Department of Computer Science, Electrical and Space Engineering

Luleå University of Technology

D7030E Advanced wireless networks

LAB 1 Measuring the influence of attenuation of radio signal on network performance for different radio propagation models

The objective of this assignment is to get familiar with ns-3 and the behavior of wireless networks (WiFi in this lab). You will be conducting an experimental study of how the various radio propagation models affect wireless radio transmission and the application-level performance. In order to capture the illustrative performance you will only work with UDP traffic.

PART 1 – The effect of signal attenuation on communication ranges in WiFi networks

As you already know, radio signals are attenuated with distance. In this exercise measurements should be taken with different distance between two nodes (Figure1). The IEEE 802.11 ad hoc mode (also known as independent basic service set, IBSS) should be used. During all experiments node(0) is a transmitter, node(1) is a receiver. You have to measure the bit-rate (see notes below how to measure them). The MAC settings should be set to agree with the IEEE 802.11a specification. Traffic type is UDP. Payload size is 1000B.

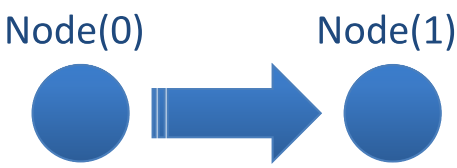

Figure 1. Topology for Scenario 1.

During experiments the following models should be used:

1. Two-Ray Ground propagation loss model (You are provided with the working simulation script for this model "LAB1_scenario1.cc").
   - NS-3: description: http://www.nsnam.org/docs/release/3.21/doxygen/classns3_1_1_two_ray_ground_propagation_loss_model.html
   - Calculation formula: http://www.nsnam.org/docs/release/3.21/doxygen/classns3_1_1_two_ray_ground_propagation_loss_model.html
2. Cost231PropagationLossModel
   - NS-3: description: http://www.nsnam.org/docs/release/3.21/doxygen/classns3_1_1_cost231_propagation_loss_model.html#a66a71d3fdabd10ff7a90a5447e656f47
   - Calculation formula: http://en.wikipedia.org/wiki/COST_Hata_model, note **C=10**;
3. FriisPropagationLossModel
   - NS-3: description: http://www.nsnam.org/docs/release/3.21/doxygen/classns3_1_1_friis_propagation_loss_model.html
   - Calculation formula: http://www.nsnam.org/docs/release/3.21/doxygen/classns3_1_1_friis_propagation_loss_model.html
4. NakagamiPropagationLossModel
   - NS-3: description: http://www.nsnam.org/doxygen/classns3_1_1_nakagami_propagation_loss_model.html
   - Calculation formula: http://www.nsnam.org/doxygen/classns3_1_1_nakagami_propagation_loss_model.html

Tasks (for ALL (4) models):

1. Calculate the initial distance between nodes (d_i), which equals to the value corresponding to the border of the transmission range for all the models.
2. Calculate the set of distances D = $\{d_i, 7d_i/8, 6d_i/8, \ldots, d_i/8\}$ between node(0) and node(1) (totally 8 values).
3. For each value in D run experiment. In each experiment measure the bit-rate.
4. Plot the bit-rate against the distance.

NOTE: Remember about units in formula, e.g. *f* could be in megahertz, etc.

Bit-rate calculation:

Take a look on Figure 2.

To the right you will see PCAP for sender opened in Wireshark

To the left you will see PCAP for receiver opened in Wireshark

For bitrate calculation you should take time when the LAST packet sent by sender (i.e. source address is 10.1.1.1) in example (right sight) it is packet number 68 and epoch time is 14.001162000 seconds

Time of arrival: you should take time when the LAST packet from the sender received by receiver in example (left sight) it is packet number 67 and epoch time is 14.002607000

Then we take size of packet in bits (8512 bits) and divide it by time difference (14.002607000 -14.001162000). The result is bitrate in the example it is about 6Mbps

Note that packets which were sent without acknowledgements (e.g. packet 67 on right side) were NOT received by the receiver and it is due to bit-rate adaptation algorithm of 802.11a. You can see that the next packet would have R flag, which means retransmission. It can be found in IEEE 802.11 Data... -> Frame Control ->Flags

