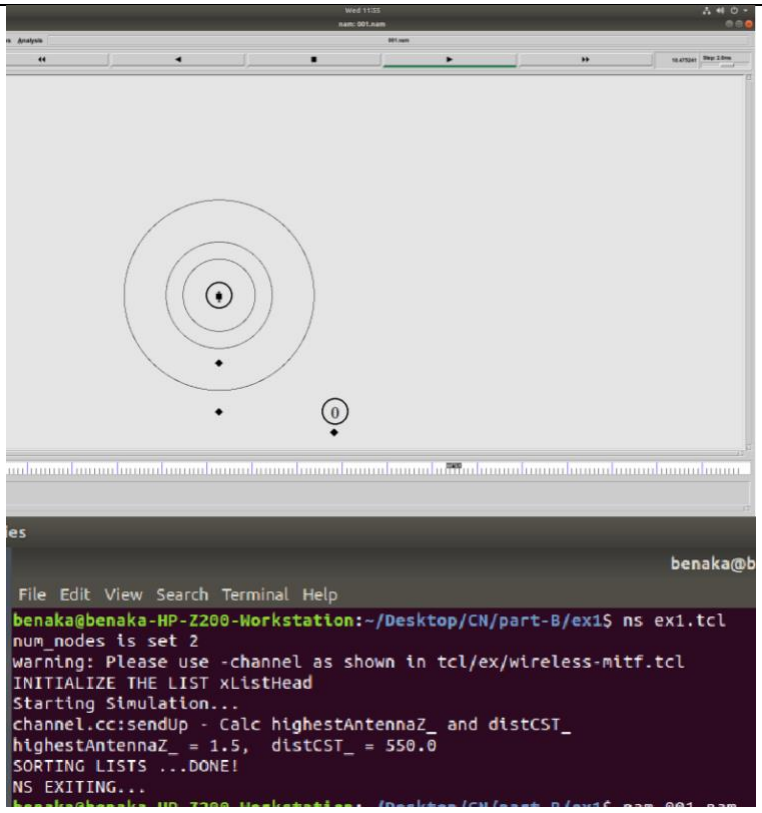
```
# Create nodes
set n0 [$ns node]
set n1 [$ns node]
set n2 [$ns node]
set n3 [$ns node]
set n4 [$ns node]
set n5 [$ns node]
set n6 [$ns node]
set n7 [$ns node]

# Create links
$ns duplex-link $n0 $n2 1.5Mb 10ms DropTail
$ns duplex-link $n1 $n2 1.5Mb 10ms DropTail
$ns duplex-link $n2 $n3 1.5Mb 10ms DropTail
$ns duplex-link $n3 $n4 1.5Mb 10ms DropTail
$ns duplex-link $n3 $n7 1.5Mb 10ms DropTail
$ns duplex-link $n4 $n5 1.5Mb 10ms DropTail
$ns duplex-link $n4 $n6 1.5Mb 10ms DropTail

# Routing protocol: say distance vector
#Protocols: CtrMcast, DM, ST, BST
set mproto DM
set mrthandle [$ns mrtproto $mproto {}]

# Allocate group addresses
set group1 [Node allocaddr]
set group2 [Node allocaddr]

# UDP Transport agent for the traffic
source set udp0 [new Agent/UDP]
$ns attach-agent $n0 $udp0
$udp0 set dst_addr_ $group1
$udp0 set dst_port_ 0
set cbr1 [new Application/Traffic/CBR]
$cbr1 attach-agent $udp0

# Transport agent for the traffic source
set udp1 [new Agent/UDP]
$ns attach-agent $n1 $udp1
$udp1 set dst_addr_ $group2
$udp1 set dst_port_ 0
set cbr2 [new Application/Traffic/CBR]
$cbr2 attach-agent $udp1

# Create receiver
set rcvr1 [new Agent/Null]
$ns attach-agent $n5 $rcvr1
$ns at 1.0 "$n5 join-group $rcvr1 $group1"

set rcvr2 [new Agent/Null]
$ns attach-agent $n6 $rcvr2
```

```
$ns at 1.5 "$n6 join-group $rcvr2 $group1"

set rcvr3 [new Agent/Null]
$ns attach-agent $n7 $rcvr3
$ns at 2.0 "$n7 join-group $rcvr3 $group1"

set rcvr4 [new Agent/Null]
$ns attach-agent $n5 $rcvr1
$ns at 2.5 "$n5 join-group $rcvr4 $group2"
set rcvr5 [new Agent/Null]
$ns attach-agent $n6 $rcvr2
$ns at 3.0 "$n6 join-group $rcvr5 $group2"
set rcvr6 [new Agent/Null]
$ns attach-agent $n7 $rcvr3
$ns at 3.5 "$n7 join-group $rcvr6 $group2"

$ns at 4.0 "$n5 leave-group $rcvr1 $group1"
$ns at 4.5 "$n6 leave-group $rcvr2 $group1"
$ns at 5.0 "$n7 leave-group $rcvr3 $group1"

$ns at 5.5 "$n5 leave-group $rcvr4 $group2"
$ns at 6.0 "$n6 leave-group $rcvr5 $group2"
$ns at 6.5 "$n7 leave-group $rcvr6 $group2"

# Schedule events
$ns at 0.5 "$cbr1 start"
$ns at 9.5 "$cbr1 stop"

$ns at 0.5 "$cbr2 start"
$ns at 9.5 "$cbr2 stop"
$ns at 10.0 "finish"
proc finish {} {
        global ns tf fd
        $ns flush-trace
        close $tf
        close $fd
        exec nam mcast.nam &
        exit 0
}


# For nam

# Group 0 source
#$udp0 set fid_ 1
#$n0 color red
$n0 label "Source 1"

# Group 1 source
#$udp1 set fid_ 2
```

	#$n1 color green $n1 label "Source 2" #Colors for packets from two mcast groups $ns color 1 red $ns color 2 green $n5 label "Receiver 1" $n5 color blue $n6 label "Receiver 2" $n6 color blue $n7 label "Receiver 3" $n7 color blue $ns run
Screenshot	
Q6.	**Set up a 2-node wireless network. Analyze TCP performance for this scenario with DSDV as routing protocol.**
Answer	001.tcl #Setting the Default Parameters ### # Setting the Default Parameters # ### set val(chan) Channel/WirelessChannel set val(prop) Propagation/TwoRayGroun d set val(netif) Phy/WirelessPhy set val(mac) Mac/802_11 set val(ifq) Queue/DropTail/PriQueue set val(ll) LL set val(ant) Antenna/OmniAntenna set val(x) 500 set val(y) 500 set val(ifqlen) 50

```
set val(nn)                     2
set val(stop)               20.0
set val(rp)             DSDV


set ns_ [new Simulator]

set tracefd       [open 001.tr w]
$ns_ trace-all $tracefd

set namtrace [open 001.nam w]
$ns_ namtrace-all-wireless $namtrace $val(x) $val(y)

set prop [new $val(prop)]

set topo [new Topography]
$topo load_flatgrid $val(x) $val(y)

create-god $val(nn)

#Node Configuration

       $ns_ node-config -adhocRouting $val(rp) \
                                -llType $val(ll) \
                                -macType $val(mac) \
                                -ifqType $val(ifq) \
                                -ifqLen $val(ifqlen) \
                                -antType $val(ant) \
                                -propType $val(prop) \
                                -phyType $val(netif) \
                                -channelType $val(chan) \
                                -topoInstance $topo \
                                -agentTrace ON \
                                -routerTrace ON \
                                -macTrace ON

#Creating Nodes
for {set i 0} {$i < $val(nn) } {incr i} {
    set node_($i) [$ns_ node]
   $node_($i) random-motion 0
    }

#Initial Positions of Nodes

for {set i 0} {$i < $val(nn)} {incr i} {
          $ns_ initial_node_pos $node_($i) 40
}

#Topology Design

$ns_ at 1.1 "$node_(0) setdest 310.0 10.0 20.0"
$ns_ at 1.1 "$node_(1) setdest 10.0 310.0 20.0"
```

	#Generating Traffic
	
	set tcp0 [new Agent/TCP]
	set sink0 [new Agent/TCPSink]
	$ns_ attach-agent $node_(0) $tcp0
	$ns_ attach-agent $node_(1) $sink0
	$ns_ connect $tcp0 $sink0
	set ftp0 [new Application/FTP]
	$ftp0 attach-agent $tcp0
	$ns_ at 1.0 "$ftp0 start"
	$ns_ at 18.0 "$ftp0 stop"
	
	#Simulation Termination
	
	for {set i 0} {$i < $val(nn) } {incr i} {
	$ns_ at $val(stop) "$node_($i) reset";
	}
	$ns_ at $val(stop) "puts \"NS EXITING...\" ; $ns_ halt"
	
	puts "Starting Simulation..."
	
