Mawlana Bhashani Science and Technology University

Santosh, Tangail-1902.

Lab Report

Department of Information and Communication Technology

Report No: 03

Report Name: TCP and router queues.

Course Title: Wireless and Mobile Communication.

Course Code: ICT-4201

Submitted By	Submitted To
Name: **Md. Sohag** ID: **IT-16030** Session: 2015-16 4th Year 2nd Semester Dept. of Information & Communication Technology, MBSTU.	Nazrul Islam Assistant Professor Dept. of Information & Communication Technology, MBSTU.

Submission Date: 11-09-2020

Objective:

I have created a topology on left side and right side . I used four Nodes ,Node1 and Node2 on left side ,on the other hand node3 and node 4 on right side.Drop tail has been added to node5 and node6.drop tail queues size are QueueSize5 and QueueSize6.I have to Install a TCP socket instance on Node2 that will connect to Node3 and also Install a TCP socket instance on Node2 that will connect to Node4. Measure packet loss and cwnd size, and plot graphs throughput/time, cwnd/time and packet loss/time for each of the flows.

Source Code:

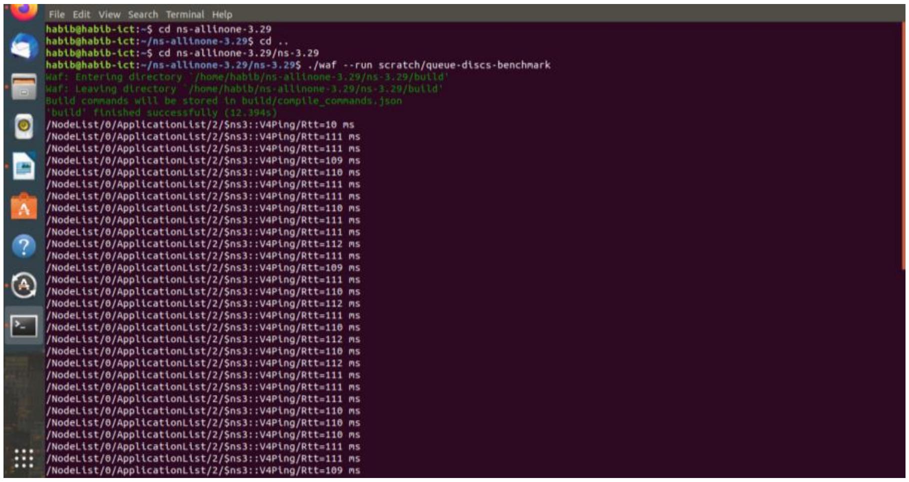
```
#include "ns3/core-module.h"

#include "ns3/network-module.h"

#include "ns3/internet-module.h"

#include "ns3/point-to-point-module.h"

#include "ns3/applications-module.h"

#include "ns3/internet-apps-module.h"

#include "ns3/traffic-control-module.h"

#include "ns3/flow-monitor-module.h"
```

```
using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("BenchmarkQueueDiscs");
void
LimitsTrace (Ptr<OutputStreamWrapper> stream, uint32_t oldVal, uint32_t newVal)
{
  *stream->GetStream () << Simulator::Now ().GetSeconds () << " " << newVal << std::endl;
}
void
BytesInQueueTrace (Ptr<OutputStreamWrapper> stream, uint32_t oldVal, uint32_t newVal)
{
  *stream->GetStream () << Simulator::Now ().GetSeconds () << " " << newVal << std::endl;
}
static void
GoodputSampling (std::string fileName, ApplicationContainer app, Ptr<OutputStreamWrapper> stream, float period)
{
  Simulator::Schedule (Seconds (period), &GoodputSampling, fileName, app, stream, period);
  double goodput;
  uint64_t totalPackets = DynamicCast<PacketSink> (app.Get (0))->GetTotalRx ();
  goodput = totalPackets * 8 / (Simulator::Now ().GetSeconds () * 1024); // Kbit/s
  *stream->GetStream () << Simulator::Now ().GetSeconds () << " " << goodput << std::endl;
}
static void PingRtt (std::string context, Time rtt)
{
  std::cout << context << "=" << rtt.GetMilliSeconds () << " ms" << std::endl;
}
int main (int argc, char *argv[])
{
  std::string bandwidth = "10Mbps";
  std::string delay = "5ms";
  std::string queueDiscType = "PfifoFast";
  uint32_t queueDiscSize = 1000;
  uint32_t netdevicesQueueSize = 50;
  bool bql = false;

  std::string flowsDatarate = "20Mbps";
  uint32_t flowsPacketsSize = 1000;
  float startTime = 0.1f; // in s
  float simDuration = 60;
  float samplingPeriod = 1;
  CommandLine cmd;
  cmd.AddValue ("bandwidth", "Bottleneck bandwidth", bandwidth);

  cmd.AddValue ("delay", "Bottleneck delay", delay);

