Networking with Linux Lab
Module 3: Animating the Network

Assignment No. 7: Introduction to NetAnim and Animation a network using NetAnim

1. Explain NetAnim and provide steps to open the NetAnim tool. Also, explain each section of the tool. Finally, demonstrate how to animate a simple network (first.xml) using NetAnim in the Network Simulator and change the node images (computers and routers).

Aim: To demonstrate the usage of NetAnim, including opening the tool, understanding its sections, and animating a simple network in the Network Simulator while customizing node images

Theory: NetAnim

NetAnim is a visualization tool commonly used with the Network Simulator (ns-3) to animate network simulations and analyze simulation results. It provides a graphical representation of the network's behavior, helping users to understand and interpret simulation outcomes more intuitively.

It is a network animation tool used with ns-3 for simulating and visualizing network behavior. It employs Discrete Event Simulation (DES) to model events like packet transmissions and node movements at discrete time points. The tool focuses on packet-level visualization, providing insights into data flow and network issues. Its real-time analysis feature aids in debugging and optimizing network protocols by offering a dynamic visual representation of the simulation.

NetAnim mainly consists of **three sections**, which are as follows:

1. Animator: This section of NetAnim is the main visualization area where the network animation takes place. It displays nodes (such as computers and routers) and their connections, allowing users to observe the dynamic behavior of the simulated network. Users can typically control parameters like playback speed, zoom level, and animation options in this section.

2. Stats: The Stats section of NetAnim provides statistical information about the simulation in real-time or after the simulation has completed. It includes metrics such as throughput, packet loss, delay, and other performance indicators. This data helps users evaluate the effectiveness and efficiency of their network designs and protocols.

3. Packets: In the Packets section, users can track individual packets as they traverse the network during the simulation. This section allows for the detailed analysis of packet routing, transmission times, and any packet-level events or errors that occur. Understanding packet behavior is crucial for diagnosing network issues and optimizing protocol performance.

Code:

> first.cc

```
#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/mobility-helper.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("FirstScriptExample");

int
main (int argc, char *argv[])
{
  CommandLine cmd (__FILE__);

  uint32_t nPackets = 1;
  cmd.AddValue("nPackets", "Number of packets to echo", nPackets);
  uint32_t nSize = 1024;
  cmd.AddValue("nSize", "Size of each packet", nSize);

  cmd.Parse (argc, argv);

  Time::SetResolution (Time::NS);
  LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);
  LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_INFO);

  NodeContainer nodes;
  nodes.Create (2);

  PointToPointHelper pointToPoint;
  pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
  pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));
  NetDeviceContainer devices;
  devices = pointToPoint.Install (nodes);

  InternetStackHelper stack;
  stack.Install (nodes);

  Ipv4AddressHelper address;
  address.SetBase ("128.0.0.0", "255.255.0.0");

  Ipv4InterfaceContainer interfaces = address.Assign (devices);

  UdpEchoServerHelper echoServer (9);

  ApplicationContainer serverApps = echoServer.Install (nodes.Get (1));
  serverApps.Start (Seconds (1.0));
  serverApps.Stop (Seconds (10.0));

  UdpEchoClientHelper echoClient (interfaces.GetAddress (1), 9);
  echoClient.SetAttribute ("MaxPackets", UintegerValue (nPackets));
  echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
  echoClient.SetAttribute ("PacketSize", UintegerValue (nSize));

  ApplicationContainer clientApps = echoClient.Install (nodes.Get (0));
  clientApps.Start (Seconds (2.0));
  clientApps.Stop (Seconds (10.0));

  // NetAnimation ---before simulator run
  MobilityHelper mobility;
  mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
  mobility.Install(nodes);

  AnimationInterface anim("first.xml");
  AnimationInterface::SetConstantPosition(nodes.Get(0), 10, 25);
  AnimationInterface::SetConstantPosition(nodes.Get(1), 40, 25);
  anim.EnablePacketMetadata(true);

  // Creating pcap files for Wireshark-pcap: packet capture information
  pointToPoint.EnablePcapAll("first");

  Simulator::Run ();
  Simulator::Destroy ();
  return 0;
}
```

Command & Screenshot:

Step 1: Open the home directory, and inside that, navigate to the workspace, then open **ns-allinone-3.32**.

