LAB1 - Introduction to ns-3
CS169: Mobile Wireless Networks - Winter 2017

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TA Information

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Lab Logistics

- There will be six lab classes and may be exercises for you to practice
- After the sixth lab, you do not have to attend.
- Homeworks will be posted with explicit due dates and times (the same for two lab sections)
- There will be one final project. I will post more information online and will let you know.

What is ns-3?

- A discrete-event network simulator, targeted primarily for research and educational use
- ns-3 is free and publicly available for use
- ns-3 is written entirely with C++ while Python user code wrappers are available.
- We will focus on how to use ns-3 to simulate simple IP networks and WiFi channels

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Architecture

Architecture
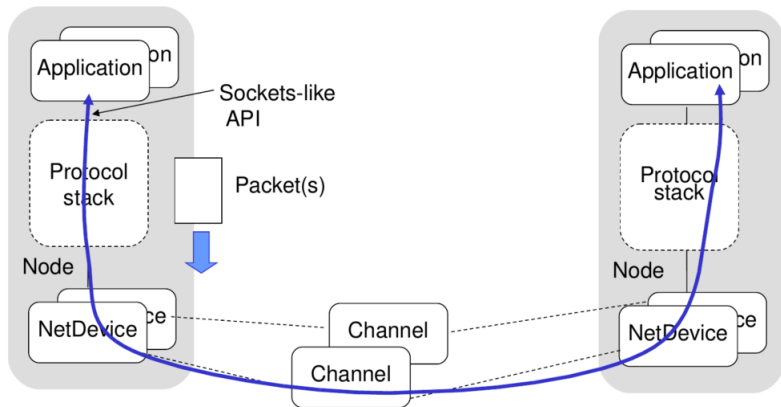
- Just like TCP/IP stacks
- Applications running in a node use Protocol Stack (TCP, UDP, IP, etc)
- Protocol Stack sends packets to NetDevices (or Network interfaces / adapters)
- Each NetDevice interfaces with each Channel (WiFi, LTE, etc.)

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Download ns-3

- $ cd /extra/CSUserName
- $ mkdir cs169lab && cd cs169lab
- $ wget
  http://www.nsnam.org/release/ns-allinone-3.25.tar.bz2
- $ tar xjf ns-allinone-3.25.tar.bz2
- $ cd ns-allinone-3.25

Addtional commands for remote access

- $ ssh CSUserName@bolt.cs.ucr.edu
- Lab 021: $ ssh delta-xx
- Lab 022: $ ssh tango-xx
- where xx is the machine number you are using

Build ns-3

- `$ ./build.py --enable-examples --enable-tests`
- `$ cd ns-3.25`
- `$ ./test.py`
- `$ ./waf --run examples/tutorial/hello-simulator`
- If you see Hello Simulator, congratulations! You have environments ready for running ns-3.

Running the first script

- $ ./waf --run examples/tutorial/first
- $ vim examples/tutorial/first.cc

Script headers

- Add module header files
  ```
  #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"
  ```
- Namespace
  ```
  using namespace ns3;
  ```
- Create log components
  ```
  NS_LOG_COMPONENT_DEFINE ("FirstScriptExample");
  ```

More headers

- Set time resolution
  ```
  Time::SetResolution (Time::NS);
  ```
- Enable log components and set log levels
  ```
  LogComponentEnable ("UdpEchoClientApplication",
  LOG_LEVEL_INFO);
  LogComponentEnable ("UdpEchoServerApplication",
  LOG_LEVEL_INFO);
  ```

Creating topology

- Create nodes
  ```
  NodeContainer nodes;
  nodes.Create (2);
  ```
- Create Channel
  ```
  PointToPointHelper pointToPoint;
  pointToPoint.SetDeviceAttribute ("DataRate",
  StringValue ("5Mbps"));
  pointToPoint.SetChannelAttribute ("Delay", StringValue
  ("2ms"));
  ```
- Create NetDevice and bind them to Channel
  ```
  NetDeviceContainer devices;
  devices = pointToPoint.Install (nodes);
  ```

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Protocol Stack

- Create InternetStack
  ```
  InternetStackHelper stack;
  stack.Install (nodes);
  ```
- Set IP network address
  ```
  Ipv4AddressHelper address;
  address.SetBase ("10.1.1.0", "255.255.255.0");
  ```
- Assign IP to NetDevice
  ```
  Ipv4InterfaceContainer interfaces = address.Assign
  (devices);
  ```

Building UDP Echo Server

- Create echo server
  ```
  UdpEchoServerHelper echoServer (9);
  ```
- Install echo server to node 1, mark it application, and set start and stop time
  ```
  ApplicationContainer serverApps = echoServer.Install
  (nodes.Get (1));
  serverApps.Start (Seconds (1.0));
  serverApps.Stop (Seconds (10.0));
  ```

Building UDP Echo Client

- Create echo client and set its attributes
  ```
  UdpEchoClientHelper echoClient (interfaces.GetAddress
  (1), 9);
  echoClient.SetAttribute ("MaxPackets", UintegerValue
  (1));
  echoClient.SetAttribute ("Interval", TimeValue (Seconds
  (1.0)));
  echoClient.SetAttribute ("PacketSize", UintegerValue
  (1024));
  ```
- Install echo client to node 0, mark it application, and set start and stop time
  ```
  ApplicationContainer clientApps = echoClient.Install
  (nodes.Get (0));
  clientApps.Start (Seconds (2.0));
  clientApps.Stop (Seconds (10.0));
  ```

Run simulator

- Run, destroy, return
  ```
  Simulator::Run ();
  Simulator::Destroy ();
  return 0;
  ```

Exercises

- Increase packet sizes 4K, 16K, 64K
- Have the client send the packets every one second for 4 packets
- Double data link rate
- Double data link delay
- Increase the number of echo clients to 2, 3, 4, 5 and have them send packets to the server

...What we have learned?

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Next Lab...

- Logging modules
- Command line arguments
- Tracing systems
- Pcap tracing