	$ns_ run

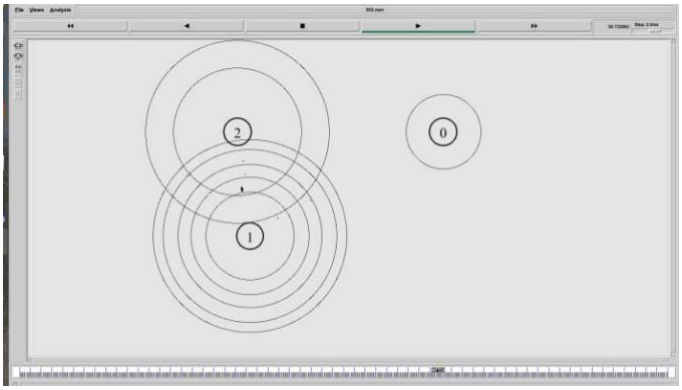
Screenshot	
Q7.	**Set up 3-node wireless network with node N1 between N0 and N2. As the nodes N0 and N2 moves towards each other they exchange packets. As they move out of each other's range they drop some packets. Analyze TCP performance for this scenario with AODV, DSDV and DSR as routing protocols.**
Answer	002.tcl #Setting the Default Parameters

```
set val(chan)           Channel/WirelessChannel
set val(prop)
                        Propagation/TwoRayGroun
d set val(netif)        Phy/WirelessPhy
set val(mac)        Mac/802_11
 #set val(ifq)        CMUPriQueue
set val(ifq)
                  Queue/DropTail/PriQueu
e set val(ll)           LL
set val(ant)       Antenna/OmniAntenna
set val(x)                 500
set val(y)                 400
set val(ifqlen)          50
set val(nn)              3
set val(stop)            60.0
 set val(rp)           AODV


set ns_ [new Simulator]

set tracefd     [open 002.tr w]
$ns_ trace-all $tracefd

set namtrace [open 002.nam w]
$ns_ namtrace-all-wireless $namtrace $val(x) $val(y)

set prop        [new $val(prop)]

set topo        [new Topography]
$topo load_flatgrid $val(x) $val(y)

create-god $val(nn)

#Node Configuration

      $ns_ node-config -adhocRouting $val(rp) \
                       -llType $val(ll) \
                       -macType $val(mac) \
                       -ifqType $val(ifq) \
                       -ifqLen $val(ifqlen) \
                       -antType $val(ant) \
                       -propType $val(prop) \
                       -phyType $val(netif) \
                  -channelType $val(chan) \
                       -topoInstance $topo \
                       -agentTrace ON \
                       -routerTrace ON \
                       -macTrace ON

#Creating Nodes
for {set i 0} {$i < $val(nn) } {incr i} {
   set node_($i) [$ns_ node]
   $node_($i) random-motion 0
```

```
    }

#Initial Positions of Nodes
$node_(0) set x_ 5.0
$node_(0) set y_ 5.0
$node_(0) set z_ 0.0

$node_(1) set x_ 490.0
$node_(1) set y_ 285.0
$node_(1) set z_ 0.0

$node_(2) set x_ 150.0
$node_(2) set y_ 240.0
$node_(2) set z_ 0.0


for {set i 0} {$i < $val(nn)} {incr i} {
        $ns_ initial_node_pos $node_($i) 40
}

#Topology Design

$ns_ at 0.0 "$node_(0) setdest 450.0 285.0 30.0"
$ns_ at 0.0 "$node_(1) setdest 200.0 285.0 30.0"
$ns_ at 0.0 "$node_(2) setdest 1.0 285.0 30.0"


$ns_ at 25.0 "$node_(0) setdest 300.0 285.0 10.0"
$ns_ at 25.0 "$node_(2) setdest 100.0 285.0 10.0"


$ns_ at 40.0 "$node_(0) setdest 490.0 285.0 5.0"
$ns_ at 40.0 "$node_(2) setdest 1.0 285.0 5.0"


#Generating Traffic
  set tcp0 [new Agent/TCP]
    set sink0 [new Agent/TCPSink]
  $ns_ attach-agent $node_(0) $tcp0
     $ns_ attach-agent $node_(2) $sink0
  $ns_ connect $tcp0 $sink0
  set ftp0 [new Application/FTP]
  $ftp0 attach-agent $tcp0
  $ns_ at 10.0 "$ftp0 start"


#Simulation Termination

for {set i 0} {$i < $val(nn) } {incr i} {
   $ns_ at $val(stop) "$node_($i) reset";
   }
   $ns_ at $val(stop) "puts \"NS EXITING...\" ; $ns_ halt"
```

puts "Starting Simulation..."
$ns_ run

Screenshot




```
benaka@benaka-HP-Z200-Workstation:~/Desktop/CN/part-B/ex2$ ns ex2.tcl
num_nodes is set 3
warning: Please use -channel as shown in tcl/ex/wireless-mitf.tcl
INITIALIZE THE LIST xListHead
Starting Simulation...
channel.cc:sendUp - Calc highestAntennaZ_ and distCST_
highestAntennaZ_ = 1.5,  distCST_ = 550.0
SORTING LISTS ...DONE!
NS EXITING...
benaka@benaka-HP-Z200-Workstation:~/Desktop/CN/part-B/ex2$
```

Q8. **Set up a 6-node wireless network; analyze TCP performance when nodes are static and mobile.**

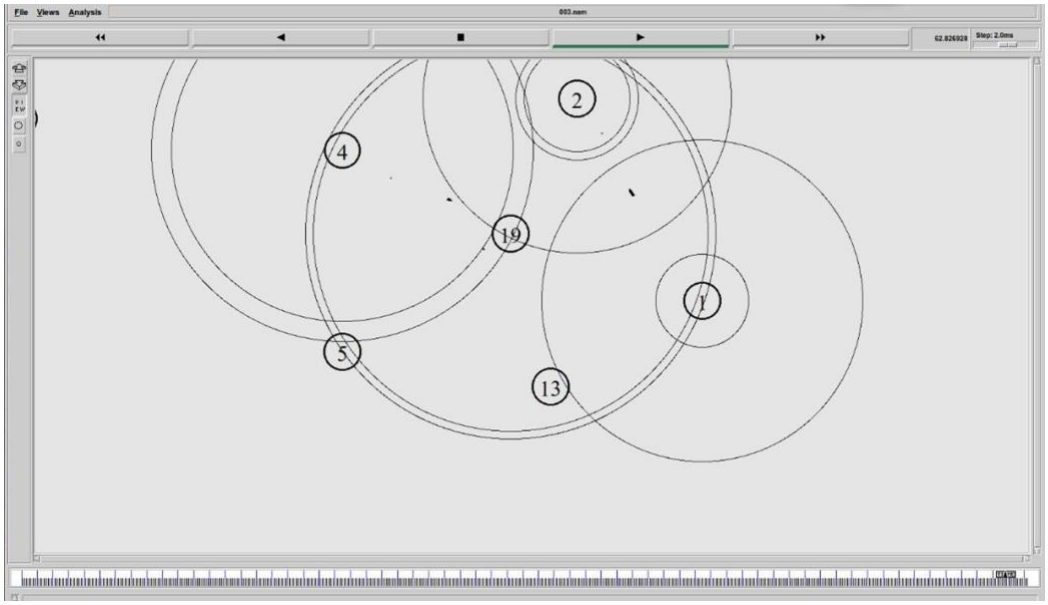
Answer

003.tcl

```
set val(chan)           Channel/WirelessChannel
set val(prop)
                        Propagation/TwoRayGroun
d set val(netif)        Phy/WirelessPhy
set val(mac)         Mac/802_11
set val(ifq)            Queue/DropTail/PriQueue
set val(ll)             LL
set val(ant)        Antenna/OmniAntenna
set val(x)                 500
set val(y)                 500
set val(ifqlen)          50
set val(nn)              25
set val(stop)           100.0
    set val(rp)         AODV
 #set val(sc)           "mob-25-50"
set val(cp)           "tcp-25-8"

set ns_ [new Simulator]

set tracefd       [open 003.tr w]
$ns_ trace-all $tracefd

set namtrace [open 003.nam w]
$ns_ namtrace-all-wireless $namtrace $val(x) $val(y)
```