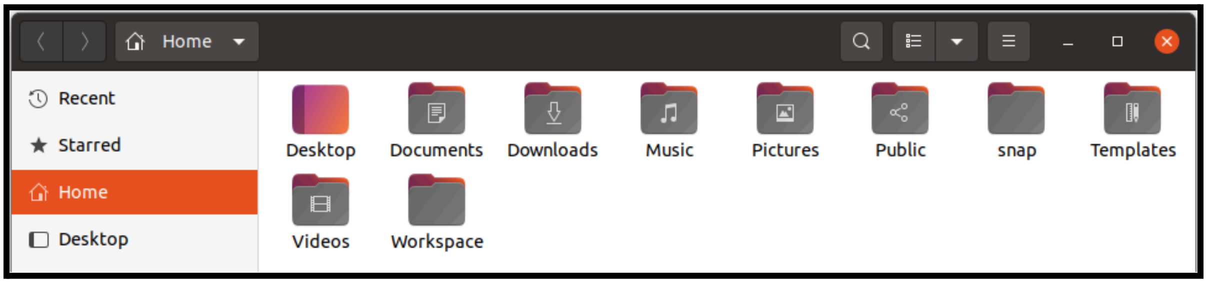


fig. home

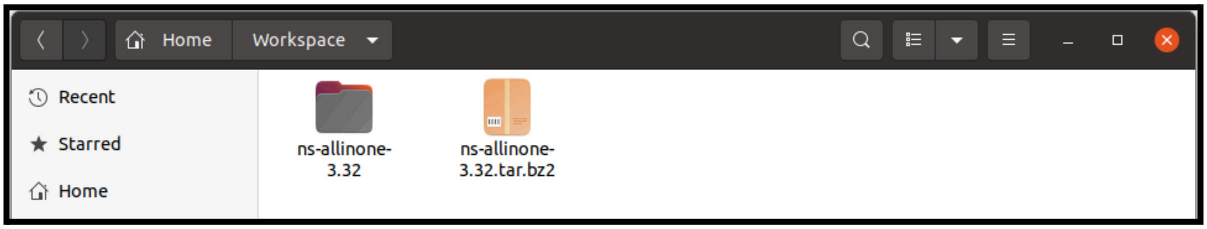


fig. workspace

Step 2: Right-click in a white space and select '**Open in Terminal**'.

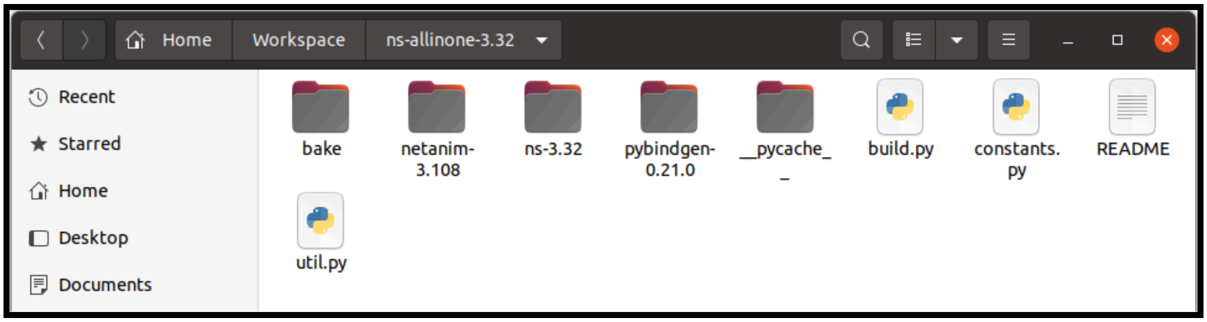
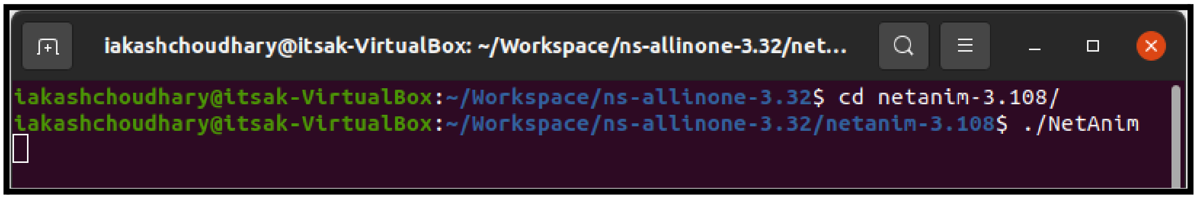


