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

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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
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/adaptive)

Each NetDevice interfaces with each Channel (WiFi, LTE, etc.)
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

Additional 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
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");
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);
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
  \texttt{UdpEchoServerHelper echoServer (9);}
- Install echo server to node 1, mark it application, and set start and stop time
  \texttt{ApplicationContainer serverApps = echoServer.Install (nodes.Get (1));}
  \texttt{serverApps.Start (Seconds (1.0));}
  \texttt{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, 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?

1. TA Information
2. Lab Logistics
3. What is ns-3?
4. ns-3 Installation
5. Running the first ns-3 script
6. Exercises
Next Lab...

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