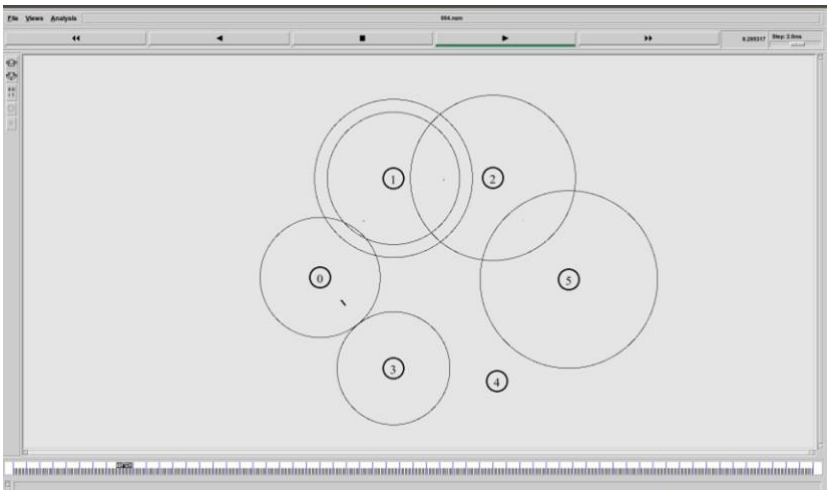
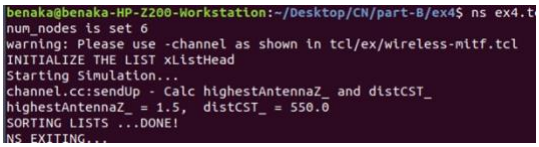
```
set prop          [new $val(prop)]

set topo          [new Topography]
$topo load_flatgrid $val(x) $val(y)

set god_ [create-god $val(nn)]

    #Node Configuration

      $ns_ node-config -adhocRouting $val(rp) \
                       -llType $val(ll) \
                       -macType $val(mac) \
                       -ifqType $val(ifq) \
                       -ifqLen $val(ifqlen) \
                       -antType $val(ant) \
                       -propType $val(prop) \
                       -phyType $val(netif) \
                  -channelType $val(chan) \
                       -topoInstance $topo \
                       -agentTrace ON \
                       -routerTrace ON \
                       -macTrace ON

#Creating Nodes
for {set i 0} {$i < $val(nn) } {incr i} {
    set node_($i) [$ns_ node]
    $node_($i) random-motion 0
}


     for {set i 0} {$i < $val(nn) } { incr i } {
               set xx [expr rand()*500]
               set yy [expr rand()*400]
               $node_($i) set X_ $xx
               $node_($i) set Y_ $yy

          }


#Initial Positions of Nodes

for {set i 0} {$i < $val(nn)} {incr i} {
         $ns_ initial_node_pos $node_($i) 40
}


#puts "Loading scenario file..."
#source $val(sc)
puts "Loading connection file..."
source $val(cp)
```

	#Simulation Termination
	
	for {set i 0} {$i < $val(nn) } {incr i} {
	$ns_ at $val(stop) "$node_($i) reset";
	}
	$ns_ at $val(stop) "puts \"NS EXITING...\" ; $ns_ halt"
	
	puts "Starting Simulation..."
	$ns_ run

Screenshot	 warning: Please use -channel as shown in tcl/ex/wireless-mitf.tcl INITIALIZE THE LIST xListHead Starting Simulation... channel.cc:sendUp - Calc highestAntennaZ_ and distCST_ highestAntennaZ_ = 1.5, distCST_ = 550.0 SORTING LISTS ...DONE! NS EXITING... benaka@benaka-HP-Z200-Workstation:~/Desktop/CN/part-B/ex2$
Q9.	**Write a TCL script to simulate the following scenario. Consider six nodes, (as shown in the figure below) moving within a flat topology of 700m x 700m. The initial positions of nodes are: n0 (150, 300), n1 (300, 500), n2(500, 500), n3 (300, 100), n4(500, 100) and n5(650, 300) respectively. A TCP connection is initiated between n0 (source) and n5 (destination) through n3 and n4 i.e., the route is 0-3-4-5. At time t = 3 seconds, the FTP application runs over it. After time t = 4 seconds, n3 (300,100) moves towards n1 (300, 500) with a speed of 5.0m/sec and after some time the path breaks. The data is then transmitted with a new path via n1 and n2 i.e., the new route is 0-1-2-5. The simulation lasts for 60 secs. In the above said case both the routes have equal cost. Use DSR as the routing protocol and the IEEE 802.11 MAC protocol..**
Answer	set val(chan) Channel/WirelessChannel set val(prop) Propagation/TwoRayGroun d set val(netif) Phy/WirelessPhy set val(mac) Mac/802_11 #set val(ifq) Queue/DropTail/PriQueue set val(ifq) CMUPriQueue set val(ll) LL set val(ant) Antenna/OmniAntenna

```
set val(x)                      700
set val(y)                      700
set val(ifqlen)            50
set val(nn)                6
set val(stop)              60.0
    set val(rp)           DSR


set ns_ [new Simulator]

set tracefd       [open 004.tr w]
$ns_ trace-all $tracefd

set namtrace [open 004.nam w]
$ns_ namtrace-all-wireless $namtrace $val(x) $val(y)

set prop          [new $val(prop)]

set topo          [new Topography]
$topo load_flatgrid $val(x) $val(y)

set god_ [create-god $val(nn)]

    #Node Configuration

      $ns_ node-config -adhocRouting $val(rp) \
                               -llType $val(ll) \
                               -macType $val(mac) \
                               -ifqType $val(ifq) \
                               -ifqLen $val(ifqlen) \
                               -antType $val(ant) \
                               -propType $val(prop) \
                               -phyType $val(netif) \
                     -channelType $val(chan) \
                               -topoInstance $topo \
                               -agentTrace ON \
                               -routerTrace ON \
                               -macTrace ON

#Creating Nodes
for {set i 0} {$i < $val(nn) } {incr i} {
    set node_($i) [$ns_ node]
    $node_($i) random-motion 0
}
#Initial Positions of Nodes



$node_(0) set X_ 150.0
$node_(0) set Y_ 300.0
$node_(0) set Z_ 0.0
```

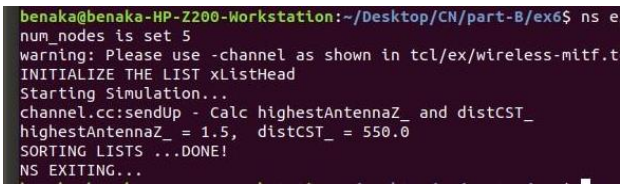
```
$node_(1) set X_ 300.0
$node_(1) set Y_ 500.0
$node_(1) set Z_ 0.0

$node_(2) set X_ 500.0
$node_(2) set Y_ 500.0
$node_(2) set Z_ 0.0

$node_(3) set X_ 300.0
$node_(3) set Y_ 100.0
$node_(3) set Z_ 0.0

$node_(4) set X_ 500.0
$node_(4) set Y_ 100.0
$node_(4) set Z_ 0.0

$node_(5) set X_ 650.0
$node_(5) set Y_ 300.0
$node_(5) set Z_ 0.0
for {set i 0} {$i < $val(nn)} {incr i} {
        $ns_ initial_node_pos $node_($i) 40
}

#Topology Design
$ns_ at 1.0 "$node_(0) setdest 160.0 300.0 2.0"
$ns_ at 1.0 "$node_(1) setdest 310.0 150.0 2.0"
$ns_ at 1.0 "$node_(2) setdest 490.0 490.0 2.0"
$ns_ at 1.0 "$node_(3) setdest 300.0 120.0 2.0"
$ns_ at 1.0 "$node_(4) setdest 510.0 90.0 2.0"
$ns_ at 1.0 "$node_(5) setdest 640.0 290.0 2.0"
$ns_ at 4.0 "$node_(3) setdest 300.0 500.0 5.0"
#Generating Traffic
  set tcp0 [new Agent/TCP]
    set sink0 [new Agent/TCPSink]
  $ns_ attach-agent $node_(0) $tcp0
     $ns_ attach-agent $node_(5) $sink0
  $ns_ connect $tcp0 $sink0
  set ftp0 [new Application/FTP]
  $ftp0 attach-agent $tcp0
  $ns_ at 5.0 "$ftp0 start"
     $ns_ at 60.0 "$ftp0 stop"


#Simulation Termination

for {set i 0} {$i < $val(nn) } {incr i} {
   $ns_ at $val(stop) "$node_($i) reset";
   }
   $ns_ at $val(stop) "puts \"NS EXITING...\" ; $ns_ halt"
```

