Practical - 03

Title: - Program to assign IPv4 Addresses to nodes.

Aim: - To assign IPv4 Addresses to nodes.

Lab Objectives: -

To get familiarize with a Network Simulation Tool

Description: -

IP Addresses

The network layer is responsible for the source-to-destination delivery of a packet, possibly across multiple networks (links). The network layer adds a header that includes the logical addresses of the sender and receiver to the packet coming from the upper layer. One of the functions of the network layer is to provide a routing mechanism.

Logical addresses are necessary for universal communications that are independent of underlying physical networks. Physical addresses are not adequate in an internetwork environment where different networks can have different address formats. A universal addressing system is needed in which each host can be identified uniquely, regardless of the underlying physical network. The logical addresses are designed for this purpose.

A logical address on the Internet is currently a 32-bit address that can uniquely define a host connected to the Internet. No two publicly addressed and visible hosts on the Internet can have the same IP address. For example, 172.18.4.10

Types of IP Addresses

- IP v4
- IP v6

IP v4 Addresses

An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a device. They are unique in the sense that each address defines one, and only one, connection to the Internet. Two devices on the Internet can never have the same address at the same time.

The IPv4 addresses are universal in the sense that the addressing system must be accepted by any host that wants to be connected to the Internet. An address space is the total number of addresses used by the protocol.

If a protocol uses N bits to define an address, the address space is 2N because each bit can have two different values (0 or 1) and N bits can have 2^N values. IPv4 uses 32-bit addresses, which means that the address space is 2^{32} or 4,294,967,296 (more than 4 billion)

There are two prevalent notations to show an IPv4 address:

Binary Notation

The following is an example of an IPv4 address in binary notation:

01110101 10010101 00011101 00000010

Dotted-decimal Notation.

The following is the dotted-decimal notation of the above address - 117.149.29.2

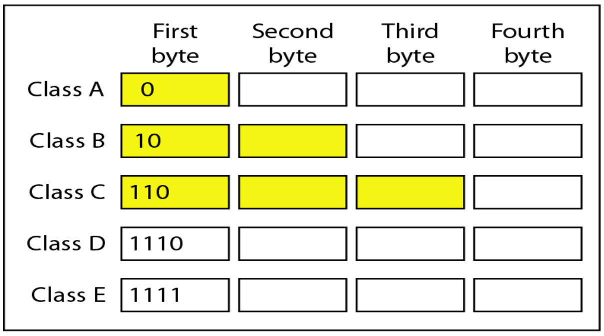
IPv4 Addresses: Classful Addressing

In classful addressing, the address space is divided into five classes: A, B, C, D and E.

Each class occupies some part of the address space.

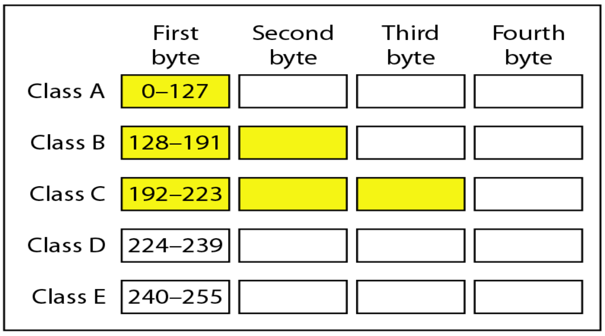
In classful addressing, an IP address in class A, B, or C is divided into netid and hostid.

These parts are of varying lengths, depending on the class of the address.



	First byte	Second byte	Third byte	Fourth byte
Class A	0			
Class B	10	▨		
Class C	110	▨	▨	
Class D	1110			
Class E	1111			

a. Binary notation



	First byte	Second byte	Third byte	Fourth byte
Class A	0–127			
Class B	128–191	▨		
Class C	192–223	▨	▨	
Class D	224–239			
Class E	240–255			

b. Dotted-decimal notation

Mask - a 32-bit number made of contiguous 1 followed by contiguous 0. The mask can help us to find the netid and the hostid.

Class	*Binary*	*Dotted-Decimal*	*CIDR*
A	11111111 00000000 00000000 00000000	255.0.0.0	/8
B	11111111 11111111 00000000 00000000	255.255.0.0	/16
C	11111111 11111111 11111111 00000000	255.255.255.0	/24

IPv4 Addresses: Classless Addressing

To overcome address depletion and give more organizations access to the Internet, classless addressing was designed and implemented.

