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Practical 1:

Default Network Topology (Point-to-Point)

Code:

```
#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-module.h"

using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("FirstScriptExample");

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

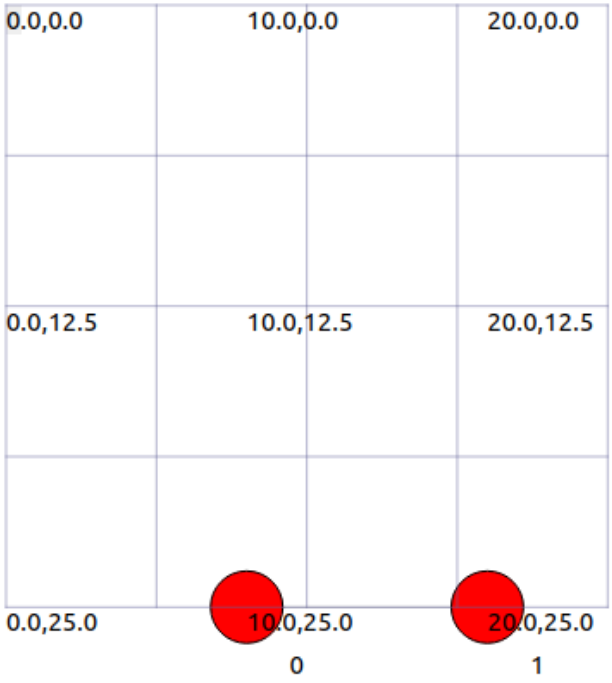
```
  clientApps.Stop (Seconds (10.0));

      //For Net Anim
      MobilityHelper mobility;
      mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
      mobility.Install(nodes);
      AnimationInterface anim("prac1.xml");
      AnimationInterface::SetConstantPosition (nodes.Get(0), 10, 25);
      AnimationInterface::SetConstantPosition(nodes.Get(1), 20,25);
      anim.EnablePacketMetadata(true);
      pointToPoint.EnablePcapAll("prac1");

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

Output:

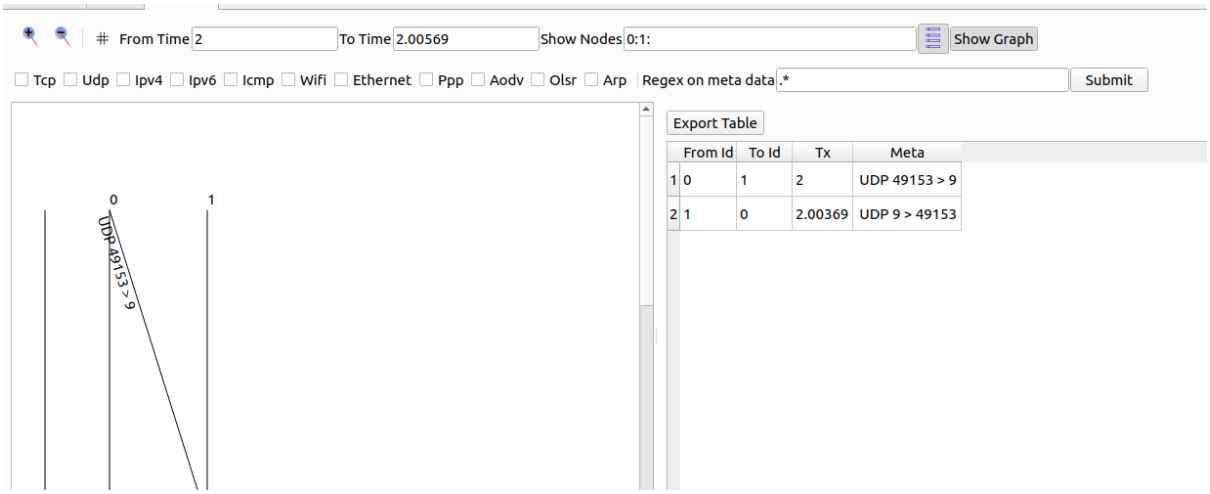
Run project

```
harshal-chavan@harshal-chavan:~/ns-allinone-3.29/ns-3.29$ ./waf --run prac1
Waf: Entering directory `/home/harshal-chavan/ns-allinone-3.29/ns-3.29/build'
[1791/1843] Compiling scratch/prac1.cc
[1822/1843] Linking build/scratch/prac1
Waf: Leaving directory `/home/harshal-chavan/ns-allinone-3.29/ns-3.29/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (12.592s)
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
harshal-chavan@harshal-chavan:~/ns-allinone-3.29/ns-3.29$
```

