Department of Computer Science, Electrical and Space Engineering

Luleå University of Technology

D7030E Advanced wireless networks

LAB 2 Measuring performance of a WiFi network in different scenarios

The objective of this assignment is to get familiar with several performance aspects of WiFi networks. You will be conducting an experimental study of how the various factors affect the quality of wireless radio transmission and the application-level performance. In order to capture the illustrative performance you will only work with UDP traffic.

Scenario 1 – Application throughput using WiFi network.

In this scenario there is one Access Point (AP) and several stations connected to the AP. During all experiments node(0) is a sender and node(1) is a receiver. You have to measure the average throughput over time. The MAC settings should be set in agreement with the IEEE 802.11b specification. Traffic type is UDP. Initial payload size is 1000B.

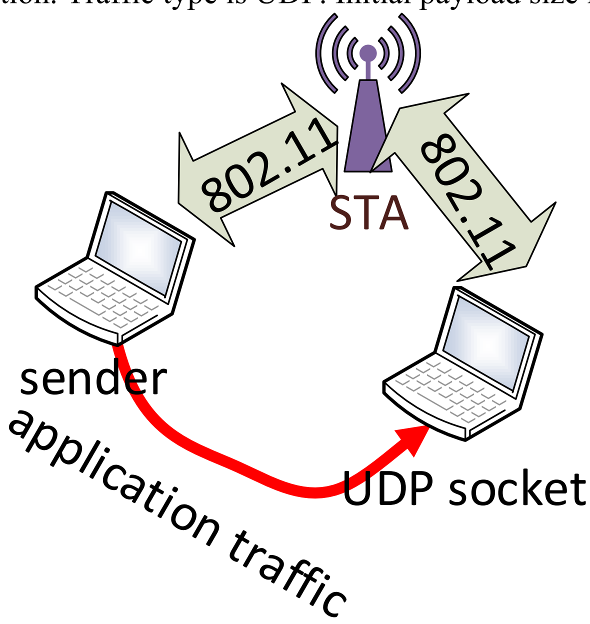

Figure 1. Topology for the first part of Scenario 1.

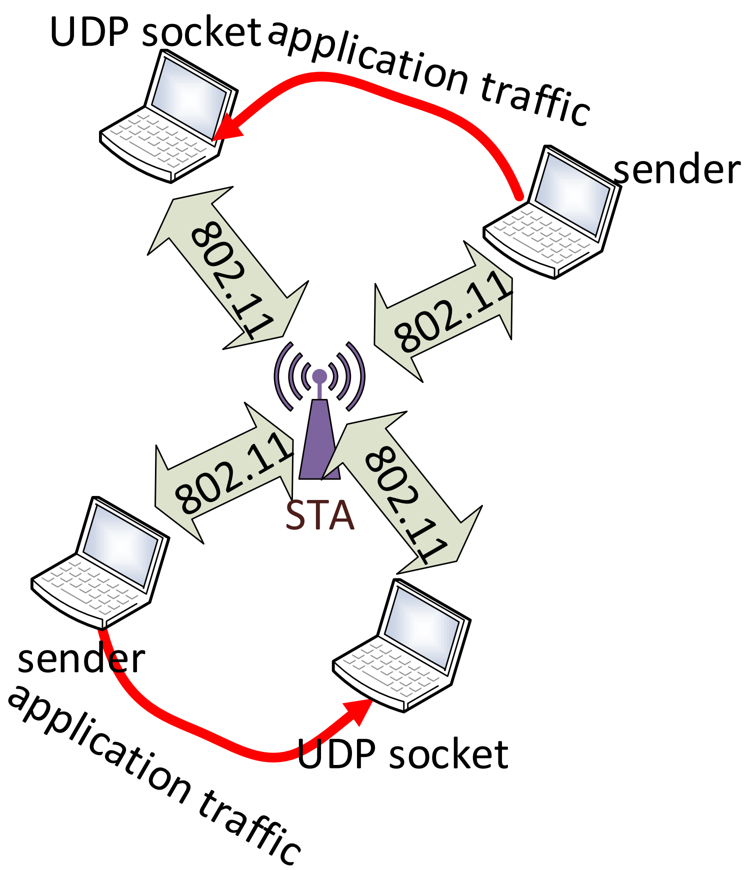

Figure 2. Topology for the second part of Scenario 1.

Tasks:

1. Study the provided script for the scenario in Figure 1. Be able to explain the details of this simulation.
2. Based on the script for the first part of Scenario 1 implement the second part as illustrated in Figure 2.
3. In your experiments you will vary the transmission rate at the physical layer in the range {1Mbps, 5.5 Mbps and 11 Mbps}.
4. For the first part of Scenario 1 keep the distances between sender, receiver, and STA equal to 10 meters (equilateral triangle). For the second scenario create topology similar to one depicted in Figure 2 (two equilateral triangles opposite to each other, STA is in the middle).
5. For both parts of Scenario 1 and for each bit rate run 2 experiments with different seeds for the random generator (Note, that the provided simulation script does not contain the randomization procedure. Therefore, you should implement it by yourself). For randomization of your simulations make use of RngSeedManager http://www.nsnam.org/doxygen/classns3_1_1_rng_seed_manager.html. In each experiment measure the application–layer throughput for each application and total throughput for the whole network (basically, the sum of independent applications throughputs)
6. Plot the mean application throughput versus the bit rate for both parts of the scenario. Indicate standard deviations for each measured point.
7. Compare how application throughput for the whole network varies for Figure 1 and Figure 2.

