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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 Lab.
Course Code: ICT-4202

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Objective:

We have to create a topology with two client node1, node 2 on left and node3 and node4 on right side. Then, we have to add a drop tail queues of size queueSize5, queueSize6 with respect to node5, node6. After that, we have to install a TCP socket instance on node1 which will connect node3.

We have to install a TCP socket instance on node2 that will also connect node3 and also another TCP socket instance on node2 for connecting node4.Then, Measuring packet loss and cwnd size, plotting graphs throughput/time, cwnd/time and packet loss/time for each of the flows.

Source Code:

```
// Network topology
//
//             192.168.1.0                    192.168.2.0
// n1 ------------------------------------ n2 ---------------------------------- n3
//   point-to-point (access link)            point-to-point (bottleneck link)
//   100 Mbps, 0.1 ms                       bandwidth [10 Mbps], delay [5 ms]
//   qdiscs PfifoFast with capacity          qdiscs queueDiscType in {PfifoFast, ARED, CoDel, FqCoDel, PIE} [PfifoFast]
//   of 1000 packets                        with capacity of queueDiscSize packets [1000]
//   net devices queues with size of 100 packets  net devices queues with size of net devices QueueSize packets [100]
// Two TCP flows are generated: one from n1 to n3 and the other from n3 to n1.
// Additionally, n1 pings n3, so that the RTT can be measured.
//
// The output will consist of a number of ping Rtt such as:
```

```
//
//    /NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
//    /NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
//    /NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=110 ms
//    /NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
//    /NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
//    /NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=112 ms
//    /NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms

#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));
```