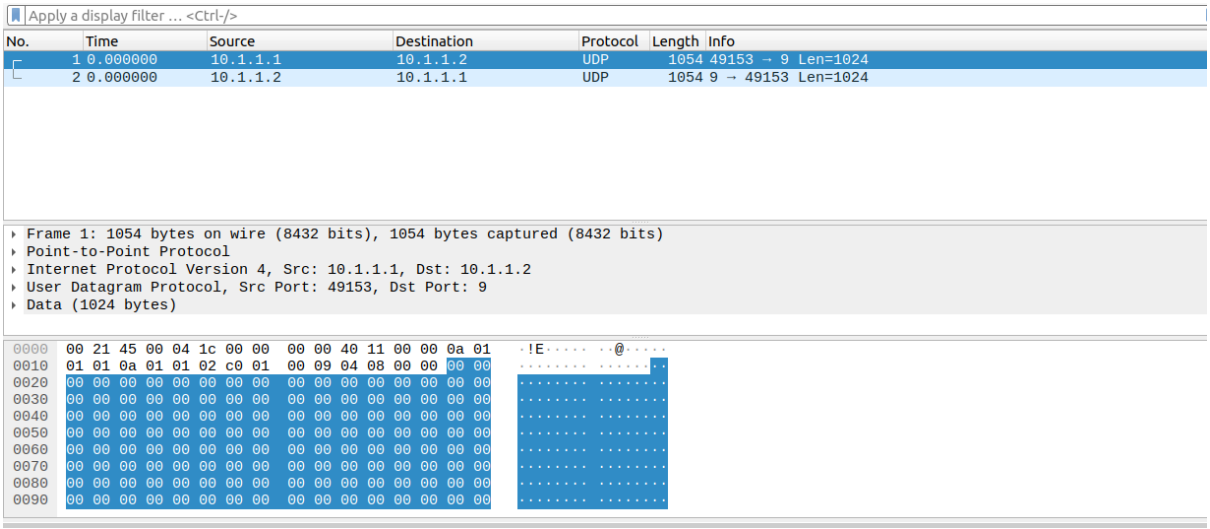
Xml file view in NetAnim



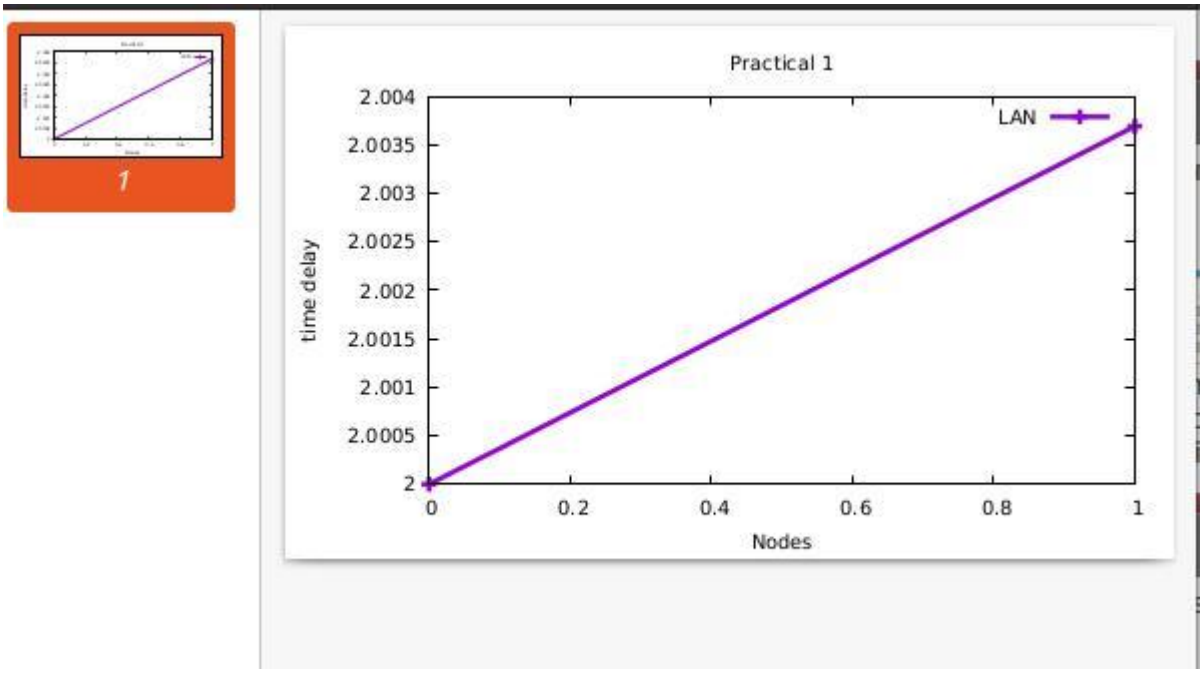
Export table



Wireshark file



Graph


1
Practical 1
LAN
time delay
2.004
2.0035
2.003
2.0025
2.002
2.0015
2.001
2.0005
2
0
0.2
0.4
0.6
0.8
1
Nodes

Practical 2:

Program to simulate Hybrid Topology (Point-to-Point + Bus Topology)

Code:

```
#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"
#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 ("Mini-Project");

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

```
uint32_t nCsma = 3;

CommandLine cmd;
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 p2pNodes;
p2pNodes.Create (2);

NodeContainer csmaNodes;
csmaNodes.Add (p2pNodes.Get (1));
csmaNodes.Create (nCsma);

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

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

CsmaHelper csma;
```

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

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

InternetStackHelper stack;
stack.Install (p2pNodes.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 (p2pNodes.Get (0));
```

