Mobile Wireless Networking
The University of Kansas EECS 882
Wireless Network Simulation with ns-3

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Outline

SW.1 Overview of ns-3 wireless network simulations
SW.2 Wireless network simulation example
SW.3 Laboratory assignment
Overview of ns-3 Wireless Simulation

Characteristics of Wireless Networks

- Network links are constructed on different mediums
  - wired
  - wireless
- Wireless nodes operate untethered
  - assuming they have power
- Wireless nodes may be mobile
  - need to choose a mobility model for the simulation needs
  - more about mobility models in the next lecture
Overview of ns-3 Wireless Simulation

Wireless Network Models in ns-3

- Currently 802.11 based wireless models supported
  - 802.11a, 802.11b, 802.11g, 802.11e, 802.11s
  - infrastructure or ad-hoc modes
  - QoS or non-QoS modes

- There are several physical layer models
  - propagation loss models: Friis, random, etc.
  - propagation delay models: speed based, random

- WiMAX and LTE modules available
- Various mobility models: RWP etc. (next lecture)
- More on MANET routing protocols in coming weeks

Overview of ns-3 Wireless Simulation

Layered View of ns-3 Wireless Models

- Mobility models affect L1→L3 in ns-3
- Wireless models in ns-3 deal with layer 2 and layer 1
  - MAC high
  - MAC low
  - physical
Overview of ns-3 Wireless Simulation

Script Structure

- C++ scripts include the following structure
  - boilerplate: important for documentation
  - module includes: include header files
  - ns-3 namespace: global declaration
  - logging: optional
  - main function: declare main function
  - topology helpers: objects to combine distinct operations
    - nodes → channels → devices → mobility → L3 → L5
  - applications: on/off application, UdpEchoClient/Server
  - tracing: .tr and/or .pcap files
  - simulator: start/end simulator, cleanup

Wireless Network Construction in ns-3

- Create type of nodes
  - stations
  - access points
- Create physical layer and channel, and associate
- Create MAC layer characteristics for node types
  - QoS or non-QoS
  - assign Service Set IDentifier (SSID)
  - and other MAC related attributes
- Install devices to nodes
- Set-up mobility models
- Configure Internet stack, application, routing models
Wireless Simulation with ns-3

Wireless Network Simulation Example

SW.1  Overview of ns-3 wireless network simulations
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Network Simulation Example

Wireless Network Simulation Setup

- Example is at examples/tutorial/third.cc
  - focus of this presentation is wireless configuration
- Network topology consists of:
  - wireless nodes/links:
    - 3 STA nodes
    - 1 AP node
    - 802.11 links, non-QoS mode, beaconing enabled
  - wired nodes:
    - 2 nodes connected via PPP link
    - 4 nodes on a CSMA LAN
- Application: UdpEchoServer
  - server on CSMA subnetwork, client on a STA node
### Network Simulation Example

**third.cc Script 1**

- NodeContainer class, create method
  - NodeContainer wifiStaNodes;
  - wifiStaNodes.Create (nWifi);
  - NodeContainer wifiApNode = p2pNodes.Get (0);

- Set WifiChannel and WifiPhy
  - YansWifiChannelHelper channel = YansWifiChannelHelper::Default ();
  - YansWifiPhyHelper phy = YansWifiPhyHelper::Default ();

- Associate channel and PHY
  - phy.SetChannel (channel.Create ());

### Network Simulation Example

**third.cc Script 2**

- Configure MAC layer
  - WifiHelper wifi = WifiHelper::Default ();
  - wifi.SetRemoteStationManager ("ns3::AarfWifiManager");
  - NqosWifiMacHelper mac = NqosWifiMacHelper::Default ();
  - Ssid ssid = Ssid ("ns-3-ssid");
  - mac.SetType ("ns3::NqstaWifiMac", "Ssid", SsidValue (ssid), "ActiveProbing", BooleanValue (false));
Network Simulation Example

third.cc Script

• Install MAC layer properties to the devices
  - NetDeviceContainer staDevices;
  - staDevices = wifi.Install (phy, mac, wifiStaNodes);

• Install mobility models to nodes
  - mobility.SetMobilityModel("ns3::ConstantPositionMobilityModel");
  - mobility.Install (wifiApNode);

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Laboratory Assignment

SW.1 Overview of ns-3 wireless network simulations
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Assignment Configuration

• Only 4 STA nodes, 1 AP node
  - infrastructure mode
  - no wired links → this means no CSMA, no PPP links
• Non-QoS MAC
• Enable ASCII and PCAP tracing on all interfaces
• Application
  - from STA 2 to STA 4
  - UdpEchoServer on port 70
• Rest of the attribute values: use from the example
  - IP address assignment
  - mobility models

Extra Credit

• Use WiMAX examples in the folder:
  - ../ns-3.12.1/src/wimax/examples
• Generate a topology with
  - 1 base station
  - 4 subscriber stations
• Simple scheduling, simple channel, default values
• Use your choice of IP addresses and other attributes
• Enable ASCII and PCAP tracing
• Properly block comment your code
• Delete unnecessary lines and simplify
Wireless Simulation with ns-3

Assignment Submission Guidelines

• Write 1–2 page summary
• Report should include the following sections:
  – experiment setup and procedure (topology, issues, etc.)
  – results and answer the following question
    • first 10 lines of tcpdump output of any .pcap file
    • does app. data from src to dst go through AP? Why?
  – conclusions (what you learned, etc.)
• You can discuss with other students but ...
  ... everyone must submit individual report
• Attach .cc file along with your submission
• Send report in PDF to: GTA and cc: Dr. Sterbenz

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EECS 882 Assignment Submission Guidelines

• Send only source files (.cc, .pl, .pdf, etc.)
  – this means no .zip, zipped, .tar files
  – no reason to send trace files
• Always to: GTA and cc: Dr. Sterbenz
• Brownie points for identifying and fixing ns-3 bugs
• ns-3 scripts will be graded based on
  – functionality
    • major grade will be deducted for errors!!!
    • warnings will reduce your grade as well
  – documentation
    • use sensible file names: e.g. lab1_ikus.cc
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EECS 882 Commenting Guidelines

• Use comments as necessary:
  - Boilerplate... (optional)
  - //GNU release blah ...
  - /* File name: lab1_ikus.cc
  - Purpose: This is a sample script etc.
  - Author: Ima KU Student
  - Date: 19 September 2011
  - Version: 1 */
  - #include <iostream.h>

• Use comments for block of codes:
  - // This is an example comment for a block of code

Further Reading

• ns-3 main page (for documents, news, announcements)
  http://www.nsnam.org/

• ns-3 wiki (howtos, roadmap)
  http://www.nsnam.org/wiki/index.php/Main_Page

• Finish all tutorial chapters

• ns-3 users mailing list (usage, implementations, discussions)
  http://groups.google.com/group/ns-3-users

• ns-3 bug list (closed, open bugs)
  http://www.nsnam.org/bugzilla/
Acknowledgements

Some material in these foils comes from the ns-3 tutorial presentations from conferences, workshops:

- Tom Henderson,
  *ns-3 tutorial*
  SIMUTools 2009
  http://www.nsnam.org/tutorials.html

- Gustavo Carneiro,
  *NS-3 Tutorial*
  RTCM 2009
  http://telecom.inescporto.pt/~gjc/NS-3-RTCM.pdf

Other References

- C++ tutorials online
  - and many more links and books on the subject

- GDB
  - http://www.gnu.org/software/gdb/

- valgrind
  - http://valgrind.org/

- gnuplot
  - http://www.gnuplot.info/

- Python
  - http://www.python.org/