In this scheme, there are no classes, but the addresses are still granted in blocks.

Mask -a mask in classless addressing is a 32-bit number in which the n leftmost bits are 1s and the 32 - n rightmost bits are 0s. In classless addressing the mask for a block can take any value from 0 to 32.

Network Addresses

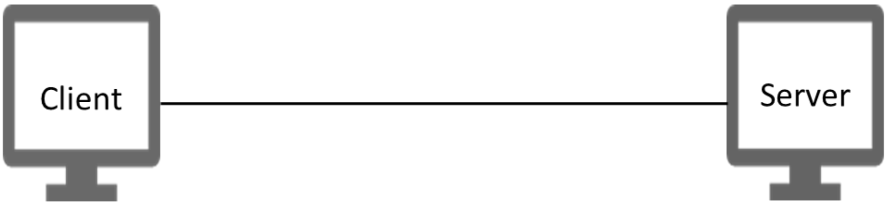
When an organization is given a block of addresses, the organization is free to allocate the addresses to the devices that need to be connected to the Internet.

The first address in the class is normally treated as a special address called as the network address and defines the organization network.

It defines the organization itself to the rest of the world.

Exercise

1. Implement the following topology and assign class B addresses to the nodes.



Code : Created Onkar Malawade A-23-0075 A2-35

```
/-- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; --/


// add required header files


#include "ns3/core-module.h"

#include "ns3/network-module.h"

#include "ns3/internet-module.h"

#include "ns3/point-to-point-module.h"
```

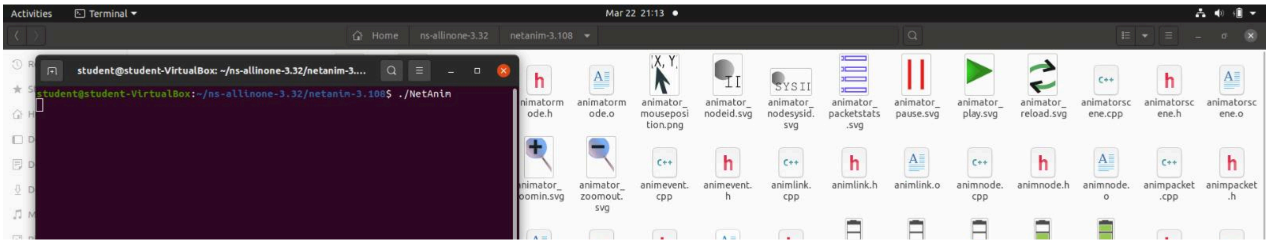
```
#include "ns3/applications-module.h"

#include "ns3/netanim-module.h"

#include "ns3/csma-module.h"

#include "ns3/ipv4-global-routing-helper.h"


// Adding namespace declaration

using namespace ns3;


//Define log component where log msgs will be saved

NS_LOG_COMPONENT_DEFINE("p2pExercise");


// Main function

int main(int argc, char *argv[]){

        // declare number of nodes in bus Topology


        // read the command line arguments

        CommandLine cmd(_FILE_);


        // Process the command line arguments

        cmd.Parse(argc, argv);


        // Set time Resolution to 1 nano second

        Time::SetResolution(Time::NS);


        // Logging

        LogComponentEnable("UdpEchoClientApplication",LOG_LEVEL_INFO);
```

```
    LogComponentEnable("UdpEchoServerApplication",LOG_LEVEL_INFO);


    // Create NodeContainer object to store our nodes

    NodeContainer nodes;


    // Create 2 nodes

    nodes.Create(2);


    // create object of the point-to-point helper object class to configure net device and the channels

    PointToPointHelper pointToPoint;


    // Configure the net Device

    pointToPoint.SetDeviceAttribute("DataRate", StringValue("5Mbps")); // Set Data Rate


    // Configure the Channel

    pointToPoint.SetChannelAttribute("Delay", StringValue("2ms")); // Set Delay Attribute


    // Install net devices on nodes

    NetDeviceContainer devices;

    devices=pointToPoint.Install(nodes);// install netdevices on node and connect with the Channels


    // Configure and Install protocol suits on nodes

    InternetStackHelper stack;

    stack.Install (nodes);
```

