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C E R T I F I C A T E

This is to certify that Mr. / Miss. **Yash Bhosle** of M.C.A. Semester II with Roll No. **C22014** has completed _____ practicals of MCAL26 – Networking with Linux under my supervision in this college during the year 2022-2023.

CO	R1: Journal	R2: Performance during lab session	R3: Implementation using different problem solving techniques	R4: Mock Viva	Attendance
CO1					
CO2					
CO3					
CO4					

Practical-in-charge

Head of Department

MCA Department
(NMITD)

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Practical 1: Installing NS-3 in Ubuntu

Steps for installing NS-3 in Ubuntu

Step 1: Update the system

$ sudo apt update

Step 2: Prerequisites for installing NS-3

$ sudo apt install build-essential autoconf automake libxmu-dev g++ python3 python3-dev pkg-config sqlite3 cmake python3-setuptools git qtbase5-dev qtchooser qt5-qmake qtbase5-dev-tools gir1.2-goocanvas-2.0 python3-gi python3-gi-cairo python3-pygraphviz gir1.2-gtk-3.0 ipython3 openmpi-bin openmpi-common openmpi-doc libopenmpi-dev autoconf cvs bzr unrar gsl-bin libgsl-dev libgslcblas0 wireshark tcpdump sqlite sqlite3 libsqlite3-dev libxml2 libxml2-dev libc6-dev libc6-dev-i386 libclang-dev llvm-dev automake python3-pip libxml2 libxml2-dev libboost-all-dev

Now download the ns3 3.35 from https://nsnam.org

Copy the softwares from the Downloads/ folder to the home folder (in my case its /home/ns-3/)

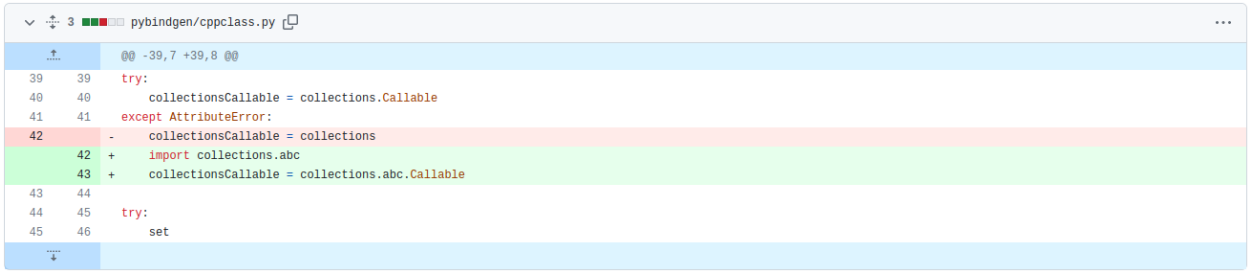
Now extract both the versions using the GUI method.

Just right click and click "Extract Here"
Now we will install ns-3.35

$ cd
$ cd ns-allinone-3.35/
$ ./build.py --enable-examples --enable-tests

In case, if you get the following error pybindgen(ns3 module antenna)

Do this step and repeat the above step



```
3 pybindgen/cppclass.py
@@ -39,7 +39,8 @@
39 39  try:
40 40      collectionsCallable = collections.Callable
41 41  except AttributeError:
42    -     collectionsCallable = collections
   42 +     import collections.abc
   43 +     collectionsCallable = collections.abc.Callable
43 44
44 45  try:
45 46      set
```

We have installed two version of ns-3.35 successfully in Ubuntu

Practical 2: Install NetAnim in Ubuntu

Steps to Install NetAnim

You can directly install NetAnim

Otherwise, you have to execute some commands but for this we need NS3 installed or compiled.

Step1: sudo apt-get install NetAnim

Step2: NetAnim file.xml

Step3: Select Xml File

Step4: Run the simulation by clicking, NS3 NetAnim successfully.

Practical 3: Install Wireshark In Ubuntu

Install WireShark

Step 1: Add the stable official PPA. To do this, go to terminal by pressing Ctrl+Alt+T and run:

sudo add-apt-repository ppa:wireshark-dev/stable

Step 2: Update the repository:

sudo apt-get update

Step 3: Install wireshark 2.0:

sudo apt-get install wireshark

Step 4: Run wireshark:

sudo wireshark

If you get a error couldn't run /usr/bin/dumpcap in child process: Permission Denied. go to the terminal again and run:

sudo dpkg-reconfigure wireshark-common

Say YES to the message box. This adds a wireshark group. Then add user to the group by typing

sudo adduser $USER wireshark

Practical 4: Point-to-Point

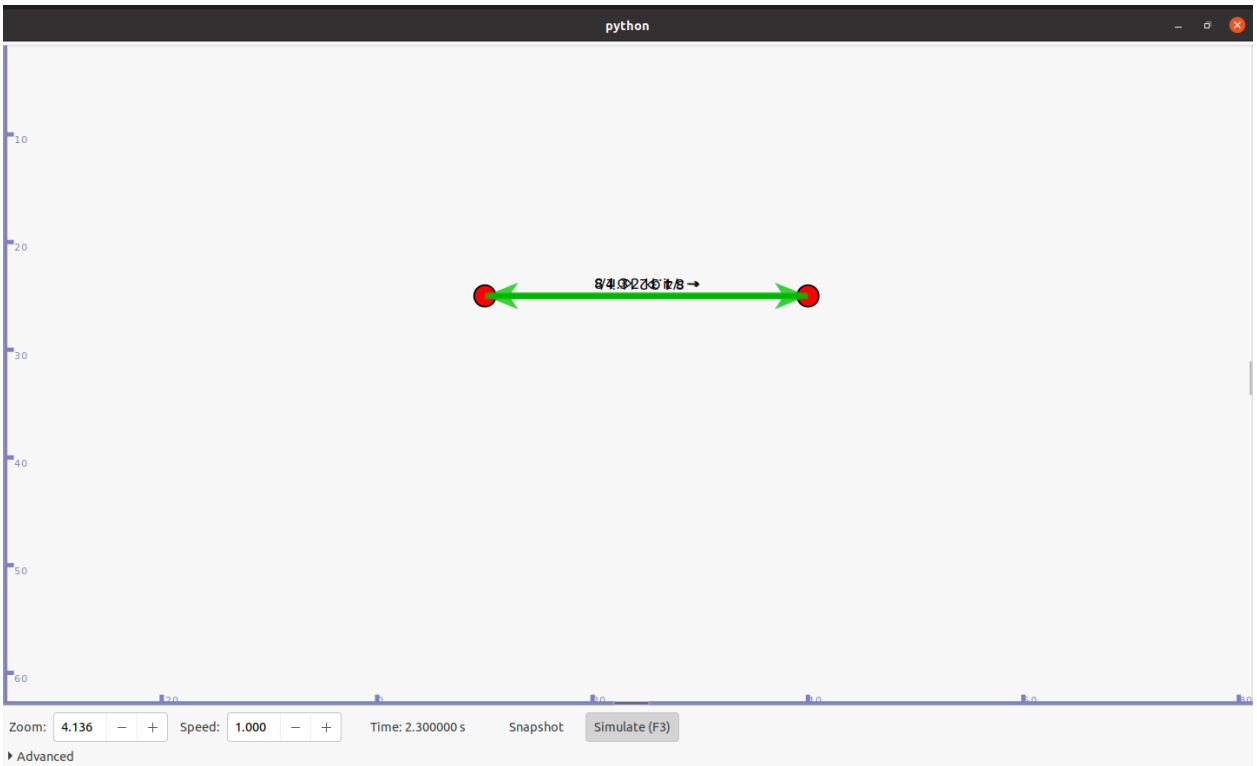
Code:

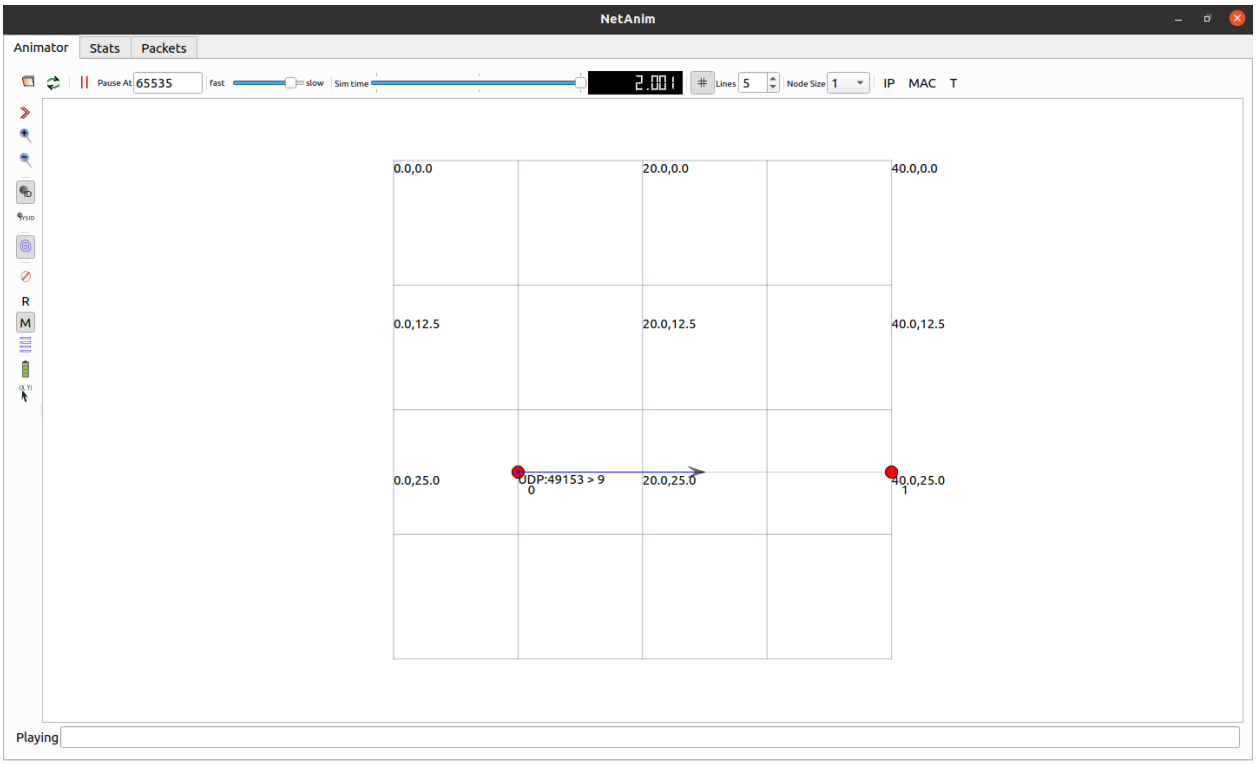
```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
 * This program is free software; you can redistribute it and/or modify
 * it under the terms of the GNU General Public License version 2 as
 * published by the Free Software Foundation;
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 */

#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"
//netanimation
#include "ns3/netanim-module.h"
#include "ns3/mobility-module.h"
```

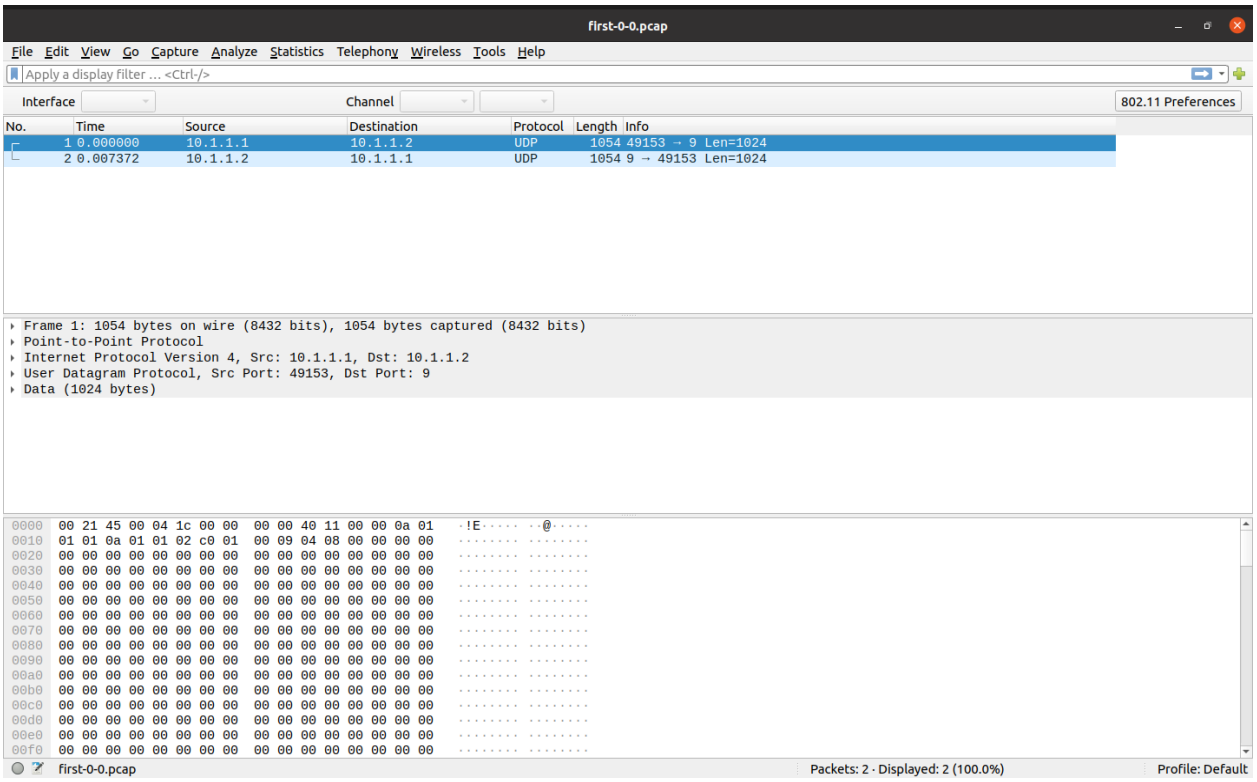
```
// Default Network Topology
//
//       10.1.1.0
// n0 -------------- n1
//    point-to-point
//

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("FirstScriptExample");

int
main (int argc, char *argv[])
{
  CommandLine cmd (__FILE__);
  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 ("10.1.1.0", "255.255.255.0");

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 (1));
echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
echoClient.SetAttribute ("PacketSize", UintegerValue (1024));

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

```
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);

pointToPoint.EnablePcapAll("first");

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




NetAnim
Animator
Stats
Packets
Pause At: 65535
fast
slow
Sim time
2.001
Lines 5
Node Size 1
IP
MAC
T
0.0,0.0
20.0,0.0
40.0,0.0
0.0,12.5
20.0,12.5
40.0,12.5
0.0,25.0
UDP:49153 > 9
0
20.0,25.0
40.0,25.0
1
Playing


first-0-0.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
Interface
Channel
802.11 Preferences
No. Time Source Destination Protocol Length Info
1 0.000000 10.1.1.1 10.1.1.2 UDP 1054 49153 → 9 Len=1024
2 0.007372 10.1.1.2 10.1.1.1 UDP 1054 9 → 49153 Len=1024
Frame 1: 1054 bytes on wire (8432 bits), 1054 bytes captured (8432 bits)
Point-to-Point Protocol
Internet Protocol Version 4, Src: 10.1.1.1, Dst: 10.1.1.2
User Datagram Protocol, Src Port: 49153, Dst Port: 9
Data (1024 bytes)
0000 00 21 45 00 04 1c 00 00 00 00 40 11 00 00 0a 01 !E · · · · · · @ · · · ·
0010 01 01 0a 01 01 02 c0 01 00 09 04 08 00 00 00 00
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0040 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0060 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0070 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0080 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0090 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00a0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00b0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00c0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00d0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00e0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00f0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
first-0-0.pcap
Packets: 2 · Displayed: 2 (100.0%)
Profile: Default

Practical 5: Star

Code:

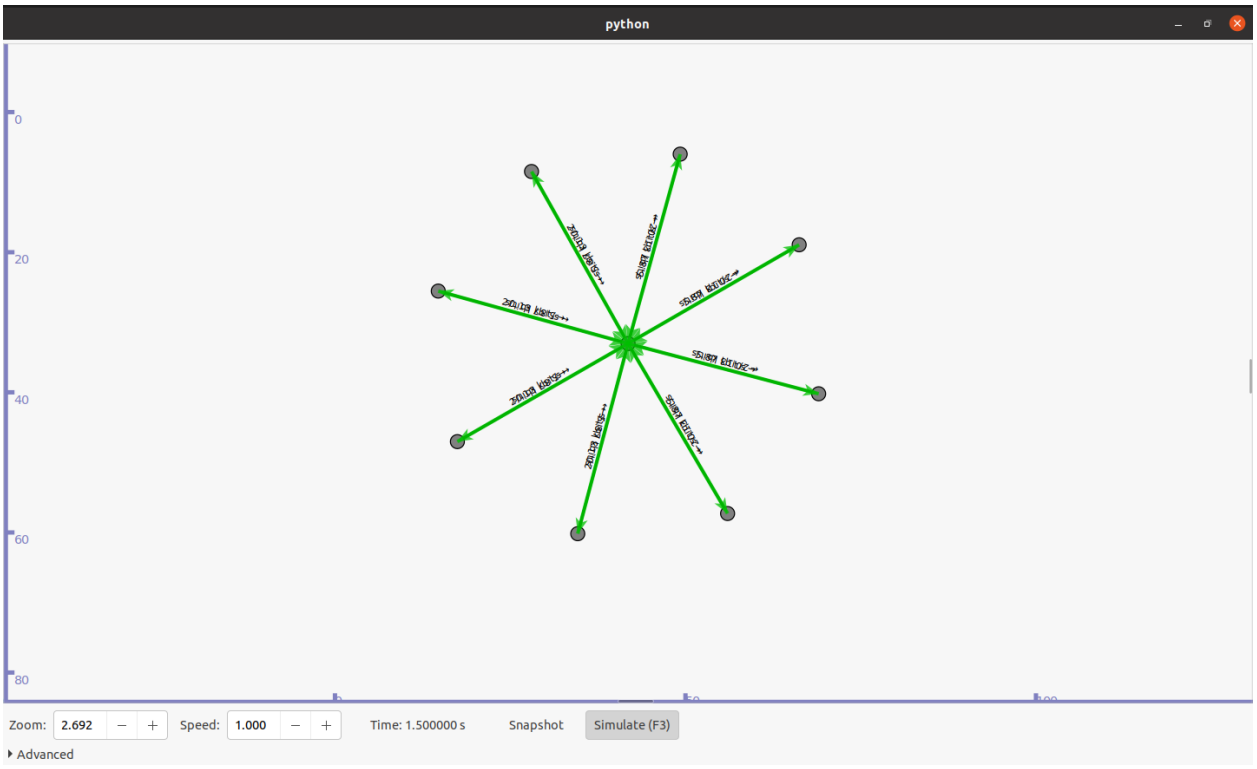
```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
 * This program is free software; you can redistribute it and/or modify
 * it under the terms of the GNU General Public License version 2 as
 * published by the Free Software Foundation;
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 *
 */

#include "ns3/core-module.h"
#include "ns3/network-module.h"
#include "ns3/netanim-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/applications-module.h"
#include "ns3/point-to-point-layout-module.h"
```

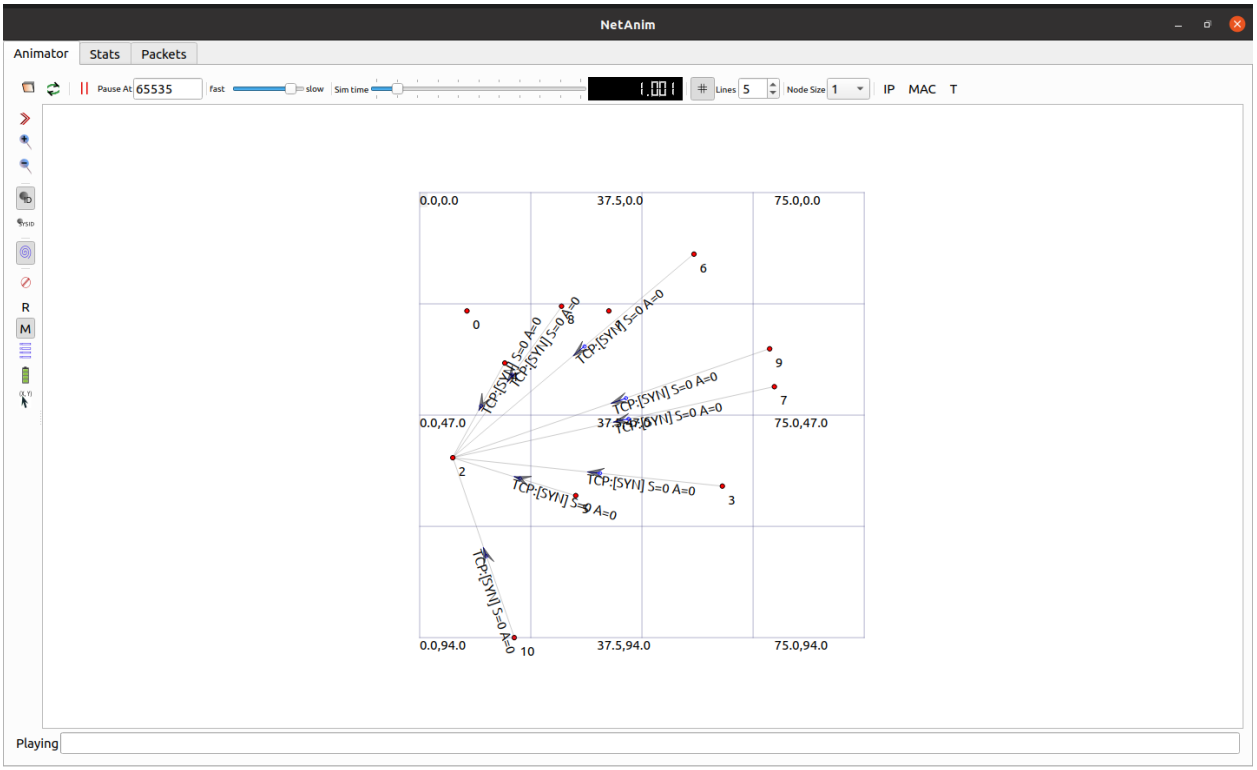
```
// Network topology (default)
//
//        n2 n3 n4              .
//         \ | /                .
//          \|/                 .
//     n1--- n0---n5            .
//          /|\                 .
//         / | \                .
//        n8 n7 n6              .
//


using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("Star");

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

  //
  // Set up some default values for the simulation.
  //
  Config::SetDefault ("ns3::OnOffApplication::PacketSize", UintegerValue (137));

  // ??? try and stick 15kb/s into the data rate
```

