University at Buffalo
The State University of New York

EE450/550: Principles of Networking
Laboratory Project - Assignment 2

Given: March 11, 2017
Due: Abril 2, 2017 (11:59 PM)

Submission Instructions:

Submit your assignment in electronic format (such as a *doc* or *pdf*) **directly on UB Learns**

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Objective:
In this laboratory assignment, you will work on the simulation of Wireless Networks:

- Before starting, you are encouraged to check the Section 6.3 in the ns-3 Tutorial available in Lecture Notes/LabTutorial/Additional Reading Materials folder in UB Learns.
- Note that here are three models available for WiFi MAC, namely, Access Point (AP) (ns3::ApWifiMac), non-AP Station (STA) (ns3::StaWifiMac), and Ad hoc network (ns3::AdhocWifiMac).

Submission materials <u>for each task</u>:

- Simulation source code (.cc) and any relevant packet trace (.pcap)
- A brief report (2—3 pages at most), briefly explaining the experimental setup (the structure of your code or what have you modified compared to other scripts), and the answers to the specific questions for each task (include any relevant screen shot of Wireshark if needed).

For convenience, create a ZIP/RAR file with the materials.

Task 1: Wireless LAN – Ad-hoc Mode

Define a **Wireless Local Area Network (LAN)** operating in **Ad-hoc Mode** with 6 nodes only. Nodes move by following a 2D random walk in a rectangular area defined by the lower-left corner (x=-100 m, y=-100 m) and the upper-right corner (x=100 m, y=100 m). Consider the following specifications:

- **Channel:** Default wireless channel in ns-3
- **Physical Layer:**
  - Default parameters in IEEE 802.11G standard
  - Adaptive rate control given by the AARF algorithm (for further details, you can check the document IEEE 802.11 Rate Adaptation: A Practical Approach, by M. Lacage, M.H. Manshaei, and T. Turletti)
- **Link Layer:**
  - Standard MAC without quality of service control
  - Remember: the network should operate in ad-hoc mode
- **Network Layer:**
  - Standard IPv4
  - Address range: 192.168.1.0/24
  - Assume that all the nodes behave as ideal routers and can exchange their routing tables in the background
- **Transport Layer:**
  - UDP
- **Application Layer:**
  - UDP Echo Server at Node 0:
    - Listening on port 20
  - UDP Echo Client at Node 5:
    - Sends 2 UDP Echo packets to the server at times 2s and 4s
  - UDP Echo Client at Node 4:
    - Sends 2 UDP Echo packets to the server at times 3s and 4s

- **Additional parameters:**
  - Set up a packet tracer ONLY on node 2

Answer the following questions:

- Are all the frames acknowledged? Explain why.
- Are there any collisions in the network? Explain why. How have you reached this conclusion?
- How can you force the nodes to utilize the RTS/CTS handshake procedure seen in class? What is the reasoning behind this procedure?
- Force the utilization of RTS/CTS in the network:
  - Are there any collisions now?
  - Which is the benefit or RTS/CTS?
  - Where can you find the Network Allocation Vector information?

Task 2: Wireless LAN – Infrastructure Mode

Define a **Wireless Local Area Network (LAN)** operating in **Infrastructure Mode** with 6 nodes and one Access Point. The network name (SSID) should be `PNET`. Consider exactly the same setup as in Task 1, but now with the presence of an AP. To start, do not force the handshaking process. In addition, set up a packet tracer ONLY on node 5 and in the AP.

Answer the following questions:

- Explain the behavior of the AP. What is happening since the very first moment the network starts operating?
- Take a look to a beacon frame. Which are the most relevant parameters defined in it?
- Are there any collisions in the network? When are these collisions happening?
- As in Task 1, force the utilization of the handshaking process and repeat the simulation. Are there any collisions now? Explain why.