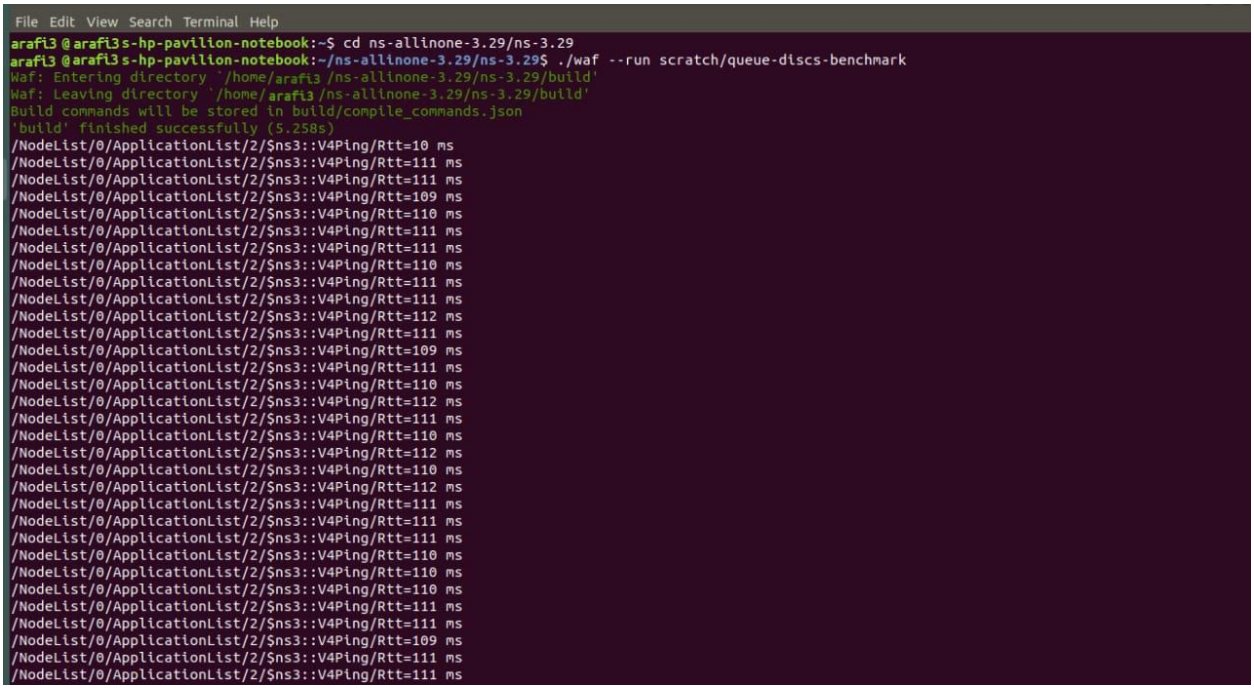
```
  tchPfifoFastAccess.Install (devicesAccessLink);

  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:


File Edit View Search Terminal Help
arafi3@arafi3s-hp-pavilion-notebook:~$ cd ns-allinone-3.29/ns-3.29
arafi3@arafi3s-hp-pavilion-notebook:~/ns-allinone-3.29/ns-3.29$ ./waf --run scratch/queue-discs-benchmark
Waf: Entering directory `/home/arafi3/ns-allinone-3.29/ns-3.29/build'
Waf: Leaving directory '/home/arafi3/ns-allinone-3.29/ns-3.29/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (5.258s)
/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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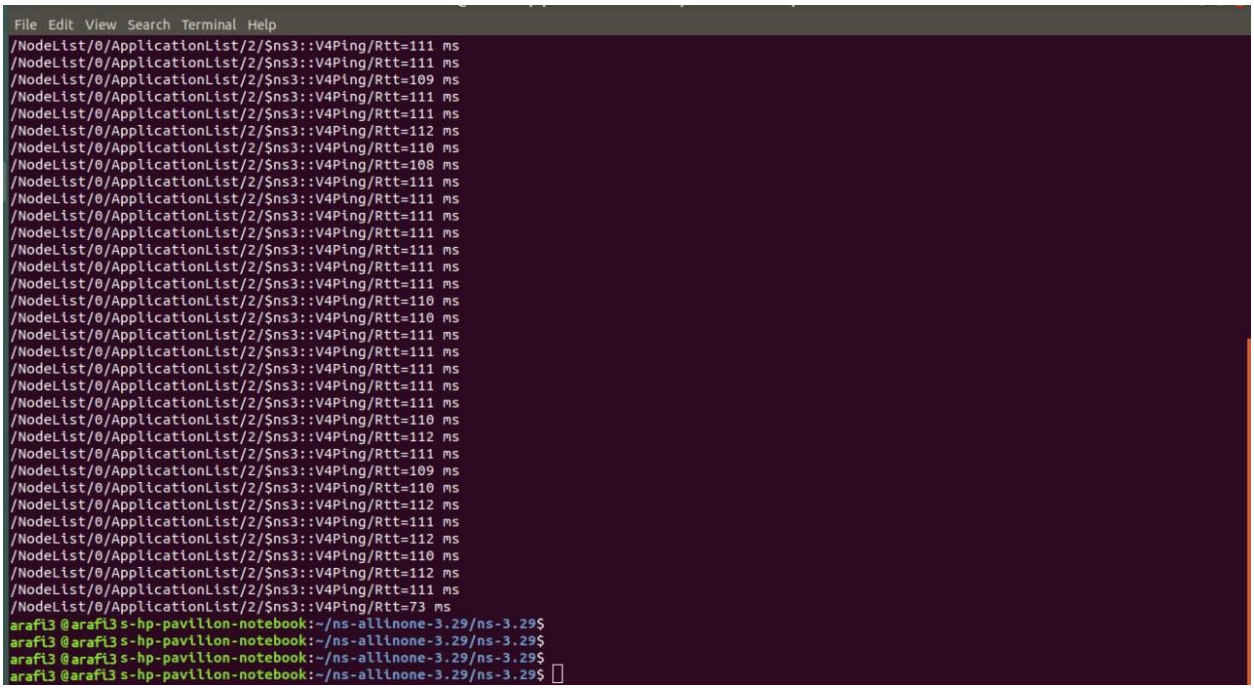
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=109 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms


File Edit View Search Terminal Help
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=111 ms
/NodeList/0/ApplicationList/2/$ns3::V4Ping/Rtt=109 ms
/NodeList/0/ApplicationList/2/$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/$ns3::V4Ping/Rtt=73 ms
arafi3@arafi3s-hp-pavilion-notebook:~/ns-allinone-3.29/ns-3.29$
arafi3@arafi3s-hp-pavilion-notebook:~/ns-allinone-3.29/ns-3.29$
arafi3@arafi3s-hp-pavilion-notebook:~/ns-allinone-3.29/ns-3.29$
arafi3@arafi3s-hp-pavilion-notebook:~/ns-allinone-3.29/ns-3.29$

Conclusion:

It is to conclude that the certain specific characteristics of TCP and Router queues, shows us the manner in which we can see that avoids routing loops, selects preferred routes, using information. It is also giving us adding benefit of preventing issues with TCP and router queues loops.