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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

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Objective:

I. Simple topology with two client node1, node 2 on the left side and node3 and node4 in the right side. Add drop tail queues of size QueueSize5 and QueueSize6 to Node5 and Node5 and Node6.
II. Install a TCP socket instance on Node1 that will connect to Node3.
III. We 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.
IV. Measure packet loss and cwnd size, and plot graphs throughput/time, cwnd/time and packet loss/time for each of the flows.
V. Plot graph throughput/cwnd and packet loss/cwnd for the first flow. Is there an optimal value for cwnd?
VI. Vary QueueSize5 and QueueSize6. Which one has immediate effect on cwnd size of the first flow

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");
  }
```

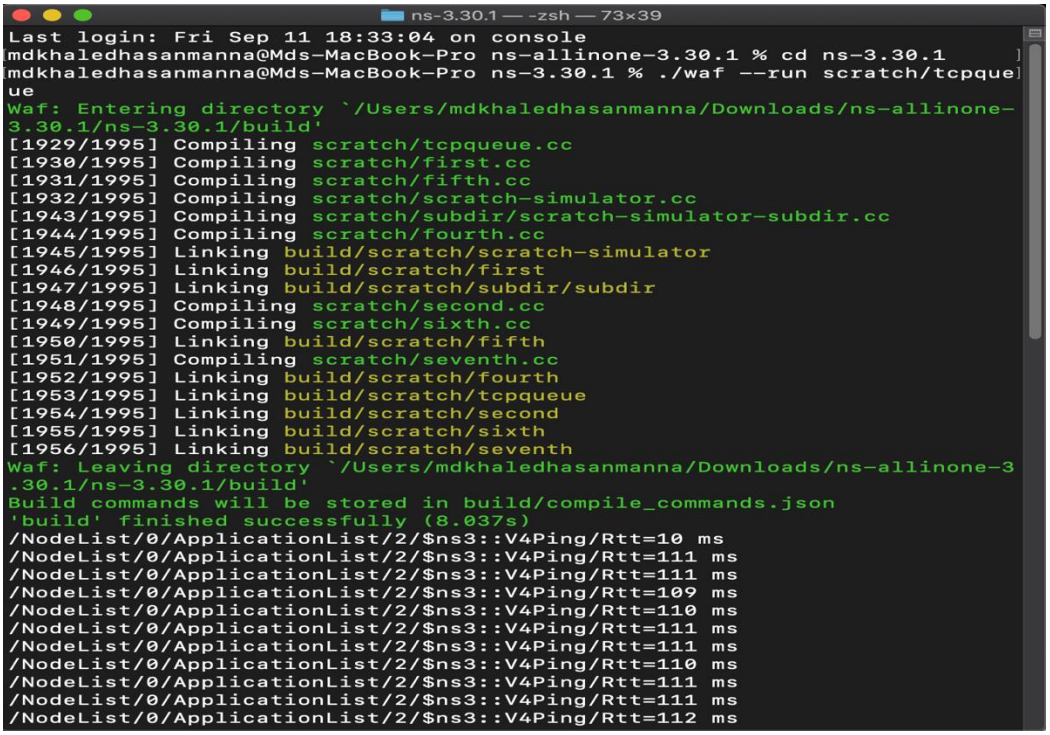
```
Config::SetDefault ("ns3::QueueBase::MaxSize", StringValue ("100p"));

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));
```

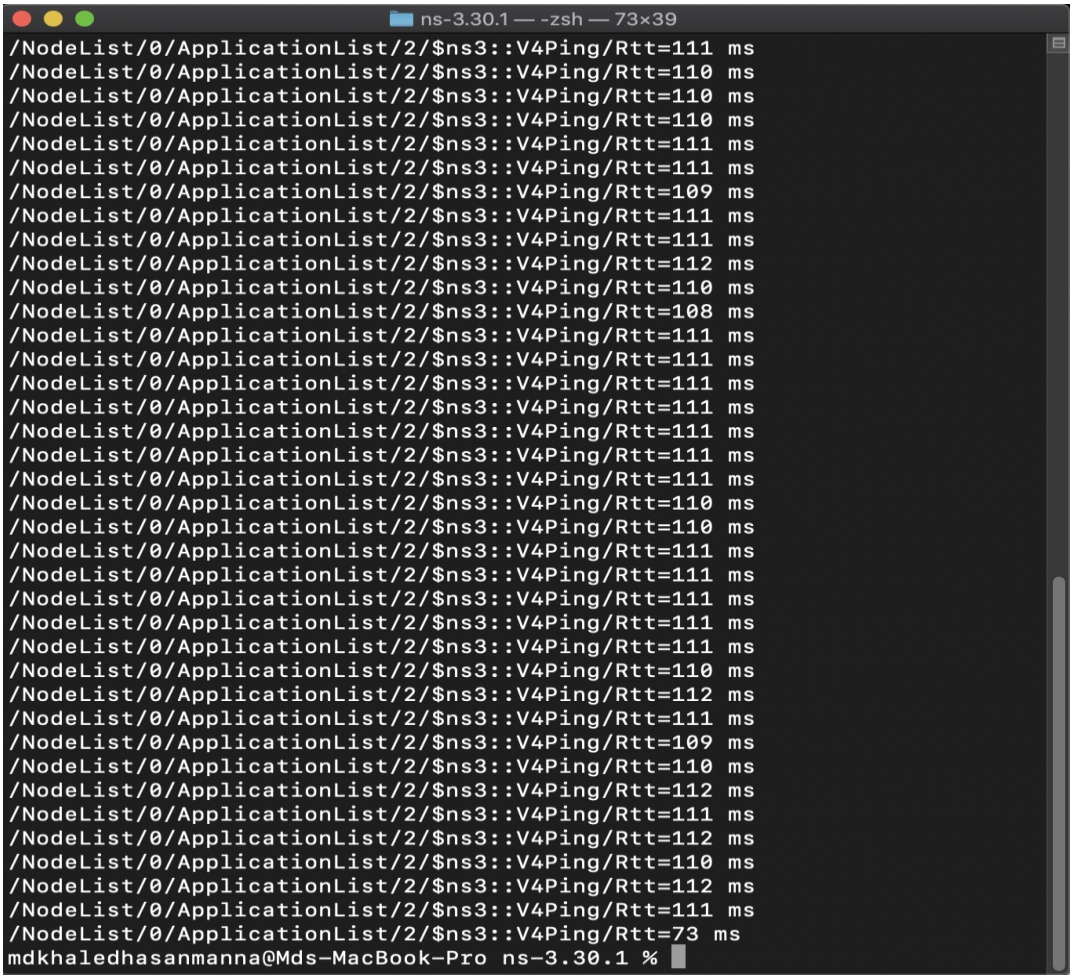
```
Ipv4InterfaceContainer n3Interface;
n3Interface.Add (interfacesBottleneck.Get (1));
Ipv4GlobalRoutingHelper::PopulateRoutingTables ();
Config::SetDefault ("ns3::TcpSocket::SegmentSize", UintegerValue (flowsPacketsSize));

// 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:





Conclusion:

Routers work at the Internet, data link, and physical layers of the **TCP**/IP structure. A router resembles an octopus whose tentacles represent all of your cabling types. TCP & Router Queues, packet drops and their effect on congestion window size.

Routers are aware of the multiple paths that your data packets can take across the network to their final destination.