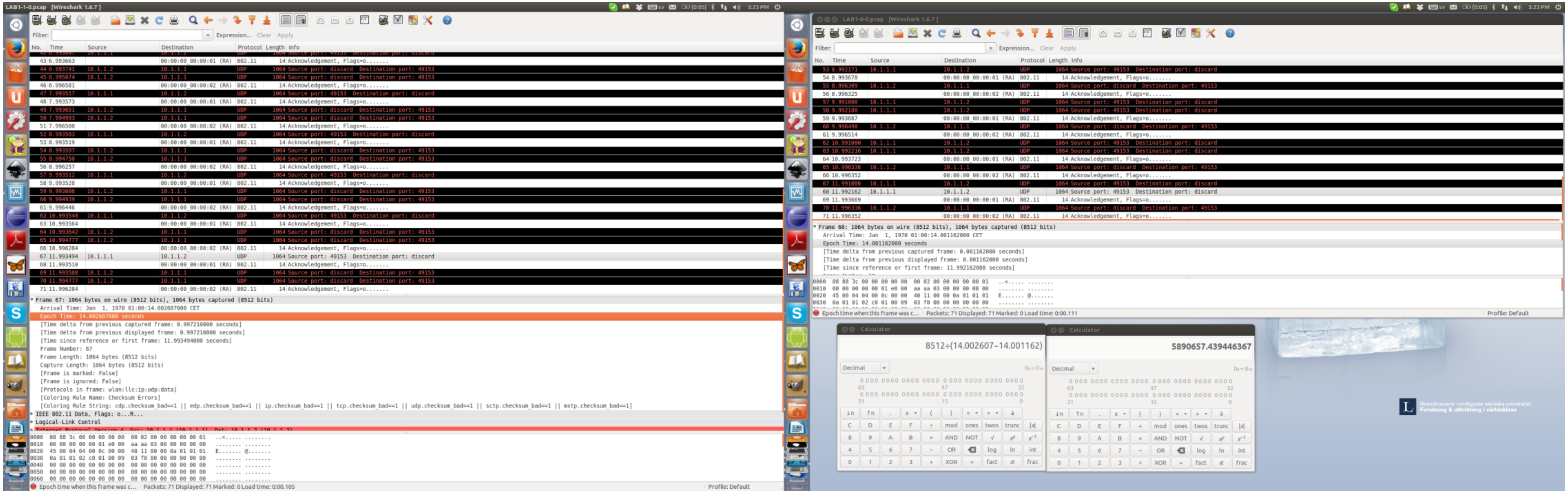

Figure 2. Bit-rate calculation.

PART II: Practical Scenario: measurements in real environment

In this part you are highly recommended to find a partner in order to perform all measurements together.

The task is to measure and model radio signal propagation in university's corridor and plot the results.

Recommendations:

1. Use your laptops.
2. Create an ad-hoc Wi-Fi network. Note:
3. There are several ways to measure signal propagation (the second way is easier), e.g.
   - Using a network sniffer (e.g. Wireshark) capture the traffic between laptops (e.g. ping one from another). Extract parameters of the radio signal from captured packets and calculate an average propagation loss for several packets: recommended http://wiki.wireshark.org/CaptureSetup/WLAN
   - Use special software to monitor received-signal strength indication (RSSI) values, e.g. http://www.nirsoft.net/utils/wifi_information_view.html.
4. Repeat the steps above for different positions of the second device increasing the distance in each experiment by 1 meter. Take several measurements at each position
5. If you are using software to capture RSSI anyway ping one laptop from another, it makes the measurements more precise.
6. Measure a section of the corridor with at least one corner as it is depicted in Figure 3. Please, take into account minimal lengths of section indicated in the figure when choosing corridor.
7. Extract path loss values from your measurements, i.e.
   path loss (dB)= *Tx power* (dB) – *RSSI*(dBm), note that RSSI is a negative value.
8. Calculate path loss for the same distance using Friis model.
9. Plot your path loss values for both measurements and Friis calculations.
10. Does Friis model mimic behavior of measured path loss? If not why?

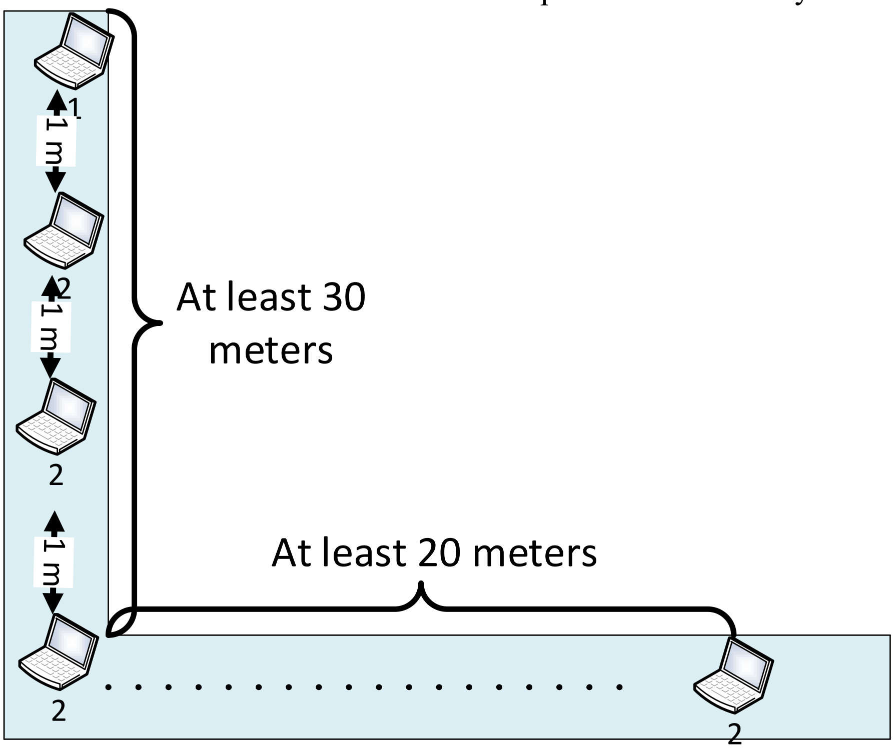

Figure 3. Setup of the experiment in part 2.

Congratulations, you have just accomplished the propagation lab!