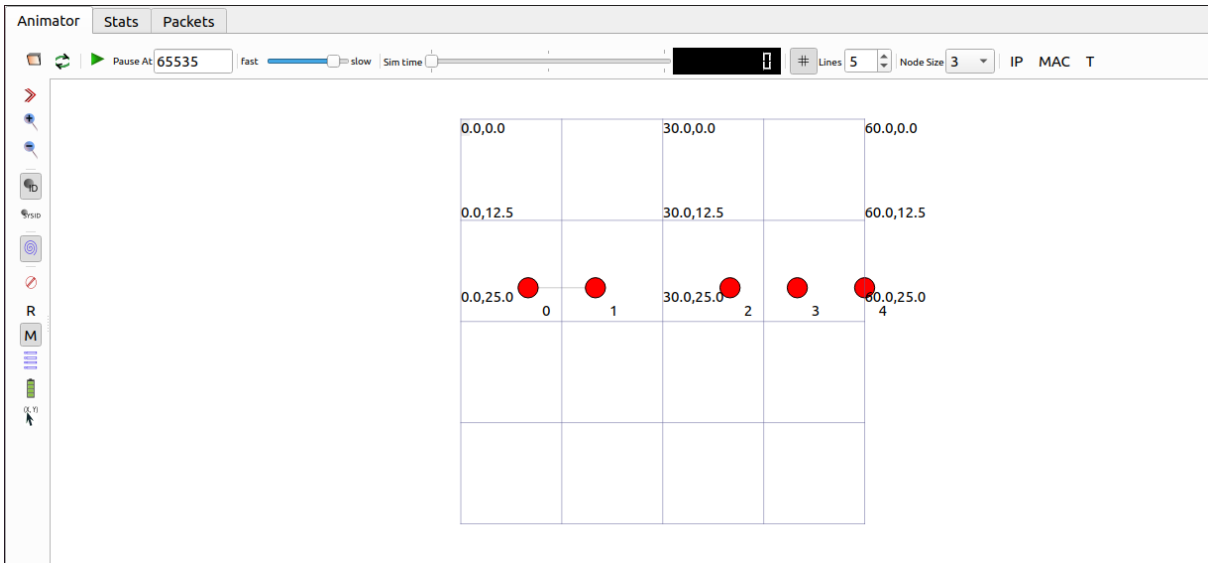
```
  clientApps.Start (Seconds (2.0));
  clientApps.Stop (Seconds (10.0));

  Ipv4GlobalRoutingHelper::PopulateRoutingTables ();

  pointToPoint.EnablePcapAll ("mini-project-hybrid-topology");
  csma.EnablePcap ("mini-project-hybrid-topology", csmaDevices.Get (1), true);

      //For Net Anim
      MobilityHelper mobility;
      mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
      mobility.Install(p2pNodes);
      mobility.Install(csmaNodes);
      AnimationInterface anim("mini-project-hybrid-topology.xml");
      AnimationInterface::SetConstantPosition (p2pNodes.Get(0), 10, 25);