fig. ns-allinone-3.32

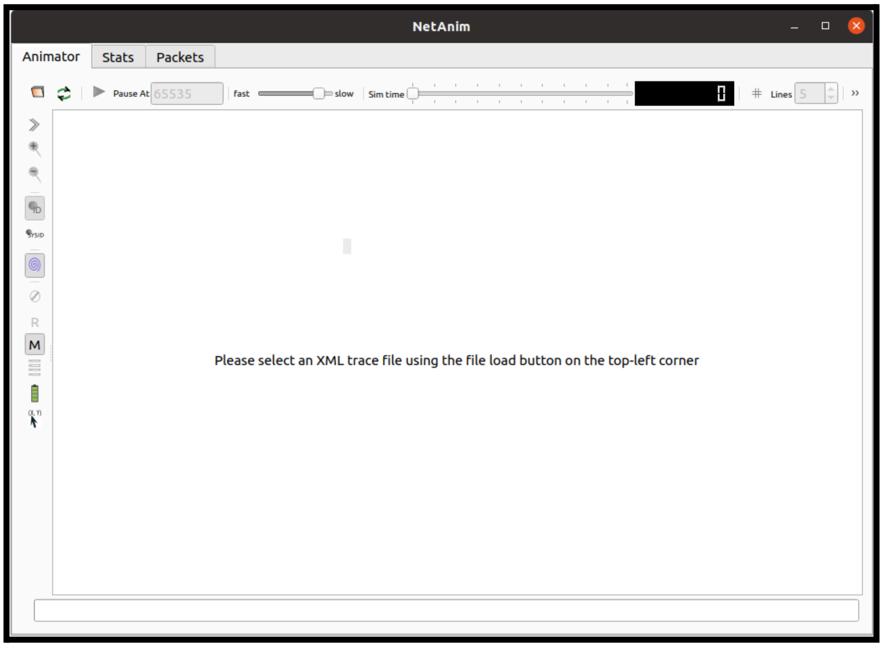
Step 3: Run the following commands:

1. Change directory to "netanim-3.108/" using the command: **$ cd netanim-3.108/**
2. Run the executable file "NetAnim" using the command: **$ ./NetAnim**


iakashchoudhary@itsak-VirtualBox: ~/Workspace/ns-allinone-3.32/net...

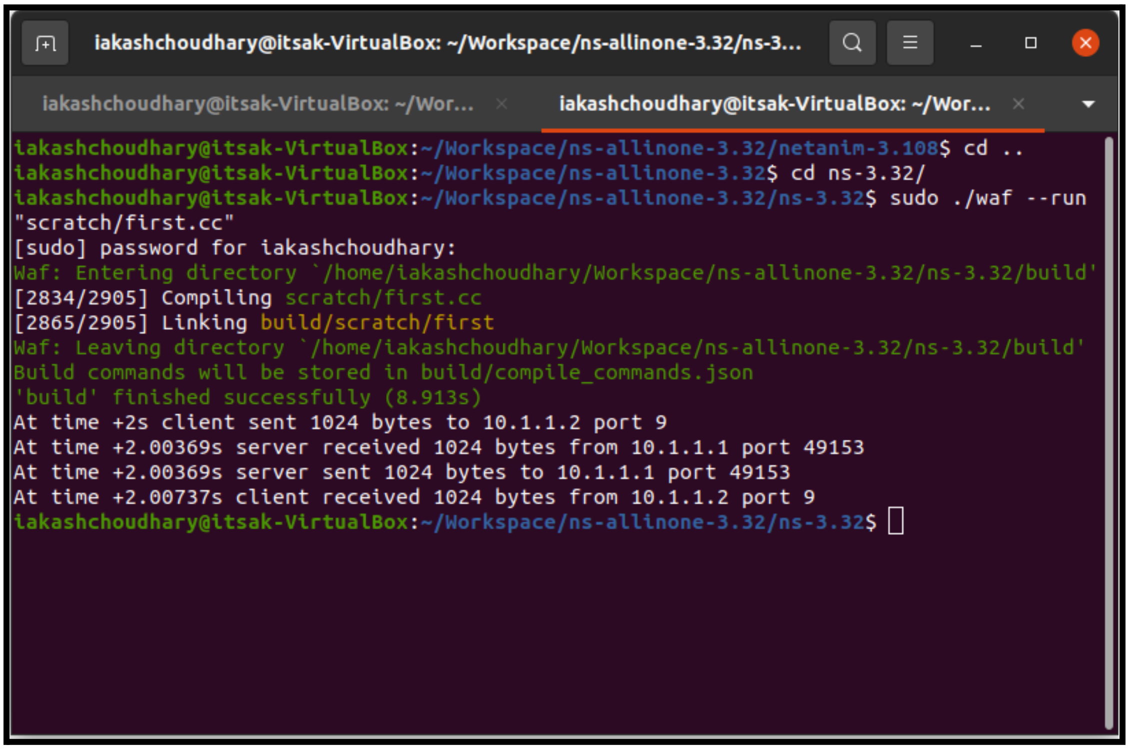
```
iakashchoudhary@itsak-VirtualBox:~/Workspace/ns-allinone-3.32$ cd netanim-3.108/
iakashchoudhary@itsak-VirtualBox:~/Workspace/ns-allinone-3.32/netanim-3.108$ ./NetAnim
```

Step 4: The **NetAnim Application** will **pop up**.