  cmd.AddValue ("queueDiscType", "Bottleneck queue disc type in {PfifoFast, ARED, CoDel, FqCoDel, PIE, prio}", queueDiscType);

  cmd.AddValue ("queueDiscSize", "Bottleneck queue disc size in packets", queueDiscSize);

  cmd.AddValue ("netdevicesQueueSize", "Bottleneck netdevices queue size in packets", netdevicesQueueSize);

  cmd.AddValue ("bql", "Enable byte queue limits on bottleneck netdevices", bql);

  cmd.AddValue ("flowsDatarate", "Upload and download flows datarate", flowsDatarate);

  cmd.AddValue ("flowsPacketsSize", "Upload and download flows packets sizes", flowsPacketsSize);

  cmd.AddValue ("startTime", "Simulation start time", startTime);

  cmd.AddValue ("simDuration", "Simulation duration in seconds", simDuration);

  cmd.AddValue ("samplingPeriod", "Goodput sampling period in seconds", samplingPeriod);

  cmd.Parse (argc, argv);

  float stopTime = startTime + simDuration;

  // Create nodes

  NodeContainer n1, n2, n3;

  n1.Create (1);

  n2.Create (1);

  n3.Create (1);
  // Create and configure access link and bottleneck link
  PointToPointHelper accessLink;
  accessLink.SetDeviceAttribute ("DataRate", StringValue ("100Mbps"));
  accessLink.SetChannelAttribute ("Delay", StringValue ("0.1ms"));

  PointToPointHelper bottleneckLink;
  bottleneckLink.SetDeviceAttribute ("DataRate", StringValue (bandwidth));
  bottleneckLink.SetChannelAttribute ("Delay", StringValue (delay));
  InternetStackHelper stack;
  stack.InstallAll ();
  // Access link traffic control configuration
  TrafficControlHelper tchPfifoFastAccess;
  tchPfifoFastAccess.SetRootQueueDisc ("ns3::PfifoFastQueueDisc", "MaxSize",
StringValue ("1000p"));
  // Bottleneck link traffic control configuration
  TrafficControlHelper tchBottleneck;
  if (queueDiscType.compare ("PfifoFast") == 0)
    {
      tchBottleneck.SetRootQueueDisc ("ns3::PfifoFastQueueDisc", "MaxSize",
       QueueSizeValue (QueueSize (QueueSizeUnit::PACKETS, queueDiscSize)));
    }
  else if (queueDiscType.compare ("ARED") == 0)
    {
      tchBottleneck.SetRootQueueDisc ("ns3::RedQueueDisc");
      Config::SetDefault ("ns3::RedQueueDisc::ARED", BooleanValue (true));
      Config::SetDefault ("ns3::RedQueueDisc::MaxSize",
       QueueSizeValue (QueueSize (QueueSizeUnit::PACKETS, queueDiscSize)));
    }
  else if (queueDiscType.compare ("CoDel") == 0)
    {
      tchBottleneck.SetRootQueueDisc ("ns3::CoDelQueueDisc");
      Config::SetDefault ("ns3::CoDelQueueDisc::MaxSize",
                          QueueSizeValue (QueueSize (QueueSizeUnit::PACKETS,
queueDiscSize)));
    }
  else if (queueDiscType.compare ("FqCoDel") == 0)
    {
      tchBottleneck.SetRootQueueDisc ("ns3::FqCoDelQueueDisc");
      Config::SetDefault ("ns3::FqCoDelQueueDisc::MaxSize",
      QueueSizeValue (QueueSize (QueueSizeUnit::PACKETS, queueDiscSize)));
    }
  else if (queueDiscType.compare ("PIE") == 0)
    {
      tchBottleneck.SetRootQueueDisc ("ns3::PieQueueDisc");
      Config::SetDefault ("ns3::PieQueueDisc::MaxSize",
      QueueSizeValue (QueueSize (QueueSizeUnit::PACKETS, queueDiscSize)));
    }