      AnimationInterface::SetConstantPosition(p2pNodes.Get(1), 20,25);
      AnimationInterface::SetConstantPosition(csmaNodes.Get(1),40,25);
      AnimationInterface::SetConstantPosition(csmaNodes.Get(2),50,25);
      AnimationInterface::SetConstantPosition(csmaNodes.Get(3),60,25);
      anim.EnablePacketMetadata(true);

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

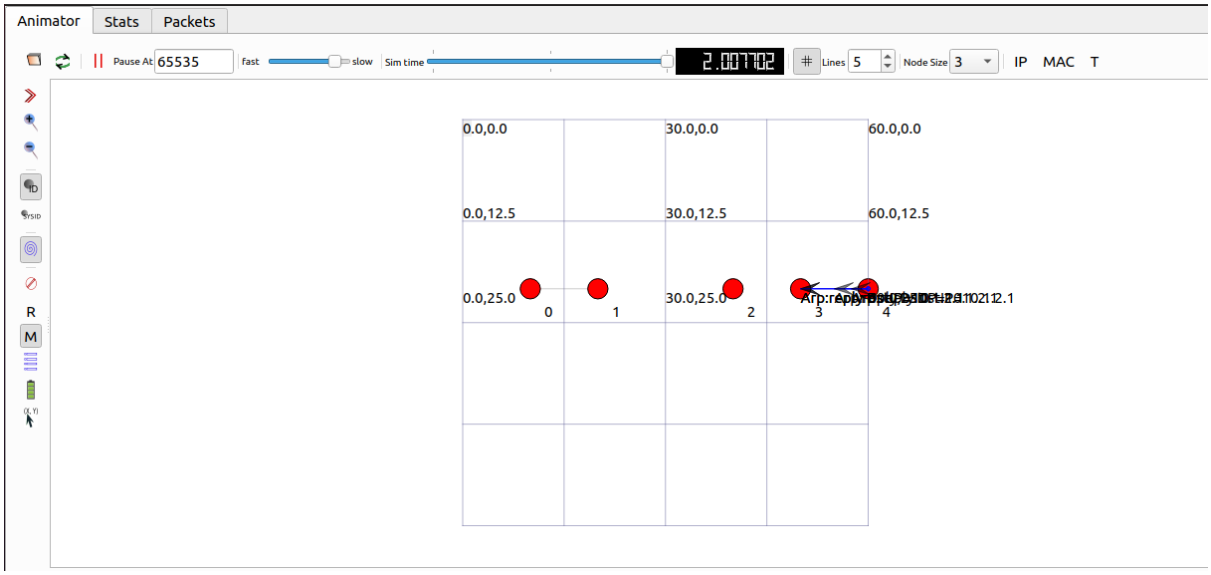
Output:

Run project

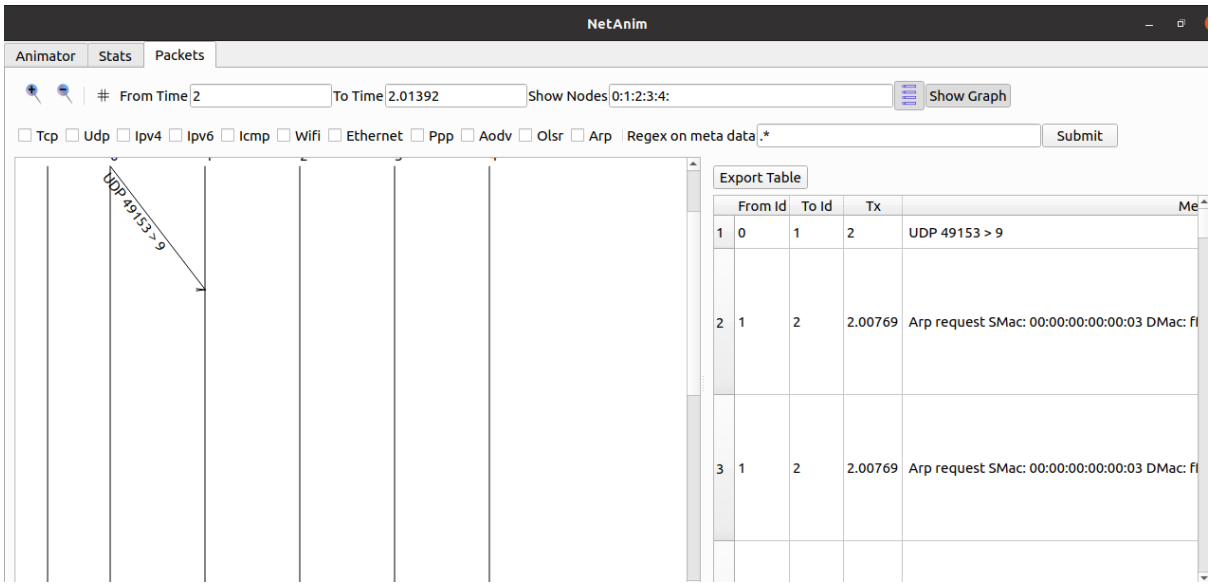
```
harshal-chavan@harshal-chavan:~/ns-allinone-3.29/ns-3.29$ ./waf --run mini-proje
ct
Waf: Entering directory `/home/harshal-chavan/ns-allinone-3.29/ns-3.29/build'