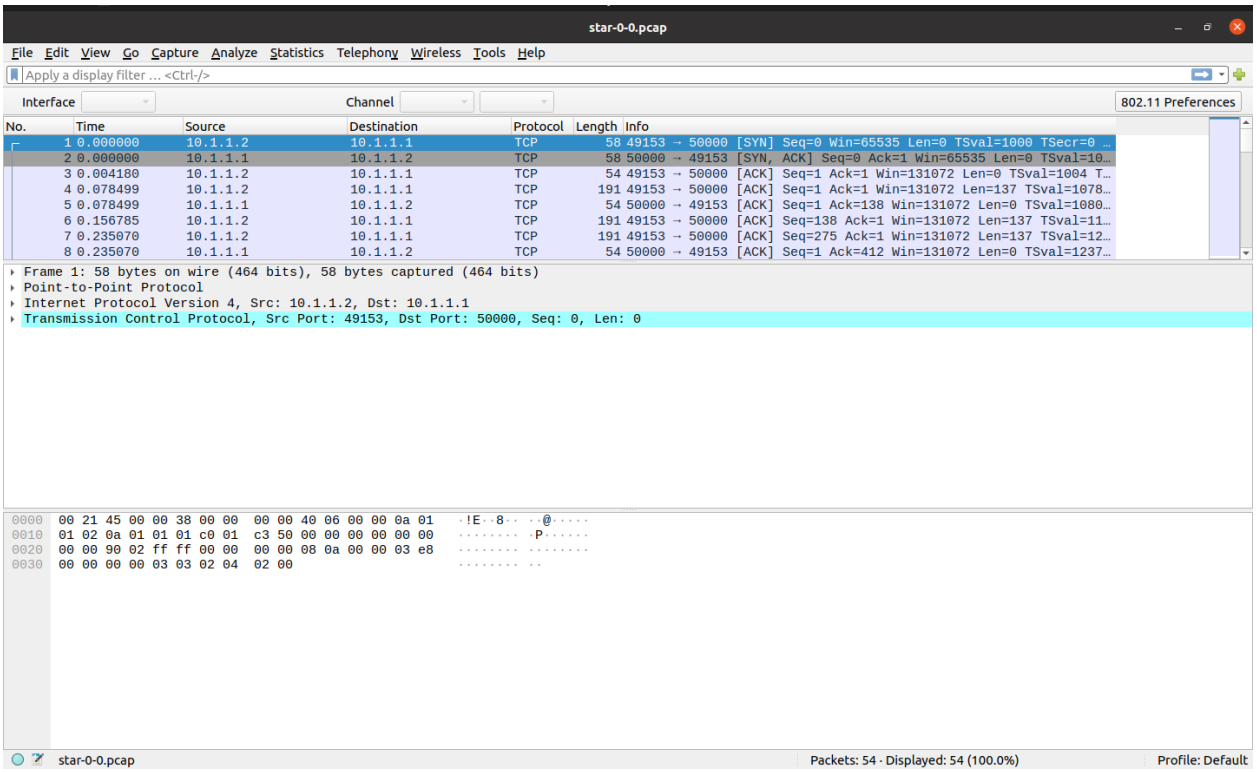
```
Config::SetDefault ("ns3::OnOffApplication::DataRate", StringValue ("14kb/s"));

//
// Default number of nodes in the star.  Overridable by command line argument.
//
uint32_t nSpokes = 8;

CommandLine cmd;
cmd.AddValue ("nSpokes", "Number of nodes to place in the star", nSpokes);
cmd.Parse (argc, argv);

NS_LOG_INFO ("Build star topology.");
PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));
PointToPointStarHelper star (nSpokes, pointToPoint);

NS_LOG_INFO ("Install internet stack on all nodes.");
InternetStackHelper internet;
star.InstallStack (internet);

NS_LOG_INFO ("Assign IP Addresses.");
star.AssignIpv4Addresses (Ipv4AddressHelper ("10.1.1.0", "255.255.255.0"));

NS_LOG_INFO ("Create applications.");
//
// Create a packet sink on the star "hub" to receive packets.
```

```
  //
  uint16_t port = 50000;
  Address hubLocalAddress (InetSocketAddress (Ipv4Address::GetAny (), port));
  PacketSinkHelper packetSinkHelper ("ns3::TcpSocketFactory", hubLocalAddress);
  ApplicationContainer hubApp = packetSinkHelper.Install (star.GetHub ());
  hubApp.Start (Seconds (1.0));
  hubApp.Stop (Seconds (10.0));


  //
  // Create OnOff applications to send TCP to the hub, one on each spoke node.
  //
  OnOffHelper onOffHelper ("ns3::TcpSocketFactory", Address ());
  onOffHelper.SetAttribute ("OnTime", StringValue
("ns3::ConstantRandomVariable[Constant=1]"));
  onOffHelper.SetAttribute ("OffTime", StringValue
("ns3::ConstantRandomVariable[Constant=0]"));


  ApplicationContainer spokeApps;


  for (uint32_t i = 0; i < star.SpokeCount (); ++i)
    {
      AddressValue remoteAddress (InetSocketAddress (star.GetHubIpv4Address (i),
port));
      onOffHelper.SetAttribute ("Remote", remoteAddress);
      spokeApps.Add (onOffHelper.Install (star.GetSpokeNode (i)));
    }
  spokeApps.Start (Seconds (1.0));
  spokeApps.Stop (Seconds (10.0));
```

```
  NS_LOG_INFO ("Enable static global routing.");
  //
  // Turn on global static routing so we can actually be routed across the star.
  //
  Ipv4GlobalRoutingHelper::PopulateRoutingTables ();

  NS_LOG_INFO ("Enable pcap tracing.");
  //
  // Do pcap tracing on all point-to-point devices on all nodes.
  //
  pointToPoint.EnablePcapAll ("star");

  NS_LOG_INFO ("Run Simulation.");
  Simulator::Run ();
  Simulator::Destroy ();
  NS_LOG_INFO ("Done.");

  return 0;
}
```


python
0
20
40
60
80
Zoom: 2.692
Speed: 1.000
Time: 1.500000 s
Snapshot
Simulate (F3)
Advanced


NetAnim
Animator
Stats
Packets
Pause At: 65535
fast
slow
Sim time
Lines: 5
Node Size: 1
IP
MAC
T
0.0,0.0
37.5,0.0
75.0,0.0
0.0,47.0
37.5,47.0
75.0,47.0
0.0,94.0
37.5,94.0
75.0,94.0
TCP:[SYN] S=0 A=0
Playing


star-0-0.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter … <Ctrl-/>
Interface
Channel
802.11 Preferences
No. Time Source Destination Protocol Length Info
1 0.000000 10.1.1.2 10.1.1.1 TCP 58 49153 → 50000 [SYN] Seq=0 Win=65535 Len=0 TSval=1000 TSecr=0 …
2 0.000000 10.1.1.1 10.1.1.2 TCP 58 50000 → 49153 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 TSval=10…
3 0.004180 10.1.1.2 10.1.1.1 TCP 54 49153 → 50000 [ACK] Seq=1 Ack=1 Win=131072 Len=0 TSval=1004 T…
4 0.078499 10.1.1.2 10.1.1.1 TCP 191 49153 → 50000 [ACK] Seq=1 Ack=1 Win=131072 Len=137 TSval=1078…
5 0.078499 10.1.1.1 10.1.1.2 TCP 54 50000 → 49153 [ACK] Seq=1 Ack=138 Win=131072 Len=0 TSval=1080…
6 0.156785 10.1.1.2 10.1.1.1 TCP 191 49153 → 50000 [ACK] Seq=138 Ack=1 Win=131072 Len=137 TSval=11…
7 0.235070 10.1.1.2 10.1.1.1 TCP 191 49153 → 50000 [ACK] Seq=275 Ack=1 Win=131072 Len=137 TSval=12…
8 0.235070 10.1.1.1 10.1.1.2 TCP 54 50000 → 49153 [ACK] Seq=1 Ack=412 Win=131072 Len=0 TSval=1237…
Frame 1: 58 bytes on wire (464 bits), 58 bytes captured (464 bits)
Point-to-Point Protocol
Internet Protocol Version 4, Src: 10.1.1.2, Dst: 10.1.1.1
Transmission Control Protocol, Src Port: 49153, Dst Port: 50000, Seq: 0, Len: 0
0000 00 21 45 00 00 38 00 00 00 00 40 06 00 00 0a 01 .!E..8.. ..@.....
0010 01 02 0a 01 01 01 c0 01 c3 50 00 00 00 00 00 00 .... .P......
0020 00 00 90 02 ff ff 00 00 00 00 08 0a 00 00 03 e8 ....
0030 00 00 00 00 03 03 02 04 02 00 ....
star-0-0.pcap
Packets: 54 · Displayed: 54 (100.0%)
Profile: Default

Practical 6: Bus Topology

Code:

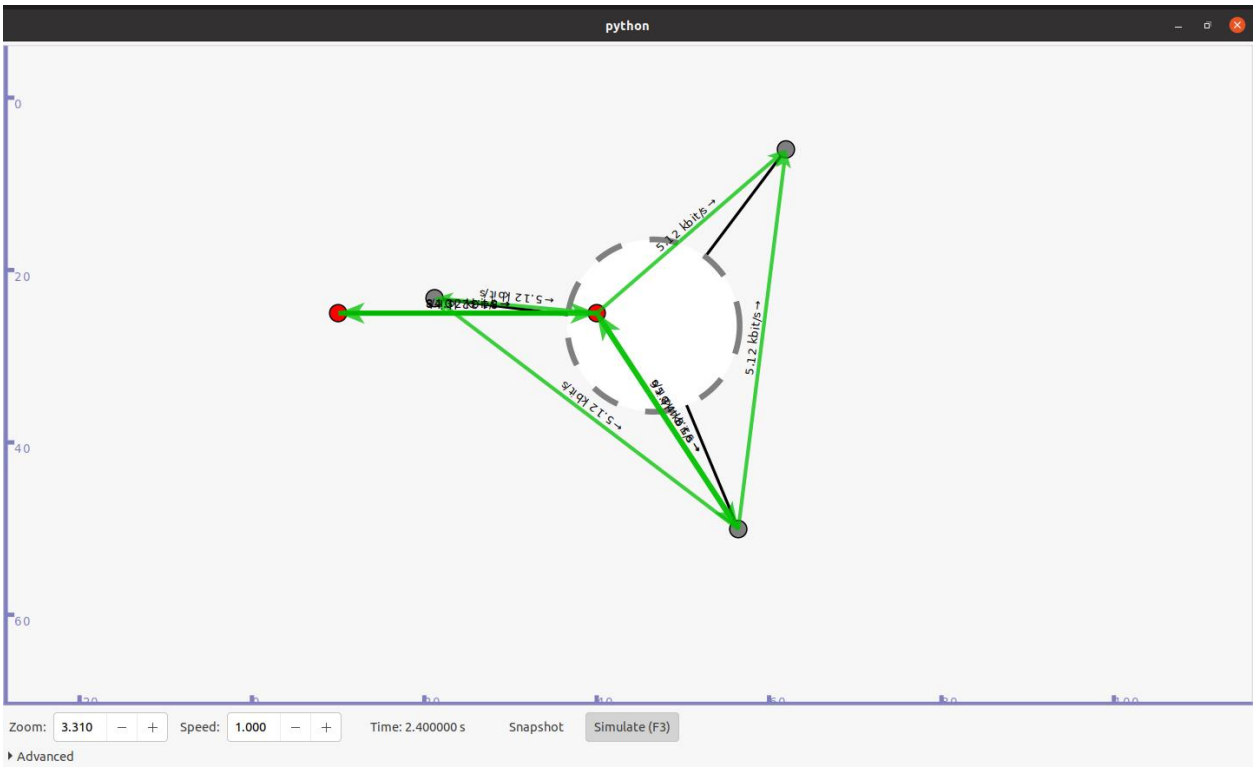
```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
 * This program is free software; you can redistribute it and/or modify
 * it under the terms of the GNU General Public License version 2 as
 * published by the Free Software Foundation;
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 */

#include "ns3/core-module.h"
#include "ns3/network-module.h"
#include "ns3/csma-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/applications-module.h"
#include "ns3/ipv4-global-routing-helper.h"
//netanimation
#include "ns3/netanim-module.h"
```

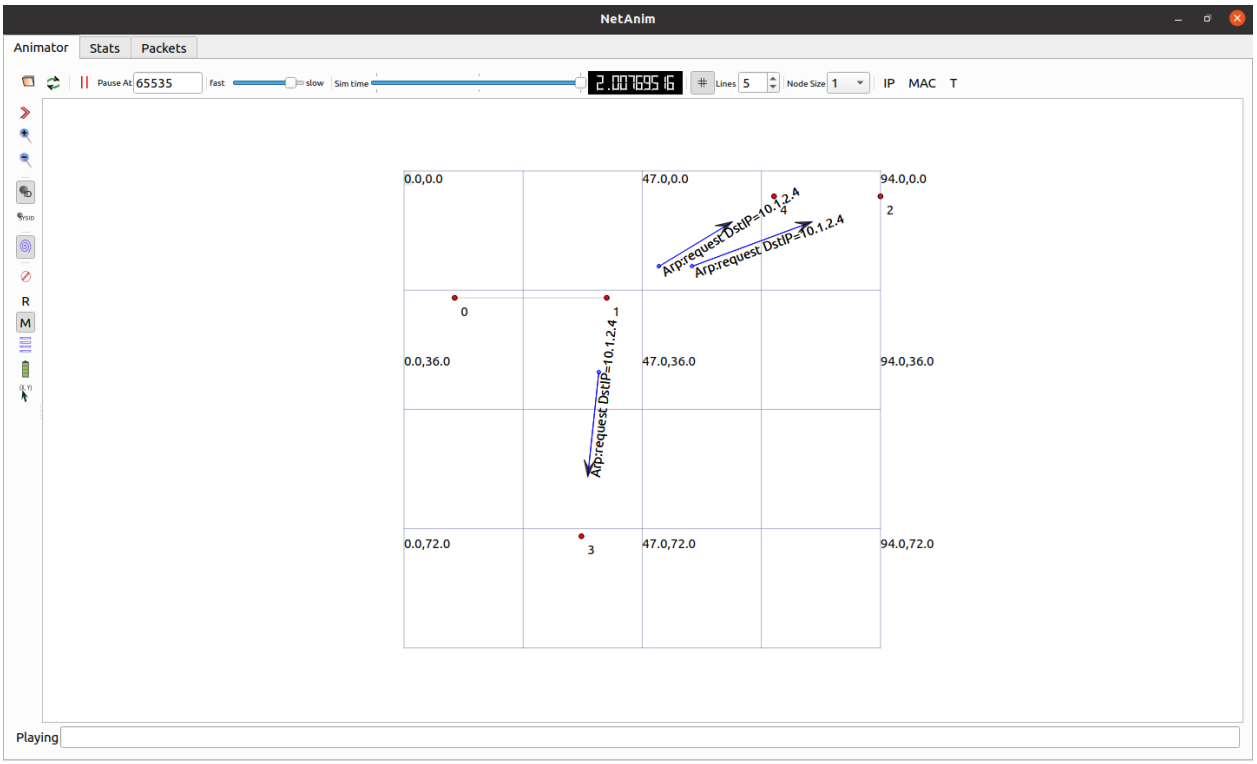
```
#include "ns3/mobility-module.h"

// Default Network Topology
//
//       10.1.1.0
// n0 ---------- n1   n2   n3   n4
//    point-to-point |    |    |    |
//                   ================
//                     LAN 10.1.2.0


using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("SecondScriptExample");

int
main (int argc, char *argv[])
{
  bool verbose = true;
  uint32_t nCsma = 3;

  CommandLine cmd (__FILE__);
  cmd.AddValue ("nCsma", "Number of \"extra\" CSMA nodes/devices", nCsma);
  cmd.AddValue ("verbose", "Tell echo applications to log if true", verbose);

  cmd.Parse (argc,argv);
```

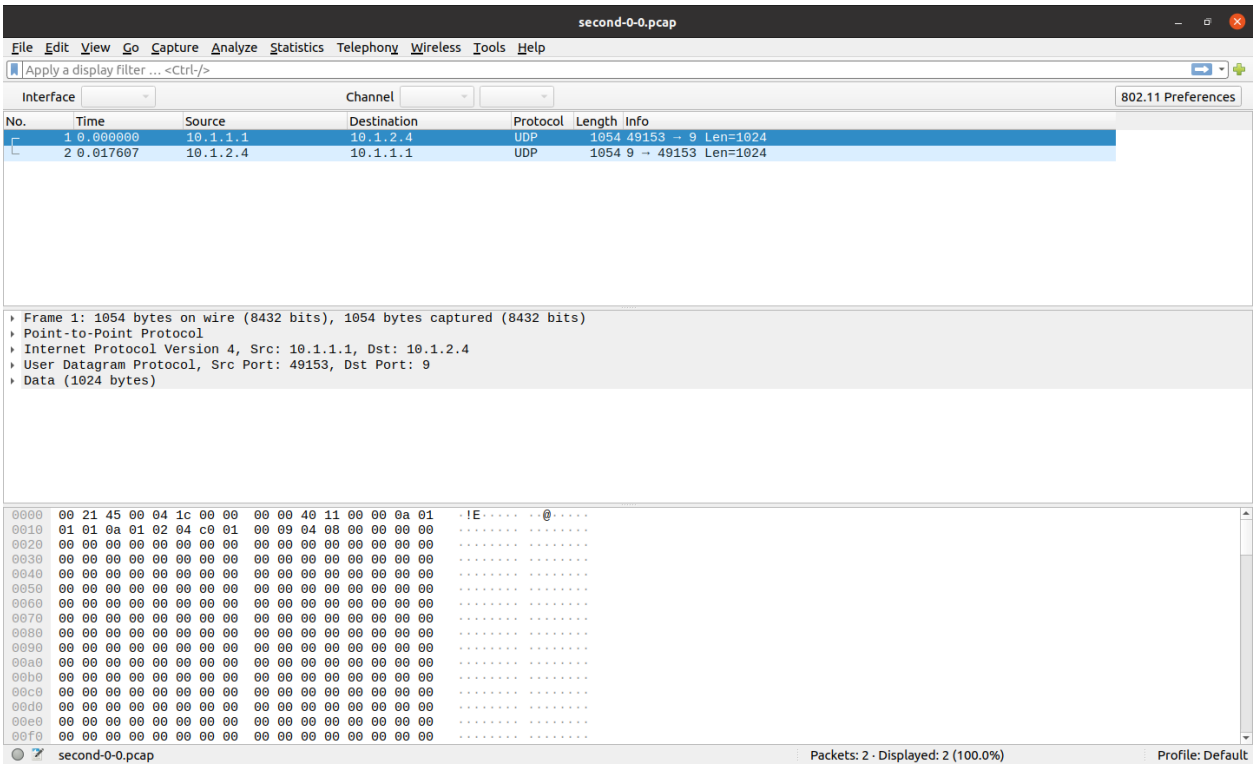
```
if (verbose)
  {
    LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);
    LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_INFO);
  }

nCsma = nCsma == 0 ? 1 : nCsma;

NodeContainer nodes;
nodes.Create (2);

NodeContainer csmaNodes;
csmaNodes.Add (nodes.Get (1));
csmaNodes.Create (nCsma);

PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));

NetDeviceContainer p2pDevices;
p2pDevices = pointToPoint.Install (nodes);

CsmaHelper csma;
csma.SetChannelAttribute ("DataRate", StringValue ("100Mbps"));
csma.SetChannelAttribute ("Delay", TimeValue (NanoSeconds (6560)));

NetDeviceContainer csmaDevices;
```

```
csmaDevices = csma.Install (csmaNodes);

InternetStackHelper stack;
stack.Install (nodes.Get (0));
stack.Install (csmaNodes);

Ipv4AddressHelper address;
address.SetBase ("10.1.1.0", "255.255.255.0");
Ipv4InterfaceContainer p2pInterfaces;
p2pInterfaces = address.Assign (p2pDevices);

address.SetBase ("10.1.2.0", "255.255.255.0");
Ipv4InterfaceContainer csmaInterfaces;
csmaInterfaces = address.Assign (csmaDevices);

UdpEchoServerHelper echoServer (9);

ApplicationContainer serverApps = echoServer.Install (csmaNodes.Get (nCsma));
serverApps.Start (Seconds (1.0));
serverApps.Stop (Seconds (10.0));

UdpEchoClientHelper echoClient (csmaInterfaces.GetAddress (nCsma), 9);
echoClient.SetAttribute ("MaxPackets", UintegerValue (1));
echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
echoClient.SetAttribute ("PacketSize", UintegerValue (1024));

ApplicationContainer clientApps = echoClient.Install (nodes.Get (0));
```

```
  clientApps.Start (Seconds (2.0));
  clientApps.Stop (Seconds (10.0));

  Ipv4GlobalRoutingHelper::PopulateRoutingTables ();

  MobilityHelper mobility;
  mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
  mobility.Install(nodes);

  AnimationInterface anim("second.xml");
  AnimationInterface::SetConstantPosition(nodes.Get(0),10,25);
  AnimationInterface::SetConstantPosition(nodes.Get(1),40,25);
  anim.EnablePacketMetadata(true);
  pointToPoint.EnablePcapAll ("second");
  csma.EnablePcap ("second", csmaDevices.Get (1), true);
  Simulator::Run ();
  Simulator::Destroy ();
  return 0;
}
```


python
0
20
40
60
5.12 kbit/s
5.12 kbit/s
5.12 kbit/s
5.12 kbit/s
Zoom: 3.310
Speed: 1.000
Time: 2.400000 s
Snapshot
Simulate (F3)
Advanced


