# Computer Networking (CN) - 2015/16

## Assignment 1

The goal of this assignment is to do a comparative performance study of rate adaptation algorithms for 802.11a/b/g wireless LANs (WLANs) in different scenarios using the ns-3 simulator [1]. Here adapting rate means adapting the physical layer transmission bit-rate by choosing from among several available modulation and coding schemes. You need to specifically focus on two adaptation algorithms: AARF [2] and CARA [3]. You may find it useful to read the paper in reference [4] that gives an overview of 802.11 rate adaptation algorithms.

You are provided a template ns-3 script [5] to create a simple 802.11g wireless LAN scenario with one AP and one client station. You can use this script as a starting point to create simulation setups for different scenarios and varying parameters within each scenario. Below is a list of various aspects of simulation setup that are particularly relevant to this assignment:

- Number of client stations associated with an access point (AP). Note that in this assignment, you will only consider infrastructure WLAN scenarios with single AP and one or more associated stations.
- Physical locations of stations relative to the AP's location.
- Rate adaptation algorithms: AARF [2] and CARA [3].
- You need to use Log Distance propagation loss model, and depending on the scenario, choose between no fading and Rayleigh fading with 1m/s environmental mobility.
- Traffic type and parameter settings: for each traffic flow between a pair of nodes (station to AP or vice versa), you need to use constant bit rate (CBR) traffic over UDP with 20Mbps data rate and 1 KB packets.

For the performance metric, focus on *network throughput* that is aggregate throughput of all traffic flows. In a scenario with only one flow, network throughput and flow's throughput are the same; otherwise, network throughput is the sum of all individual flow throughputs. In the template script [5], as a sample for throughput calculation in ns-3, you are provided a function that computes the throughput of a flow between two nodes using ns-3's FlowMonitor framework.

The assignment is divided into three parts, each focusing on a different scenario. These different parts are specified below:

1) **Varying sender-receiver separation distance with and without fading:** This part models a WLAN scenario that consists of an AP and only one associated station node. The goal for this part is to compare the throughput performance of AARF and CARA with no fading and in presence of Rayleigh fading at different distances of physical separation between AP and station locations starting from 5m and going till 100m in steps of 5m. Either the AP or the station node should be configured as the traffic sender and the other

node will be the receiver. The traffic flow between the two nodes must be as per the settings mentioned above. The results from this part need to be summarised in a plot with Throughput (Mbps) on the y-axis, Sender-Receiver Separation Distance (m) on the x-axis and four different curves corresponding to the four alternatives compared: AARF (no fading), CARA (no fading), AARF (Rayleigh fading), CARA (Rayleigh fading). In your submission, you need to include this plot and your interpretation of the results shown by the plot.

2) **Varying number of station nodes, fixed sender-receiver distance and no fading:** In this part, you will vary the number of station nodes from 1 till 50 in steps of 5 and placing them at a fixed distance randomly on the circumference of the circle with radius 10m centred at the AP. Only no fading case is considered. Each station node is part of a traffic from/to the AP; for each flow, the roles of sender and receiver are randomly assigned between AP and the station node. The goal of this part is to compare the network (aggregate) throughput performance of AARF and CARA as a function of number of station nodes. As in part 1), you need to include in your submission the plot with the throughput curves for AARF and CARA versus number of nodes, and your discussion of results.
3) **Varying number of randomly distributed station nodes and Rayleigh fading:** This part models a typical WLAN scenario at home or public Wi-Fi hotspot. Here station nodes are randomly distributed around the AP within a circle of radius 25m centred at the AP. Rayleigh fading is enabled. The number of station nodes is varied from 1 to 50 and traffic flows from/to station nodes are setup as in part 2). Plot showing the network throughput with AARF and CARA versus number of station nodes must be included in your submission along with your interpretation of the results.

Each data point in your plots must be an average from 5 simulation runs, each with a different seed to the simulator's random number generator. The simulation time for each run should last 10 seconds with start time for traffic flows at random times within the first 100ms of the simulation.

If you need clarifications or have further questions, then in the first instance please contact the course teaching assistants, Galini Tsoukaneri <G.Tsoukaneri@sms.ed.ac.uk> or Mah-Rukh Fida <M.Fida@sms.ed.ac.uk>.

## Assessment

This assignment is worth 15% of the overall course mark (or 60% of the coursework mark). You will receive marks for your work on this assignment on a scale of 0-100: part 1 and part 2 will each receive a maximum of 40 marks, whereas part 3 is allocated a maximum of 20 marks.

## Submission

**The deadline for this assignment is 12noon on Friday, 26th Feb 2016.**

Your submission must be electronic via the *submit* command. You need to submit a folder with your simulation scripts, plots and your discussion of results in those plots for each of the three parts.

**No late submissions are allowed, except under extenuating circumstances** as per the School of Informatics policy on late submission of coursework.

**You are expected to work on this assignment on your own.** Or else, you will be committing plagiarism (see School of Informatics guidelines on plagiarism); such acts will be seriously dealt with as detailed under the university page on academic misconduct.

## References


1. ns-3 network simulator
2. M. Lacage, M. H. Manshaei and T. Turletti, "IEEE 802.11 Rate Adaptation: A Practical Approach," in *Proc. 7th ACM International Symposium on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM '04)*, 2004.
3. J. Kim, S. Kim, S. Choi and D. Qiao, "Collision-Aware Rate Adaptation for IEEE 802.11 WLANs," in *Proc. IEEE INFOCOM*, 2006.
4. S. Biaz and S. Wu, "Rate Adaptation Algorithms for IEEE 802.11 Networks: A Survey and Comparison," in *Proc. IEEE Symposium on Computers and Communications (ISCC'08)*, 2008.
5. Template ns-3 script