[1788/1841] Compiling scratch/mini-project.cc
[1801/1841] Linking build/scratch/mini-project
Waf: Leaving directory `/home/harshal-chavan/ns-allinone-3.29/ns-3.29/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (2m44.709s)
At time 2s client sent 1024 bytes to 10.1.2.4 port 9
At time 2.0078s server received 1024 bytes from 10.1.1.1 port 49153
At time 2.0078s server sent 1024 bytes to 10.1.1.1 port 49153
At time 2.01761s client received 1024 bytes from 10.1.2.4 port 9
harshal-chavan@harshal-chavan:~/ns-allinone-3.29/ns-3.29$
```

Xml file view in NetAnim





Export table



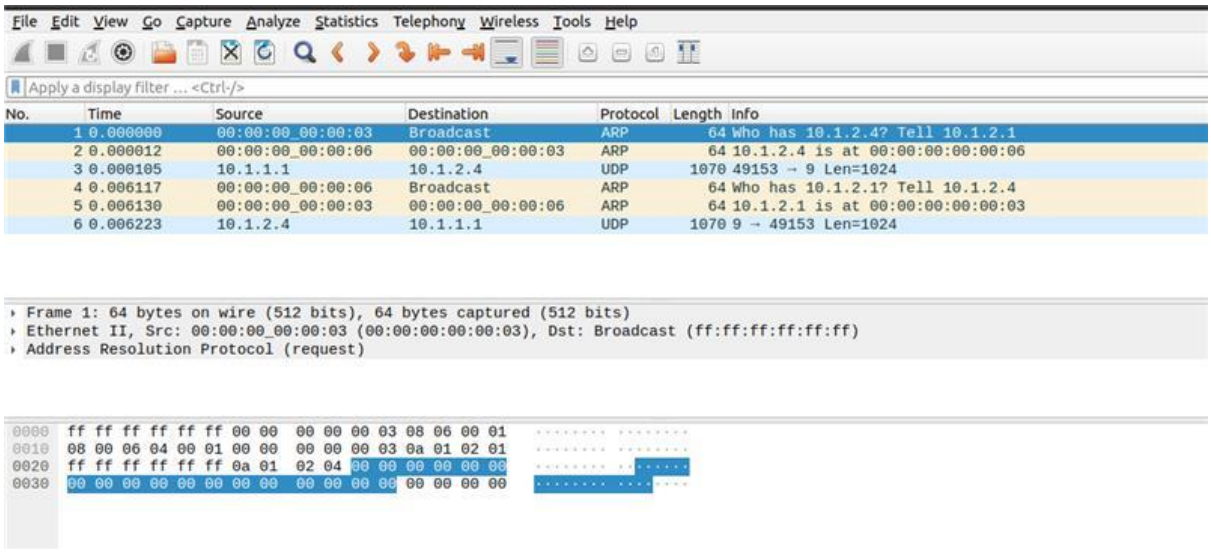
Exported data.txt file