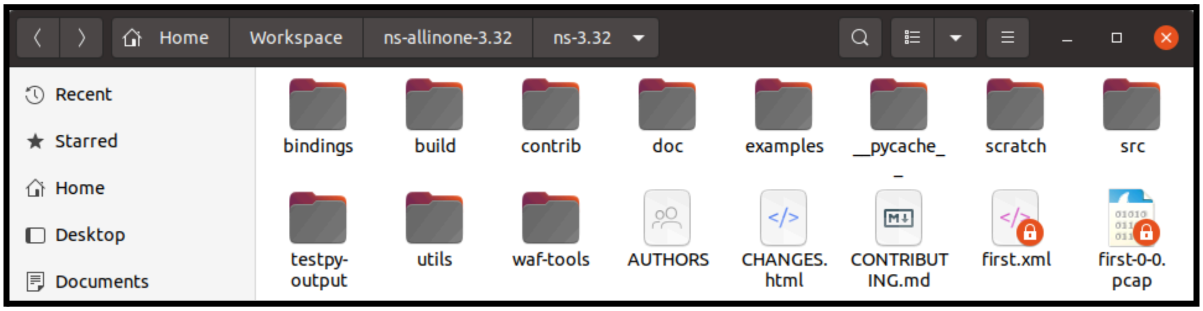
Please select an XML trace file using the file load button on the top-left corner

Step 5: Run the following command: **$ cd ..**; **$ cd ns-3.32/**; **$ sudo ./waf --run "scratch/first.cc"**. By doing this, it will create the **first.xml** file for the NetAnim simulation.

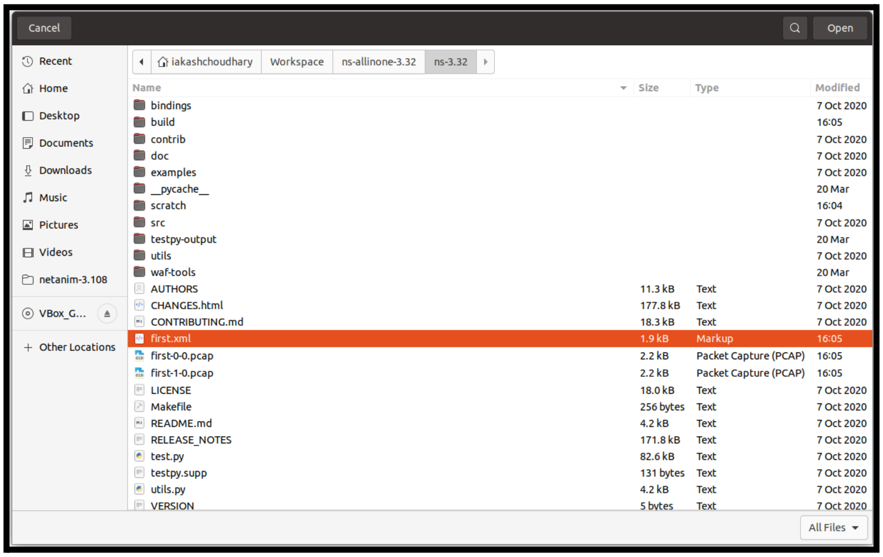

iakashchoudhary@itsak-VirtualBox: ~/Workspace/ns-allinone-3.32/ns-3...
iakashchoudhary@itsak-VirtualBox: ~/Wor...
iakashchoudhary@itsak-VirtualBox: ~/Wor...

```
iakashchoudhary@itsak-VirtualBox:~/Workspace/ns-allinone-3.32/netanim-3.108$ cd ..
iakashchoudhary@itsak-VirtualBox:~/Workspace/ns-allinone-3.32$ cd ns-3.32/
iakashchoudhary@itsak-VirtualBox:~/Workspace/ns-allinone-3.32/ns-3.32$ sudo ./waf --run
"scratch/first.cc"
[sudo] password for iakashchoudhary:
Waf: Entering directory `/home/iakashchoudhary/Workspace/ns-allinone-3.32/ns-3.32/build'
[2834/2905] Compiling scratch/first.cc
[2865/2905] Linking build/scratch/first
Waf: Leaving directory `/home/iakashchoudhary/Workspace/ns-allinone-3.32/ns-3.32/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (8.913s)
At time +2s client sent 1024 bytes to 10.1.1.2 port 9
At time +2.00369s server received 1024 bytes from 10.1.1.1 port 49153
At time +2.00369s server sent 1024 bytes to 10.1.1.1 port 49153
At time +2.00737s client received 1024 bytes from 10.1.1.2 port 9
iakashchoudhary@itsak-VirtualBox:~/Workspace/ns-allinone-3.32/ns-3.32$ 
```

Step 6: You can find the file 'first.xml' inside the ns-3.32 directory.