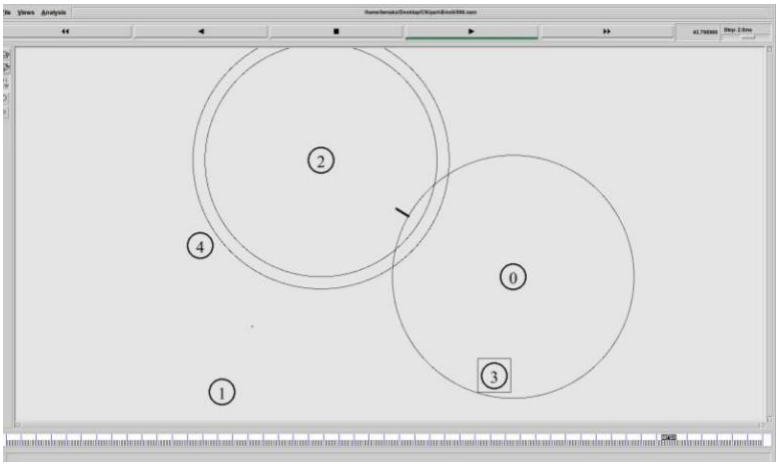
	puts "Starting Simulation..." $ns_ run
Screenshot	 
Q10.	**Set up a wireless network with mobile nodes, induce 1 to 10% error to the network using uniform error model. Plot the congestion window for TCP connections. Write your observation on TCP performance as error increases in the network.**
Answer	006.tcl. set val(chan) Channel/WirelessChannel set val(prop) Propagation/TwoRayGroun d set val(netif) Phy/WirelessPhy set val(mac) Mac/802_11 set val(ifq) Queue/DropTail/PriQueue set val(ll) LL set val(ant) Antenna/OmniAntenna set val(x) 500 set val(y) 500 set val(ifqlen) 50 set val(nn) 5 set val(stop) 50.0 set val(rp) AODV set ns_ [new Simulator] set tracefd [open 006.tr w] $ns_ trace-all $tracefd set namtrace [open 006.nam w] $ns_ namtrace-all-wireless $namtrace $val(x) $val(y)

```
set prop          [new $val(prop)]

set topo          [new Topography]
$topo load_flatgrid $val(x) $val(y)

create-god $val(nn)

    #Node Configuration

      $ns_ node-config -adhocRouting $val(rp) \
                       -llType $val(ll) \
                       -macType $val(mac) \
                       -ifqType $val(ifq) \
                       -ifqLen $val(ifqlen) \
                       -antType $val(ant) \
                       -propType $val(prop) \
                       -phyType $val(netif) \
                  -channelType $val(chan) \
                       -topoInstance $topo \
                       -agentTrace ON \
                       -routerTrace ON \
                       -macTrace ON \
                  -IncomingErrProc "uniformErr" \
                       -OutgoingErrProc "uniformErr"

proc uniformErr {} {
set err [new ErrorModel]
$err unit pkt
$err set rate_ 0.01
return $err
}

#Creating Nodes
for {set i 0} {$i < $val(nn) } {incr i} {
    set node_($i) [$ns_ node]
    $node_($i) random-motion 0
}
#Initial Positions of Nodes

for {set i 0} {$i < $val(nn)} {incr i} {
         $ns_ initial_node_pos $node_($i) 40
}
#Topology Design

$ns_ at 1.0 "$node_(0) setdest 10.0 10.0 50.0"
$ns_ at 1.0 "$node_(1) setdest 10.0 100.0 50.0"
$ns_ at 1.0 "$node_(4) setdest 50.0 50.0 50.0"
$ns_ at 1.0 "$node_(2) setdest 100.0 100.0 50.0"
$ns_ at 1.0 "$node_(3) setdest 100.0 10.0 50.0"

#Generating Traffic
  set tcp0 [new Agent/TCP]
```

```
    set sink0 [new Agent/TCPSink]
  $ns_ attach-agent $node_(0) $tcp0
     $ns_ attach-agent $node_(2) $sink0
  $ns_ connect $tcp0 $sink0
  set ftp0 [new Application/FTP]
  $ftp0 attach-agent $tcp0
  $ns_ at 1.0 "$ftp0 start"
     $ns_ at 50.0 "$ftp0 stop"

       set tcp1 [new Agent/TCP]
    set sink1 [new Agent/TCPSink]
  $ns_ attach-agent $node_(1) $tcp1
     $ns_ attach-agent $node_(2) $sink1
  $ns_ connect $tcp1 $sink1
  set ftp1 [new Application/FTP]
  $ftp1 attach-agent $tcp1
  $ns_ at 1.0 "$ftp1 start"
     $ns_ at 50.0 "$ftp1 stop"

#Simulation Termination

for {set i 0} {$i < $val(nn) } {incr i} {
   $ns_ at $val(stop) "$node_($i) reset";
   }
   $ns_ at $val(stop) "puts \"NS EXITING...\" ; $ns_ halt"

puts "Starting Simulation..."
    $ns_ run
```

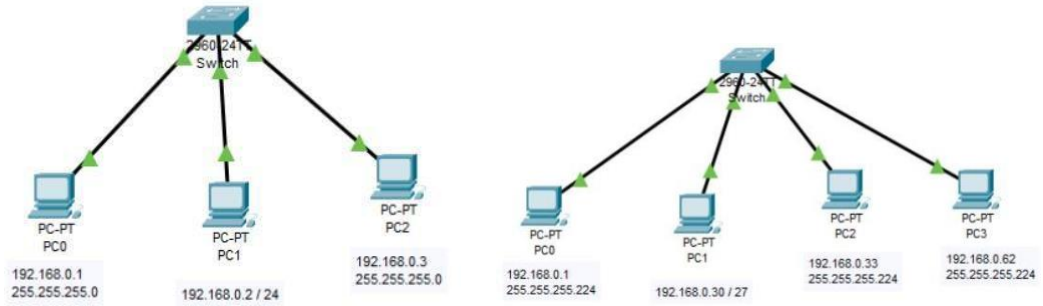
Screenshot





PART-B

Q1.	**Study of network IP Experiments** **i. Classification of IP address ii. Sub netting iii. Super netting**
Answer	**<u>a. Demonstration of Class C IP address.</u>** Wired network of 3 systems, all 3 systems have same network ids. The Network id for this network is 192.168.0 and the host id is 1, 2 and 3. These addresses are class C IP addresses, in which first 3 octet represent network Id (netid) and the 4th octet represents host Id. Out of last octet (8-bit value) 256 IP addresses can be generate out of which first host address 0 is not assigned to any host and IP address with 0 in 4th octet place is used to refer network Id and last addresses are 255 is used as broadcast Id. So effectively 254 Host address are used in Class C addresses. **<u>PC0 command Prompt</u>** C:\>ping 192.168.0.2 Pinging 192.168.0.2 with 32 bytes of data: Reply from 192.168.0.2: bytes=32 time<1ms TTL=128 Reply from 192.168.0.2: bytes=32 time=1ms TTL=128 Reply from 192.168.0.2: bytes=32 time<1ms TTL=128 Reply from 192.168.0.2: bytes=32 time<1ms TTL=128 Ping statistics for 192.168.0.2: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss), Approximate round trip times in milli-seconds: Minimum = 0ms, Maximum = 1ms, Average = 0ms C:\>ping 192.168.0.3 Pinging 192.168.0.3 with 32 bytes of data: Reply from 192.168.0.3: bytes=32 time=1ms TTL=128 Reply from 192.168.0.3: bytes=32 time=3ms TTL=128 Reply from 192.168.0.3: bytes=32 time<1ms TTL=128 Reply from 192.168.0.3: bytes=32 time<1ms TTL=128 Ping statistics for 192.168.0.3: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss), Approximate round trip times in milli-seconds: Minimum = 0ms, Maximum = 3ms, Average = 1ms Similarly **1. Ping from PC1 to PC0 and PC2** **2. Ping from PC2 to PC0 and PC1** **<u>b. Subnetting</u>** Subnetting allows you to create multiple logical networks that exist within a single Class A, B, or C network. If you do not subnet, you are only able to use one network from your Class A, B, or C network, which is unrealistic. Each data link on a network must have a unique network ID, with every node on that link being a member of the same network. If you break a major network (Class A, B, or C) into smaller subnetworks, it allows you to create a network of interconnecting subnetworks. Each data link on this network would then have a unique network/subnetwork ID. Any device, or gateway, that connects

	networks/subnetworks has n distinct IP addresses, one for each network / subnetwork that it interconnects. In order to subnet a network, extend the natural mask with some of the bits from the host ID portion of the address in order to create a subnetwork ID. For example, given a Class C network of 204.17.5.0 which has a natural mask of 255.255.255.0, you can create subnets in this manner: 204.17.5.0 - 11001100.00010001.00000101.00000000 255.255.255.224 - 11111111.11111111.11111111.11100000 _____|sub|___ By extending the mask to be 255.255.255.224, you have taken three bits (indicated by "sub") from the original host portion of the address and used them to make subnets. With these three bits, it is possible to create eight subnets. With the remaining five host ID bits, each subnet can have up to 32 host addresses (25), 30 of which can actually be assigned to a device since host ids of all zeros or all ones are not allowed (it is very important to remember this). So, with this in mind, these subnets have been created. 204.17.5.0 255.255.255.224 host address range 1 to 30 204.17.5.32 255.255.255.224 host address range 33 to 62 204.17.5.64 255.255.255.224 host address range 65 to 94 204.17.5.96 255.255.255.224 host address range 97 to 126 204.17.5.128 255.255.255.224 host address range 129 to 158 204.17.5.160 255.255.255.224 host address range 161 to 190 204.17.5.192 255.255.255.224 host address range 193 to 222 204.17.5.224 255.255.255.224 host address range 225 to 254 PC0 and PC1 are in one subnet and PC2 and PC3 are another subnet. PC0 can communicate with PC1 and vice versa but not with PC2 and PC3 Similarly PC2 and PC3 can communicate with each other but cannot communicate PC0 and PC1.
Screenshot	
Q2.	**Configure static and Dynamic Routing Information in the router and test the connectivity between networks.**
Answer	**<u>Static Routing</u>** Static Routing is also known as non-adaptive routing which doesn't change routing table unless the network administrator changes or modify them manually. Static routing does not use complex routing algorithms and It provides high or more security than dynamic routing.Dynamic routing is also known as adaptive routing which change routing table according to the change in topology. Dynamic routing uses complex routing algorithms and it does not provide high security like static routing. When thenetwork change(topology) occurs, it sends the message to router to ensure that changes then the routes are recalculated for sending updated routing information. **<u>On router-3</u>** Router>enable

Router#config ter
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int
Router(config)#int fa0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#inter se2/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial2/0, changed state to down
Router(config-if)#clock rate 64000
Router(config-if)#exit
Router(config)#
%LINK-5-CHANGED: Interface Serial2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
Router(config)#ip route 192.168.3.0 255.255.255.0 192.168.2.2
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router#copy run star
Router#copy run startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router#

On router-4

Router>en
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 192.168.2.2 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#inte se2/0
Router(config-if)#ip address 192.168.2.2 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface Serial2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
Router(config-if)#exit

Router(config)#ip route 192.168.1.0 255.255.255.0 192.168.2.1
Router#wr
Building configuration...
[OK]

Dynamic Routing Demonstration

In Router-0

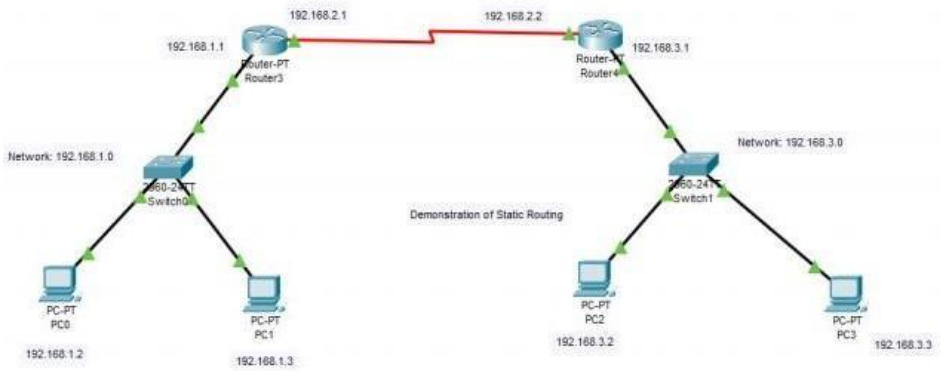
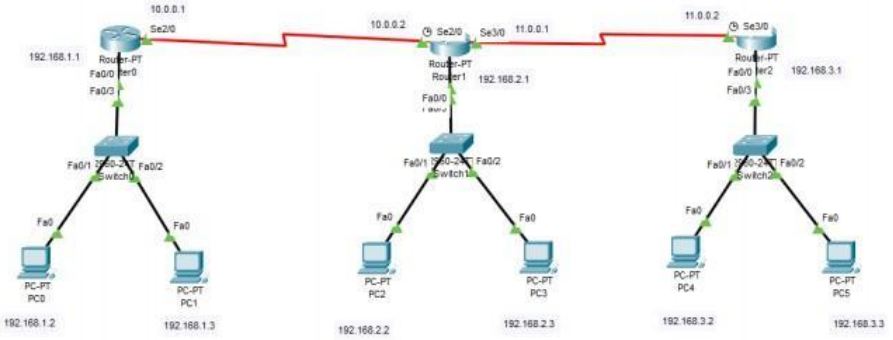
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#exit
Router(config)#interface Serial2/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 10.0.0.0
Router(config-router)#network 11.0.0.0
Router(config-router)#network 192.168.1.0
Router(config-router)#network 192.168.2.0
Router(config-router)#network 192.168.3.0
Router(config-router)#exit
Router(config)#exit
Router#copy run startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router#

In Router-1

Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#exit
Router(config)#interface Serial2/0
Router(config-if)#ip address 10.0.0.2 255.0.0.0

Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial2/0, changed state to up
Router(config-if)#exit
Router(config)#interface Serial3/0
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
ip address 11.0.0.1 255.0.0.0
Router(config-if)#ip address 11.0.0.1 255.0.0.0
Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial3/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial3/0, changed state to up
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 10.0.0.0
Router(config-router)#network 11.0.0.0
Router(config-router)#network 192.168.1.0
Router(config-router)#network 192.168.2.0
Router(config-router)#network 192.168.3.0
Router(config)#exit
Router#copy run start
Router#copy run startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
Router#

In Router-2
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial3/0
Router(config-if)#ip address 11.0.0.2
255.0.0.0 Router(config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial3/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial3/0, changed state to up%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 10.0.0.0
Router(config-router)#network 11.0.0.0
Router(config-router)#network 192.168.1.0
Router(config-router)#network 192.168.2.0
Router(config-router)#network 192.168.3.0
Router(config-router)#exit
Router(config)#exit

	Router#copy run start Destination filename [startup-config]? Building configuration... [OK]
Screenshot	a. Static Routing Demonstration  b. Dynamic Routing Demonstration 
Q3.	**Configure Network Address Translation (NAT) and test static NAT, dynamic NAT and PAT.**
Answer	**a. Static NAT** Static NAT (Network Address Translation) - Static NAT (Network Address Translation) is one-to-one mapping of a private IP address to a public IP address. Static NAT (Network Address Translation) is useful when a network device inside a private network needs to be accessible from internet. **<u>Router-0</u>** Router>enable Router#configure terminal Router(config)#interface Serial2/0 Router(config-if)#ip address 10.0.0.1 255.0.0.0 Router(config-if)#no shutdown Router(config-if)#exit Router(config)#interface FastEthernet1/0 Router(config-if)#ip address 192.168.1.1 255.255.255.0 Router(config-if)#no shutdown Router(config)#interface FastEthernet0/0 Router(config-if)#ip address 192.168.2.1 255.255.255.0 Router(config-if)#no shutdown Router(config-if)#exit

Router(config)#router rip
Router(config-router)#network 192.168.2.0
Router(config-router)#network 10.0.0.0
Router(config-router)#exit
Router(config)#inter se2/0
Router(config-if)#ip nat out
Router(config-if)#inter fa1/0
Router(config-if)#ip nat in
Router(config)#ip nat inside source static 192.168.1.2 10.0.0.3
Router(config)#exit
Router#wr
Building configuration...
[OK]

Router-1

Router>enable
Router#configure terminal
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 8.8.8.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface Serial3/0
Router(config-if)#ip address 10.0.0.2 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#router rip
Router(config-router)#network 10.0.0.0
Router(config-router)#network 8.0.0.0

b. Dynamic NAT

Dynamic NAT can be defined as mapping of a private IP address to a public IP address from a group of public IP addresses called as NAT pool. Dynamic NAT establishes a one-to-one mapping between a private IP address to a public IP address. Here the public IP address is taken from the pool of IP addresses configured on the end NAT router. The public to private mapping may vary based on the available public IP address in NAT pool.

