ICSI 445/660 Fall 2016 – Homework 2
Due November 15, 2016 11:59PM via Blackboard

October 31, 2016

1 Requirements and policies

Each student should complete this homework individually. Your turn-in is due through Blackboard. Note that while this assignment is not implementation-heavy, it requires deep understanding of the ns-3 modules you will be using as well as several 802.11 rate adaptation algorithms for you to be able to reason about the obtained results. This will likely raise questions, so make sure you start early to be able to make use of office hours. **Late submissions will not be accepted**.

2 Assignment overview and objectives

The purpose of this assignment is to use ns-3[1] network simulator in order to evaluate several 802.11 rate adaptation algorithms. Following your simulation, you will also practice efficient commentary on experimental result by applying the WALTER principle. To complete this assignment you must have ns-3 installed (hopefully, you already have it through HW1). Note that ns-3 runs only under Linux, so if you don't have access to a Linux machine, you can do one of the following: (i) create a dual-boot machine, (ii) install Linux in a virtual machine or (iii) use a Linux environment like Cygwin. The directions for installing ns-3 can be found on the following URL `https://www.nsnam.org/docs/tutorial/html/getting-started.html`.

The assignment consists of two parts. In the first part you will answer questions to demonstrate that you understand the operation of several rate adaptation mechanisms. In the second part you will run several WLAN simulations with different parameters in order to evaluate and compare the performance of rate adaptation algorithms.

3 Part 1: Rate adaptation principles.

Some of these questions require you to refer to our lectures and papers on rate adaptation in 802.11 networks. Others will require you to do independent research in order to answer.

1. Describe the basic operation of rate adaptation algorithms. Why do we need to fall back to a lower modulation and coding scheme (MSC) in the face of poor channel conditions between a sender and a receiver?

2. Recall our discussion of rate adaptation in congested networks. Should rate adaptation be performed differently in congested networks?

3. Describe the operation of ARF and AARF algorithms. How is the Minstrel algorithm different than ARF and AARF?

4 Part 2: Evaluation of rate adaptation algorithms

In this part you will run a simulation and analyze the results. We will work with an example called `rate-adaptation-distance` provided through the ns-3 code base. Run the `rate-adaptation-distance` ex-

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[1]https://www.nsnam.org/

ample using `waf`[2] and note where the program stores the output .txt and .plt[3] files. Once you fully understand how to run the example and where to find the output you can proceed to the actual measurements.

For your measurements, you will execute `rate-adaptation-distance` with various input parameters in order to evaluate several rate adaptation algorithms on different WLAN networks. Once you have the simulation output files saved, you will use Gnuplot[4] to produce graphs of your simulation data and comment on the results.

1. You will begin by familiarizing yourselves with the `rate-adaptation-distance` implementation. Open `rate-adaptation-distance.cc` and study the code. What topology does it build? What is the behavior of the nodes during a simulation? What commandline arguments can you supply? Create a table like the one below for all the commandline arguments.

#	Argument	Possible values	Description
1	channelWidth	Open. Traditionally, 20MHz. Recent standards support channel bondng of up to 160MHz.	The channel width at which the link between the AP and the client should be established.
2	...	...	...

2. Run `rate-adaptation-distance` using Minstrel, ARF and AARF rate adaptation algorithms. Write down the exact `waf` command for each simulation. Modify the output .plt files, to be able to plot the results of the three runs on the same graph. Comment on your results. Use the WALTER[5] principle for every graph commentary.

3. Run Minstrel for three different channel widths. Note that only recent 802.11 standards support channel bonding, so make sure you are using a 802.11 standard that supports channel bonding. Write down the exact `waf` commands you used in this simulation. Plot the results of the three runs on the same graph and comment on your results using WALTER.

5 Turn in

This homework is due by 11:59PM on Tuesday, November 15, 2016. The turn-in consists of the answers to the questions in part 1 and 2 (in a single PDF) and a single zip archive of all the .plt files produced by your simulations. Turn in your work through Blackboard as two files – the first file is your PDF with answers and the second file is a zip archive with your .plt files. You can use the submission template below to format your answers.

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[2] If you are unsure how to do this, follow the "Running a script" instructions on the Getting Started page `https://www.nsnam.org/docs/tutorial/html/getting-started.html`

[3] While a .plt file extension has been adopted by many graphical programs, in the context of the `rate-adaptation-distance` example, it is a Gnuplot plot control file. Take a close look at the .plt files produced by your simulation. Then use Gnuplot to plot graphs of your simulation data. More on how to use Gnuplot here `http://www.gnuplot.info/`.

[4] `http://www.gnuplot.info/`

[5] WALTER is an extremely useful way to think and comment on your experimental results. Study this principle thoroughly and apply it in your answers. Use it whenever you need to present some results on a graph. Here is a short paper on WALTER `http://janetkayfetz.com/talking-and-writing-about-data-with-walter/`

ICSI 445/660 Fall 2016 – Homework 2 Submission Template
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1 Part 1: Rate adaptation principles.

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2. Recall our discussion of rate adaptation in congested networks. Should rate adaptation be performed differently in congested networks?

3. Describe the operation of ARF and AARF algorithms. How is the Minstrel algorithm different than ARF and AARF?

2 Part 2: Evaluation of rate adaptation algorithms

1. You will begin by familiarizing yourselves with the `rate-adaptation-distance` implementation. Open `rate-adaptation-distance.cc` and study the code. What topology does it build?

   What is the behavior of the nodes during a simulation?

   What commandline arguments can you supply? Create a table like the one below for all the commandline arguments.

#	Argument	Possible values	Description
1	`channelWidth`	Open. Traditionally, 20MHz. Recent standards support channel bondng of up to 160MHz.	The channel width at which the link between the AP and the client should be established.
2			

2. Run `rate-adaptation-distance` using Minstrel, ARF and AARF rate adaptation algorithms. Write down the exact `waf` command for each simulation.

   Modify the output .plt files, to be able to plot the results of the three runs on the same graph. Comment on your results. Use the WALTER principle for every graph commentary.

3. Run Minstrel for three different channel widths. Note that only recent 802.11 standards support channel bonding, so make sure you are using a 802.11 standard that supports channel bonding. Write down the exact `waf` commands you used in this simulation.

   Plot the results of the three runs on the same graph and comment on your results using WALTER.