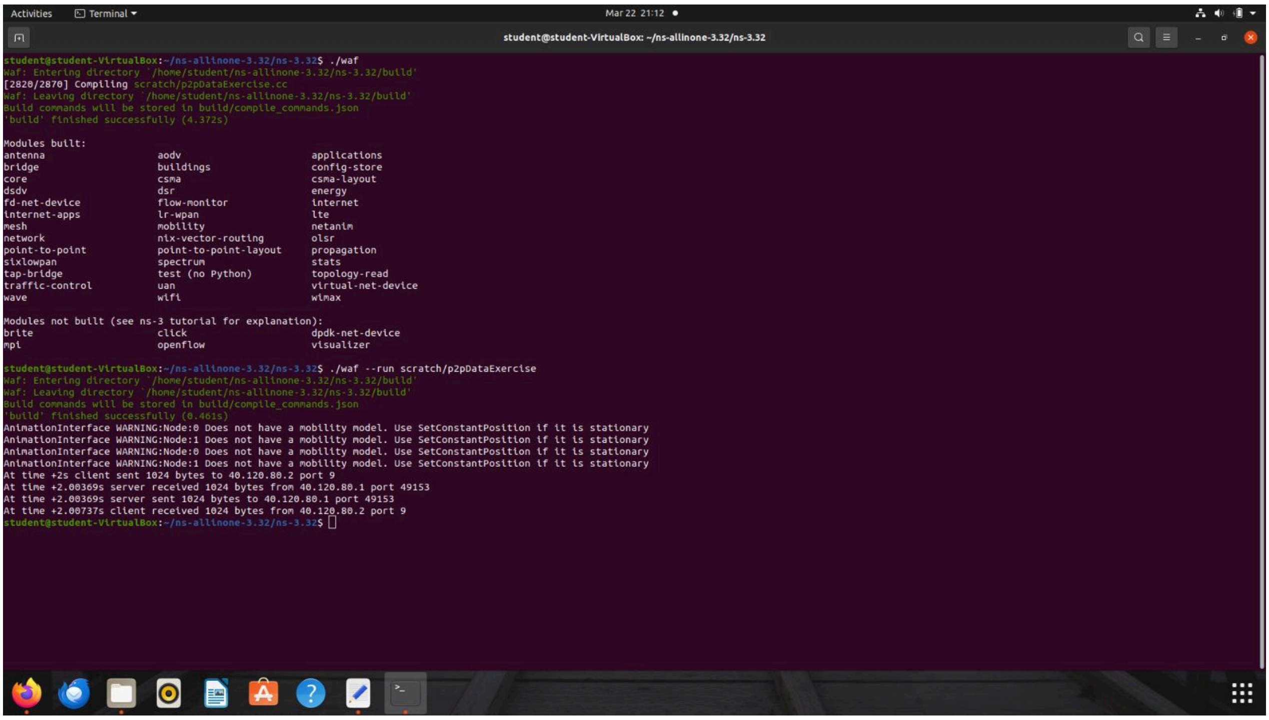
```
// configure network IP address and subnet mask for network

Ipv4AddressHelper address;

// set data

address.SetBase("40.120.80.0","255.255.240.0");


// Assign IP addresses to the interfaces of netDevices

Ipv4InterfaceContainer interfaces = address.Assign(devices);


// Configure our Applications

// Configure UDPEchoServerApplication

UdpEchoServerHelper echoServer(9); // Setting port number of server application


// Application Container create object to store server application and install on node(1)

ApplicationContainer serverApp = echoServer.Install(nodes.Get(1)); // indexed 1 server


// Configure start and stop time of server Application

serverApp.Start(Seconds(1.0)); // server app should start first

serverApp.Stop(Seconds(10.0)); // server app should stop


// Configure UdpEchoClientApplication

UdpEchoClientHelper echoClient(interfaces.GetAddress(1),9);


// Configure the attribute of client Application

echoClient.SetAttribute("MaxPackets", UintegerValue (1));

echoClient.SetAttribute("Interval", TimeValue (Seconds(1.0)));

echoClient.SetAttribute("PacketSize", UintegerValue (1024));
```

```
        // Install Client Application on Node 0

        ApplicationContainer clientApp = echoClient.Install(nodes.Get(0));


        // Configure Start and Stop Time

        clientApp.Start(Seconds(2.0));

        clientApp.Stop(Seconds(10.0));


        // Enables Routing IP Address:- "40.120.80.0"

        Ipv4GlobalRoutingHelper::PopulateRoutingTables();


        // for Running the code 4056

        AnimationInterface anim("p2pAniExcer.xml");

        anim.SetConstantPosition(nodes.Get(0),20.0,30.0);

        anim.SetConstantPosition(nodes.Get(1),40.0,30.0);


        // Simulation on Run and start

        Simulator::Run();


        // Destory this Resourses

        Simulator::Destroy();


        return 0;

}
```