```
From Id        To Id   Tx      Meta
0       1       2        UDP 49153 > 9
1       2       2.00769         Arp request SMac: 00:00:00:00:00:03 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       2       2.00769         Arp request SMac: 00:00:00:00:00:03 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       3       2.00769         Arp request SMac: 00:00:00:00:00:03 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       3       2.00769         Arp request SMac: 00:00:00:00:00:03 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       4       2.00769         Arp request SMac: 00:00:00:00:00:03 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       4       2.00769         Arp request SMac: 00:00:00:00:00:03 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.1 DstIp : 10.1.2.4
4       1       2.0077   Arp reply SMac: 00:00:00:00:00:06 DMac: 00:00:00:00:00:03  SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       1       2.0077   Arp reply SMac: 00:00:00:00:00:06 DMac: 00:00:00:00:00:03  SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       2       2.0077   Arp reply SMac: 00:00:00:00:00:06 DMac: 00:00:00:00:00:03  SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       3       2.0077   Arp reply SMac: 00:00:00:00:00:06 DMac: 00:00:00:00:00:03  SrcIp : 10.1.2.4 DstIp : 10.1.2.1
1       2       2.00771         UDP 49153 > 9
1       3       2.00771         UDP 49153 > 9
1       4       2.00771         UDP 49153 > 9
1       4       2.00771         UDP 49153 > 9
4       1       2.0138   Arp request SMac: 00:00:00:00:00:06 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       1       2.0138   Arp request SMac: 00:00:00:00:00:06 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       2       2.0138   Arp request SMac: 00:00:00:00:00:06 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       2       2.0138   Arp request SMac: 00:00:00:00:00:06 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       3       2.0138   Arp request SMac: 00:00:00:00:00:06 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.4 DstIp : 10.1.2.1
4       3       2.0138   Arp request SMac: 00:00:00:00:00:06 DMac: ff:ff:ff:ff:ff:ff SrcIp : 10.1.2.4 DstIp : 10.1.2.1
1       2       2.01382         Arp reply SMac: 00:00:00:00:00:03 DMac: 00:00:00:00:00:06  SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       3       2.01382         Arp reply SMac: 00:00:00:00:00:03 DMac: 00:00:00:00:00:06  SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       4       2.01382         Arp reply SMac: 00:00:00:00:00:03 DMac: 00:00:00:00:00:06  SrcIp : 10.1.2.1 DstIp : 10.1.2.4
1       4       2.01382         Arp reply SMac: 00:00:00:00:00:03 DMac: 00:00:00:00:00:06  SrcIp : 10.1.2.1 DstIp : 10.1.2.4
```

.plt file

```
set terminal pdf
set output "mini-project.pdf"
set title "P2P and Bus Topology"
set xlabel "Nodes"
set ylabel "time delay"
plot "data.txt" using 1:3 with linespoint title "LAN" lw 4
```

Wireshark file



Graph: