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

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Wireless Simulation with ns-3

Outline

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SW.2  Wireless network simulation example
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Overview

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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
Overview of ns-3 Wireless Simulation

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
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Wireless Network Simulation Example

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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

- **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

- 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

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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
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Extra Credit

• Use WiMAX examples in the folder:
  – ../ns-3.25/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
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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
Wireless Simulation with ns-3
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
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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/
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](http://www.nsnam.org/tutorials.html)

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