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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));
```

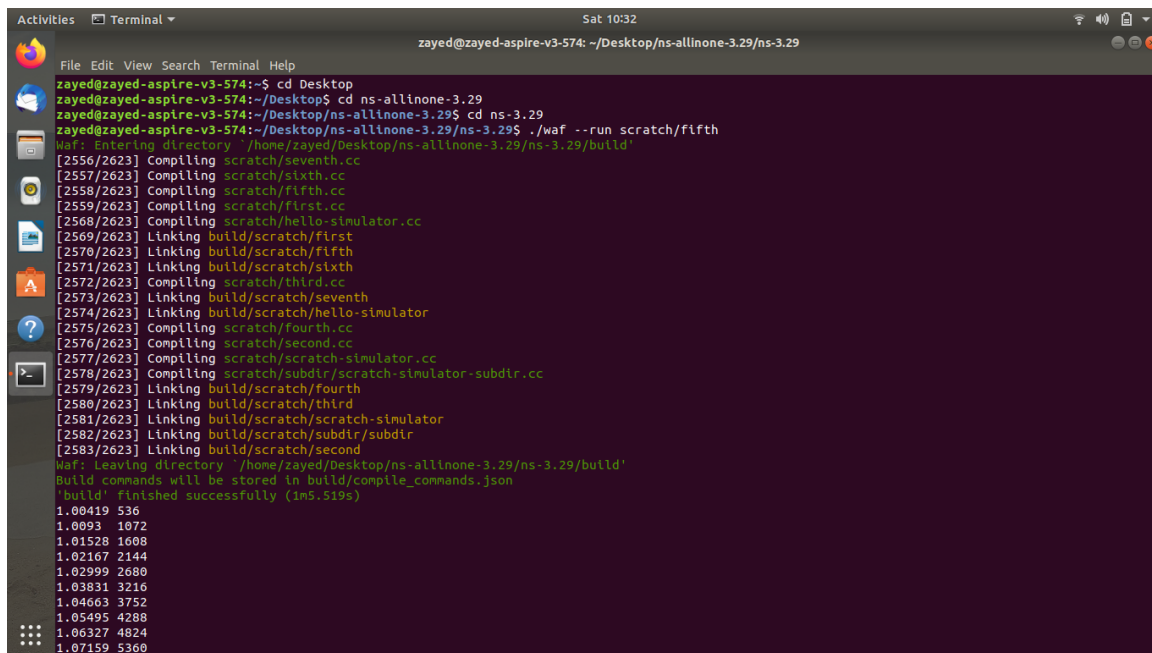
```
Simulator::Run ();
```

```
Simulator::Destroy ();
```

```
return 0;
```

```
}
```

OUTPUT :



```
Activities Terminal Sat 10:32
zayed@zayed-aspire-v3-574: ~/Desktop/ns-allinone-3.29/ns-3.29
File Edit View Search Terminal Help
zayed@zayed-aspire-v3-574:~$ cd Desktop
zayed@zayed-aspire-v3-574:~/Desktop$ cd ns-allinone-3.29
zayed@zayed-aspire-v3-574:~/Desktop/ns-allinone-3.29$ cd ns-3.29
zayed@zayed-aspire-v3-574:~/Desktop/ns-allinone-3.29/ns-3.29$ ./waf --run scratch/fifth
Waf: Entering directory '/home/zayed/Desktop/ns-allinone-3.29/ns-3.29/build'
[2556/2623] Compiling scratch/seventh.cc
[2557/2623] Compiling scratch/sixth.cc
[2558/2623] Compiling scratch/fifth.cc
[2559/2623] Compiling scratch/first.cc
[2568/2623] Compiling scratch/hello-simulator.cc
[2569/2623] Linking build/scratch/first
[2570/2623] Linking build/scratch/fifth
[2571/2623] Linking build/scratch/sixth
[2572/2623] Compiling scratch/third.cc
[2573/2623] Linking build/scratch/seventh
[2574/2623] Linking build/scratch/hello-simulator
[2575/2623] Compiling scratch/fourth.cc
[2576/2623] Compiling scratch/second.cc
[2577/2623] Compiling scratch/scratch-simulator.cc
[2578/2623] Compiling scratch/subdir/scratch-simulator-subdir.cc
[2579/2623] Linking build/scratch/fourth
[2580/2623] Linking build/scratch/third
[2581/2623] Linking build/scratch/scratch-simulator
[2582/2623] Linking build/scratch/subdir/subdir
[2583/2623] Linking build/scratch/second
Waf: Leaving directory '/home/zayed/Desktop/ns-allinone-3.29/ns-3.29/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (1m5.519s)
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
```

```
Activities Terminal Sat 10:32 zayed@zayed-aspire-v3-574: ~/Desktop/ns-allinone-3.29/ns-3.29
File Edit View Search Terminal Help
3.9096 9478
3.91792 9508
3.92624 9538
3.93456 9568
3.94288 9598
3.9512 9627
3.95952 9656
3.96784 9685
3.97616 9714
3.98448 9743
3.9928 9772
4.00112 9801
4.00944 9830
4.01776 9859
4.02608 9888
4.0344 9917
4.04272 9945
4.05104 9973
4.05936 10001
4.06768 10029
4.076 10057
4.08432 10085
4.09264 10113
4.10096 10141
4.10928 10169
4.1176 10197
4.12592 10225
4.13424 10253
4.14256 10281
4.15088 10308
4.1592 10335
4.16752 10362
4.17584 10389
4.18416 10416
4.19248 10443
4.2008 10470

Activities Terminal Sat 10:32 zayed@zayed-aspire-v3-574: ~/Desktop/ns-allinone-3.29/ns-3.29
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
zayed@zayed-aspire-v3-574:~/Desktop/ns-allinone-3.29/ns-3.29$
```