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Experiment No:02

Experiment Name: TCP variants

Objectives: In this experiment, the TCP variants have been applied based on the ns-3 installation.

Theoretical Explanation:

TCP is a transport layer protocol, part of the TCP/IP suite which defines how to establish and maintain a connection in a network. It is a connection-oriented, end-to-end reliable protocol designed to fit into a layered hierarchy of protocols which supports a variety network applications. TCP's design philosophy has evolved considerably from where the goal was to develop an effective packet switching protocol to a protocol which is fair, robust and reliable. As the internet traffic has increased substantially over the past few decades it was important for TCP to be fair and take into consideration the congestion in a network.

The TCP variants were supported by the NS-3.25 and 3.26 versions. Now these are user-friendly with the newer versions(example ns-3.29,ns-3.30)

To host TCP Socket attributes common to all implementations as follow :

– Send Buffer
– Receive Buffer
– Segment Size
– Slow Start Threshold
– Initial Congestion Window
– and few more

ns3.25 version support following TCP Variants :
– Tahoe
– Reno
– New Reno (default)

– Westwood
– Westwood+
– Hybla
– High Speed

TCP Reno

It was introduced in 1990 by Van Jacobson. It has the same features like TCP Tahoe. We can also represent it as follows:-
TCP Tahoe + Fast Recovery = TCP Reno

In TCP Reno when three duplicate packets are received, then it is the sign of congestion. If congestion occurs, then TCP Reno retransmits the packets and enters a new mechanism that is fast recovery. The following shows the algorithm for TCP Reno:-

```
if (cwnd<ssthresh)
cwnd = cwnd + 1 # slow start
else if (cwnd>= ssthresh)
cwnd = cwnd + 1/cwnd# congestion avoidance
if (duplicate ACK)
If (duplicate ACK = = (1 || 2))
cwnd = ssthresh #packet delayed/ out-of-packet received
```



```
ssthresh = cwnd/2
else (duplicate ACK > 2)
cwnd = cwnd + Number (ACK) # packet loss due to congestion
ssthresh = cwnd/2
```

The algorithm shows if cwnd (congestion window) is less than the threshold value (that is represented using variable ssthresh) then congestion window is increment by one otherwise it enters the slow start. As in algorithm shows if one or two acknowledgments are received, then threshold value is set half of the congestion window, but if more than two acknowledgments are received then it indicates the congestion. For each duplicate acknowledgment received increase congestion window by 1. TCP Reno has a limitation that, it can detect only single packet loss .

TCP New Reno

TCP New Reno is the extension of TCP Reno. It has some advantages over TCP Reno that can detect the multiple packet loss and it does not leave the fast recovery until it receives acknowledgment of all packets, present in the window . The fast recovery phase proceeds as in TCP Reno, when a fresh acknowledgment is received then there are two cases:- (i) If it acknowledges all the packets which are outstanding when entered fast recovery, then it exits fast recovery and set cwnd to ssthresh and still continues congestion avoidance. (ii) If the acknowledgment is an incomplete acknowledgement, then it deduces that the next packet in line was lost and it retransmits that packet and sets the number of duplicate acknowledgment received on 0 . We have some advantages of TCP New Reno these advantages are given below to measure the retransmit the packet :

It can detect multiple packet loss. Its congestion avoidance mechanism is very efficient and utilizes network resources much more efficiently. TCP New Reno has few retransmits because of its modified congestion avoidance and slow start.

TCP SACK

TCP SACK or selective acknowledgement requires that packets should acknowledge selectively. It is an option enabling a receiver to tell the sender the range of noncontiguous packets received. Without SACK, the receiver

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        cwnd = cwnd + 1 # slow start
                    else if (cwnd>= ssthresh) cwnd = cwnd + 1/cwnd#
                    congestion avoidance if (duplicate ACK)
        If (duplicate ACK = = (1 || 2))
        cwnd = ssthresh #packet delayed/ out-of-packet received
                              ssthresh = cwnd/2 else (duplicate
                              ACK> 2)
        cwnd = cwnd + Number (ACK) # packet loss due to congestion ssthresh =
        cwnd/2
```

The algorithm shows if cwnd (congestion window) is less than the threshold value (that is represented using variable ssthresh) then congestion window is increment by one otherwise it enters the slow start. As in algorithm shows if one or two acknowledgments are received, then threshold value is set half of the congestion window, but if more than two acknowledgments are received then it indicates the congestion. For each duplicate acknowledgment received increase congestion window by 1. TCP Reno has a limitation that, it can detect only single packet loss .

Pseudo Code for the TCP variants:

```
#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");

class MyApp : public Application

{

public:



  MyApp ();

  virtual ~MyApp();
```

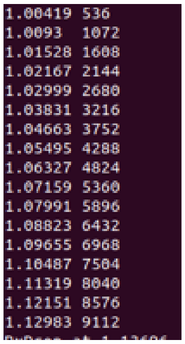
```
  void Setup (Ptr<Socket> socket, Address address, uint32_t packetSize, uint32_t nPackets,
DataRate dataRate);

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;
};
```

The generated output:



```
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
```

```
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)

{

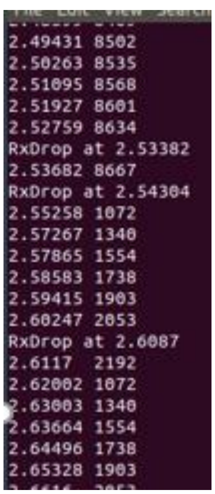
  Ptr<Packet> packet = Create<Packet> (m_packetSize);
```

```
  m_socket->Send (packet);

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

void
```

Output measured :



```
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
```

```
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);

}

  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));

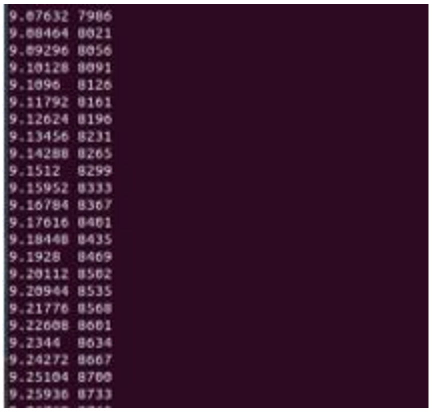
  Simulator::Run ();

  Simulator::Destroy ();


  return 0;

}
```

The obtained output:



Discussion: In this experiment the TCP(Transfer control protocol) variants were evaluated. The ns-3.30(upgraded version) were used. The code was written in C++ language. First Installing a TCP socket on sNode1 that connects to next Node. Then Installed a UDP socket instance on the former which will connect to another Node. When this connection is established the TCP application at time 1sec was started. Again the UDP application at time 20s at rate Rate1 such that it clogs half of the bridge's link capacity. Increase the UDP application's rate at time 30s to rate Rate2 such that it clogs the whole of the dumbbell bridge's capacity. Although TCP has six important variations the experiment were done for Tahoe, old Reno and new Reno.