  else if (queueDiscType.compare ("prio") == 0)
    {
      uint16_t handle = tchBottleneck.SetRootQueueDisc ("ns3::PrioQueueDisc",
"Priomap",
       StringValue ("0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1"));
      TrafficControlHelper::ClassIdList cid = tchBottleneck.AddQueueDiscClasses
(handle, 2, "ns3::QueueDiscClass");
      tchBottleneck.AddChildQueueDisc (handle, cid[0], "ns3::FifoQueueDisc");
      tchBottleneck.AddChildQueueDisc (handle, cid[1], "ns3::RedQueueDisc");
    }
  else
    {
      NS_ABORT_MSG ("--queueDiscType not valid");
    }

  if (bql)
    {
      tchBottleneck.SetQueueLimits ("ns3::DynamicQueueLimits");
    }
  Config::SetDefault ("ns3::QueueBase::MaxSize", StringValue ("100p"));
  NetDeviceContainer devicesAccessLink = accessLink.Install (n1.Get (0), n2.Get (0));
  tchPfifoFastAccess.Install (devicesAccessLink);
  Ipv4AddressHelper address;
  address.SetBase ("192.168.0.0", "255.255.255.0");
  address.NewNetwork ();
  Ipv4InterfaceContainer interfacesAccess = address.Assign (devicesAccessLink);
  Config::SetDefault ("ns3::QueueBase::MaxSize", StringValue (std::to_string (netdevicesQueueSize) + "p"));
  NetDeviceContainer devicesBottleneckLink = bottleneckLink.Install (n2.Get (0), n3.Get (0));
  QueueDiscContainer qdiscs;
  qdiscs = tchBottleneck.Install (devicesBottleneckLink);
  address.NewNetwork ();
  Ipv4InterfaceContainer interfacesBottleneck = address.Assign (devicesBottleneckLink);
  Ptr<NetDeviceQueueInterface> interface = devicesBottleneckLink.Get (0)->GetObject<NetDeviceQueueInterface> ();
  Ptr<NetDeviceQueue> queueInterface = interface->GetTxQueue (0);
  Ptr<DynamicQueueLimits> queueLimits = StaticCast<DynamicQueueLimits> (queueInterface->GetQueueLimits ());

  AsciiTraceHelper ascii;
  if (bql)
    {
      queueDiscType = queueDiscType + "-bql";
      Ptr<OutputStreamWrapper> streamLimits = ascii.CreateFileStream
(queueDiscType + "-limits.txt");
      queueLimits->TraceConnectWithoutContext ("Limit",MakeBoundCallback
(&LimitsTrace, streamLimits));
    }
  Ptr<Queue<Packet> > queue = StaticCast<PointToPointNetDevice>
(devicesBottleneckLink.Get (0))->GetQueue ();
  Ptr<OutputStreamWrapper> streamBytesInQueue = ascii.CreateFileStream
(queueDiscType + "-bytesInQueue.txt");
  queue->TraceConnectWithoutContext ("BytesInQueue",MakeBoundCallback
(&BytesInQueueTrace, streamBytesInQueue));
  Ipv4InterfaceContainer n1Interface;
  n1Interface.Add (interfacesAccess.Get (0));
  Ipv4InterfaceContainer n3Interface;
  n3Interface.Add (interfacesBottleneck.Get (1));
  Ipv4GlobalRoutingHelper::PopulateRoutingTables ();
  Config::SetDefault ("ns3::TcpSocket::SegmentSize", UintegerValue
(flowsPacketsSize));

  // Flows configuration
  // Bidirectional TCP streams with ping like flent tcp_bidirectional test.
  uint16_t port = 7;
  ApplicationContainer uploadApp, downloadApp, sourceApps;
  // Configure and install upload flow
  Address addUp (InetSocketAddress (Ipv4Address::GetAny (), port));
  PacketSinkHelper sinkHelperUp ("ns3::TcpSocketFactory", addUp);
