Experiment N0: 02
Name of Experiments: TCP Variants

Objective:

1. Create a simple dumbbell topology, two client Node1 and Node2 on the left side of the dumbbell and server nodes Node3 and Node4 on the right side of the dumbbell. Let Node5 and Node6 form the bridge of the dumbbell. Use point to point links.
2. Install a TCP socket instance on Node1 that will connect to Node3.
3. Install a UDP socket instance on Node2 that will connect to Node4.
4. Start the TCP application at time 1s.
5. Start the UDP application at time 20s at rate Rate1 such that it clogs half the dumbbell bridge's link capacity.
6. Increase the UDP application's rate at time 30s to rate Rate2 such that it clogs the whole of the dumbbell bridge's capacity.
7. Use the ns-3 tracing mechanism to record changes in congestion window size of the TCP instance over time. Use gnuplot/matplotlib to visualise plots of cwnd vs time.
8. Mark points of fast recovery and slow start in the graphs.
9. Perform the above experiment for TCP variants Tahoe, Reno and New Reno, all of which are available with ns-3.

Source Code:

```
#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"
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
//
```

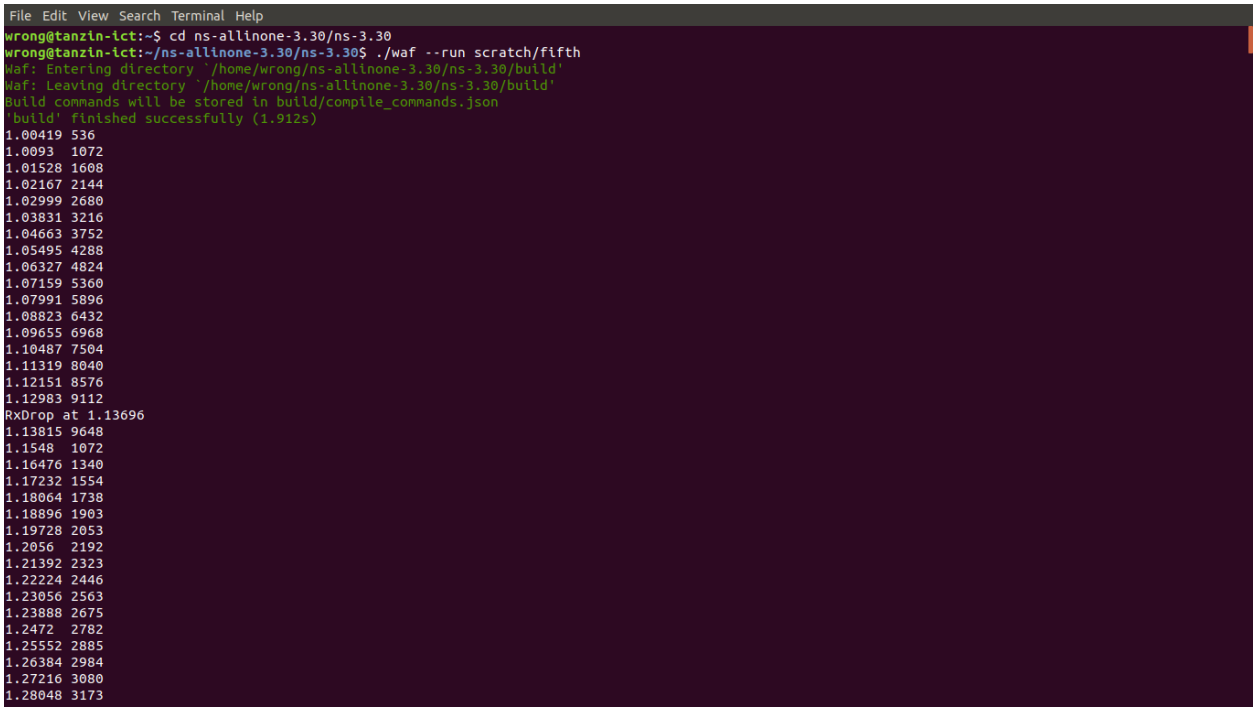
```
//
// We want to look at changes in the ns-3 TCP congestion window. We need
// to crank up a flow and hook the CongestionWindow attribute on the socket
// of the sender. Normally one would use an on-off application to generate a
// flow, but this has a couple of problems. First, the socket of the 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;
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));
Simulator::Stop (Seconds (20));
Simulator::Run ();
Simulator::Destroy ();
return 0;
}
```

OUTPUT :



```
File  Edit  View  Search  Terminal  Help
6.71344 4259
6.72176 4326
6.73008 4392
6.7384  4457
6.74672 4521
6.75504 4584
6.76336 4646
6.77168 4707
6.78    4768
6.78832 4828
6.79664 4887
6.80496 4945
6.81328 5003
6.8216  5060
6.82992 5116
6.83824 5172
6.84656 5227
6.85488 5281
6.8632  5335
6.87152 5388
6.87984 5441
6.88816 5493
6.89648 5545
6.9048  5596
6.91312 5647
6.92144 5697
6.92976 5747
6.93808 5796
6.9464  5845
6.95472 5894
6.96304 5942
6.97136 5990
6.97968 6037
6.988   6084
6.99632 6131
7.00464 6177
7.01296 6223
7.02128 6269
7.0296  6314
7.03792 6359
7.04624 6404
```

```
File  Edit  View  Search  Terminal  Help
8.99312 7622
9.00144 7659
9.00976 7696
9.01808 7733
9.0264  7770
9.03472 7806
9.04304 7842
9.05136 7878
9.05968 7914
9.068   7950
9.07632 7986
9.08464 8021
9.09296 8056
9.10128 8091
9.1096  8126
9.11792 8161
9.12624 8196
9.13456 8231
9.14288 8265
9.1512  8299
9.15952 8333
9.16784 8367
9.17616 8401
9.18448 8435
9.1928  8469
9.20112 8502
9.20944 8535
9.21776 8568
9.22608 8601
9.2344  8634
9.24272 8667
9.25104 8700
9.25936 8733
9.26768 8765
9.276   8797
9.28432 8829
9.29264 8861
9.30096 8893
9.30928 8925
9.3176  8957
wrong@tanzin-ict:~/ns-allinone-3.30/ns-3.30$
```

Conclusion:

With this experiment, we can learn how to install TCP and TCP socket, create dumbbell topology. Ns-3 tracing mechanism is used to record changes in congestion window size of the TCP instance over time and gnuplot to visualise plots of cwnd vs time. Congestion and packet loss will interact with TCP's connectivity and timing issues, and ultimately the overall performance of the network.