Router-0

Router>enable
Router#conf t
Router(config)#int
se2/0
Router(config-if)#ip nat outside
Router(config)#int fa0/0
Router(config-if)#ip nat inside
Router(config-if)#exit
Router(config)#acc
Router(config)#access-list 1 permit 192.168.2.0 0.0.0.255
Router(config)#ip nat pool NAT 10.0.0.5 10.0.0.10 netmask 255.255.255.0
Router(config)#ip nat inside source list 1 pool NAT
Router(config)#exit
Router#show ip nat translations

```
Router#show ip nat translations |
Pro  Inside global     Inside local       Outside local      Outside global
icmp 10.0.0.5:10       192.168.2.3:10     8.8.8.8:10         8.8.8.8:10
icmp 10.0.0.5:11       192.168.2.3:11     8.8.8.8:11         8.8.8.8:11
icmp 10.0.0.5:12       192.168.2.3:12     8.8.8.8:12         8.8.8.8:12
icmp 10.0.0.5:13       192.168.2.3:13     8.8.8.8:13         8.8.8.8:13
---  10.0.0.3          192.168.1.2        ---                ---
tcp 10.0.0.6:1025      192.168.2.2:1025   8.8.8.8:80         8.8.8.8:80
```

PAT

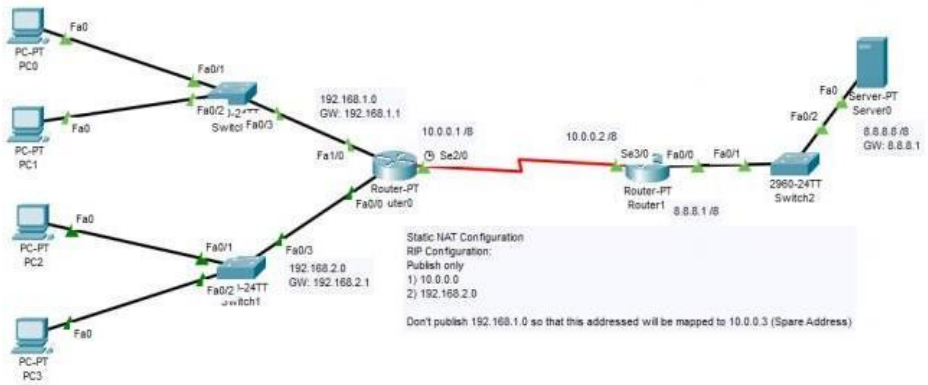
PAT (Port Address Translation) - Port Address Translation (PAT) is another type of dynamic NAT which can map multiple private IP addresses to a single public IP address by using a technology known as Port Address Translation. Here when a client from inside network communicate to a host in the internet, the router changes the source port (TCP or UDP) number with another port number. These port mappings are kept in a table. When the router receives from internet, it will refer the table which keep the port mappings and forward the data packet to the original sender.

Router - 0

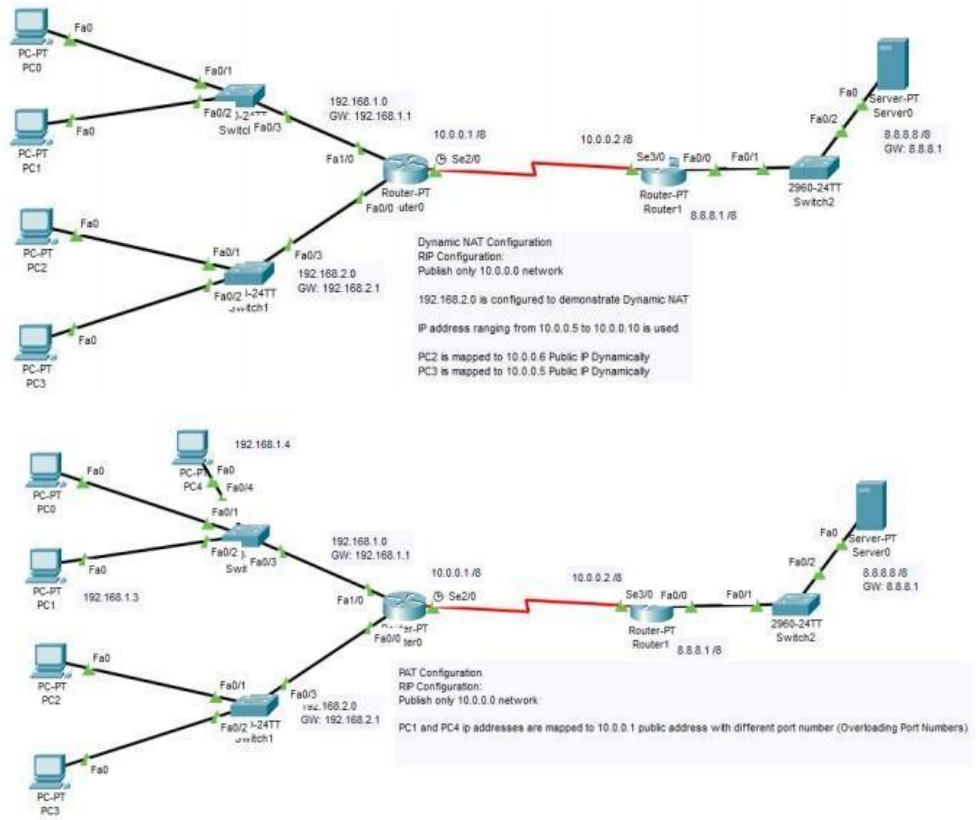
Router#conf t
Router(config)#inte se2/0
Router(config-if)#ip nat outside
Router(config-if)#int fa0/0
Router(config-if)#ip nat inside
Router(config)#access-list 1 permit 192.168.1.0 0.0.0.255
Router(config-if)#ip nat inside source list 1 interface se2/0 overload
Router(config)#exit

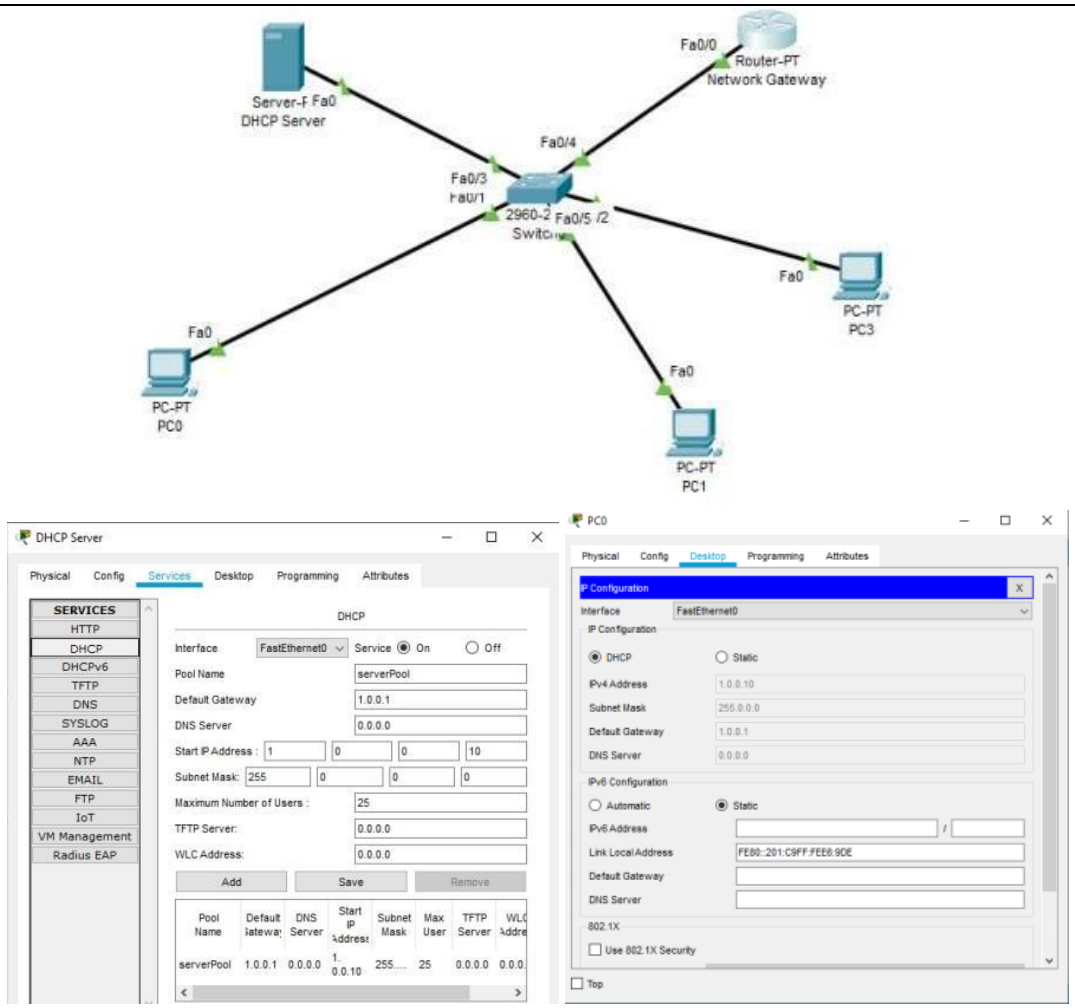
```
Router#show ip nat translations
Pro  Inside global     Inside local       Outside local      Outside global
---  10.0.0.3          192.168.1.2        ---                ---
tcp 10.0.0.1:1024      192.168.1.4:1025   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.1:1025      192.168.1.3:1025   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.3:1025      192.168.1.2:1025   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.3:1026      192.168.1.2:1026   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.3:1027      192.168.1.2:1027   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.3:1028      192.168.1.2:1028   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.3:1029      192.168.1.2:1029   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.3:1030      192.168.1.2:1030   8.8.8.8:80         8.8.8.8:80
tcp 10.0.0.6:1025      192.168.2.2:1025   8.8.8.8:80         8.8.8.8:80
```