NetAnim
Animator
Stats
Packets
Pause At 65535
fast
slow
Sim time
2.007695 s
Lines 5
Node Size 1
IP
MAC
T
0.0,0.0
47.0,0.0
94.0,0.0
0.0,36.0
47.0,36.0
94.0,36.0
0.0,72.0
47.0,72.0
94.0,72.0
0
1
2
3
Arp:request DstIP=10.1.2.4
Arp:request DstIP=10.1.2.4
Arp:request DstIP=10.1.2.4
Playing



Practical 7: Mesh

Code:

```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
 * Copyright (c) 2008,2009 IITP RAS
 *
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 * it under the terms of the GNU General Public License version 2 as
 * published by the Free Software Foundation;
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 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 *
 * Author: Kirill Andreev <andreev@iitp.ru>
 *
 *
 * By default this script creates m_xSize * m_ySize square grid topology with
 * IEEE802.11s stack installed at each node with peering management
 * and HWMP protocol.
 * The side of the square cell is defined by m_step parameter.
 * When topology is created, UDP ping is installed to opposite corners
 * by diagonals. packet size of the UDP ping and interval between two
```

```
 * successive packets is configurable.
 *
 *  m_xSize * step
 *  |<--------->|
 *   step
 *  |<--->|
 *  * --- * --- * <---Ping sink  _
 *  | \   |   / |              ^
 *  |   \ | /   |              |
 *  * --- * --- * m_ySize * step |
 *  |   / | \   |              |
 *  | /   |   \ |              |
 *  * --- * --- *              _
 *  ^ Ping source
 *
 *  See also MeshTest::Configure to read more about configurable
 *  parameters.
 */

#include <iostream>
#include <sstream>
#include <fstream>
#include "ns3/core-module.h"
#include "ns3/internet-module.h"
#include "ns3/network-module.h"
#include "ns3/applications-module.h"
#include "ns3/mesh-module.h"
```

```
#include "ns3/mobility-module.h"
#include "ns3/mesh-helper.h"
#include "ns3/yans-wifi-helper.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("TestMeshScript");

/**
 * \ingroup mesh
 * \brief MeshTest class
 */
class MeshTest
{
public:
  /// Init test
  MeshTest ();
  /**
   * Configure test from command line arguments
   *
   * \param argc command line argument count
   * \param argv command line arguments
   */
  void Configure (int argc, char ** argv);
  /**
   * Run test
   * \returns the test status
```

```
   */
  int Run ();
private:
  int       m_xSize; ///< X size
  int       m_ySize; ///< Y size
  double    m_step; ///< step
  double    m_randomStart; ///< random start
  double    m_totalTime; ///< total time
  double    m_packetInterval; ///< packet interval
  uint16_t  m_packetSize; ///< packet size
  uint32_t  m_nIfaces; ///< number interfaces
  bool      m_chan; ///< channel
  bool      m_pcap; ///< PCAP
  bool      m_ascii; ///< ASCII
  std::string m_stack; ///< stack
  std::string m_root; ///< root
  /// List of network nodes
  NodeContainer nodes;
  /// List of all mesh point devices
  NetDeviceContainer meshDevices;
  /// Addresses of interfaces:
  Ipv4InterfaceContainer interfaces;
  /// MeshHelper. Report is not static methods
  MeshHelper mesh;
private:
  /// Create nodes and setup their mobility
  void CreateNodes ();
```

```
  /// Install internet m_stack on nodes
  void InstallInternetStack ();
  /// Install applications
  void InstallApplication ();
  /// Print mesh devices diagnostics
  void Report ();
};
MeshTest::MeshTest () :
  m_xSize (3),
  m_ySize (3),
  m_step (100.0),
  m_randomStart (0.1),
  m_totalTime (100.0),
  m_packetInterval (0.1),
  m_packetSize (1024),
  m_nIfaces (1),
  m_chan (true),
  m_pcap (false),
  m_ascii (false),
  m_stack ("ns3::Dot11sStack"),
  m_root ("ff:ff:ff:ff:ff:ff")
{
}
void
MeshTest::Configure (int argc, char *argv[])
{
  CommandLine cmd (__FILE__);
```

```
  cmd.AddValue ("x-size", "Number of nodes in a row grid", m_xSize);
  cmd.AddValue ("y-size", "Number of rows in a grid", m_ySize);
  cmd.AddValue ("step",   "Size of edge in our grid (meters)", m_step);
  // Avoid starting all mesh nodes at the same time (beacons may collide)
  cmd.AddValue ("start",  "Maximum random start delay for beacon jitter (sec)",
m_randomStart);
  cmd.AddValue ("time",  "Simulation time (sec)", m_totalTime);
  cmd.AddValue ("packet-interval",  "Interval between packets in UDP ping (sec)",
m_packetInterval);
  cmd.AddValue ("packet-size",  "Size of packets in UDP ping (bytes)", m_packetSize);
  cmd.AddValue ("interfaces", "Number of radio interfaces used by each mesh point",
m_nIfaces);
  cmd.AddValue ("channels",   "Use different frequency channels for different
interfaces", m_chan);
  cmd.AddValue ("pcap",   "Enable PCAP traces on interfaces", m_pcap);
  cmd.AddValue ("ascii",   "Enable Ascii traces on interfaces", m_ascii);
  cmd.AddValue ("stack",  "Type of protocol stack. ns3::Dot11sStack by default",
m_stack);
  cmd.AddValue ("root", "Mac address of root mesh point in HWMP", m_root);


  cmd.Parse (argc, argv);
  NS_LOG_DEBUG ("Grid:" << m_xSize << "*" << m_ySize);
  NS_LOG_DEBUG ("Simulation time: " << m_totalTime << " s");
  if (m_ascii)
    {
      PacketMetadata::Enable ();
    }
}
void
```

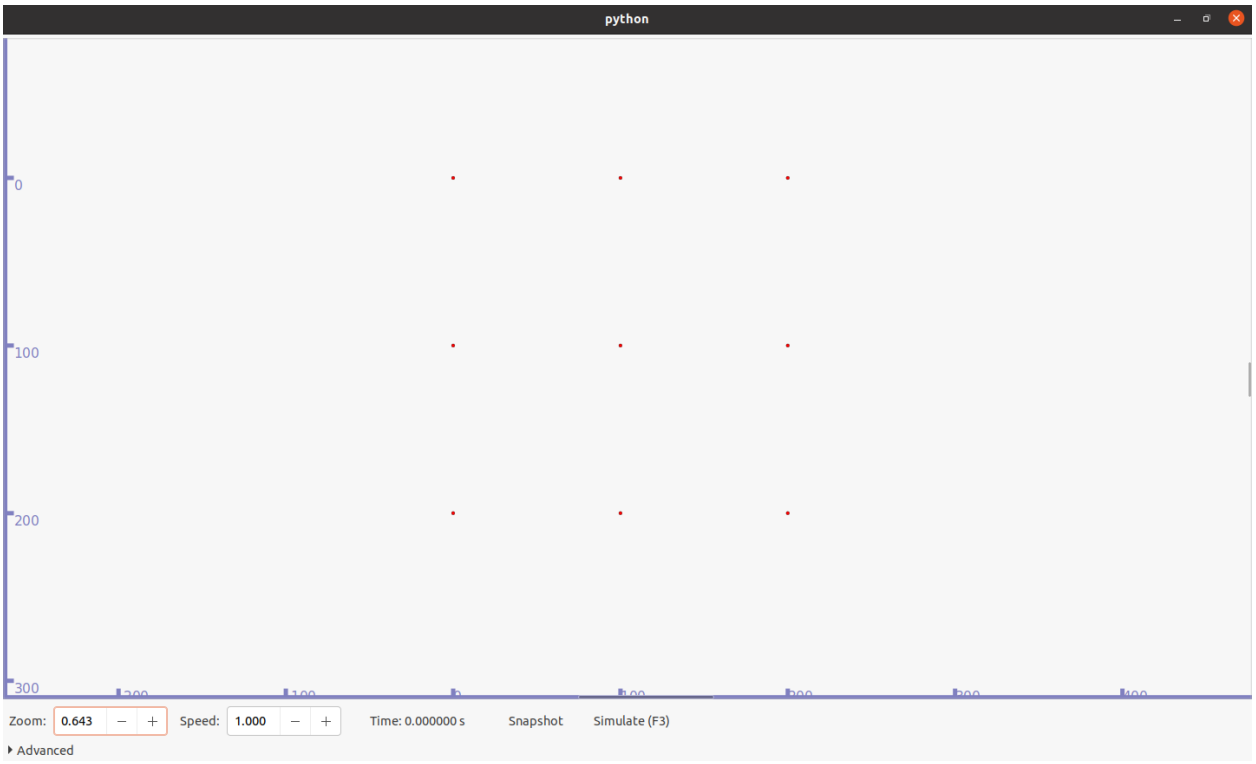
```
MeshTest::CreateNodes ()
{
  /*
   * Create m_ySize*m_xSize stations to form a grid topology
   */
  nodes.Create (m_ySize*m_xSize);
  // Configure YansWifiChannel
  YansWifiPhyHelper wifiPhy;
  YansWifiChannelHelper wifiChannel = YansWifiChannelHelper::Default ();
  wifiPhy.SetChannel (wifiChannel.Create ());
  /*
   * Create mesh helper and set stack installer to it
   * Stack installer creates all needed protocols and install them to
   * mesh point device
   */
  mesh = MeshHelper::Default ();
  if (!Mac48Address (m_root.c_str ()).IsBroadcast ())
    {
      mesh.SetStackInstaller (m_stack, "Root", Mac48AddressValue (Mac48Address
(m_root.c_str ())));
    }
  else
    {
      //If root is not set, we do not use "Root" attribute, because it
      //is specified only for 11s
      mesh.SetStackInstaller (m_stack);
    }
```

```
if (m_chan)
  {
    mesh.SetSpreadInterfaceChannels (MeshHelper::SPREAD_CHANNELS);
  }
else
  {
    mesh.SetSpreadInterfaceChannels (MeshHelper::ZERO_CHANNEL);
  }
mesh.SetMacType ("RandomStart", TimeValue (Seconds (m_randomStart)));
// Set number of interfaces - default is single-interface mesh point
mesh.SetNumberOfInterfaces (m_nIfaces);
// Install protocols and return container if MeshPointDevices
meshDevices = mesh.Install (wifiPhy, nodes);
// Setup mobility - static grid topology
MobilityHelper mobility;
mobility.SetPositionAllocator ("ns3::GridPositionAllocator",
                               "MinX", DoubleValue (0.0),
                               "MinY", DoubleValue (0.0),
                               "DeltaX", DoubleValue (m_step),
                               "DeltaY", DoubleValue (m_step),
                               "GridWidth", UintegerValue (m_xSize),
                               "LayoutType", StringValue ("RowFirst"));
mobility.SetMobilityModel ("ns3::ConstantPositionMobilityModel");
mobility.Install (nodes);
if (m_pcap)
  wifiPhy.EnablePcapAll (std::string ("mp-"));
if (m_ascii)
```

```
  {
    AsciiTraceHelper ascii;
    wifiPhy.EnableAsciiAll (ascii.CreateFileStream ("mesh.tr"));
  }
}
void
MeshTest::InstallInternetStack ()
{
 InternetStackHelper internetStack;
 internetStack.Install (nodes);
 Ipv4AddressHelper address;
 address.SetBase ("10.1.1.0", "255.255.255.0");
 interfaces = address.Assign (meshDevices);
}
void
MeshTest::InstallApplication ()
{
 UdpEchoServerHelper echoServer (9);
 ApplicationContainer serverApps = echoServer.Install (nodes.Get (0));
 serverApps.Start (Seconds (0.0));
 serverApps.Stop (Seconds (m_totalTime));
 UdpEchoClientHelper echoClient (interfaces.GetAddress (0), 9);
 echoClient.SetAttribute ("MaxPackets", UintegerValue
((uint32_t)(m_totalTime*(1/m_packetInterval))));
 echoClient.SetAttribute ("Interval", TimeValue (Seconds (m_packetInterval)));
 echoClient.SetAttribute ("PacketSize", UintegerValue (m_packetSize));
 ApplicationContainer clientApps = echoClient.Install (nodes.Get (m_xSize*m_ySize-
1));
```

```
  clientApps.Start (Seconds (0.0));
  clientApps.Stop (Seconds (m_totalTime));
}
int
MeshTest::Run ()
{
  CreateNodes ();
  InstallInternetStack ();
  InstallApplication ();
  Simulator::Schedule (Seconds (m_totalTime), &MeshTest::Report, this);
  Simulator::Stop (Seconds (m_totalTime));
  Simulator::Run ();
  Simulator::Destroy ();
  return 0;
}
void
MeshTest::Report ()
{
  unsigned n (0);
  for (NetDeviceContainer::Iterator i = meshDevices.Begin (); i != meshDevices.End ();
++i, ++n)
    {
      std::ostringstream os;
      os << "mp-report-" << n << ".xml";
      std::cerr << "Printing mesh point device #" << n << " diagnostics to " << os.str () <<
"\n";
      std::ofstream of;
      of.open (os.str ().c_str ());
```

```
    if (!of.is_open ())
      {
        std::cerr << "Error: Can't open file " << os.str () << "\n";
        return;
      }
    mesh.Report (*i, of);
    of.close ();
  }
}
int
main (int argc, char *argv[])
{
 MeshTest t;
 t.Configure (argc, argv);
 return t.Run ();
}
```


python
0
100
200
300
Zoom: 0.643
Speed: 1.000
Time: 0.000000 s
Snapshot
Simulate (F3)
Advanced

Practical 8: Hybrid

Code:

```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
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 * it under the terms of the GNU General Public License version 2 as
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 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 */

#include <fstream>
#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"
//netanimation
#include "ns3/netanim-module.h"
#include "ns3/mobility-module.h"
```

```
using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("FifthScriptExample");

//
============================================================
============
//
//        node 0                node 1
//   +----------------+    +----------------+
//   |    ns-3 TCP    |    |    ns-3 TCP    |
//   +----------------+    +----------------+
//   |    10.1.1.1    |    |    10.1.1.2    |
//   +----------------+    +----------------+
//   | point-to-point |    | point-to-point |
//   +----------------+    +----------------+
//           |                      |
//           +----------------------+
//                5 Mbps, 2 ms
//
//
// We want to look at changes in the ns-3 TCP congestion window.  We need
// to crank up a flow and hook the CongestionWindow attribute on the socket
// of the sender.  Normally one would use an on-off application to generate a
// flow, but this has a couple of problems.  First, the socket of the on-off
// application is not created until Application Start time, so we wouldn't be
// able to hook the socket (now) at configuration time.  Second, even if we
```

```
// could arrange a call after start time, the socket is not public so we
// couldn't get at it.
//
// So, we can cook up a simple version of the on-off application that does what
// we want.  On the plus side we don't need all of the complexity of the on-off
// application.  On the minus side, we don't have a helper, so we have to get
// a little more involved in the details, but this is trivial.
//
// So first, we create a socket and do the trace connect on it; then we pass
// this socket into the constructor of our simple application which we then
// install in the source node.
//
// ============================================================================
//
class MyApp : public Application
{
public:

  MyApp ();
  virtual ~MyApp();

  void Setup (Ptr<Socket> socket, Address address, uint32_t packetSize, uint32_t
nPackets, DataRate dataRate);

private:
  virtual void StartApplication (void);
  virtual void StopApplication (void);
```

```
  void ScheduleTx (void);
  void SendPacket (void);

  Ptr<Socket>     m_socket;
  Address         m_peer;
  uint32_t        m_packetSize;
  uint32_t        m_nPackets;
  DataRate        m_dataRate;
  EventId         m_sendEvent;
  bool            m_running;
  uint32_t        m_packetsSent;
};

MyApp::MyApp ()
  : m_socket (0),
    m_peer (),
    m_packetSize (0),
    m_nPackets (0),
    m_dataRate (0),
    m_sendEvent (),
    m_running (false),
    m_packetsSent (0)
{
}

MyApp::~MyApp()
```

```
{
  m_socket = 0;
}

void
MyApp::Setup (Ptr<Socket> socket, Address address, uint32_t packetSize, uint32_t
nPackets, DataRate dataRate)
{
  m_socket = socket;
  m_peer = address;
  m_packetSize = packetSize;
  m_nPackets = nPackets;
  m_dataRate = dataRate;
}

void
MyApp::StartApplication (void)
{
  m_running = true;
  m_packetsSent = 0;
  m_socket->Bind ();
  m_socket->Connect (m_peer);
  SendPacket ();
}

void
MyApp::StopApplication (void)
```

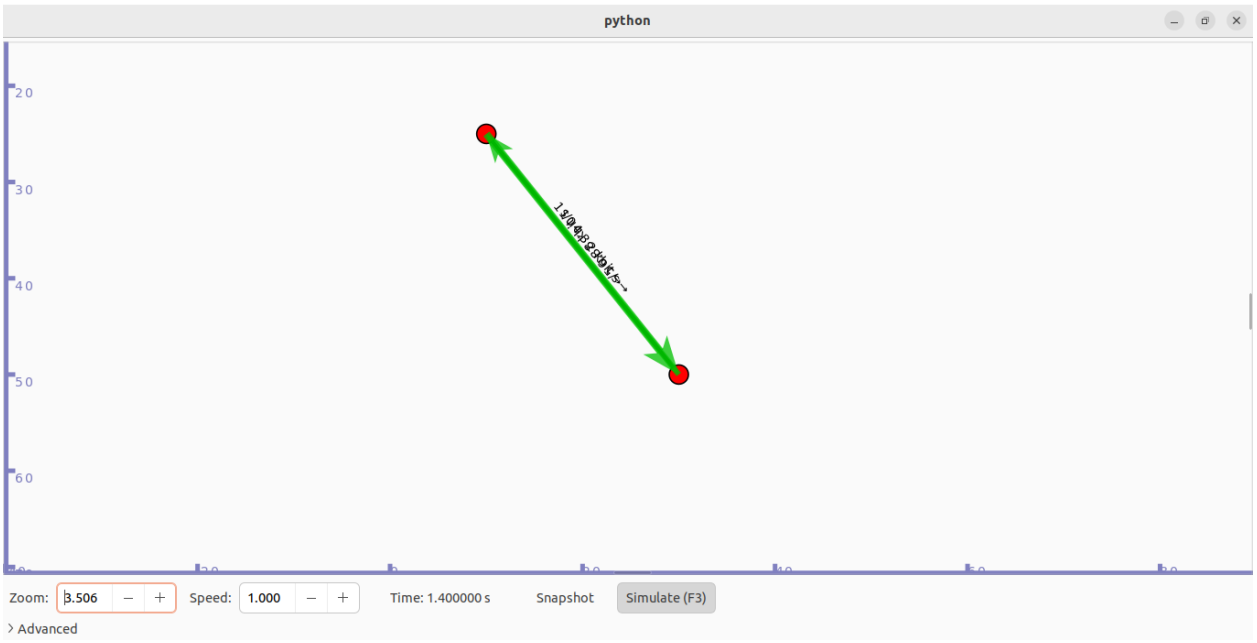
```
{
  m_running = false;

  if (m_sendEvent.IsRunning ())
    {
      Simulator::Cancel (m_sendEvent);
    }

  if (m_socket)
    {
      m_socket->Close ();
    }
}

void
MyApp::SendPacket (void)
{
  Ptr<Packet> packet = Create<Packet> (m_packetSize);
  m_socket->Send (packet);

  if (++m_packetsSent < m_nPackets)
    {
      ScheduleTx ();
    }
}

void
```