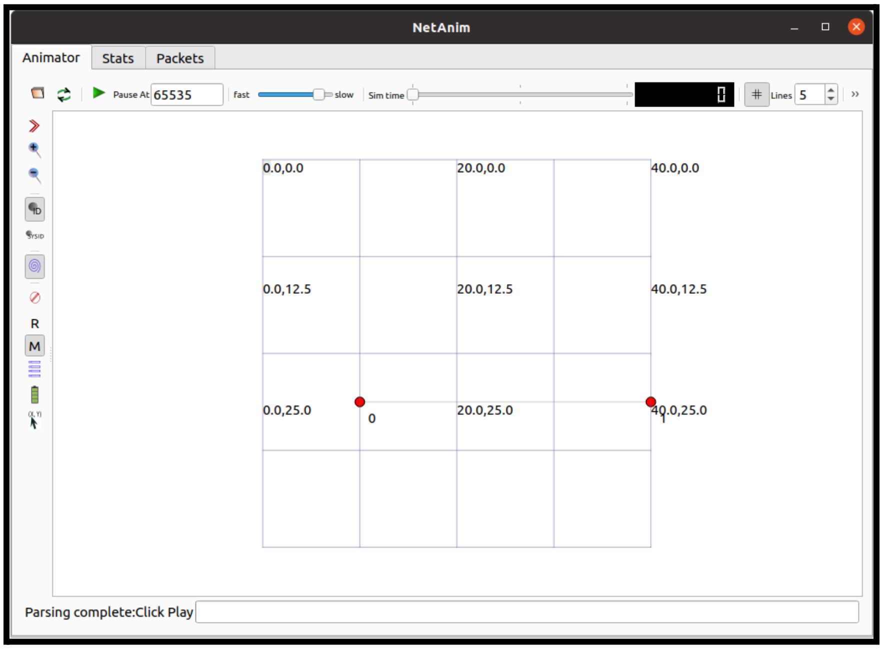


Step 7: Switch back to NetAnim, click on the folder icon, choose 'first.xml,' and click 'Open'.



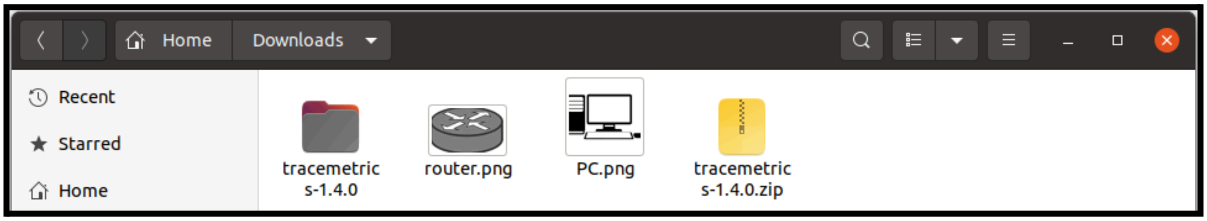
Name	Size	Type	Modified
bindings			7 Oct 2020
build			16:05
contrib			7 Oct 2020
doc			7 Oct 2020
examples			7 Oct 2020
__pycache__			20 Mar
scratch			16:04
src			7 Oct 2020
testpy-output			20 Mar
utils			7 Oct 2020
waf-tools			20 Mar
AUTHORS	11.3 kB	Text	7 Oct 2020
CHANGES.html	177.8 kB	Text	7 Oct 2020
CONTRIBUTING.md	18.3 kB	Text	7 Oct 2020
first.xml	1.9 kB	Markup	16:05
first-0-0.pcap	2.2 kB	Packet Capture (PCAP)	16:05
first-1-0.pcap	2.2 kB	Packet Capture (PCAP)	16:05
LICENSE	18.0 kB	Text	7 Oct 2020
Makefile	256 bytes	Text	7 Oct 2020
README.md	4.2 kB	Text	7 Oct 2020
RELEASE_NOTES	171.8 kB	Text	7 Oct 2020
test.py	82.6 kB	Text	7 Oct 2020
testpy.supp	131 bytes	Text	7 Oct 2020
utils.py	4.2 kB	Text	7 Oct 2020
VERSION	5 bytes	Text	7 Oct 2020

Step 8: It will display the network topology from first.xml.