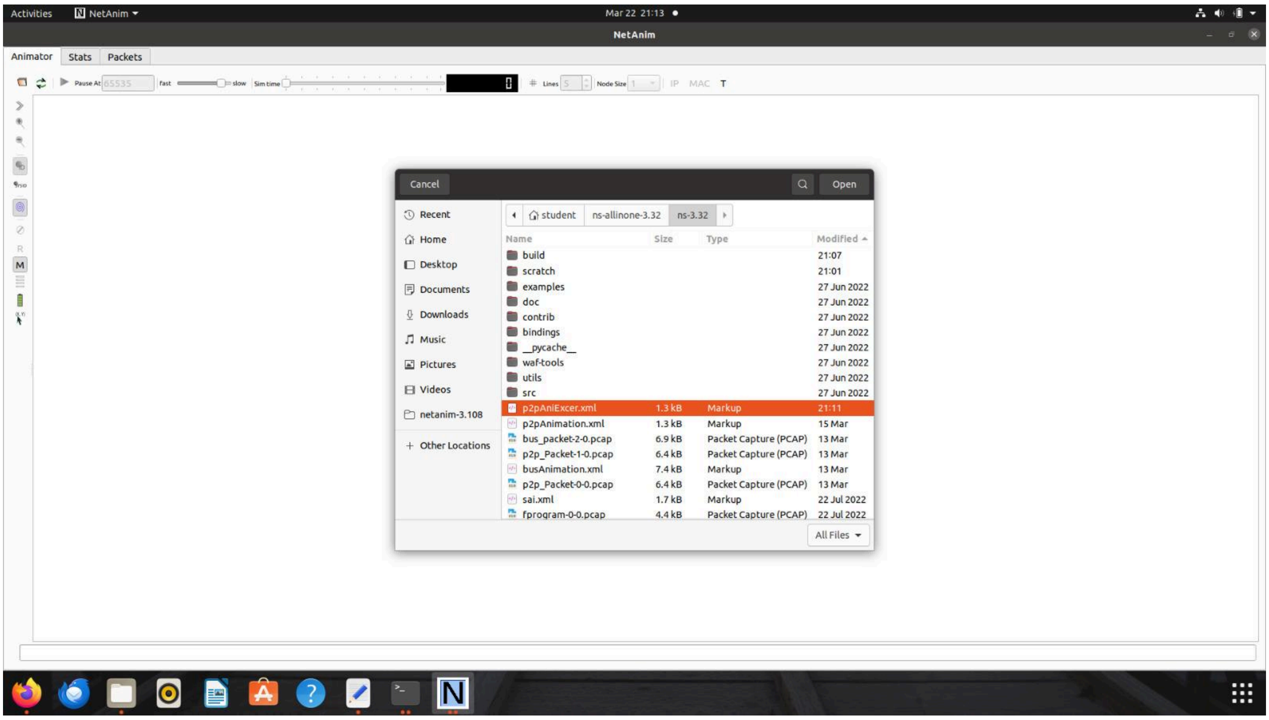
Output



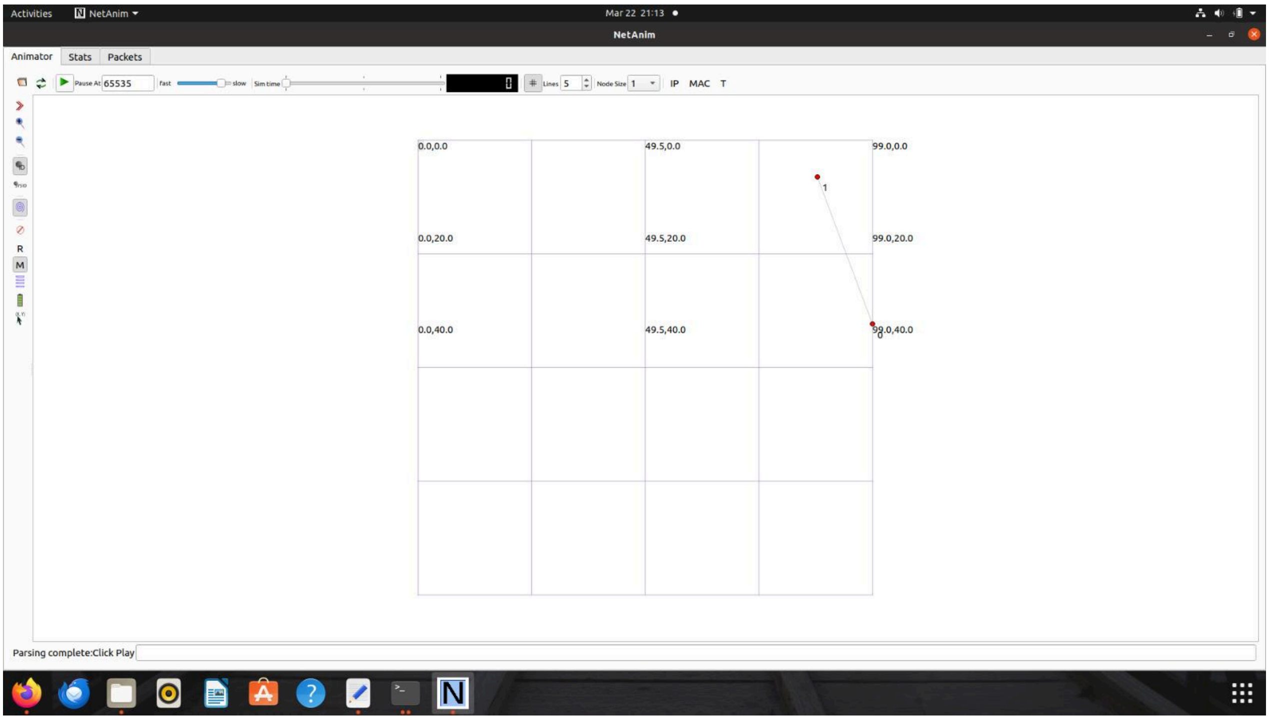
```
student@student-VirtualBox:~/ns-allinone-3.32/netanim-3.108$ ./NetAnim
```



