

WirelessLab WS 2016/17

Homework 5: IEEE 802.11 Physical and Link Layer measurements

This homework focuses on the IEEE 802.11 standard - mainly understanding frame detection mechanisms of today's WiFi cards through physical and link layer measurements.

Question 1: (70 Points) *Weak vs. strong signal detection*

In this question, your goal is to understand the impact of the weak and strong signal detection mechanism and sensitivity. First of all you need to disable the Ambient Noise Immunity (ANI) algorithm, a proprietary algorithm by Qualcomm Atheros that changes the receive sensitivity settings frequently, for the physical WiFi device through the following command (for the ath5k card):

```
> echo "ani-off" > /sys/kernel/debug/ieee80211/phy<X>/ath5k/ani
```

Important: Again use the ath5k card for communication and the ath9k card as the monitor.

Note: For this experiment we removed the antenna of your ath5k cards. Your cards have two antennas ports named *A* and *B*: The pigtailed on antenna port *B* are still attached, antenna port *A* has nothing attached to it. Explicitly select antenna port *B* on both ath5k cards by using:

```
> echo "fixed-B" > /sys/kernel/debug/ieee80211/phy<X>/ath5k/antenna
```

Hint: Depending on the signal quality you experience you can tweak (reduce) the signal strength even further by selecting antenna port *A* using "fixed-A" instead. **Be careful:** When the signal is too weak your nodes lose wireless connection to each other and the *ani* settings will be reset.



Setup an Iperf experiment with only UDP traffic at 25 Mbit for 30 seconds per run and repeat each run ten times. Fix the modulation rate on both interfaces at 24 Mbps. Additionally set up

- Experiment with two significantly different settings of the transmission power and weak signal detection enabled (i.e. *ofdm-on* and *cck-on*) and disabled, meaning only strong signal detection is active (i.e. *ofdm-off* and *cck-off*).
- Using the same iperf setup (selecting a reasonable low transmission power and with weak signal detection enabled) now experiment with the sensitivity level (i.e. *sens-low* and *sens-high*) and the noise immunity level (i.e. *noise-high* and *noise-low*).

Plot the frame delivery ratio (Layer 2) for all eight experiments in a boxplot and plot the UDP throughput in a different boxplot. Explain your setup, results, describe and discuss the differences. Attach the output of the files *ani* and *antenna* in the folder `/sys/kernel/debug/ieee80211/phyX/ath5k/` to your results.

— Turn the page —

Question 2: (30 Points) *Spectral scan*

In this question, you will experiment with the internal spectral scan mechanism of modern WiFi cards. Specifically, Atheros AR92xx and AR93xx WiFi cards give you a signal level for each subcarrier. This allows you to measure the utilization of a frequency band.

For this, you will have to do the following.

- Use the ath9k card which supports spectral scans.
- Read http://wireless.kernel.org/en/users/Drivers/ath9k/spectral_scan/ for the instructions on how to run the spectral scan.
- Write code that processes the scanned binary data. You can extract the parsing algorithm from this example: https://github.com/simonwunderlich/FFT_eval
- Plot a heatmap of the data (RSSI vs. Frequency) that resembles the one in the tutorial.
- Describe and discuss the results.

Please submit a PDF document containing *a cover page* with your names and group ID, and *having your group number in its file name*.

The PDF should contain for all questions:

- A description of your approach. Which tools did you use? Where can we find the scripts?
- The plots produced by your scripts. Please number them and reference them in the text, so we know which plot belongs to which question - If we don't understand what you submit, we cannot grade it.
- A description of what you observed from the plots. Are there outliers? Is there any notable phenomenon?
- If applicable: What were your expectations about the performance? Does the plot match with your expectations? If not, what could be the explanation?

Please also include your scripts in a format in which we could run them ourselves.

All code must be properly documented using inline comments in English.

Make an archive (.tar.gz, .zip) containing *a directory* with all of your files and *having your group number in its file name*. All files that belong to a specific question must have the question/subquestion in their filenames. Please try not to clutter your submission with temporary files.

Due Date: Wednesday, November 30th, 23:55.