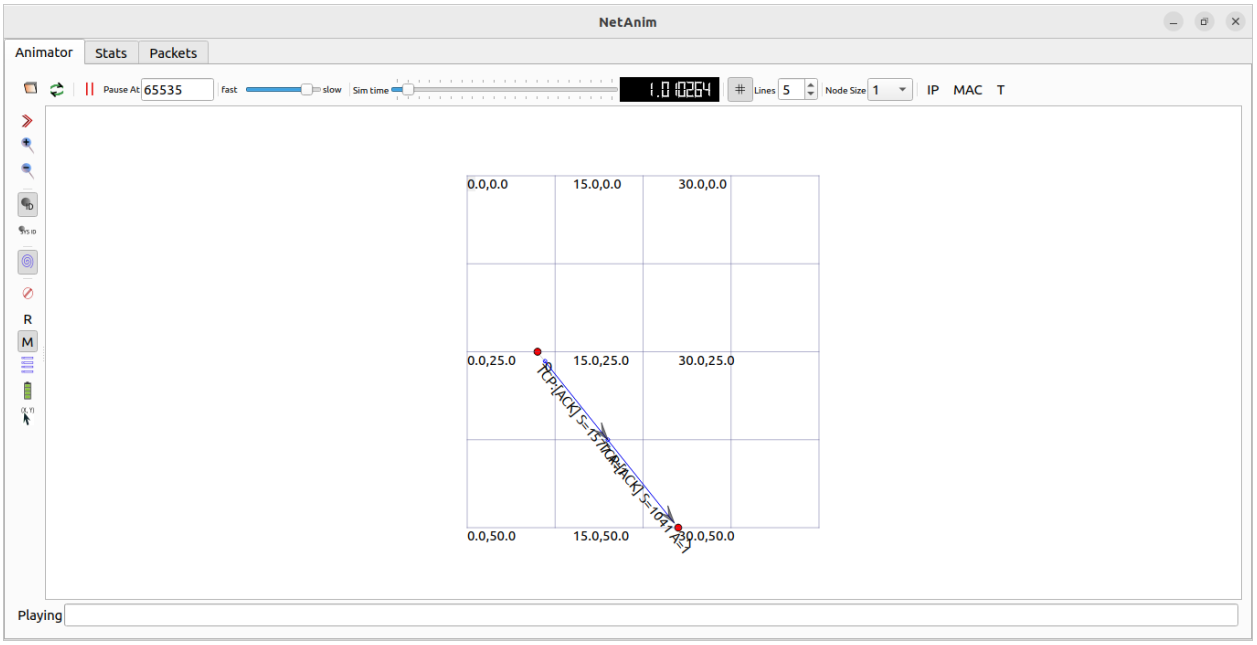
```
MyApp::ScheduleTx (void)
{
  if (m_running)
    {
      Time tNext (Seconds (m_packetSize * 8 / static_cast<double>
(m_dataRate.GetBitRate ())));
      m_sendEvent = Simulator::Schedule (tNext, &MyApp::SendPacket, this);
    }
}

static void
CwndChange (uint32_t oldCwnd, uint32_t newCwnd)
{
  NS_LOG_UNCOND (Simulator::Now ().GetSeconds () << "\t" << newCwnd);
}

static void
RxDrop (Ptr<const Packet> p)
{
  NS_LOG_UNCOND ("RxDrop at " << Simulator::Now ().GetSeconds ());
}

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

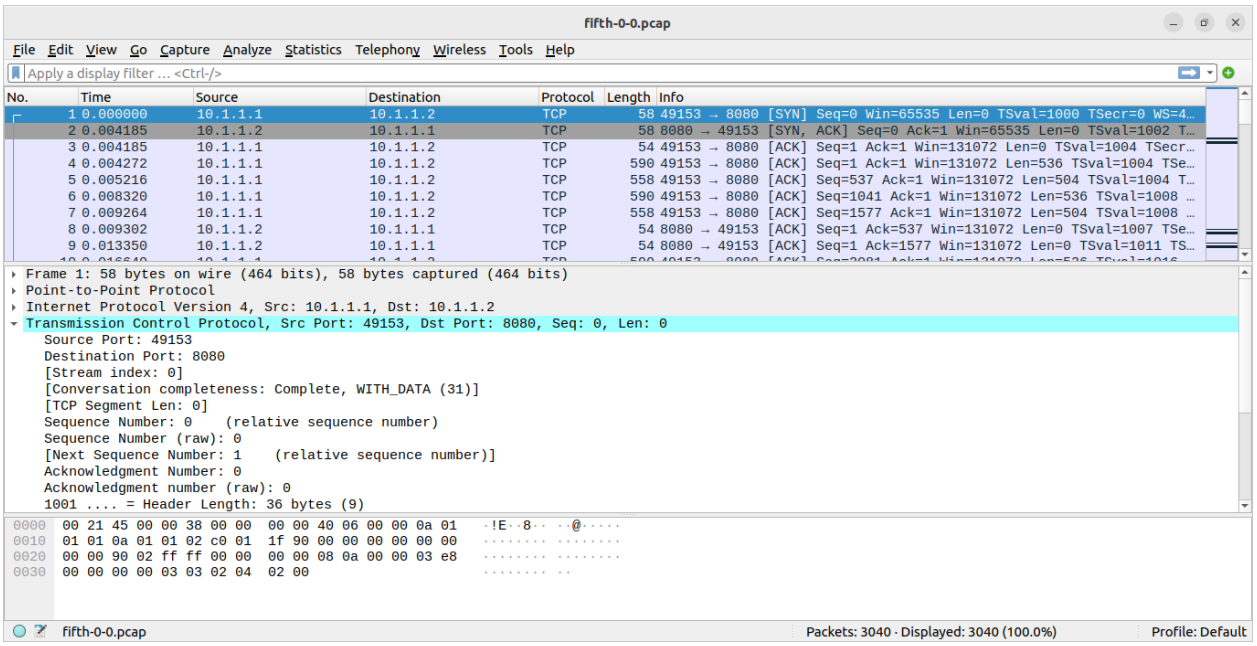
```
NodeContainer nodes;
nodes.Create (2);

PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));

NetDeviceContainer devices;
devices = pointToPoint.Install (nodes);

Ptr<RateErrorModel> em = CreateObject<RateErrorModel> ();
em->SetAttribute ("ErrorRate", DoubleValue (0.00001));
devices.Get (1)->SetAttribute ("ReceiveErrorModel", PointerValue (em));

InternetStackHelper stack;
stack.Install (nodes);

Ipv4AddressHelper address;
address.SetBase ("10.1.1.0", "255.255.255.252");
Ipv4InterfaceContainer interfaces = address.Assign (devices);

uint16_t sinkPort = 8080;
Address sinkAddress (InetSocketAddress (interfaces.GetAddress (1), sinkPort));
PacketSinkHelper packetSinkHelper ("ns3::TcpSocketFactory", InetSocketAddress
(Ipv4Address::GetAny (), sinkPort));
ApplicationContainer sinkApps = packetSinkHelper.Install (nodes.Get (1));
```

```
  sinkApps.Start (Seconds (0.));
  sinkApps.Stop (Seconds (20.));

  Ptr<Socket> ns3TcpSocket = Socket::CreateSocket (nodes.Get (0),
TcpSocketFactory::GetTypeId ());
  ns3TcpSocket->TraceConnectWithoutContext ("CongestionWindow", MakeCallback
(&CwndChange));

  Ptr<MyApp> app = CreateObject<MyApp> ();
  app->Setup (ns3TcpSocket, sinkAddress, 1040, 1000, DataRate ("1Mbps"));
  nodes.Get (0)->AddApplication (app);
  app->SetStartTime (Seconds (1.));
  app->SetStopTime (Seconds (20.));

  devices.Get (1)->TraceConnectWithoutContext ("PhyRxDrop", MakeCallback
(&RxDrop));


  MobilityHelper mobility;
  mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
  mobility.Install(nodes);

  AnimationInterface anim("fifth.xml");
  AnimationInterface::SetConstantPosition(nodes.Get(0),10,25);
  AnimationInterface::SetConstantPosition(nodes.Get(1),30,50);
  anim.EnablePacketMetadata(true);

  pointToPoint.EnablePcapAll("fifth");
```

```
Simulator::Stop (Seconds (20));
Simulator::Run ();
Simulator::Destroy ();

return 0;
}
```






fifth-0-0.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
1 0.000000 10.1.1.1 10.1.1.2 TCP 58 49153 → 8080 [SYN] Seq=0 Win=65535 Len=0 TSval=1000 TSecr=0 WS=4…
2 0.004185 10.1.1.2 10.1.1.1 TCP 58 8080 → 49153 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 TSval=1002 T…
3 0.004185 10.1.1.1 10.1.1.2 TCP 54 49153 → 8080 [ACK] Seq=1 Ack=1 Win=131072 Len=0 TSval=1004 TSecr…
4 0.004272 10.1.1.1 10.1.1.2 TCP 590 49153 → 8080 [ACK] Seq=1 Ack=1 Win=131072 Len=536 TSval=1004 TSe…
5 0.005216 10.1.1.1 10.1.1.2 TCP 558 49153 → 8080 [ACK] Seq=537 Ack=1 Win=131072 Len=504 TSval=1004 T…
6 0.008320 10.1.1.1 10.1.1.2 TCP 590 49153 → 8080 [ACK] Seq=1041 Ack=1 Win=131072 Len=536 TSval=1008 …
7 0.009264 10.1.1.1 10.1.1.2 TCP 558 49153 → 8080 [ACK] Seq=1577 Ack=1 Win=131072 Len=504 TSval=1008 …
8 0.009302 10.1.1.2 10.1.1.1 TCP 54 8080 → 49153 [ACK] Seq=1 Ack=537 Win=131072 Len=0 TSval=1007 TSe…
9 0.013350 10.1.1.2 10.1.1.1 TCP 54 8080 → 49153 [ACK] Seq=1 Ack=1577 Win=131072 Len=0 TSval=1011 TS…
Frame 1: 58 bytes on wire (464 bits), 58 bytes captured (464 bits)
Point-to-Point Protocol
Internet Protocol Version 4, Src: 10.1.1.1, Dst: 10.1.1.2
Transmission Control Protocol, Src Port: 49153, Dst Port: 8080, Seq: 0, Len: 0
Source Port: 49153
Destination Port: 8080
[Stream index: 0]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 0
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 0
Acknowledgment number (raw): 0
1001 .... = Header Length: 36 bytes (9)
0000 00 21 45 00 00 38 00 00 00 00 40 06 00 00 0a 01 ·!E··8···· ··@·····
0010 01 01 0a 01 01 02 c0 01 1f 90 00 00 00 00 00 00 ···· ···· ····
0020 00 00 90 02 ff ff 00 00 00 00 08 0a 00 00 03 e8 ···· ···· ····
0030 00 00 00 00 03 03 02 04 02 00 ···· ···· ··
fifth-0-0.pcap
Packets: 3040 · Displayed: 3040 (100.0%)
Profile: Default

Practical 9: (UDP-server)

Code:

```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
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 * This program is distributed in the hope that it will be useful,
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 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 */

// Network topology
//
//       n0    n1   n2   n3
//       |    |    |    |
//       =================
//              LAN
//
// - UDP flows from n0 to n1 and back
// - DropTail queues
```
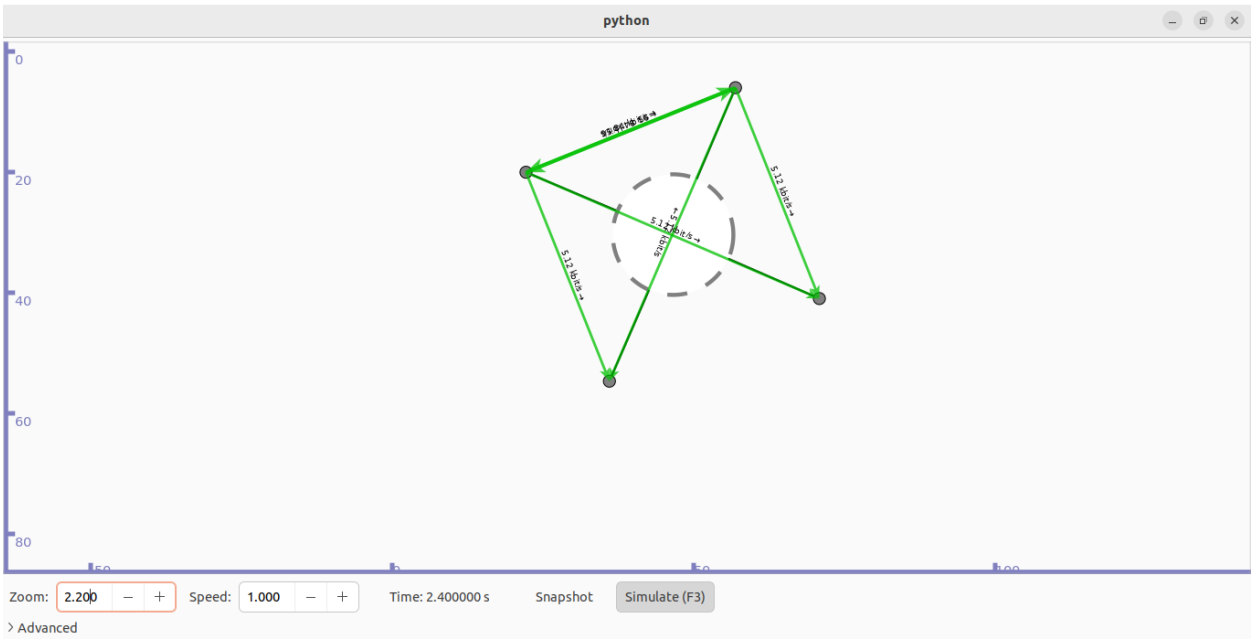

```
// - Tracing of queues and packet receptions to file "udp-echo.tr"

#include <fstream>
#include "ns3/core-module.h"
#include "ns3/csma-module.h"
#include "ns3/applications-module.h"
#include "ns3/internet-module.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("UdpEchoExample");

int
main (int argc, char *argv[])
{
//
// Users may find it convenient to turn on explicit debugging
// for selected modules; the below lines suggest how to do this
//
#if 0
  LogComponentEnable ("UdpEchoExample", LOG_LEVEL_INFO);
  LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_ALL);
  LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_ALL);
#endif
//
// Allow the user to override any of the defaults and the above Bind() at
// run-time, via command-line arguments
```

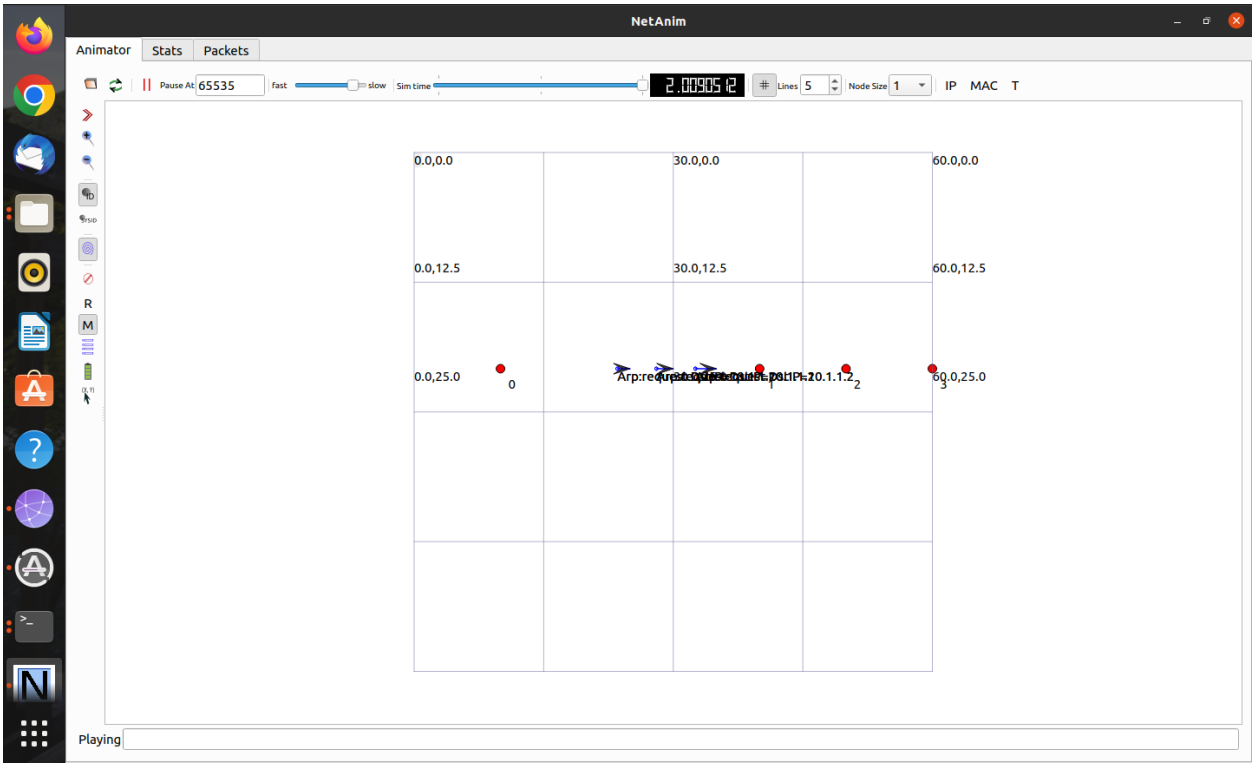
```
//
  bool useV6 = false;
  Address serverAddress;

  CommandLine cmd (__FILE__);
  cmd.AddValue ("useIpv6", "Use Ipv6", useV6);
  cmd.Parse (argc, argv);
//
// Explicitly create the nodes required by the topology (shown above).
//
  NS_LOG_INFO ("Create nodes.");
  NodeContainer n;
  n.Create (4);

  InternetStackHelper internet;
  internet.Install (n);

  NS_LOG_INFO ("Create channels.");
//
// Explicitly create the channels required by the topology (shown above).
//
  CsmaHelper csma;
  csma.SetChannelAttribute ("DataRate", DataRateValue (DataRate (5000000)));
  csma.SetChannelAttribute ("Delay", TimeValue (MilliSeconds (2)));
  csma.SetDeviceAttribute ("Mtu", UintegerValue (1400));
  NetDeviceContainer d = csma.Install (n);
```

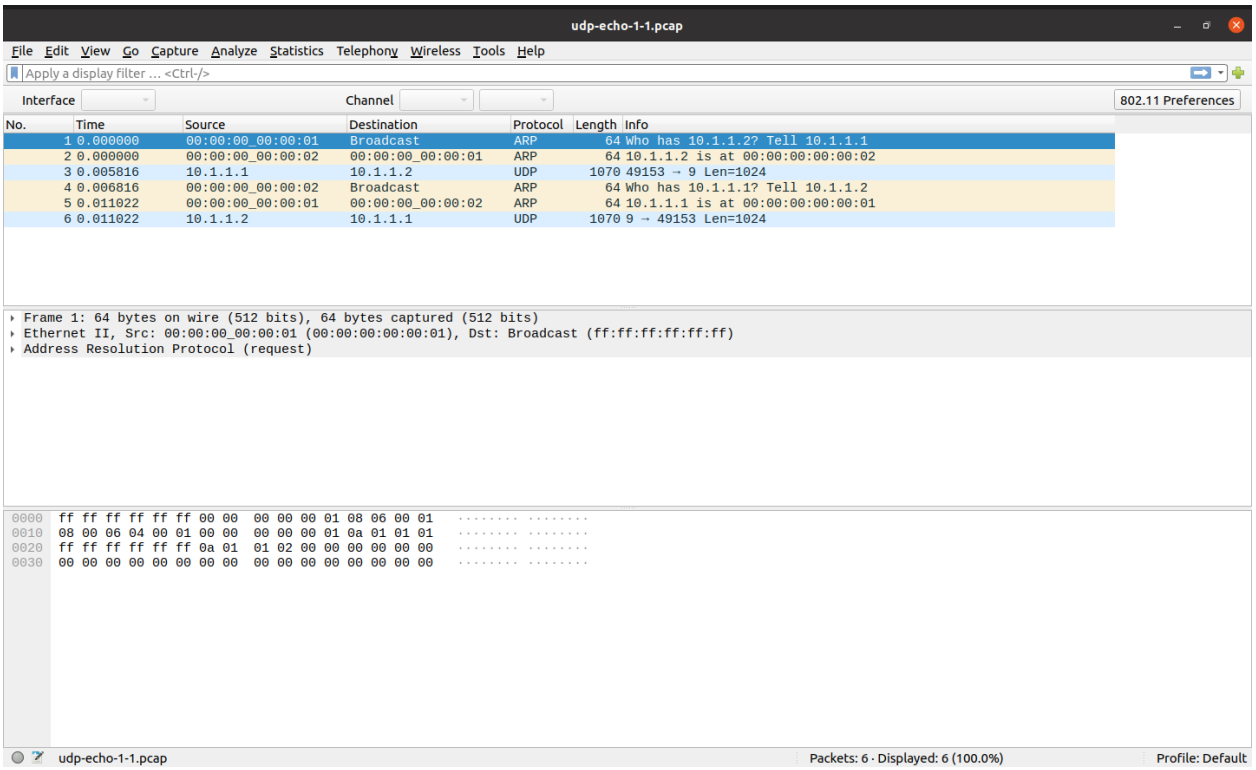
```
//
// We've got the "hardware" in place.  Now we need to add IP addresses.
//
  NS_LOG_INFO ("Assign IP Addresses.");
  if (useV6 == false)
    {
      Ipv4AddressHelper ipv4;
      ipv4.SetBase ("10.1.1.0", "255.255.255.0");
      Ipv4InterfaceContainer i = ipv4.Assign (d);
      serverAddress = Address(i.GetAddress (1));
    }
  else
    {
      Ipv6AddressHelper ipv6;
      ipv6.SetBase ("2001:0000:f00d:cafe::", Ipv6Prefix (64));
      Ipv6InterfaceContainer i6 = ipv6.Assign (d);
      serverAddress = Address(i6.GetAddress (1,1));
    }