  sinkHelperUp.SetAttribute ("Protocol", TypeIdValue (TcpSocketFactory::GetTypeId
()));
  uploadApp.Add (sinkHelperUp.Install (n3));

  InetSocketAddress socketAddressUp = InetSocketAddress (n3Interface.GetAddress
(0), port);
  OnOffHelper onOffHelperUp ("ns3::TcpSocketFactory", Address ());
  onOffHelperUp.SetAttribute ("Remote", AddressValue (socketAddressUp));
  onOffHelperUp.SetAttribute ("OnTime", StringValue
("ns3::ConstantRandomVariable[Constant=1]"));
  onOffHelperUp.SetAttribute ("OffTime", StringValue
("ns3::ConstantRandomVariable[Constant=0]"));
  onOffHelperUp.SetAttribute ("PacketSize", UintegerValue (flowsPacketsSize));
  onOffHelperUp.SetAttribute ("DataRate", StringValue (flowsDatarate));
  sourceApps.Add (onOffHelperUp.Install (n1));

  port = 8;
  // Configure and install download flow
  Address addDown (InetSocketAddress (Ipv4Address::GetAny (), port));
  PacketSinkHelper sinkHelperDown ("ns3::TcpSocketFactory", addDown);
  sinkHelperDown.SetAttribute ("Protocol", TypeIdValue
(TcpSocketFactory::GetTypeId ()));
```

```
  downloadApp.Add (sinkHelperDown.Install (n1));


  InetSocketAddress socketAddressDown = InetSocketAddress (n1Interface.GetAddress (0), port);
  OnOffHelper onOffHelperDown ("ns3::TcpSocketFactory", Address ());
  onOffHelperDown.SetAttribute ("Remote", AddressValue (socketAddressDown));
  onOffHelperDown.SetAttribute ("OnTime", StringValue ("ns3::ConstantRandomVariable[Constant=1]"));
  onOffHelperDown.SetAttribute ("OffTime", StringValue ("ns3::ConstantRandomVariable[Constant=0]"));
  onOffHelperDown.SetAttribute ("PacketSize", UintegerValue (flowsPacketsSize));
  onOffHelperDown.SetAttribute ("DataRate", StringValue (flowsDatarate));
  sourceApps.Add (onOffHelperDown.Install (n3));


  // Configure and install ping
  V4PingHelper ping = V4PingHelper (n3Interface.GetAddress (0));
  ping.Install (n1);


  Config::Connect ("/NodeList/*/ApplicationList/*/$ns3::V4Ping/Rtt", MakeCallback (&PingRtt));
  uploadApp.Start (Seconds (0));
  uploadApp.Stop (Seconds (stopTime));
  downloadApp.Start (Seconds (0));
  downloadApp.Stop (Seconds (stopTime));
```

```
sourceApps.Start (Seconds (0 + 0.1));

  sourceApps.Stop (Seconds (stopTime - 0.1));

  Ptr<OutputStreamWrapper> uploadGoodputStream = ascii.CreateFileStream
(queueDiscType + "-upGoodput.txt");

  Simulator::Schedule (Seconds (samplingPeriod), &GoodputSampling,
queueDiscType + "-upGoodput.txt", uploadApp,

                       uploadGoodputStream, samplingPeriod);

  Ptr<OutputStreamWrapper> downloadGoodputStream = ascii.CreateFileStream
(queueDiscType + "-downGoodput.txt");

  Simulator::Schedule (Seconds (samplingPeriod), &GoodputSampling,
queueDiscType + "-downGoodput.txt", downloadApp,

 downloadGoodputStream, samplingPeriod);

// Flow monitor

  Ptr<FlowMonitor> flowMonitor;

   FlowMonitorHelper flowHelper;

  flowMonitor = flowHelper.InstallAll();

 Simulator::Stop (Seconds (stopTime));

  Simulator::Run ();

  flowMonitor->SerializeToXmlFile(queueDiscType + "-flowMonitor.xml", true, true);

  Simulator::Destroy ();

  return 0;

}
```