Screenshot

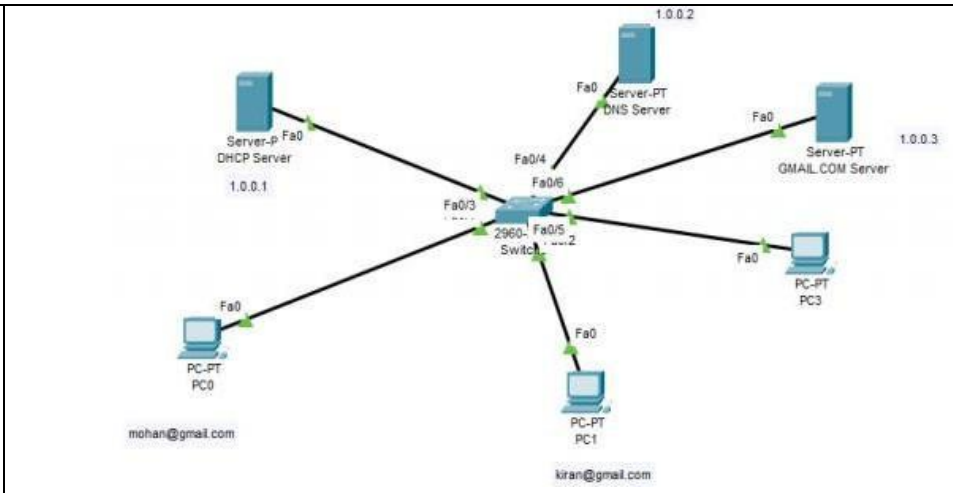


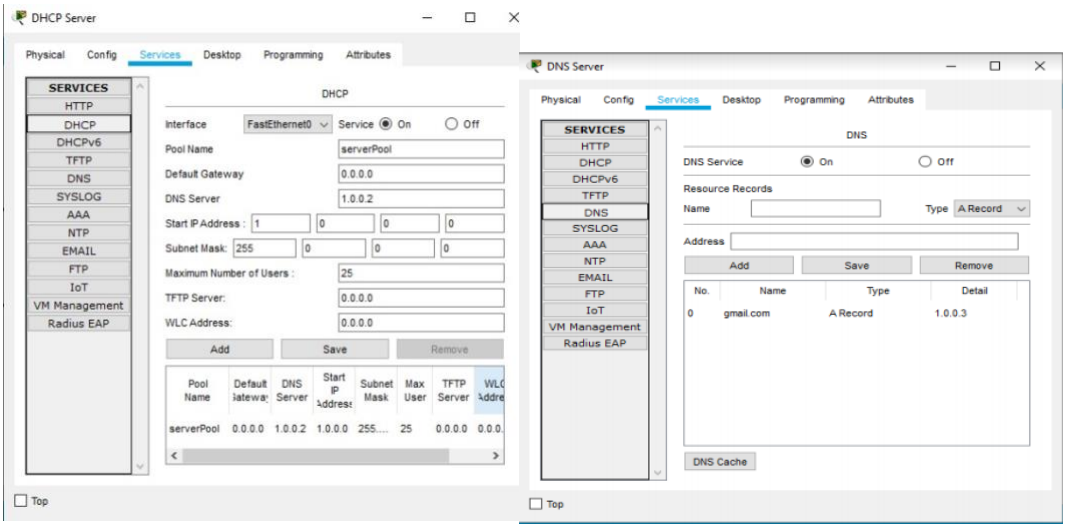
Ip address 192.168.1.2 is statically mapped to 10.0.0.3 Public IP

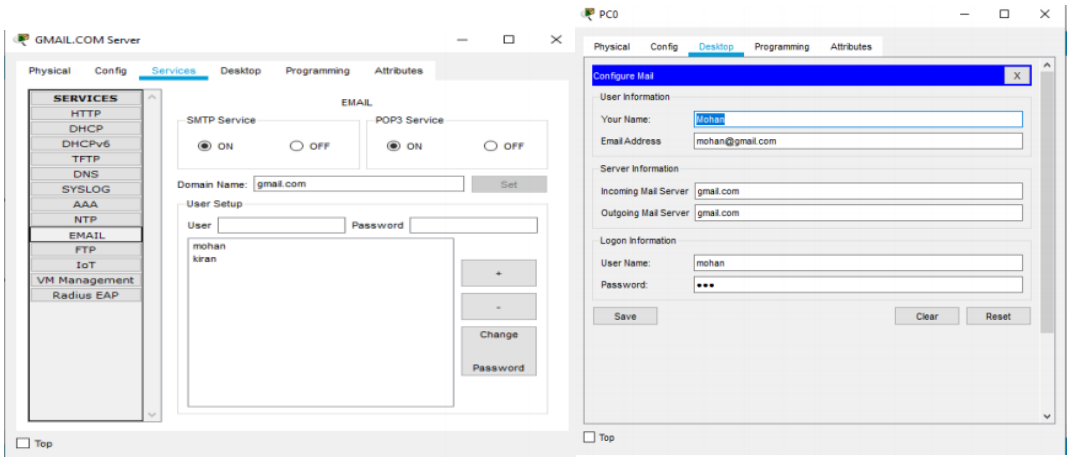
	
Q4.	**Configure a DHCP server to dynamically assign IP address, subnet mask and default gateway to the hosts in the network.**
Answer	A DHCP Server is a network server that automatically provides and assigns IP addresses, default gateways and other network parameters to client devices. It relies on the standard protocol known as Dynamic Host Configuration Protocol or DHCP to respond to broadcast queries by clients. A DHCP server automatically sends the required network parameters for clients to properly communicate on the network. Without it, the network administrator has to manually set up every client that joins the network, which can be cumbersome, especially in large networks. DHCP servers usually assign each client with a unique dynamic IP address, which changes when the client's lease for that IP address has expired. Router>enable Router#configure terminal Enter configuration commands, one per line. End with CNTL/Z. Router(config)#interface FastEthernet0/0 Router(config-if)#ip address 1.0.0.1 255.0.0.0 Router(config-if)#no shutdown %LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up Router#copy run start Router#copy run startup-config Destination filename [startup-config]? Building configuration... [OK]

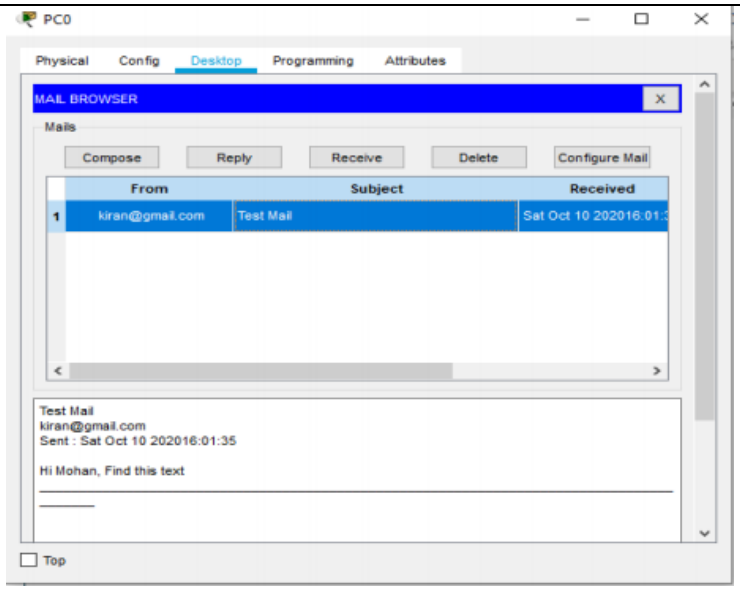
Screenshot	
Q5.	**Configure and test DNS and Email server in a network.**
Answer	The Domain Name System (DNS) is the phonebook of the Internet. Humans access information online through domain names, like nytimes.com or espn.com. Web browsers interact through Internet Protocol (IP) addresses. DNS translates domain names to IP addresses so browsers can load Internet resources. Each device connected to the Internet has a unique IP address which other machines use to find the device. DNS servers eliminate the need for humans to memorize IP addresses such as 192.168.1.1 (in IPv4), or more complex newer alphanumeric IP addresses such as 2400:cb00:2048:1::c629:d7a2 (in IPv6).