  NS_LOG_INFO ("Create Applications.");
//
// Create a UdpEchoServer application on node one.
//
  uint16_t port = 9;  // well-known echo port number
  UdpEchoServerHelper server (port);
  ApplicationContainer apps = server.Install (n.Get (1));
  apps.Start (Seconds (1.0));
```

```
  apps.Stop (Seconds (10.0));

//
// Create a UdpEchoClient application to send UDP datagrams from node zero to
// node one.
//
  uint32_t packetSize = 1024;
  uint32_t maxPacketCount = 1;
  Time interPacketInterval = Seconds (1.);
  UdpEchoClientHelper client (serverAddress, port);
  client.SetAttribute ("MaxPackets", UintegerValue (maxPacketCount));
  client.SetAttribute ("Interval", TimeValue (interPacketInterval));
  client.SetAttribute ("PacketSize", UintegerValue (packetSize));
  apps = client.Install (n.Get (0));
  apps.Start (Seconds (2.0));
  apps.Stop (Seconds (10.0));

#if 0
//
// Users may find it convenient to initialize echo packets with actual data;
// the below lines suggest how to do this
//
  client.SetFill (apps.Get (0), "Hello World");

  client.SetFill (apps.Get (0), 0xa5, 1024);

  uint8_t fill[] = { 0, 1, 2, 3, 4, 5, 6};
```

```
  client.SetFill (apps.Get (0), fill, sizeof(fill), 1024);
#endif

  AsciiTraceHelper ascii;
  csma.EnableAsciiAll (ascii.CreateFileStream ("udp-echo.tr"));
  csma.EnablePcapAll ("udp-echo", false);

//
// Now, do the actual simulation.
//
  NS_LOG_INFO ("Run Simulation.");
  Simulator::Run ();
  Simulator::Destroy ();
  NS_LOG_INFO ("Done.");
}
```




NetAnim
Animator
Stats
Packets
Pause At 65535
fast
slow
Sim time
Lines 5
Node Size 1
IP
MAC
T
0.0,0.0
30.0,0.0
60.0,0.0
0.0,12.5
30.0,12.5
60.0,12.5
0.0,25.0
60.0,25.0
0
1
2
3
Playing


udp-echo-1-1.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
Interface
Channel
802.11 Preferences
No. Time Source Destination Protocol Length Info
1 0.000000 00:00:00_00:00:01 Broadcast ARP 64 Who has 10.1.1.2? Tell 10.1.1.1
2 0.000000 00:00:00_00:00:02 00:00:00_00:00:01 ARP 64 10.1.1.2 is at 00:00:00:00:00:02
3 0.005816 10.1.1.1 10.1.1.2 UDP 1070 49153 → 9 Len=1024
4 0.006816 00:00:00_00:00:02 Broadcast ARP 64 Who has 10.1.1.1? Tell 10.1.1.2
5 0.011022 00:00:00_00:00:01 00:00:00_00:00:02 ARP 64 10.1.1.1 is at 00:00:00:00:00:01
6 0.011022 10.1.1.2 10.1.1.1 UDP 1070 9 → 49153 Len=1024
Frame 1: 64 bytes on wire (512 bits), 64 bytes captured (512 bits)
Ethernet II, Src: 00:00:00_00:00:01 (00:00:00:00:00:01), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
Address Resolution Protocol (request)
0000 ff ff ff ff ff ff 00 00 00 00 00 01 08 06 00 01
0010 08 00 06 04 00 01 00 00 00 00 00 01 0a 01 01 01
0020 ff ff ff ff ff ff 0a 01 01 02 00 00 00 00 00 00
0030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
udp-echo-1-1.pcap
Packets: 6 · Displayed: 6 (100.0%)
Profile: Default

Practical 10: (UDP-Client-Server)

Code:

```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
 * Copyright (c) 2009 INRIA
 *
 * This program is free software; you can redistribute it and/or modify
 * it under the terms of the GNU General Public License version 2 as
 * published by the Free Software Foundation;
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 *
 * Author: Mohamed Amine Ismail <amine.ismail@sophia.inria.fr>
 */


// Network topology
//
//       n0    n1
//       |     |
//       =======
```

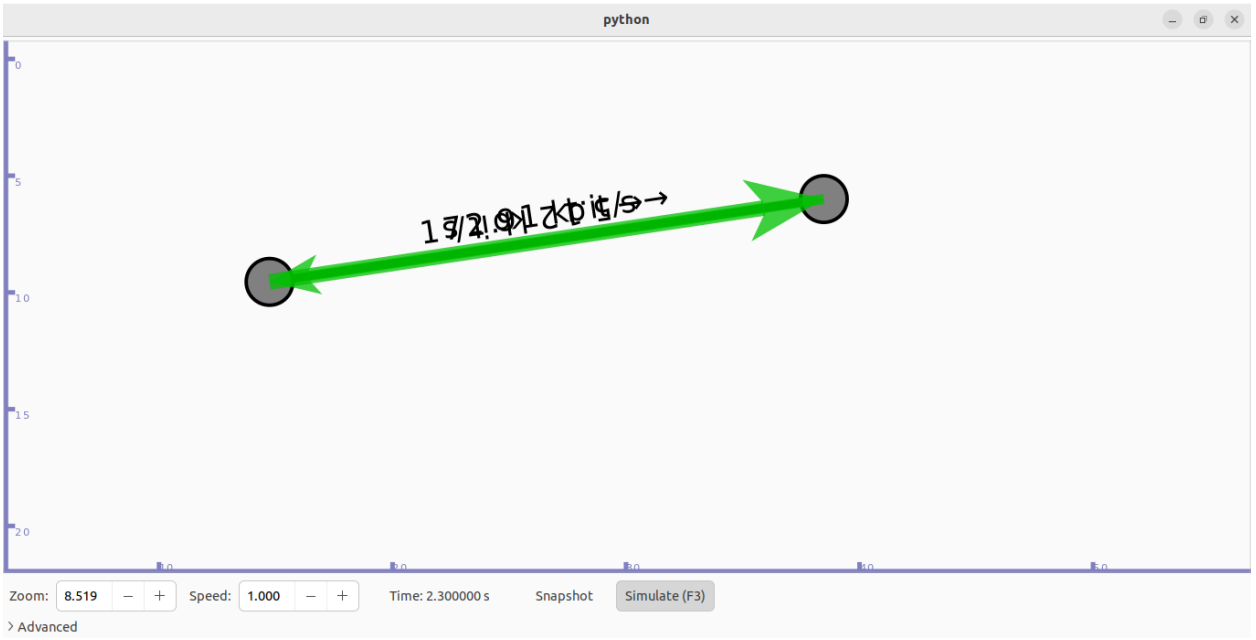
```
//        LAN (CSMA)
//
// - UDP flow from n0 to n1 of 1024 byte packets at intervals of 50 ms
//   - maximum of 320 packets sent (or limited by simulation duration)
//   - option to use IPv4 or IPv6 addressing
//   - option to disable logging statements

#include <fstream>
#include "ns3/core-module.h"
#include "ns3/csma-module.h"
#include "ns3/applications-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
//netanimation
#include "ns3/netanim-module.h"
#include "ns3/mobility-module.h"



using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("UdpClientServerExample");

int
main (int argc, char *argv[])
{
  // Declare variables used in command-line arguments
```

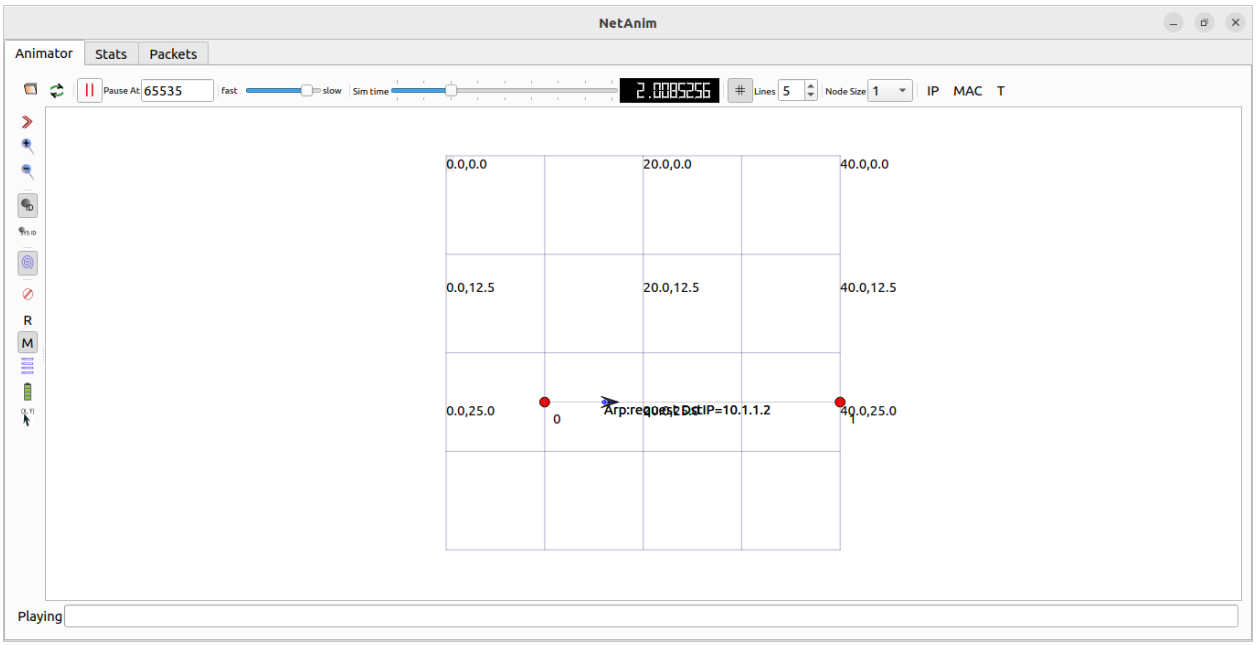
```
bool useV6 = false;
bool logging = true;
Address serverAddress;

CommandLine cmd (__FILE__);
cmd.AddValue ("useIpv6", "Use Ipv6", useV6);
cmd.AddValue ("logging", "Enable logging", logging);
cmd.Parse (argc, argv);

if (logging)
 {
  LogComponentEnable ("UdpClient", LOG_LEVEL_INFO);
  LogComponentEnable ("UdpServer", LOG_LEVEL_INFO);
 }

NS_LOG_INFO ("Create nodes in above topology.");
NodeContainer n;
n.Create (2);


 PointToPointHelper pointToPoint;
pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));

NetDeviceContainer devices;
devices = pointToPoint.Install (n);
```

```
InternetStackHelper internet;
internet.Install (n);

NS_LOG_INFO ("Create channel between the two nodes.");
CsmaHelper csma;
csma.SetChannelAttribute ("DataRate", DataRateValue (DataRate (5000000)));
csma.SetChannelAttribute ("Delay", TimeValue (MilliSeconds (2)));
csma.SetDeviceAttribute ("Mtu", UintegerValue (1400));
NetDeviceContainer d = csma.Install (n);

NS_LOG_INFO ("Assign IP Addresses.");
if (useV6 == false)
 {
   Ipv4AddressHelper ipv4;
   ipv4.SetBase ("10.1.1.0", "255.255.255.0");
   Ipv4InterfaceContainer i = ipv4.Assign (d);
   serverAddress = Address (i.GetAddress (1));
 }
else
 {
   Ipv6AddressHelper ipv6;
   ipv6.SetBase ("2001:0000:f00d:cafe::", Ipv6Prefix (64));
   Ipv6InterfaceContainer i6 = ipv6.Assign (d);
   serverAddress = Address(i6.GetAddress (1,1));
 }

NS_LOG_INFO ("Create UdpServer application on node 1.");
```

```
uint16_t port = 4000;
UdpServerHelper server (port);
ApplicationContainer apps = server.Install (n.Get (1));
apps.Start (Seconds (1.0));
apps.Stop (Seconds (10.0));

NS_LOG_INFO ("Create UdpClient application on node 0 to send to node 1.");
uint32_t MaxPacketSize = 1024;
Time interPacketInterval = Seconds (0.05);
uint32_t maxPacketCount = 320;
UdpClientHelper client (serverAddress, port);
client.SetAttribute ("MaxPackets", UintegerValue (maxPacketCount));
client.SetAttribute ("Interval", TimeValue (interPacketInterval));
client.SetAttribute ("PacketSize", UintegerValue (MaxPacketSize));
apps = client.Install (n.Get (0));
apps.Start (Seconds (2.0));
apps.Stop (Seconds (10.0));

NS_LOG_INFO ("Run Simulation.");


MobilityHelper mobility;
mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
mobility.Install(n);

AnimationInterface anim("udp-client-server.xml");
AnimationInterface::SetConstantPosition(n.Get(0),10,25);
```

```
  AnimationInterface::SetConstantPosition(n.Get(1),40,25);
  anim.EnablePacketMetadata(true);

  pointToPoint.EnablePcapAll("udp-client-server");


  Simulator::Run ();
  Simulator::Destroy ();
  NS_LOG_INFO ("Done.");
}
```

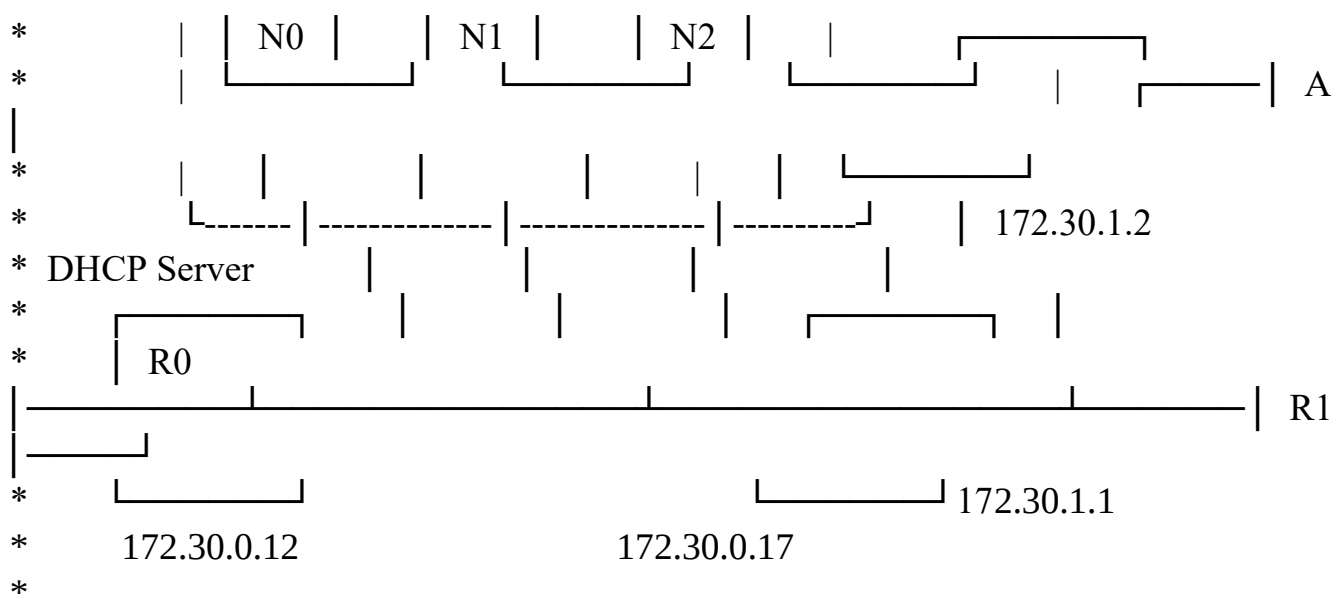



NetAnim
Animator
Stats
Packets
Pause At
65535
fast
slow
Sim time
Lines
5
Node Size
1
IP
MAC
T
0.0,0.0
20.0,0.0
40.0,0.0
0.0,12.5
20.0,12.5
40.0,12.5
0.0,25.0
40.0,25.0
0
1
Playing

Practical 11: (DHCP)

Code:

```
/* -*- Mode:C++; c-file-style:"gnu"; indent-tabs-mode:nil; -*- */
/*
 * Copyright (c) 2011 UPB
 * Copyright (c) 2017 NITK Surathkal
 *
 * This program is free software; you can redistribute it and/or modify
 * it under the terms of the GNU General Public License version 2 as
 * published by the Free Software Foundation;
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA  02111-1307  USA
 *
 * Author: Radu Lupu <rlupu@elcom.pub.ro>
 *         Ankit Deepak <adadeepak8@gmail.com>
 *         Deepti Rajagopal <deeptir96@gmail.com>
 *
 */

/*
 * Network layout:
 *
 * R0 is a DHCP server. The DHCP server announced R1 as the default router.
 * Nodes N1 will send UDP Echo packets to node A.
 *
 *
 *              ┌-----------------------------------------------┐
 *             | DHCP Clients                                   |
 *             |                          172.30.0.14   |
 *             |                          DHCP static   |
 *             |   ┌──────────┐      ┌──────────┐      ┌──────────┐      |
```



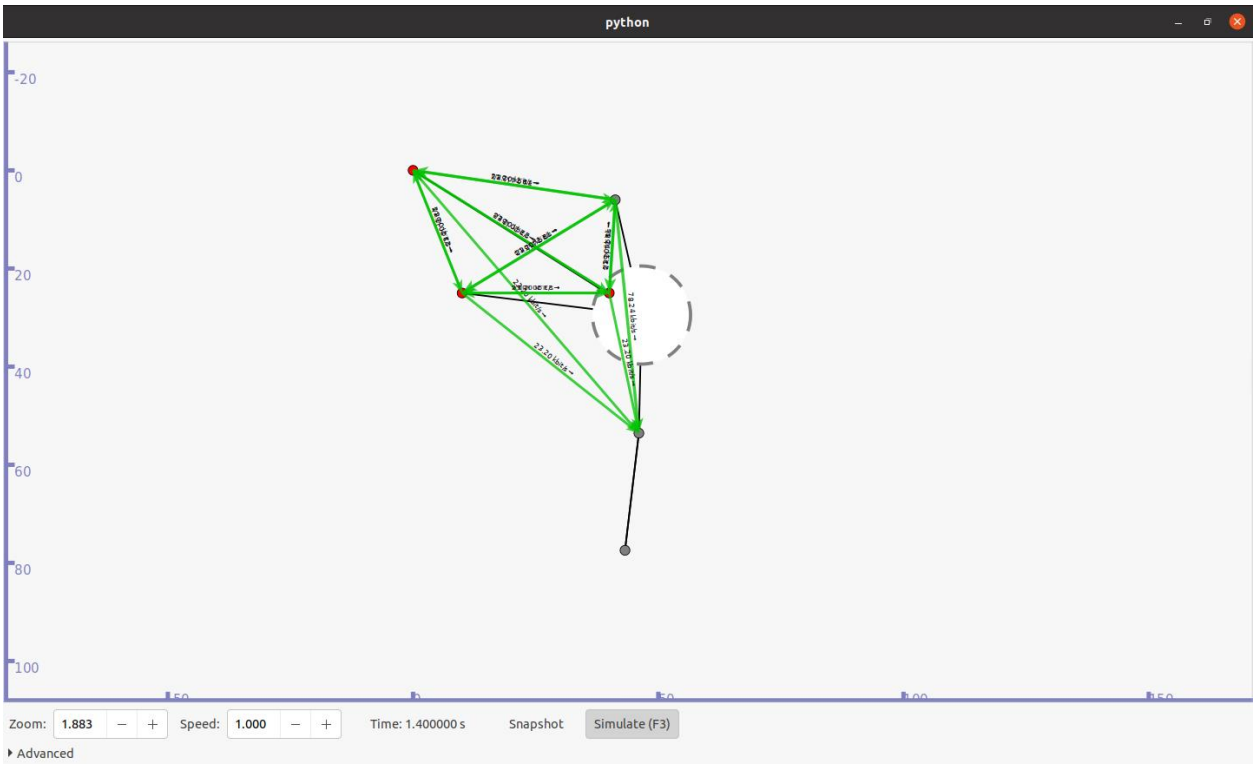

```
 * Things to notice:
 * 1) The routes in A are manually set to have R1 as the default router,
 *    just because using a dynamic outing in this example is an overkill.
 * 2) R1's address is set statically though the DHCP server helper interface.
 *    This is useful to prevent address conflicts with the dynamic pool.
 *    Not necessary if the DHCP pool is not conflicting with static addresses.
 * 3) N2 has a dynamically-assigned, static address (i.e., a fixed address assigned via DHCP).
 *
 */

#include "ns3/core-module.h"
#include "ns3/internet-apps-module.h"
#include "ns3/csma-module.h"
#include "ns3/internet-module.h"
#include "ns3/point-to-point-module.h"
#include "ns3/applications-module.h"