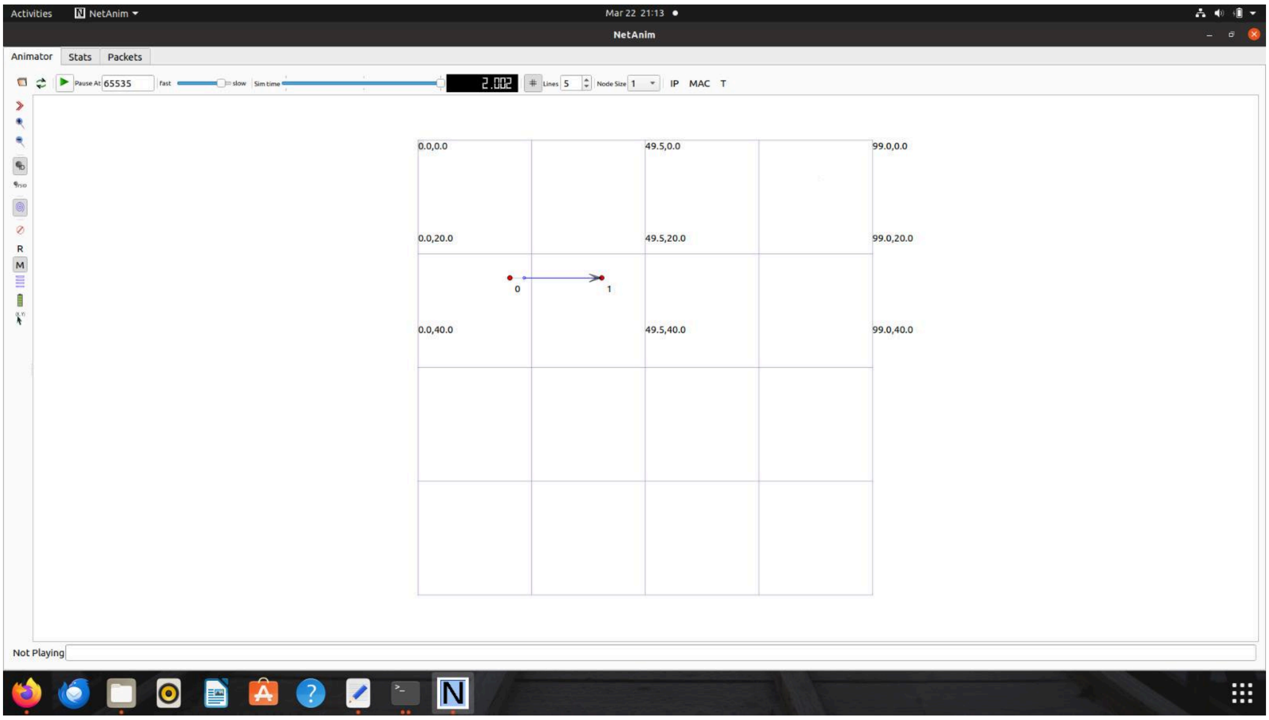
```
student@student-VirtualBox:~/ns-allinone-3.32/ns-3.32$ ./waf
Waf: Entering directory `/home/student/ns-allinone-3.32/ns-3.32/build'
[2820/2870] Compiling scratch/p2pDataExercise.cc
Waf: Leaving directory `/home/student/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (4.372s)

Modules built:
antenna                   aodv                      applications
bridge                    buildings                 config-store
core                      csma                      csma-layout
dsdv                      dsr                       energy
fd-net-device             flow-monitor              internet
internet-apps             lr-wpan                   lte
mesh                      mobility                  netanim
network                   nix-vector-routing        olsr
point-to-point            point-to-point-layout     propagation
sixlowpan                 spectrum                  stats
tap-bridge                test (no Python)          topology-read
traffic-control           uan                       virtual-net-device
wave                      wifi                      wimax

Modules not built (see ns-3 tutorial for explanation):
brite                     click                     dpdk-net-device
mpi                       openflow                  visualizer

student@student-VirtualBox:~/ns-allinone-3.32/ns-3.32$ ./waf --run scratch/p2pDataExercise
Waf: Entering directory `/home/student/ns-allinone-3.32/ns-3.32/build'
Waf: Leaving directory `/home/student/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.461s)
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:0 Does not have a mobility model. Use SetConstantPosition if it is stationary