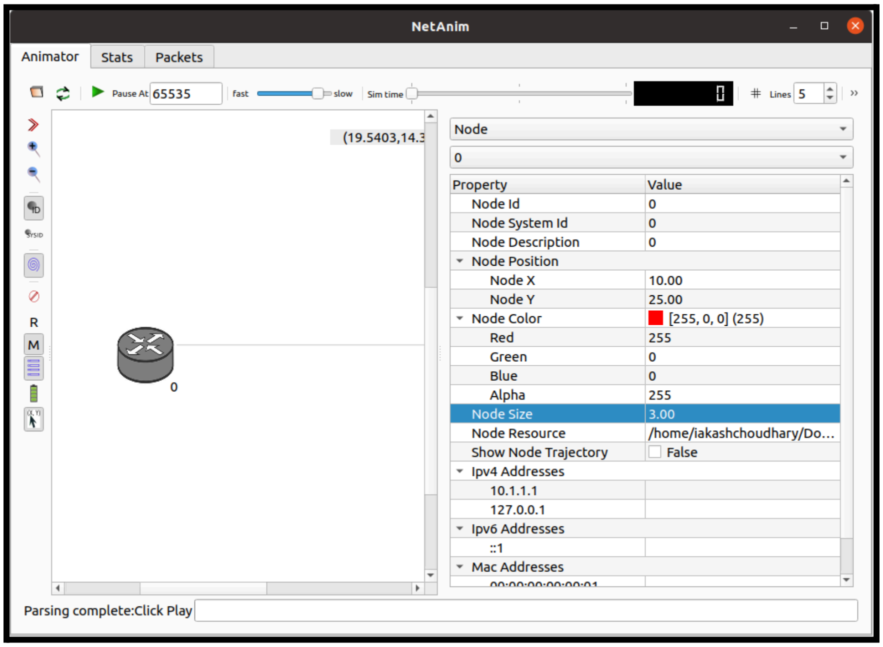


Parsing complete:Click Play

Step 9: Download the router and PC icons in .png format.



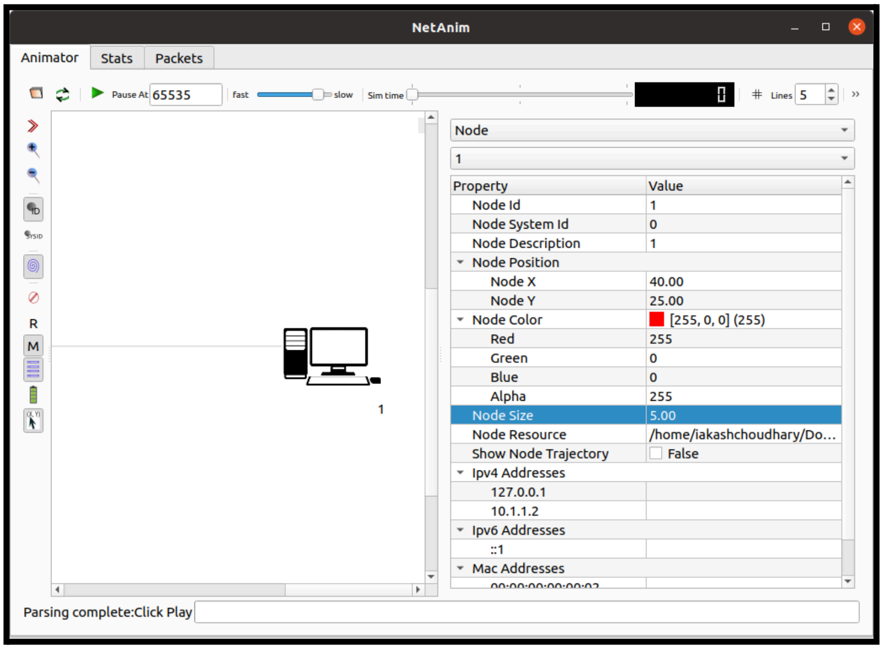
Step 10: Click on 'Node Properties,' change the node size, and set the resource for Node 0.



Property	Value
Node Id	0
Node System Id	0
Node Description	0
Node Position	
Node X	10.00
Node Y	25.00
Node Color	🟥 [255, 0, 0] (255)
Red	255
Green	0
Blue	0
Alpha	255
Node Size	3.00
Node Resource	/home/iakashchoudhary/Do...
Show Node Trajectory	□ False
Ipv4 Addresses	
10.1.1.1	
127.0.0.1	
Ipv6 Addresses	
::1	
Mac Addresses	
00:00:00:00:00:01	