//netanim code
#include "ns3/netanim-module.h"
#include "ns3/mobility-module.h"


using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("DhcpExample");
```

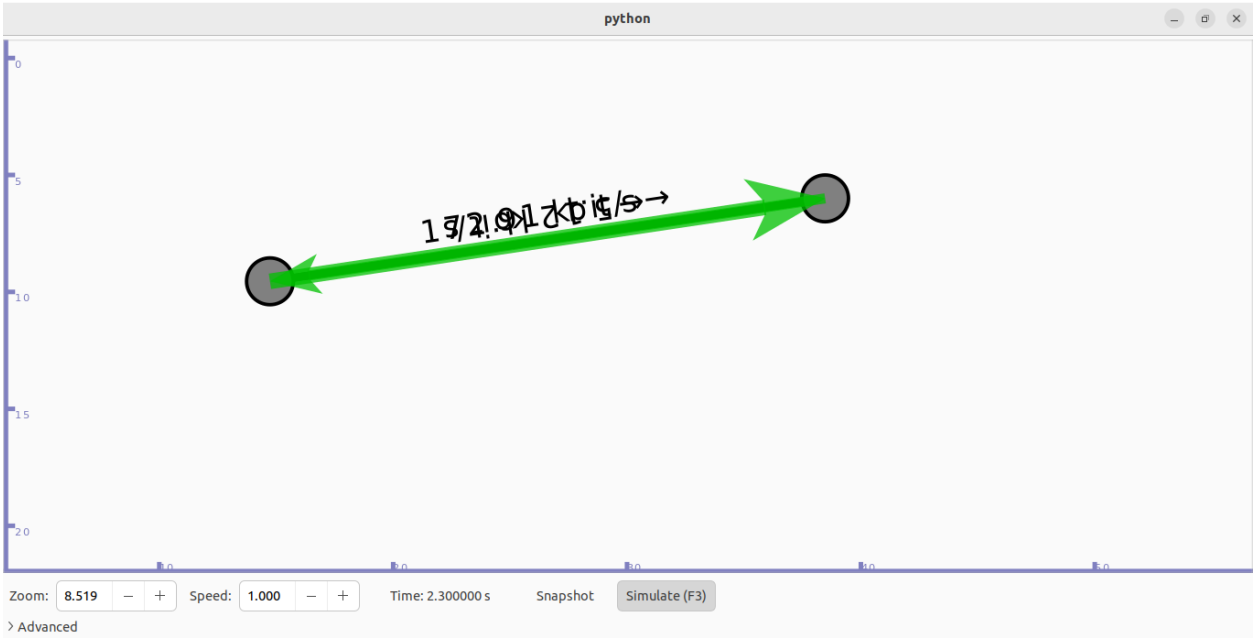
```
int
main (int argc, char *argv[])
{
  CommandLine cmd (__FILE__);

  bool verbose = false;
  bool tracing = false;
  cmd.AddValue ("verbose", "turn on the logs", verbose);
  cmd.AddValue ("tracing", "turn on the tracing", tracing);

  cmd.Parse (argc, argv);

  // GlobalValue::Bind ("ChecksumEnabled", BooleanValue (true));

  if (verbose)
    {
      LogComponentEnable ("DhcpServer", LOG_LEVEL_ALL);
      LogComponentEnable ("DhcpClient", LOG_LEVEL_ALL);
      LogComponentEnable ("UdpEchoServerApplication", LOG_LEVEL_INFO);
      LogComponentEnable ("UdpEchoClientApplication", LOG_LEVEL_INFO);
    }

  Time stopTime = Seconds (20);

  NS_LOG_INFO ("Create nodes.");
  NodeContainer nodes;
  NodeContainer router;
  nodes.Create (3);
  router.Create (2);

  NodeContainer net (nodes, router);

  NS_LOG_INFO ("Create channels.");
  CsmaHelper csma;
  csma.SetChannelAttribute ("DataRate", StringValue ("5Mbps"));
  csma.SetChannelAttribute ("Delay", StringValue ("2ms"));
  csma.SetDeviceAttribute ("Mtu", UintegerValue (1500));
  NetDeviceContainer devNet = csma.Install (net);
```

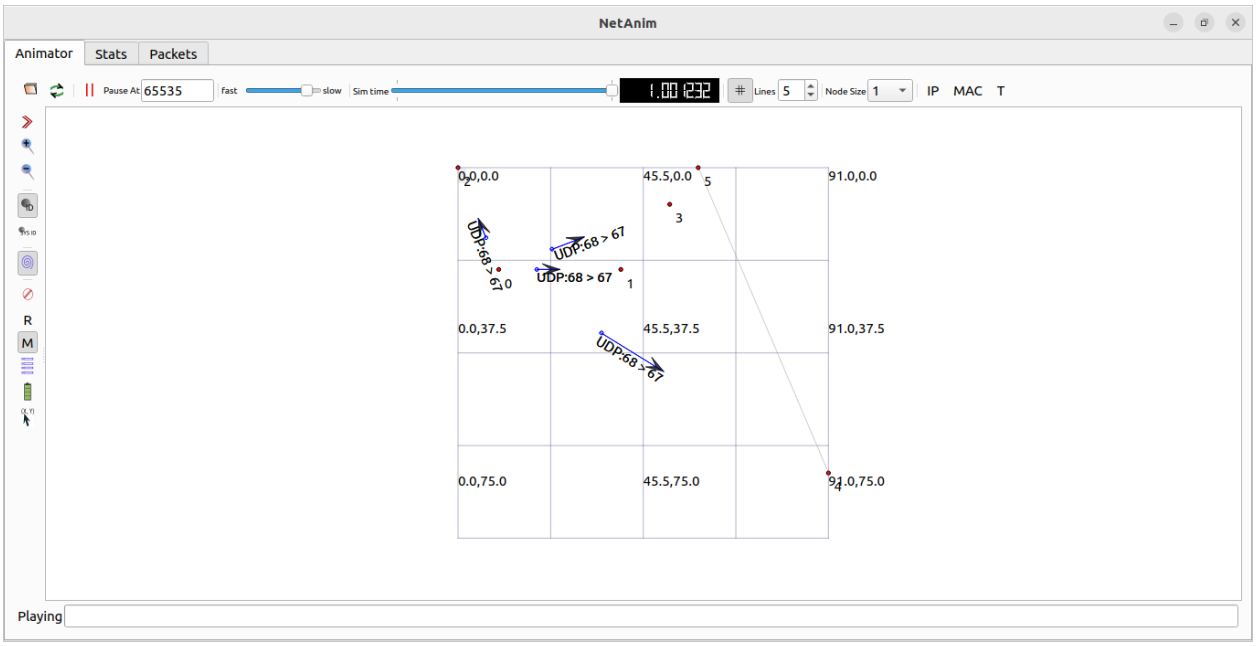
```
  NodeContainer p2pNodes;
  p2pNodes.Add (net.Get (4));
  p2pNodes.Create (1);

  PointToPointHelper pointToPoint;
  pointToPoint.SetDeviceAttribute ("DataRate", StringValue ("5Mbps"));
  pointToPoint.SetChannelAttribute ("Delay", StringValue ("2ms"));

  NetDeviceContainer p2pDevices;
  p2pDevices = pointToPoint.Install (p2pNodes);

  InternetStackHelper tcpip;
  tcpip.Install (nodes);
  tcpip.Install (router);
  tcpip.Install (p2pNodes.Get (1));

  Ipv4AddressHelper address;
  address.SetBase ("172.30.1.0", "255.255.255.0");
  Ipv4InterfaceContainer p2pInterfaces;
  p2pInterfaces = address.Assign (p2pDevices);

  // manually add a routing entry because we don't want to add a dynamic routing
  Ipv4StaticRoutingHelper ipv4RoutingHelper;
  Ptr<Ipv4> ipv4Ptr = p2pNodes.Get (1)->GetObject<Ipv4> ();
  Ptr<Ipv4StaticRouting> staticRoutingA = ipv4RoutingHelper.GetStaticRouting
(ipv4Ptr);
  staticRoutingA->AddNetworkRouteTo (Ipv4Address ("172.30.0.0"), Ipv4Mask ("/24"),
                                     Ipv4Address ("172.30.1.1"), 1);

  NS_LOG_INFO ("Setup the IP addresses and create DHCP applications.");
  DhcpHelper dhcpHelper;

  // The router must have a fixed IP.
  Ipv4InterfaceContainer fixedNodes = dhcpHelper.InstallFixedAddress (devNet.Get (4),
Ipv4Address ("172.30.0.17"), Ipv4Mask ("/24"));
  // Not really necessary, IP forwarding is enabled by default in IPv4.
  fixedNodes.Get (0).first->SetAttribute ("IpForward", BooleanValue (true));
```

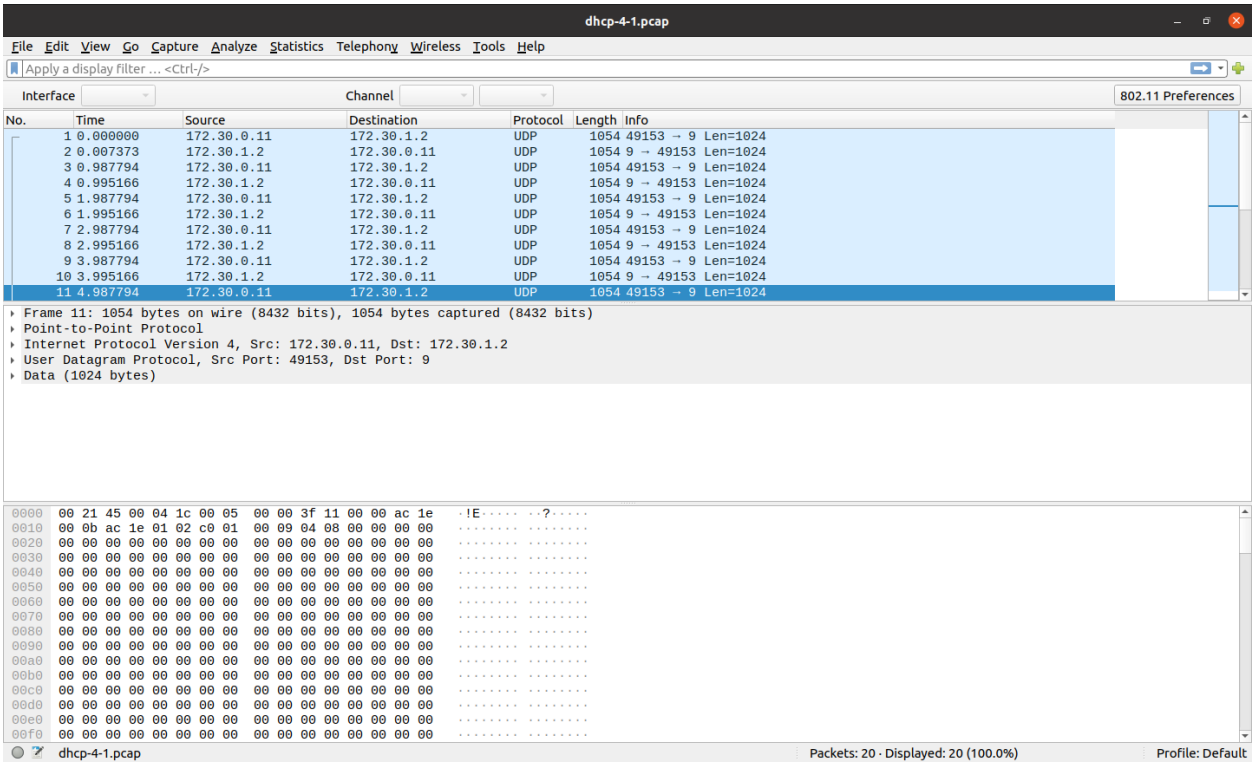
```
  // DHCP server
  ApplicationContainer dhcpServerApp = dhcpHelper.InstallDhcpServer (devNet.Get (3),
Ipv4Address ("172.30.0.12"),
                                                    Ipv4Address ("172.30.0.0"), Ipv4Mask
("/24"),
                                                    Ipv4Address ("172.30.0.10"), Ipv4Address
("172.30.0.15"),
                                                    Ipv4Address ("172.30.0.17"));

  // This is just to show how it can be done.
  DynamicCast<DhcpServer> (dhcpServerApp.Get (0))->AddStaticDhcpEntry
(devNet.Get (2)->GetAddress (), Ipv4Address ("172.30.0.14"));

  dhcpServerApp.Start (Seconds (0.0));
  dhcpServerApp.Stop (stopTime);

  // DHCP clients
  NetDeviceContainer dhcpClientNetDevs;
  dhcpClientNetDevs.Add (devNet.Get (0));
  dhcpClientNetDevs.Add (devNet.Get (1));
  dhcpClientNetDevs.Add (devNet.Get (2));

  ApplicationContainer dhcpClients = dhcpHelper.InstallDhcpClient
(dhcpClientNetDevs);
  dhcpClients.Start (Seconds (1.0));
  dhcpClients.Stop (stopTime);

  UdpEchoServerHelper echoServer (9);

  ApplicationContainer serverApps = echoServer.Install (p2pNodes.Get (1));
  serverApps.Start (Seconds (0.0));
  serverApps.Stop (stopTime);

  UdpEchoClientHelper echoClient (p2pInterfaces.GetAddress (1), 9);
  echoClient.SetAttribute ("MaxPackets", UintegerValue (100));
  echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
  echoClient.SetAttribute ("PacketSize", UintegerValue (1024));

  ApplicationContainer clientApps = echoClient.Install (nodes.Get (1));
```

```
  clientApps.Start (Seconds (10.0));
  clientApps.Stop (stopTime);


  MobilityHelper mobility;
  mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
  mobility.Install(nodes);

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



  Simulator::Stop (stopTime + Seconds (10.0));

  if (tracing)
    {
      csma.EnablePcapAll ("dhcp-csma");
      pointToPoint.EnablePcapAll ("dhcp-p2p");
    }