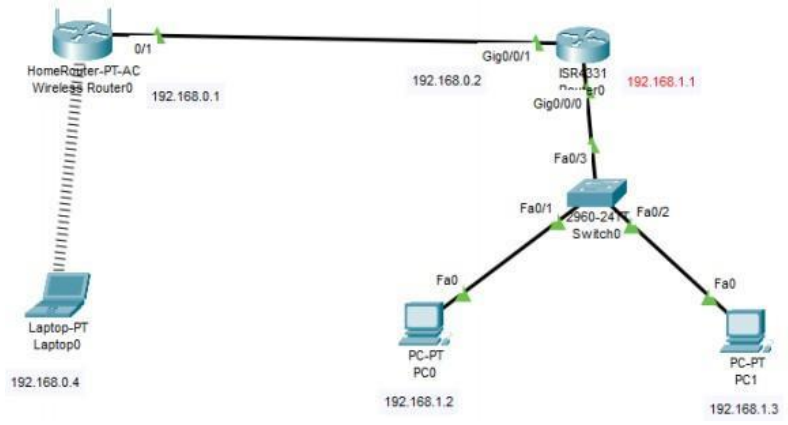
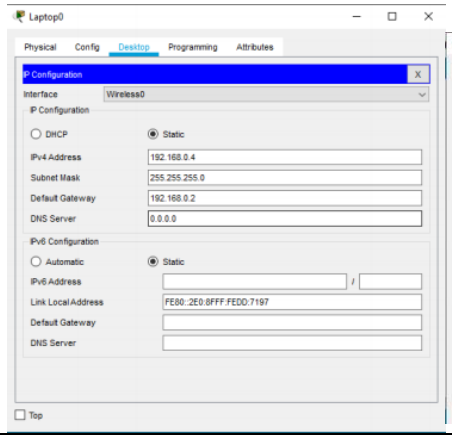
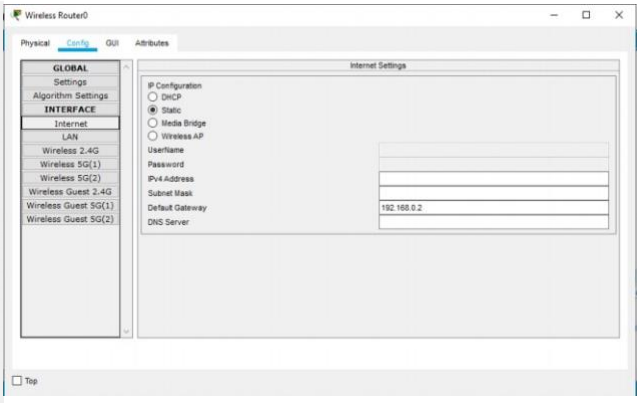
Screenshot

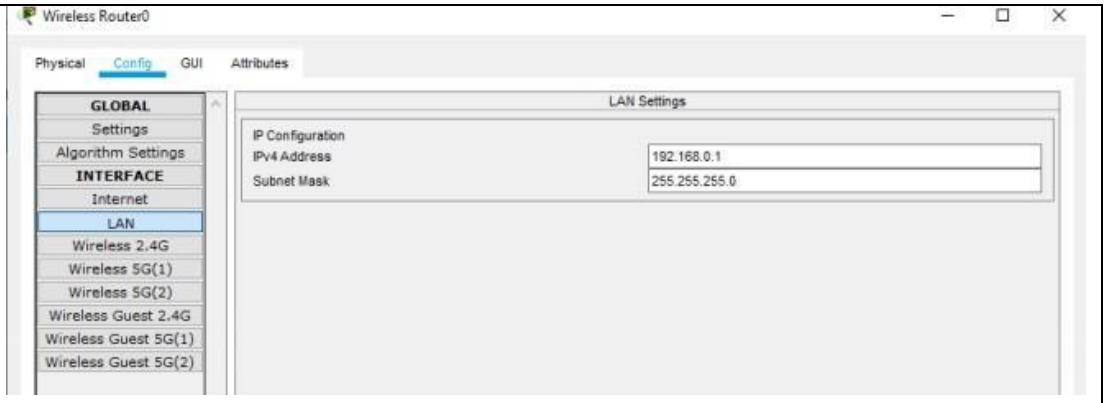

1.0.0.2
Server-PT
DNS Server
Fa0
Server-P
DHCP Server
1.0.0.1
Fa0
Fa0/4
Fa0/6
Fa0/3
2960-
Switch
Fa0/5
Fa0
Server-PT
GMAIL.COM Server
1.0.0.3
Fa0
PC-PT
PC3
Fa0
PC-PT
PC0
mohan@gmail.com
Fa0
PC-PT
PC1
kiran@gmail.com


DHCP Server
Physical
Config
Services
Desktop
Programming
Attributes
SERVICES
HTTP
DHCP
DHCPv6
TFTP
DNS
SYSLOG
AAA
NTP
EMAIL
FTP
IoT
VM Management
Radius EAP
DHCP
Interface
FastEthernet0
Service
On
Off
Pool Name
serverPool
Default Gateway
0.0.0.0
DNS Server
1.0.0.2
Start IP Address :
Subnet Mask:
255
Maximum Number of Users :
25
TFTP Server:
0.0.0.0
WLC Address:
0.0.0.0
Add
Save
Remove
Pool Name
Default Gateway
DNS Server
Start IP Address
Subnet Mask
Max User
TFTP Server
WLC Address
serverPool
0.0.0.0
1.0.0.2
1.0.0.0
255....
25
0.0.0.0
0.0.0.
Top
DNS Server
Physical
Config
Services
Desktop
Programming
Attributes
SERVICES
HTTP
DHCP
DHCPv6
TFTP
DNS
SYSLOG
AAA
NTP
EMAIL
FTP
IoT
VM Management
Radius EAP
DNS
DNS Service
On
Off
Resource Records
Name
Type
A Record
Address
Add
Save
Remove
No.
Name
Type
Detail
0
gmail.com
A Record
1.0.0.3
DNS Cache
Top


GMAIL.COM Server
Physical
Config
Services
Desktop
Programming
Attributes
SERVICES
HTTP
DHCP
DHCPv6
TFTP
DNS
SYSLOG
AAA
NTP
EMAIL
FTP
IoT
VM Management
Radius EAP
EMAIL
SMTP Service
ON
OFF
POP3 Service
ON
OFF
Domain Name:
gmail.com
Set
User Setup
User
Password
mohan
kiran
+
-
Change
Password
Top
PC0
Physical
Config
Desktop
Programming
Attributes
Configure Mail
X
User Information
Your Name:
Mohan
Email Address
mohan@gmail.com
Server Information
Incoming Mail Server
gmail.com
Outgoing Mail Server
gmail.com
Logon Information
User Name:
mohan
Password:
Save
Clear
Reset
Top



Q6.	**Configure Wireless router to support mobile devices to connect to the internet.**
Screenshot	  


Wireless Router0
Physical
Config
GUI
Attributes
GLOBAL
Settings
Algorithm Settings
INTERFACE
Internet
LAN
Wireless 2.4G
Wireless 5G(1)
Wireless 5G(2)
Wireless Guest 2.4G
Wireless Guest 5G(1)
Wireless Guest 5G(2)
LAN Settings
IP Configuration
IPv4 Address
192.168.0.1
Subnet Mask
255.255.255.0