Parsing complete:Click Play

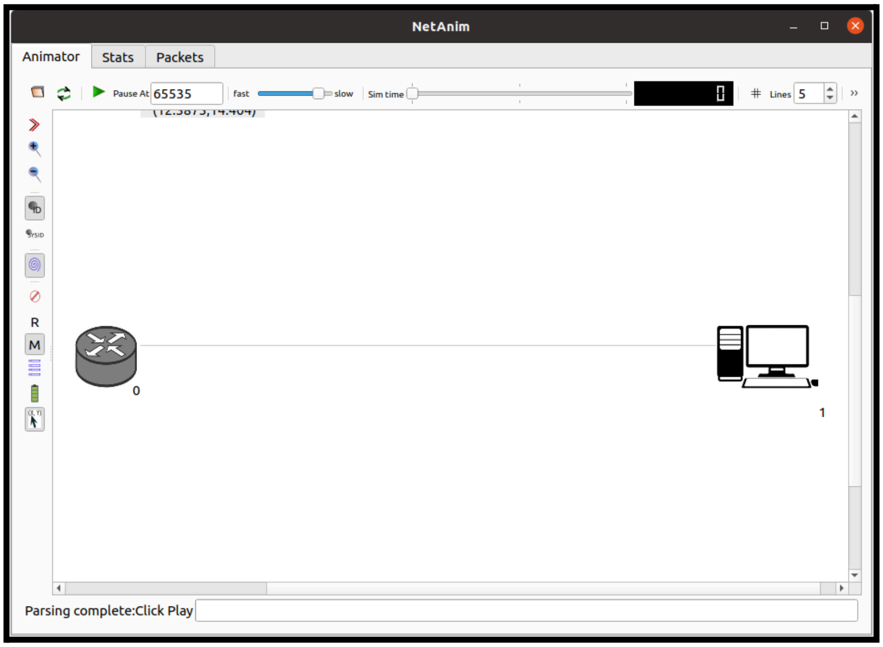
Step 11: Click on 'Node Properties,' change the node size, and set the resource for Node 1.



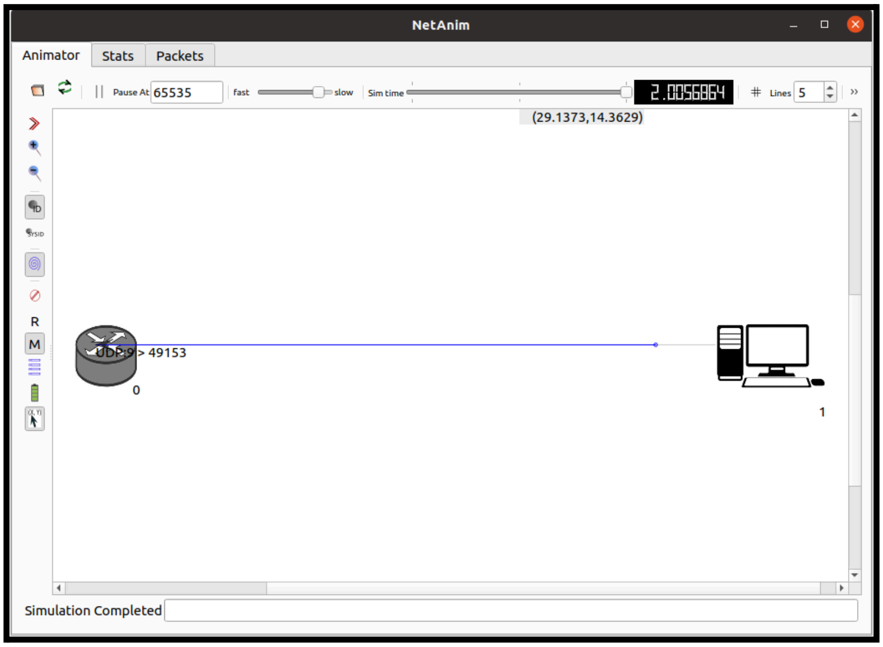
Property	Value
Node Id	1
Node System Id	0
Node Description	1
Node Position	
Node X	40.00
Node Y	25.00
Node Color	🟥 [255, 0, 0] (255)
Red	255
Green	0
Blue	0
Alpha	255
Node Size	5.00
Node Resource	/home/iakashchoudhary/Do...
Show Node Trajectory	□ False
Ipv4 Addresses	
127.0.0.1	
10.1.1.2	
Ipv6 Addresses	
::1	
Mac Addresses	
00:00:00:00:00:02	