  NS_LOG_INFO ("Run Simulation.");
  Simulator::Run ();
  Simulator::Destroy ();
  NS_LOG_INFO ("Done.");
}
```


python
-20
0
20
40
60
80
100
Zoom: 1.883
Speed: 1.000
Time: 1.400000 s
Snapshot
Simulate (F3)
Advanced


python
0
5
10
15
20
Zoom: 8.519
Speed: 1.000
Time: 2.300000 s
Snapshot
Simulate (F3)
Advanced


NetAnim
Animator
Stats
Packets
Pause At 65535
fast
slow
Sim time
Lines 5
Node Size 1
IP
MAC
T
0.0,0.0
45.5,0.0
91.0,0.0
0.0,37.5
45.5,37.5
91.0,37.5
0.0,75.0
45.5,75.0
91.0,75.0
UDP:68 > 67
UDP:68 > 67
UDP:68 > 67
Playing


dhcp-4-1.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
Interface
Channel
802.11 Preferences
No. Time Source Destination Protocol Length Info
1 0.000000 172.30.0.11 172.30.1.2 UDP 1054 49153 → 9 Len=1024
2 0.007373 172.30.1.2 172.30.0.11 UDP 1054 9 → 49153 Len=1024
3 0.987794 172.30.0.11 172.30.1.2 UDP 1054 49153 → 9 Len=1024
4 0.995166 172.30.1.2 172.30.0.11 UDP 1054 9 → 49153 Len=1024
5 1.987794 172.30.0.11 172.30.1.2 UDP 1054 49153 → 9 Len=1024
6 1.995166 172.30.1.2 172.30.0.11 UDP 1054 9 → 49153 Len=1024
7 2.987794 172.30.0.11 172.30.1.2 UDP 1054 49153 → 9 Len=1024
8 2.995166 172.30.1.2 172.30.0.11 UDP 1054 9 → 49153 Len=1024
9 3.987794 172.30.0.11 172.30.1.2 UDP 1054 49153 → 9 Len=1024
10 3.995166 172.30.1.2 172.30.0.11 UDP 1054 9 → 49153 Len=1024
11 4.987794 172.30.0.11 172.30.1.2 UDP 1054 49153 → 9 Len=1024
Frame 11: 1054 bytes on wire (8432 bits), 1054 bytes captured (8432 bits)
Point-to-Point Protocol
Internet Protocol Version 4, Src: 172.30.0.11, Dst: 172.30.1.2
User Datagram Protocol, Src Port: 49153, Dst Port: 9
Data (1024 bytes)
0000 00 21 45 00 04 1c 00 05 00 00 3f 11 00 00 ac 1e
0010 00 0b ac 1e 01 02 c0 01 00 09 04 08 00 00 00 00
dhcp-4-1.pcap
Packets: 20 · Displayed: 20 (100.0%)
Profile: Default

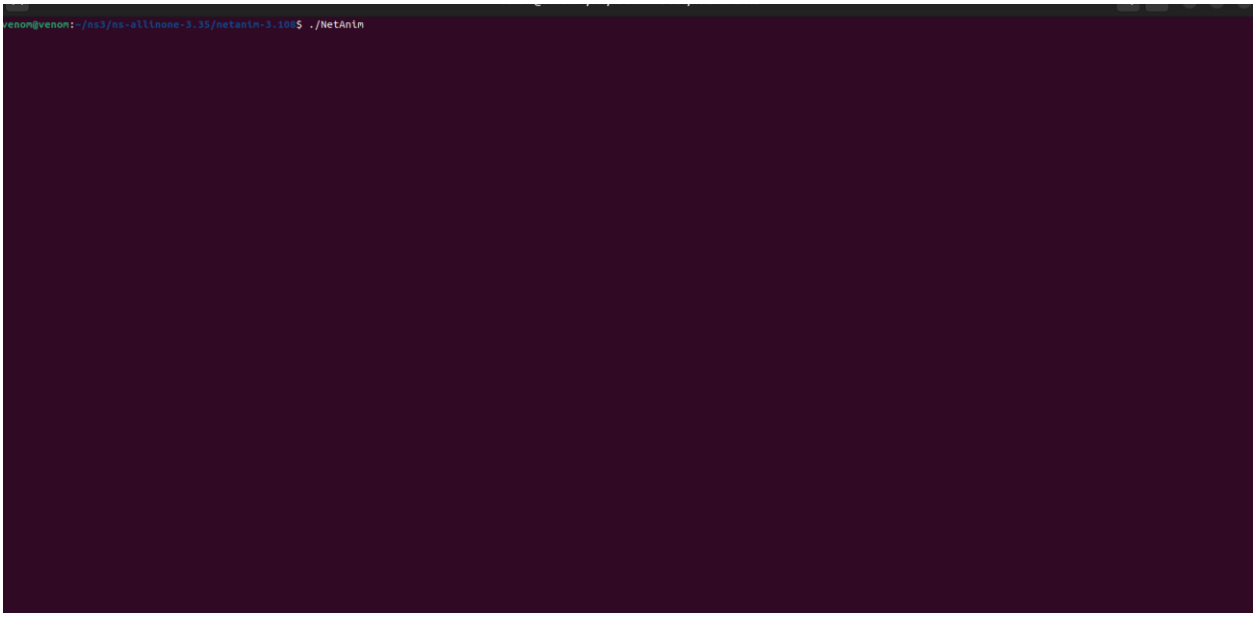
Practical 12: Animate a simple Network using NetAnim in Network Stimulator

Step 1: Generate the XML file using Mobility helper in first.cc and the code below to create the XML file

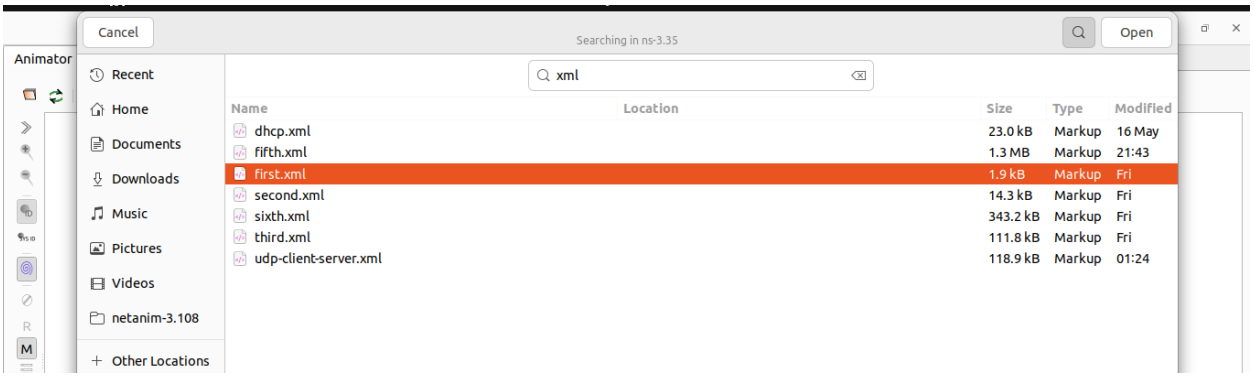
```
79
80  MobilityHelper mobility;
81  mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
82  mobility.Install(nodes);
83
84  AnimationInterface anim("first.xml");
85  AnimationInterface::SetConstantPosition(nodes.Get(0),10,25);
86  AnimationInterface::SetConstantPosition(nodes.Get(1),40,25);
87  anim.EnablePacketMetadata(true);
88
89  pointToPoint.EnablePcapAll("first");
90
91  Simulator::Run ();
92  Simulator::Destroy ();
93  return 0;
94 }
```

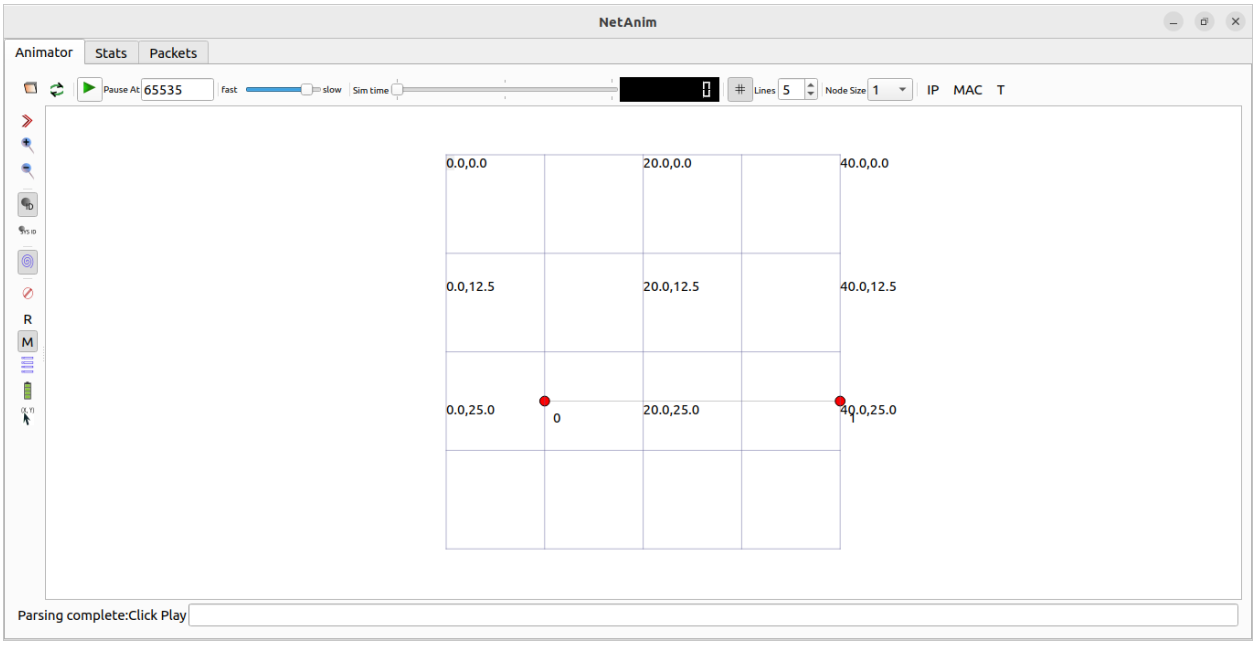
C++ Tab Width: 8 Ln 89, Col 39 INS

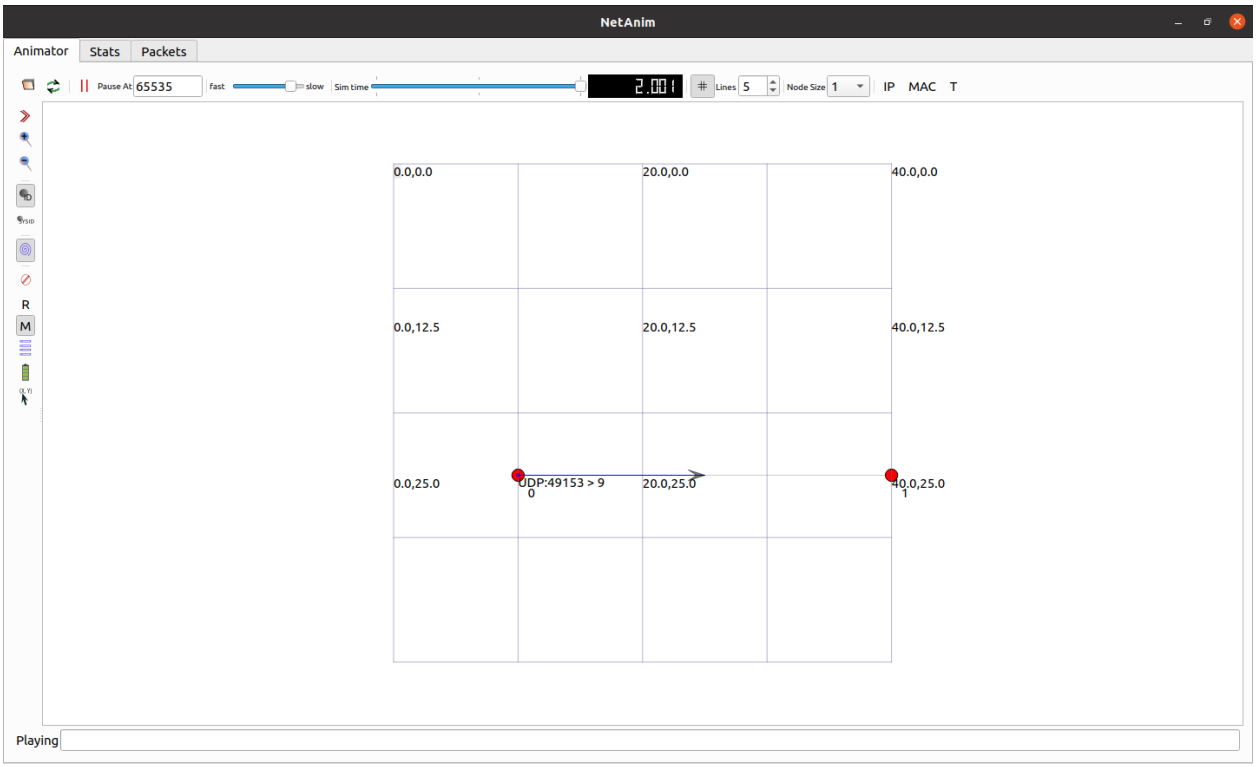
Then change directory to NetAnim folder and open terminal and enter ./NetAnim to start NetAnim



Open the XML File that was just generated now and click the play button to start the stimulation


Cancel
Searching in ns-3.35
Open
Animator
Recent
Home
Documents
Downloads
Music
Pictures
Videos
netanim-3.108
Other Locations
xml
Name
Location
Size
Type
Modified
dhcp.xml 23.0 kB Markup 16 May
fifth.xml 1.3 MB Markup 21:43
first.xml 1.9 kB Markup Fri
second.xml 14.3 kB Markup Fri
sixth.xml 343.2 kB Markup Fri
third.xml 111.8 kB Markup Fri
udp-client-server.xml 118.9 kB Markup 01:24


NetAnim
Animator
Stats
Packets
Pause At 65535
fast
slow
Sim time
Lines 5
Node Size 1
IP
MAC
T
0.0,0.0
20.0,0.0
40.0,0.0
0.0,12.5
20.0,12.5
40.0,12.5
0.0,25.0
20.0,25.0
40.0,25.0
0
1
Parsing complete:Click Play


NetAnim
Animator
Stats
Packets
Pause At
65535
fast
slow
Sim time
2.001
Lines
5
Node Size
1
IP
MAC
T
R
M
0.0,0.0
20.0,0.0
40.0,0.0
0.0,12.5
20.0,12.5
40.0,12.5
0.0,25.0
UDP:49153 > 9
0
20.0,25.0
40.0,25.0
1
Playing

Practical 13: Network Traffic Analysis using WireShark

Wireshark is a network protocol analyzer, or an application that captures packets from a networkconnection, such as from your computer to your home office or the internet. Packet is the name given to a discrete unit of data in a typical Ethernet network.

Wireshark is the most often-used packet sniffer in the world. Like any other packet sniffer,Wireshark does three things:

1. **Packet Capture:** Wireshark listens to a network connection in real time and then grabsentire streams of traffic – quite possibly tens of thousands of packets at a time.
2. **Filtering:** Wireshark is capable of slicing and dicing all of this random live data usingfilters. By applying a filter, you can obtain just the information you need to see.
3. **Visualization:** Wireshark, like any good packet sniffer, allows you to dive right into the verymiddle of a network packet. It also allows you to visualize entire conversations and network streams.

How to Install Wireshark on Linux

To install Wireshark using the following sequence (notice that you'll need to have root permissions):

$ sudo apt-get install wireshark

$ sudo dpkg-reconfigure wireshark-common

$ sudo usermod -a -G wireshark $USER

$ newgrp wireshark

Once you have completed the above steps, you then log out and log back in, and then startWireshark:

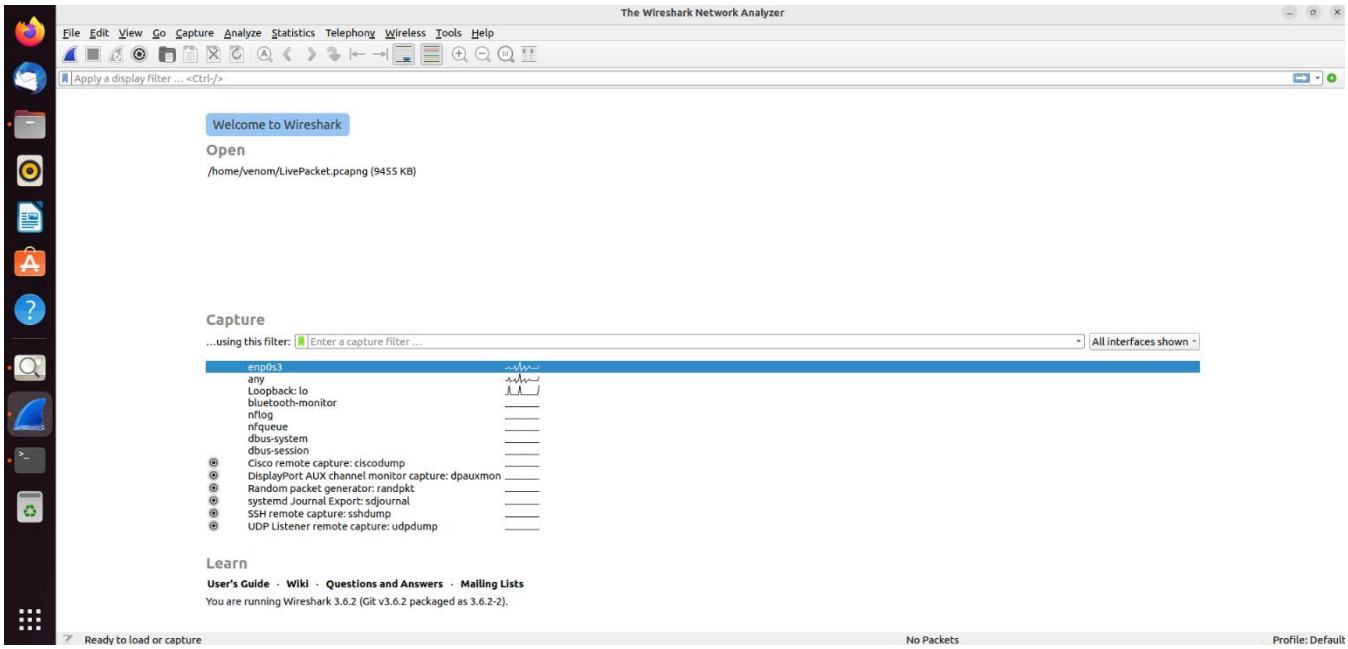
$ sudo wireshark

How to Capture Packets Using Wireshark

Once you've installed Wireshark, you can start grabbing network traffic. But remember: To captureany packets, you need to have proper permissions on your computer to put Wireshark into promiscuous mode.

- In a Linux system, it usually means that you have root access.

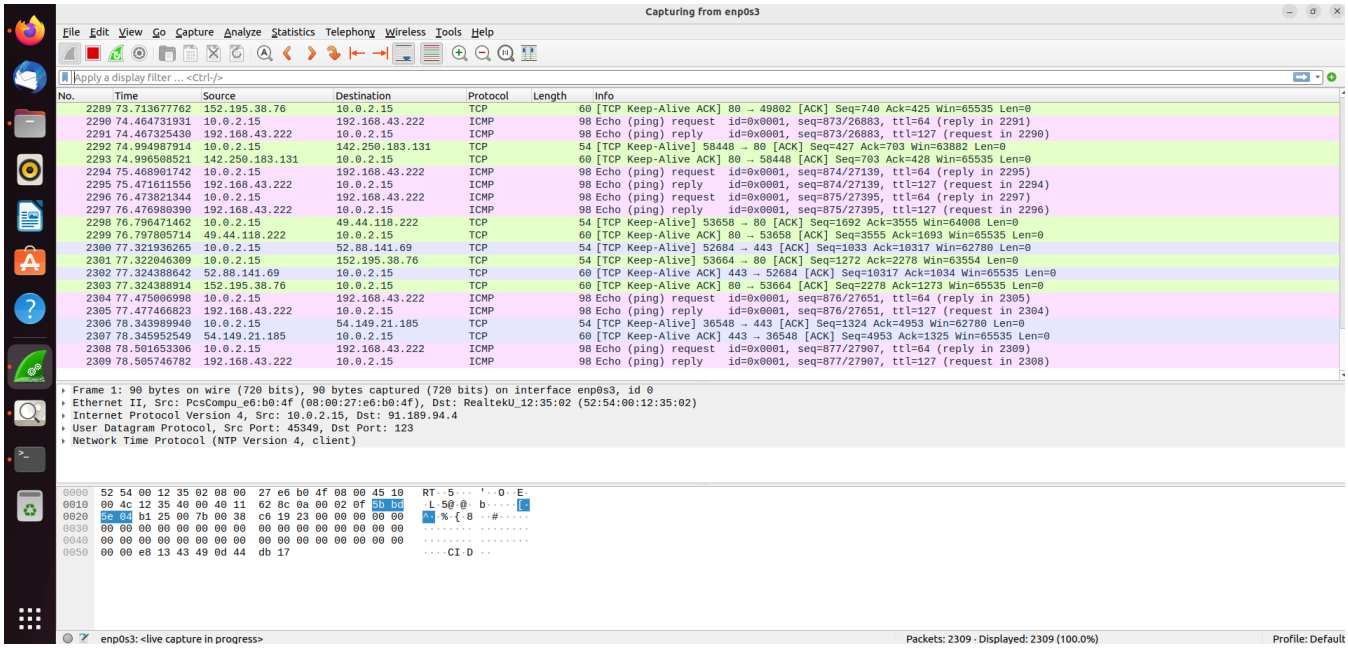
As long as you have the right permissions, you have several options to actually start the capture.Perhaps the best is to select Capture >> Options from the main window. This will bring up the Capture Interfaces window, as shown below



This window will list all available interfaces. In this case, Wireshark provides several to choosefrom.

For this example, we'll select the wlp interface, which is the most active interface. Wiresharkvisualizes the traffic by showing a moving line, which represents the packets on the network.

Once the network interface is selected, you simply click the Start button to begin your capture. Asthe capture begins, it's possible to view the packets that appear on the screen, as shown in image below



In the above image we can see all the packets that are tranferred using the current network.

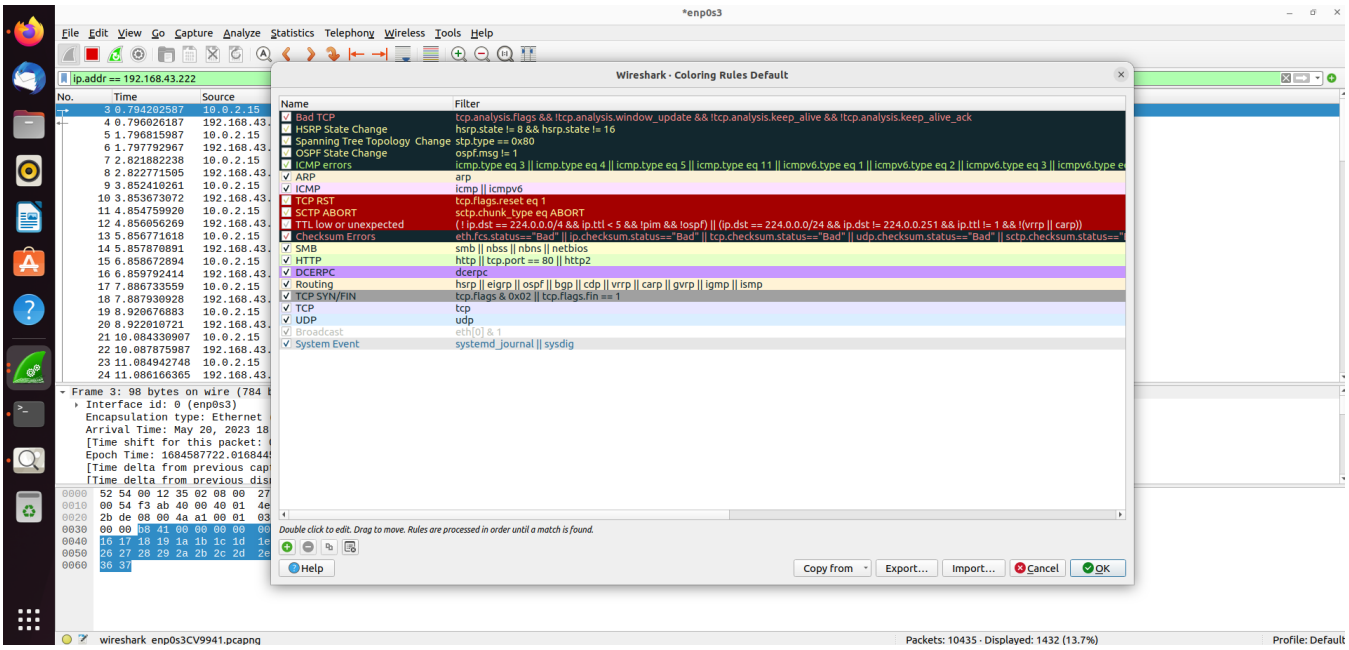
What the Color Coding Means in Wireshark

Now that you have some packets, it's time to figure out what they mean. Wireshark tries to help youidentify packet types by applying common-sense color coding. The table below describes the default colors given to major packet types.

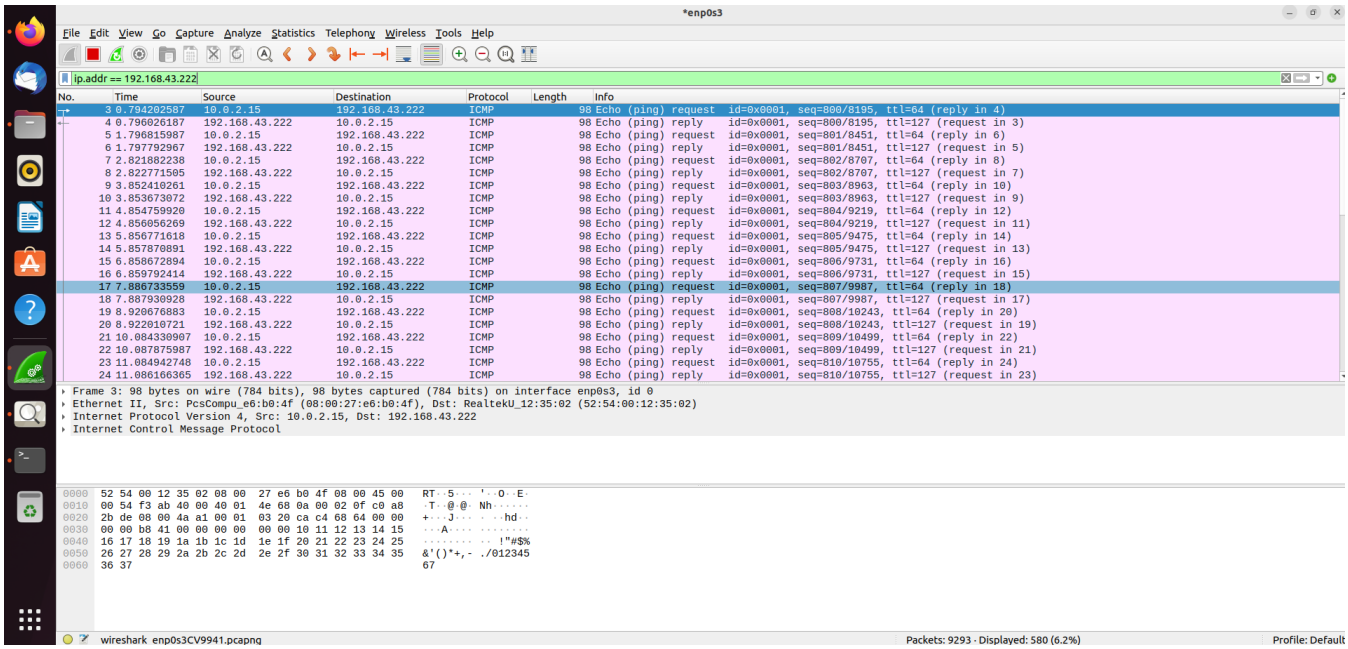
Color in Wireshark	Packet Type
Light purple	TCP
Light blue	UDP
Black	Packets with errors
Light green	HTTP traffic