Output:



```
habib@habib-ict:~$ cd ns-allinone-3.29
habib@habib-ict:~/ns-allinone-3.29$ cd ..
habib@habib-ict:~$ cd ns-allinone-3.29/ns-3.29
habib@habib-ict:~/ns-allinone-3.29/ns-3.29$ ./waf --run scratch/queue-discs-benchmark
Waf: Entering directory `/home/habib/ns-allinone-3.29/ns-3.29/build'
Waf: Leaving directory `/home/habib/ns-allinone-3.29/ns-3.29/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (12.394s)
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=10 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=109 ms
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/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=109 ms
```

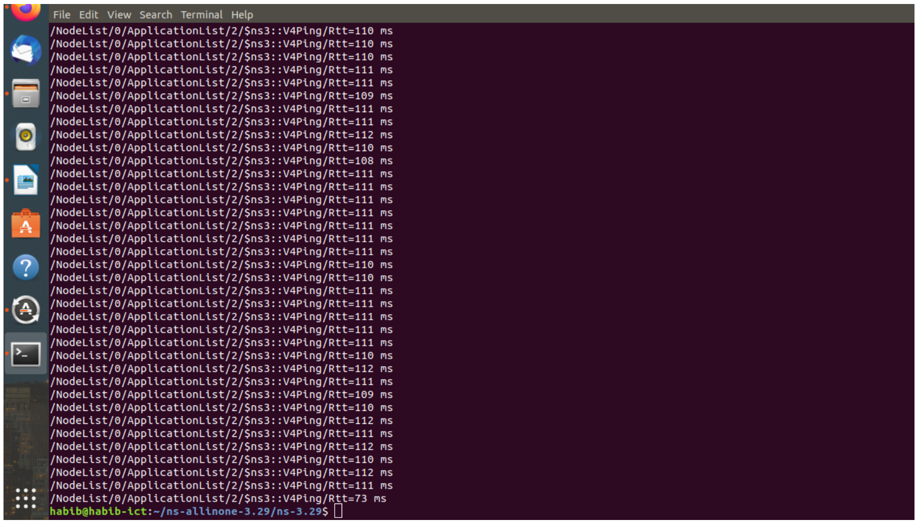

```
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=110 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=110 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=110 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
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/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=112 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=73 ms
habib@habib-ict:~/ns-allinone-3.29/ns-3.29$
```

Conclusion:

With the way the Internet works, we have no direct control of what people send us. It's a bit like your (physical!) mailbox at home. There is no way you can influence the world to modify the amount of mail they send you, short of contacting everybody.

However, the Internet is mostly based on TCP/IP which has a few features that help us. TCP/IP has no way of knowing the capacity of the network between two hosts, so it just starts sending data faster and faster ('slow start') and when packets start getting lost, because there is no room to send them, it will slow down. In fact it is a bit smarter than this, but more about that later.