Parsing complete:Click Play

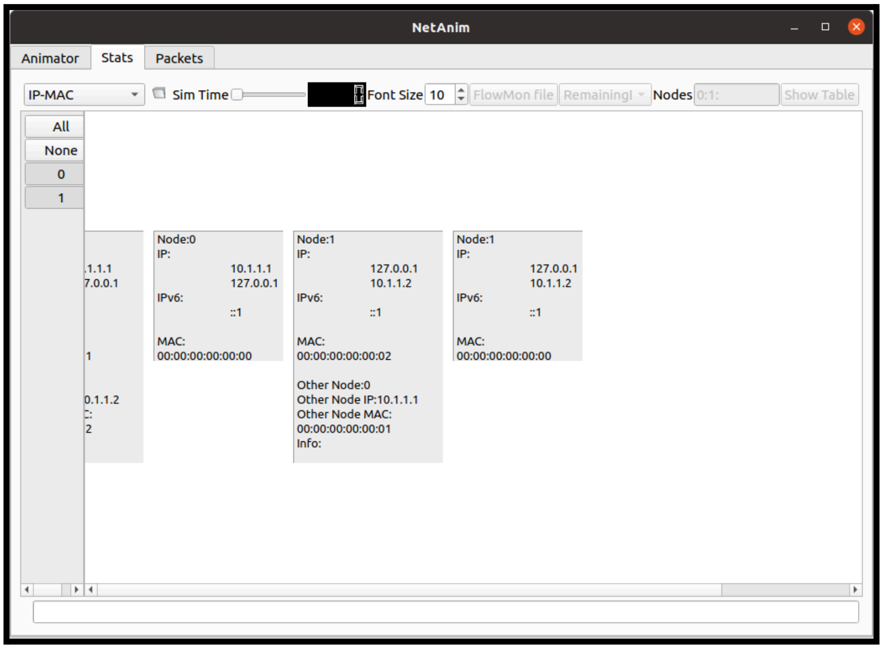
Step 12: Now, click on the play icon to start the network simulation.



Animator: NetAnim's Animator section provides visualization capabilities for network simulations, allowing users to visually represent network topologies, node movements, and data transmissions in real-time animations



Stats: The Stats section of NetAnim furnishes statistical data on various aspects of the simulated network, such as packet delivery ratios, throughput, latency, and other performance metrics, aiding in the analysis and evaluation of network behavior.



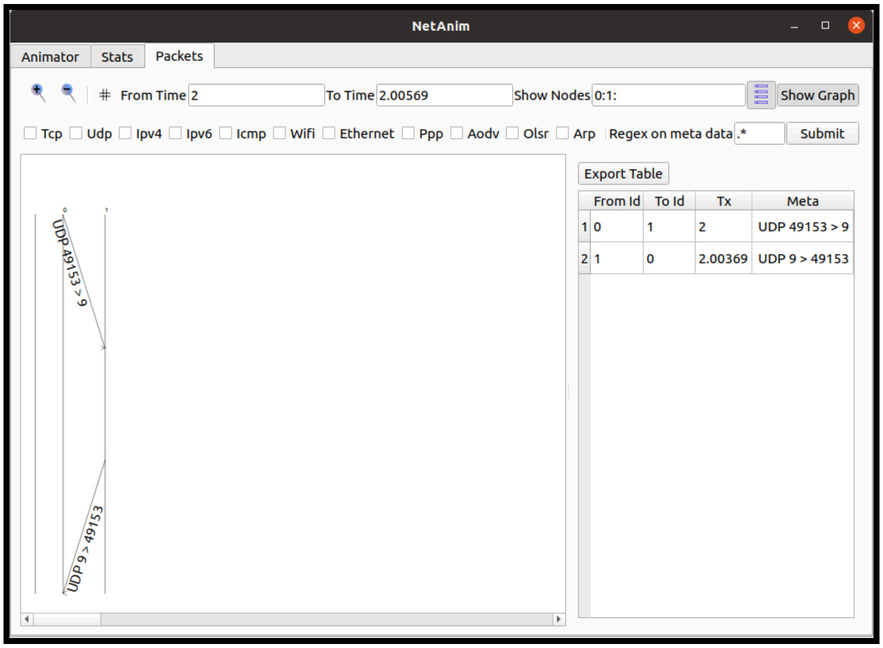
```
.1.1.1
7.0.0.1

1

0.1.1.2
C:
2
```

```
Node:0
IP:
                10.1.1.1
                127.0.0.1
IPv6:
                ::1

MAC:
00:00:00:00:00:00
```

```
Node:1
IP:
                127.0.0.1
                10.1.1.2
IPv6:
                ::1

MAC:
00:00:00:00:00:02

Other Node:0
Other Node IP:10.1.1.1
Other Node MAC:
00:00:00:00:00:01
Info:
```

```
Node:1
IP:
                127.0.0.1
                10.1.1.2
IPv6:
                ::1

MAC:
00:00:00:00:00:00
```

Packets: NetAnim's Packets section offers insights into packet-level details within the simulated network, including packet generation, transmission, routing paths, and reception, enabling users to monitor and troubleshoot packet-level activities during simulations.



From Time 2 To Time 2.00569 Show Nodes 0:1: Regex on meta data .*

	From Id	To Id	Tx	Meta
1	0	1	2	UDP 49153 > 9
2	1	0	2.00369	UDP 9 > 49153

Conclusion: NetAnim provides a user-friendly interface to visualize and analyze network simulations, allowing users to easily understand network behavior and performance through graphical representations.