Light yellow	Windows-specific traffic, including Server Message Blocks (SMB) andNetBIOS

Dark yellow	Routing
Dark gray	TCP SYN, FIN and ACK traffic

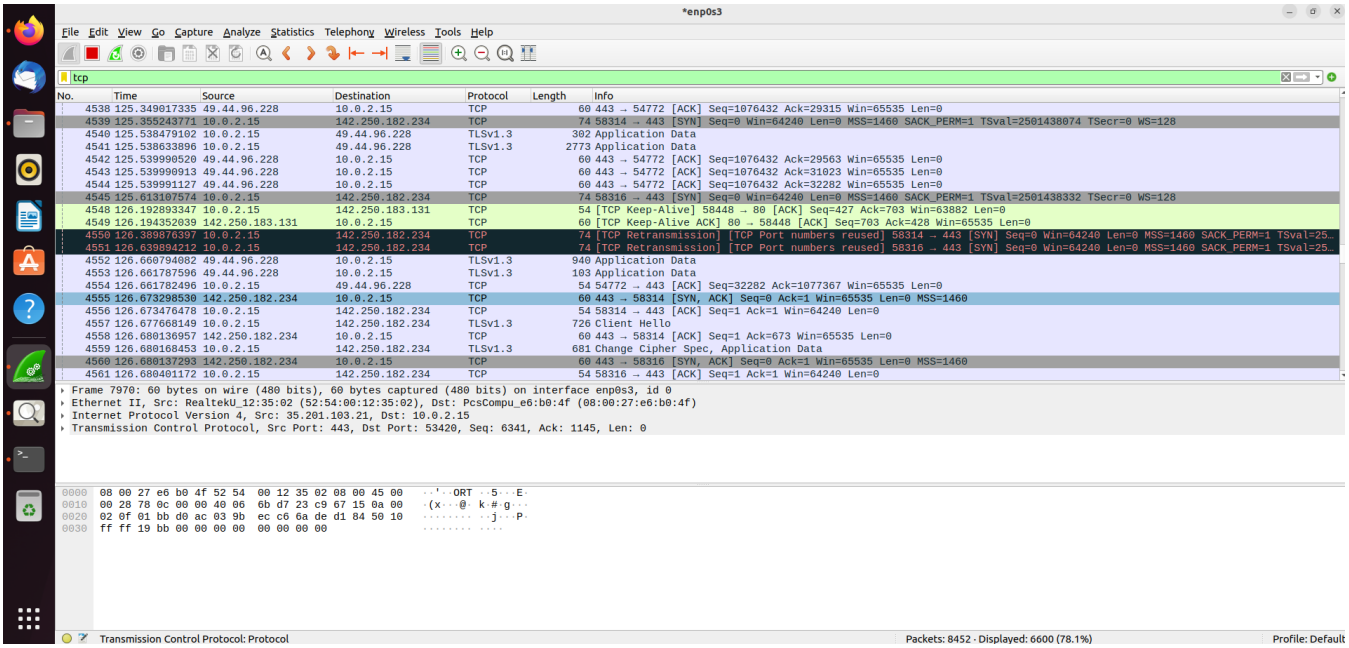
The default coloring scheme is shown below in image below. You can view this by going toView >> Coloring Rules.



You can even change the defaults or apply a custom rule. If you don’t want any coloring at all, go toView, then click Colorize Packet List. It’s a toggle, so if you want the coloring back, simply go backand click Colorize Packet List again. It’s possible, even, to colorize specific conversations between computers.

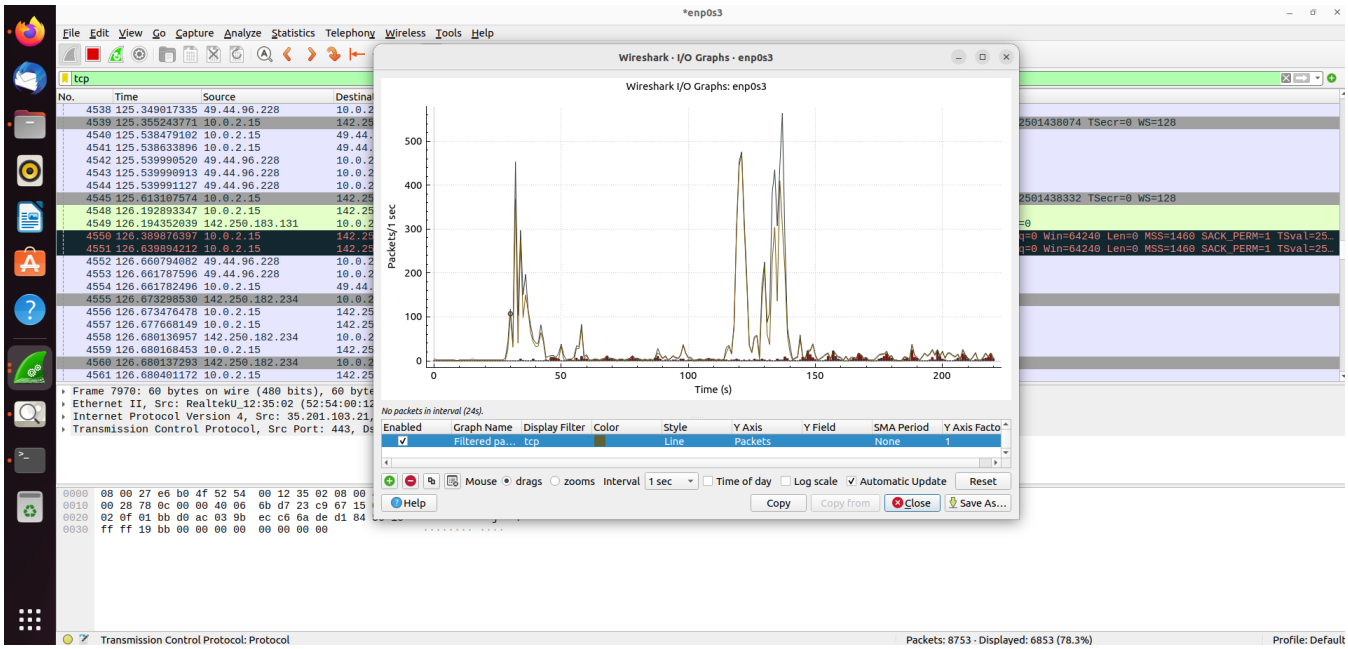


In the above screenshot we can see that there are light blue which indicate TPC protocols, UDP(light blue), TCP (light purple), TCP handshake (dark gray), HTTP (Green), Bad TCP(Black)



However, you’re not limited to just interpreting by color. It’s possible to view the input/output (I/O)statistics of an entire packet capture.

In Wireshark, just go to Statistics >> I/O Graph, and you’ll see a graph similar to the one shown inImage below



How to Filter and Inspect Packets in Wireshark

You can apply Wireshark filters in two ways:

1. In the Display Filter window, at the top of the screen
2. By highlighting a packet (or a portion of a packet) and right-clicking

on the packetWireshark filters use key phrases, such as the following:

ip.addr	Specifies an IPv4 address
ipv6.addr	Specifies an IPv6 address
src	Source - where the packet came from
dst	Destination - where the packet is going

You can also use the following values:

& &	Means “and,” as in, “Choose the IP address of 192.168.2.1 and 192.168.2.2”

== Means “equals,” as in “Choose only IP address 192.168.2.1”

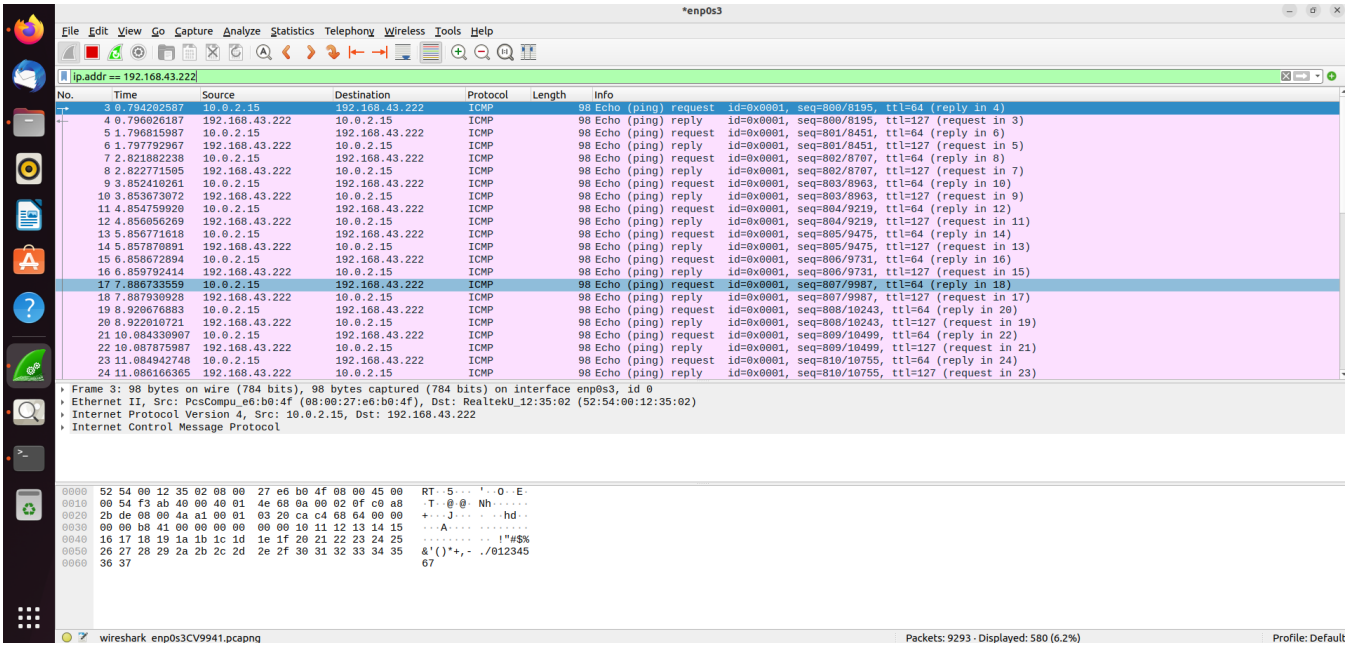
! Means “not,” as in, do not show a particular IP address or source port

Valid filter rules are always colored green. If you make a mistake on a filter rule, the box will turn avivid pink.

Let's start with a couple of basic rules. For example, let's say you want to see packets that have only the IP address of 192.168.53.216 somewhere inside. You would create the following commandline, and put it into the Filter window:

ip.addr == 192.168.43.222

The image below shows the results of adding that filter:

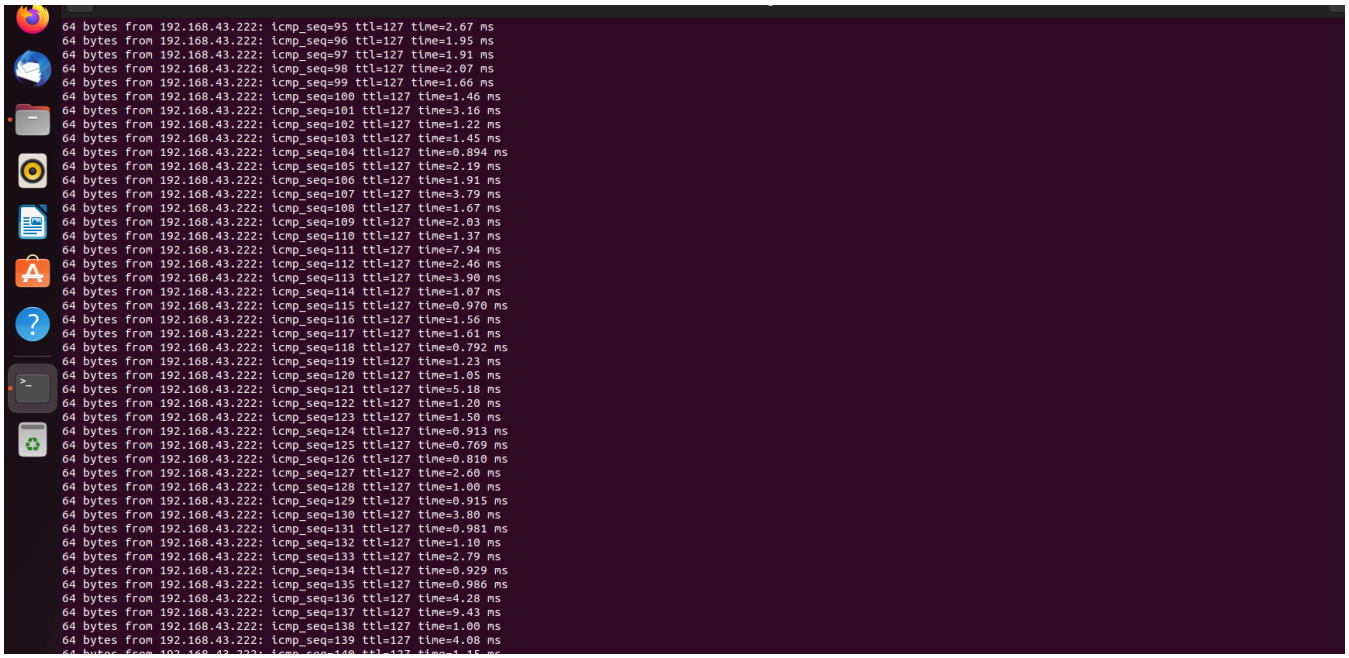


In this example we have tried to make a connection between two devices using

ping commandping 192.168.43.222

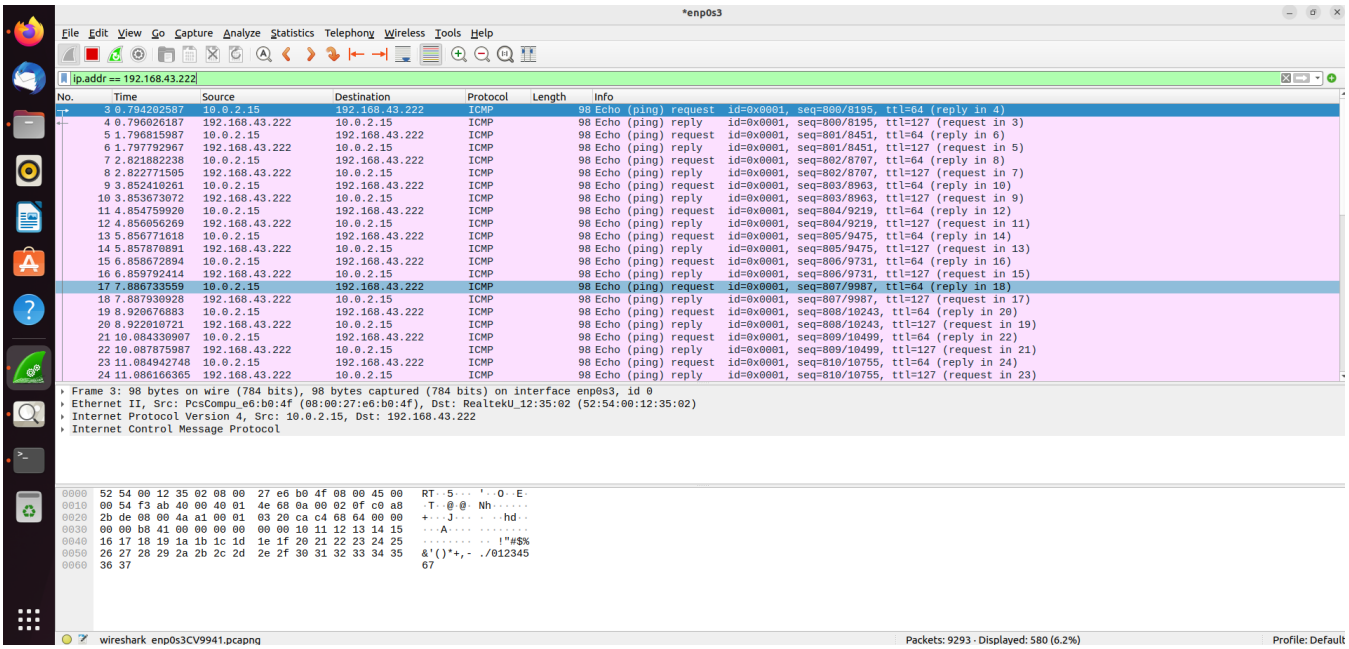
this allows us to send ping request to the device with the IP address 192.168.42.1

In the screenshot below we can observe that the connection have successfully achived using ping



Now we analyze the ping request using wireshark. In the below image we can now filter using ip.addr == 192.168.42.1 here we can now see all he packets that are getting transfered between thetwo devices.

Here there are requests and responses that we can now use to minitor the connection between thesetwo devices.


*enp0s3
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
ip.addr == 192.168.43.222
No. Time Source Destination Protocol Length Info
3 0.794202587 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=800/8195, ttl=64 (reply in 4)
4 0.796026187 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=800/8195, ttl=127 (request in 3)
5 1.796815987 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=801/8451, ttl=64 (reply in 6)
6 1.797792967 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=801/8451, ttl=127 (request in 5)
7 2.821882238 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=802/8707, ttl=64 (reply in 8)
8 2.822771505 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=802/8707, ttl=127 (request in 7)
9 3.852410261 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=803/8963, ttl=64 (reply in 10)
10 3.853673072 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=803/8963, ttl=127 (request in 9)
11 4.854759920 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=804/9219, ttl=64 (reply in 12)
12 4.856056269 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=804/9219, ttl=127 (request in 11)
13 5.856771618 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=805/9475, ttl=64 (reply in 14)
14 5.857870891 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=805/9475, ttl=127 (request in 13)
15 6.858672894 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=806/9731, ttl=64 (reply in 16)
16 6.859792414 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=806/9731, ttl=127 (request in 15)
17 7.886733559 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=807/9987, ttl=64 (reply in 18)
18 7.887930928 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=807/9987, ttl=127 (request in 17)
19 8.920676883 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=808/10243, ttl=64 (reply in 20)
20 8.922010721 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=808/10243, ttl=127 (request in 19)
21 10.084330907 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=809/10499, ttl=64 (reply in 22)
22 10.087875987 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=809/10499, ttl=127 (request in 21)
23 11.084942748 10.0.2.15 192.168.43.222 ICMP 98 Echo (ping) request id=0x0001, seq=810/10755, ttl=64 (reply in 24)
24 11.086166365 192.168.43.222 10.0.2.15 ICMP 98 Echo (ping) reply id=0x0001, seq=810/10755, ttl=127 (request in 23)
Frame 3: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface enp0s3, id 0
Ethernet II, Src: PcsCompu_e6:b0:4f (08:00:27:e6:b0:4f), Dst: RealtekU_12:35:02 (52:54:00:12:35:02)
Internet Protocol Version 4, Src: 10.0.2.15, Dst: 192.168.43.222
Internet Control Message Protocol
0000 52 54 00 12 35 02 08 00 27 e6 b0 4f 08 00 45 00
0010 00 54 f3 ab 40 00 40 01 4e 68 0a 00 02 0f c0 a8
0020 2b de 08 00 4a a1 00 01 03 20 ca c4 68 64 00 00
0030 00 00 b8 41 00 00 00 00 00 00 10 11 12 13 14 15
0040 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23 24 25
0050 26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 34 35
0060 36 37
wireshark enp0s3CV9941.pcapng
Packets: 9293 · Displayed: 580 (6.2%)
Profile: Default

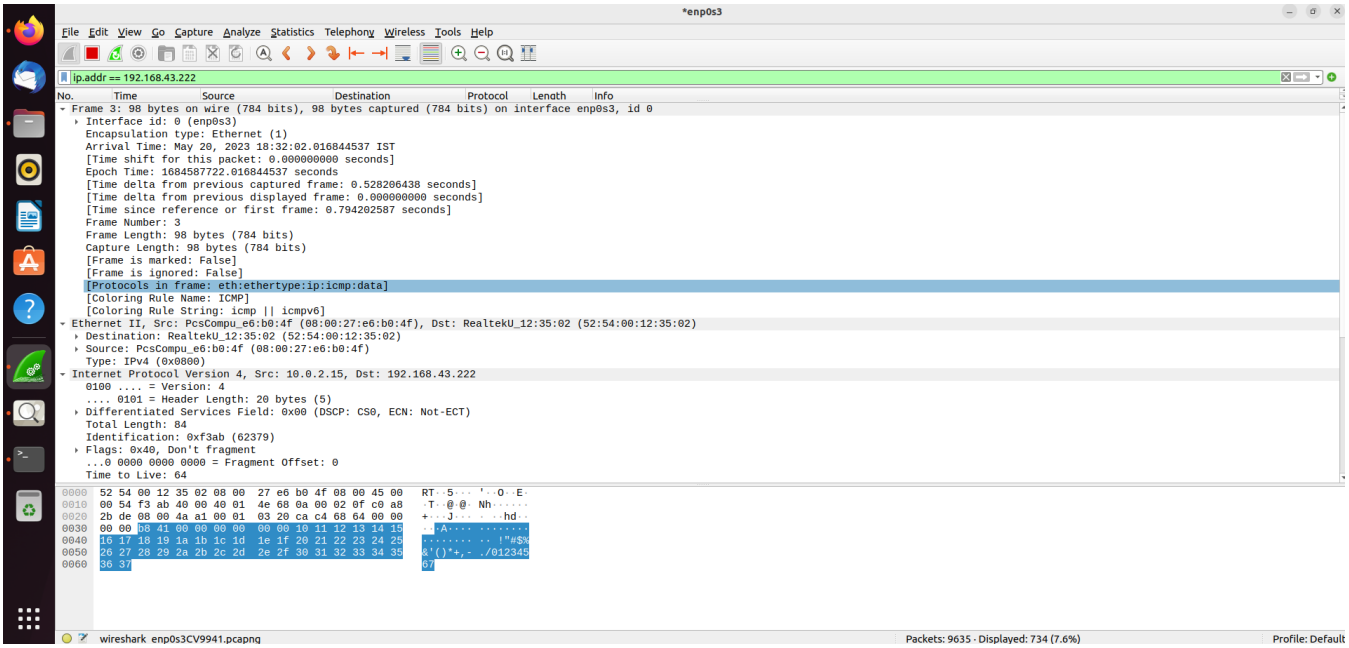
Request

The below image is the visual representation of the request that was generated.Here we can see the following data

1. Source IP: 192.168.42.222

2. Destination IP: 192.168.42.1

3. Length of the packet: 98 bytes
4. Type of the message: Echo (ping) request
5. Frame number: 2



Response

The below image is the visual representation of the response that was generated.Here we can see the following data

1. Source IP: 192.168.53.85
2. Destination IP: 192.168.53.216
3. Length of the packet: 98 bytes
4. Type of the message: Echo (ping) response
5. Request frame: 3
6. Response time: 206.677 ms