



# Mawlana Bhashani Science and Technology University

Santosh, Tangail-1902.

## Lab Report

### Department of Information and Communication Technology

**Report No:** 02

**Report Name:** TCP Variants.

**Course Title:** Wireless and Mobile Communication Lab

**Course Code:** ICT-4202

Submitted By	Submitted To
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## **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 :**

```
nilanjana@nilanjana-HP-Pavillon-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
nilanjana@nilanjana-HP-Pavillon-Notebook:~$ cd ns-allinone-3.30
nilanjana@nilanjana-HP-Pavillon-Notebook:~/ns-allinone-3.30$ cd ns-3.30
nilanjana@nilanjana-HP-Pavillon-Notebook:~/ns-allinone-3.30/ns-3.30$ ./waf --run scratch/fifth
Waf: Entering directory '/home/nilanjana/ns-allinone-3.30/ns-3.30/build'
Waf: Leaving directory '/home/nilanjana/ns-allinone-3.30/ns-3.30/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (1.431s)
1.00419 536
1.0093 1072
1.01528 1608
1.02167 2144
1.02999 2680
1.03831 3216
1.04663 3752
1.05495 4288
1.06327 4824
1.07159 5360
1.07991 5896
1.08823 6432
1.09655 6968
1.10487 7504
1.11319 8040
1.12151 8576
1.12983 9112
RxDrop at 1.13696
1.13815 9648
1.1548 1072
1.16476 1340
1.17232 1554
1.18064 1738
1.18896 1903
1.19728 2053
1.2056 2192
1.21392 2323
1.22224 2446
1.23056 2563
1.23888 2675
1.2472 2782
```

```
nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
1.23888 2675
1.2472 2782
1.25552 2885
1.26384 2984
1.27216 3080
1.28048 3173
1.2888 3263
1.29712 3351
1.30544 3436
1.31376 3519
1.32208 3600
1.3304 3679
1.33872 3757
1.34704 3833
1.35536 3907
1.36368 3980
1.372 4052
1.38032 4122
1.38864 4191
1.39696 4259
RxDrop at 1.4032
1.41272 4326
1.42104 1072
1.431 1340
RxDrop at 1.43648
1.63767 1554
1.6528 1072
1.66281 1340
1.66878 1554
1.67476 1738
1.68073 1903
1.68576 2053
1.69079 2192
1.69582 2323
1.69771 2446
1.7018 2563
1.70369 2675
1.70777 2782

nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
1.70369 2675
1.70777 2782
1.70966 2885
1.71375 2984
1.71564 3080
1.71878 3173
1.72067 3263
1.72381 3351
1.7257 3436
1.72758 3519
1.72978 3600
1.73167 3679
1.73356 3757
1.73576 3833
1.73764 3907
1.73953 3980
1.74142 4052
1.74331 4122
1.7452 4191
1.74708 4259
1.74897 4326
1.75086 4392
1.75275 4457
1.75464 4521
1.75652 4584
1.75841 4646
1.76215 4707
1.77047 4768
1.77879 4828
1.78711 4887
1.79543 4945
1.80375 5003
1.81207 5060
1.82039 5116
1.82871 5172
1.83703 5227
1.84535 5281
1.85367 5335
```

```
nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
1.84535 5281
1.85367 5335
1.86199 5388
1.87031 5441
1.87863 5493
1.88695 5545
1.89527 5596
1.90359 5647
1.91191 5697
1.92023 5747
1.92855 5796
1.93687 5845
1.94519 5894
1.95351 5942
1.96183 5990
1.97015 6037
1.97847 6084
1.98679 6131
1.99511 6177
2.00343 6223
2.01175 6269
2.02007 6314
2.02839 6359
2.03671 6404
2.04503 6448
2.05335 6492
2.06167 6536
2.06999 6579
2.07831 6622
2.08663 6665
2.09495 6708
2.10327 6750
2.11159 6792
2.11991 6834
2.12823 6876
2.13655 6917
2.14487 6958
2.15319 6999

nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
2.44439 8299
2.45271 8333
2.46103 8367
2.46935 8401
2.47767 8435
2.48599 8469
2.49431 8502
2.50263 8535
2.51095 8568
2.51927 8601
2.52759 8634
RxDrop at 2.53382
2.53682 8667
RxDrop at 2.54304
2.55258 1072
2.57267 1340
2.57865 1554
2.58583 1738
2.59415 1903
2.60247 2053
RxDrop at 2.6087
2.6117 2192
2.62002 1072
2.63003 1340
2.63664 1554
2.64496 1738
2.65328 1903
2.6616 2053
2.66992 2192
2.67824 2323
2.68656 2446
2.69488 2563
2.7032 2675
2.71152 2782
2.71984 2885
2.72816 2984
2.73648 3080
2.7448 3173
```

```
nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
2.73648 3080
2.7448 3173
2.75312 3263
2.76144 3351
2.76976 3436
2.77808 3519
2.7864 3600
2.79472 3679
2.80304 3757
2.81136 3833
2.81968 3907
2.828 3980
2.83632 4052
2.84464 4122
2.85296 4191
2.86128 4259
2.8696 4326
2.87792 4392
2.88624 4457
2.89456 4521
2.90288 4584
2.9112 4646
2.91952 4707
2.92784 4768
2.93616 4828
2.94448 4887
2.9528 4945
2.96112 5003
2.96944 5060
2.97776 5116
2.98608 5172
2.9944 5227
3.00272 5281
3.01104 5335
3.01936 5388
3.02768 5441
3.036 5493
3.04432 5545
```

```
nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
2.73648 3080
2.7448 3173
2.75312 3263
2.76144 3351
2.76976 3436
2.77808 3519
2.7864 3600
2.79472 3679
2.80304 3757
2.81136 3833
2.81968 3907
2.828 3980
2.83632 4052
2.84464 4122
2.85296 4191
2.86128 4259
2.8696 4326
2.87792 4392
2.88624 4457
2.89456 4521
2.90288 4584
2.9112 4646
2.91952 4707
2.92784 4768
2.93616 4828
2.94448 4887
2.9528 4945
2.96112 5003
2.96944 5060
2.97776 5116
2.98608 5172
2.9944 5227
3.00272 5281
3.01104 5335
3.01936 5388
3.02768 5441
3.036 5493
3.04432 5545
```



```
nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
3.63504 8435
3.64336 8469
3.65168 8502
3.66 8535
3.66832 8568
3.67664 8601
3.68496 8634
3.69328 8667
3.7016 8700
3.70992 8733
3.71824 8765
3.72656 8797
3.73488 8829
3.7432 8861
3.75152 8893
3.75984 8925
3.76816 8957
3.77648 8989
3.7848 9020
3.79312 9051
3.80144 9082
3.80976 9113
3.81808 9144
3.8264 9175
3.83472 9206
3.84304 9237
3.85136 9268
3.85968 9298
3.868 9328
3.87632 9358
3.88464 9388
3.89296 9418
3.90128 9448
3.9096 9478
3.91792 9508
3.92624 9538
3.93456 9568
3.94288 9598

nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
4.25904 10659
4.26736 10685
4.27568 10711
4.284 10737
4.29232 10763
4.30064 10789
4.30896 10815
4.31728 10841
4.3256 10867
4.33392 10893
4.34224 10919
4.35056 10945
4.35888 10971
4.3672 10997
4.37552 11023
4.38384 11049
4.39216 11075
4.40048 11100
4.4088 11125
4.41712 11150
4.42544 11175
4.43376 11200
4.44208 11225
4.4504 11250
4.45872 11275
4.46704 11300
4.47536 11325
4.48368 11350
4.492 11375
4.50032 11400
4.50864 11425
4.51696 11450
4.52528 11475
4.5336 11500
4.54192 11524
4.55024 11548
4.55856 11572
4.56688 11596
```

```
nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
4.8664 12440
4.87472 12463
4.88304 12486
4.89136 12509
4.89968 12531
4.908 12553
4.91632 12575
4.92464 12597
4.93296 12619
4.94128 12641
4.9496 12663
4.95792 12685
4.96624 12707
4.97456 12729
4.98288 12751
4.9912 12773
4.99952 12795
5.00784 12817
5.01616 12839
5.02448 12861
5.0328 12883
5.04112 12905
5.04944 12927
5.05776 12949
5.06608 12971
5.0744 12993
5.08272 13015
5.09104 13037
5.09936 13059
5.10768 13080
5.116 13101
5.12432 13122
5.13264 13143
5.14096 13164
5.14928 13185
5.1576 13206
5.16592 13227
5.17424 13248

nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
6.66352 3833
6.67184 3907
6.68016 3980
6.68848 4052
6.6968 4122
6.70512 4191
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
```