NOTE1: The data rate of applications in this Scenario is intentionally chosen to be much higher than the maximum possible bit rate of the physical layer. This is to guarantee maximum offered load for the scenarios.
NOTE2: In Wireshark you can use ip.src==[first station IP] in filtering window and then Statistics -> Summary in order to observe the number of packets and time.
NOTE3: In your calculations for throughput, please, take into account the fact that PCAP traces are being taken in promiscuous mode, e.g. station 2 hears the packets from station 1 even if the packets are not for station2 (for AP). Basically, it means that number of packets received by station2 from stations is **two times less** (another half was for AP). You could check it in PCAP traces, because packets have different MAC addressed in the source field. To conclude, during throughput calculations please divide the result by two.

Scenario 2. The effect of different packet sizes on the application level throughput

In this scenario you will use the topology as depicted in Figure 1. Use Two-Ray Ground propagation model. Place the nodes (sender – STA – UDP socket) at distance $d_i/2$, where d_i you have calculated in the previous lab. In this scenario you will use UDP traffic. In your experiments you will vary the transmission rate at the physical layer in the range {1Mbps, 5.5 Mbps and 11 Mbps}. You will also vary the UDP payload in the range {400B, 700B, 1000B}.

Tasks:

1. For EACH transmission rate in the range of transmission rates run two experiments with EVERY packet size. Calculate an average throughput in bits per second. For randomization of your simulations make use of RngSeedManager http://www.nsnam.org/doxygen/classns3_1_1_rng_seed_manager.html
2. Select measurements for packet size equals 1000 bytes. Fill a table where in the upper row you list the physical layer transmission rate and in the lower row you write the measured throughput. Did you achieve the absolute maximum transmission rate?
3. Plot a graph showing the dependency of the average throughput versus packet size for physical layer transmission rate equals 11 Mb/s.
4. Explain the observed behavior.
5. Select the simulation trace for 11Mb/s transmission rate and 400B payload size. Measure the time for transmission of a SINGLE packet. Taking the packet's TOTAL size (including headers on all layers) in bits calculate the transmission rate.
6. Is it equal to 11Mb/s? If not why?

Scenario 2. Hidden terminal problem

The RTS/CTS virtual carrier sensing mechanism is implemented as an option in the IEEE 802.11 standards. It mitigates the effect of the hidden terminal and the exposed terminal problems. Here you will study the impact of using RTS/CTS on the network performance.

As it is shown in Figure 3, you need to setup a network of three nodes: the senders (located at Node(0) and Node(2)) and the access point (Node(1)). Access point should implement 2 opened receiving sockets. Note, that it is safer to have different ports for senders' applications. Use the simulation script for Scenario 1 as the baseline for this experiment. This time, however, enable the RTS/CTS mode and change distances between stations, so they would not hear each other. The size of packet's payload is 1000B, the bitrate is 1Mbps.
The distances between node(0) - node(1) and node(1) - node(2) should be all equal to d_i for TwoRayGround propagation model. Traffic type: UDP. Run the experiments when RTS/CTS

is enabled and then when it is disabled. Measure the throughput at the receiver (Node 1) and the packet delivery ratio for both sessions (node(0)->node(1), node(2)->node(1)). For this purpose add FlowMonitor to the scenario (see the following script as an example: /examples/wireless/wifi-hidden-terminal.cc)

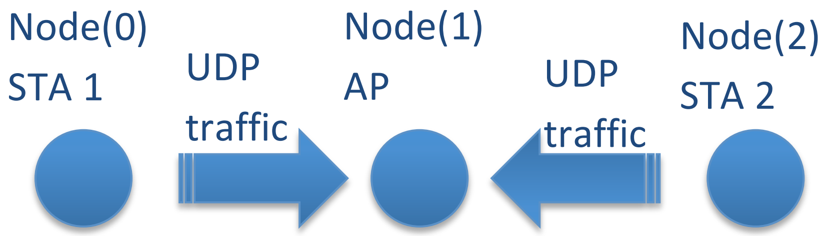

Figure 3. Topology for Scenario 2

Tasks:

1. Run experiments for both modes and calculate the throughput and the packet delivery ratio.
2. Study the PCAP traces for both modes: Do you observe any difference between the measured throughput at the receiver with and without using RTS/CTS. Motivate your answer.

NOTE4: Use the following command to enable RTS/CTS mode

```
Config::SetDefault
("ns3::WifiRemoteStationManager::RtsCtsThreshold", StringValue
("0"));
```

Congrats, you have just accomplished the WiFi lab!