AnimationInterface WARNING:Node:1 Does not have a mobility model. Use SetConstantPosition if it is stationary
At time +2s client sent 1024 bytes to 40.120.80.2 port 9
At time +2.00369s server received 1024 bytes from 40.120.80.1 port 49153
At time +2.00369s server sent 1024 bytes to 40.120.80.1 port 49153
At time +2.00737s client received 1024 bytes from 40.120.80.2 port 9
student@student-VirtualBox:~/ns-allinone-3.32/ns-3.32$
```



Name	Size	Type	Modified
build			21:07
scratch			21:01
examples			27 Jun 2022
doc			27 Jun 2022
contrib			27 Jun 2022
bindings			27 Jun 2022
__pycache__			27 Jun 2022
waf-tools			27 Jun 2022
utils			27 Jun 2022
src			27 Jun 2022
p2pAniExcer.xml	1.3 kB	Markup	21:11
p2pAnimation.xml	1.3 kB	Markup	15 Mar
bus_packet-2-0.pcap	6.9 kB	Packet Capture (PCAP)	13 Mar
p2p_Packet-1-0.pcap	6.4 kB	Packet Capture (PCAP)	13 Mar
busAnimation.xml	7.4 kB	Markup	13 Mar
p2p_Packet-0-0.pcap	6.4 kB	Packet Capture (PCAP)	13 Mar
sai.xml	1.7 kB	Markup	22 Jul 2022
fprogram-0-0.pcap	4.4 kB	Packet Capture (PCAP)	22 Jul 2022



Parsing complete:Click Play



Not Playing

Conclusion: Implemented UDP Client server topology, assigned IP v4 addresses to the nodes and simulated traffic between in UDP client server.

After performing this Practical/lab, students are expected to answer the following questions.

1. What is the size of IPv4 address?
2. What is the range of addresses in Class B? What is the default mask of Class B Addresses in CIDR notation and dotted decimal notation.
3. In a block of addresses, we know the IP address of one host is 182.44.82.16/26. What is the first address (network address) , the last address and total number of addresses in this block?

References