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```
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
7.05456 6448
7.06288 6492
7.0712 6536
7.07952 6579
7.08784 6622
7.09616 6665
7.10448 6708
7.1128 6750
7.12112 6792
7.12944 6834
7.13776 6876
7.14608 6917
7.1544 6958
7.16272 6999
7.17104 7040
7.17936 7080
7.18768 7120
7.196 7160
7.20432 7200
7.21264 7239
7.22096 7278
7.22928 7317
7.2376 7356
7.24592 7395
7.25424 7433
7.26256 7471
7.27088 7509
```

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```
7.89399 5845
7.90231 5894
7.91063 5942
7.91895 5990
7.92727 6037
7.93559 6084
7.94391 6131
7.95223 6177
7.96055 6223
7.96887 6269
7.97719 6314
7.98551 6359
7.99383 6404
8.00215 6448
8.01047 6492
8.01879 6536
8.02711 6579
8.03543 6622
8.04375 6665
8.05207 6708
8.06039 6750
8.06871 6792
8.07703 6834
8.08535 6876
8.09367 6917
8.10199 6958
8.11031 6999
8.11863 7040
8.12695 7080
8.13527 7120
8.14359 7160
8.15191 7200
RxDrop at 8.15814
8.16114 7239
8.16946 1072
8.17946 1340
8.18608 1554
8.1944 1738
```

```
nilanjana@nilanjana-HP-Pavilion-Notebook: ~/ns-allinone-3.30/ns-3.30
File Edit View Search Terminal Help
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
nilanjana@nilanjana-HP-Pavilion-Notebook:~/ns-allinone-3.30/ns-3.30$
```

## **Conclusion:**

Transmission Control Protocol (TCP) is a widely applied solution as it guarantees the delivery of data by implementing acknowledgement based techniques and used in wired networks as it ensures guard against the common remedy congestion in networks. The TCP congestion-avoidance algorithm is the primary basis for congestion control in the Internet. Per the end-to-end principle congestion control is largely a function of internet hosts, not the network itself. There are several variations and versions of the algorithm implemented in protocol stacks of operating systems of computers that connect to the Internet.