

EE597 Fall'21 Lab 2

MAC

Assigned: 03/10/2021

Due: 11:59 pm PDT, 03/29/2021, via Blackboard

[Google doc link](#)

0. Overview

In this project, we aim to study the saturation throughput in an IEEE 802.11 network that uses CSMA/CA with binary exponential backoff to avoid collisions (also referred to as DCF). You are required to simulate a specific wireless transmission scenario in both NS-3 and numerical calculation (using any programming environment of your choice, e.g., C, python or matlab).

Submit the comparison plots and explain the trends you observe and describe (in sufficient detail) your implementation. Code (including comments) does not count as description and hence do not include your code files in the report. All code files and the electronic report should be submitted online via blackboard. Finally, please make sure that your code works with the NS-3 installation on the provided [virtual machine](#).

VM Info:

- User: ee597
- Password: ee597

1. Environment

Please use the [virtual box](#) software to run the provided [virtual machine image \(ubuntu 18.04\)](#), which has ns-3 preinstalled in ~/ns-3-allinone/. If you have an ubuntu 18.04 system and prefer to code in your native environment, please make sure to test in vm before final submission. To get familiar with the development environment, please study the following examples

- ~/ns-3-allinone/ns-3-dev/examples/wireless/wifi-pcf.cc
- ~/ns-3-allinone/ns-3-dev/examples/wireless/wireless-ad-hoc.cc
- ~/ns-3-allinone/ns-3-dev/examples/tutorial/thrid.cc (a description of this tutorial can be found [here](#))

To compile and run the example, please run the following command in the ns-3 root directory

- ./waf --run "wifi-simple-adhoc --rss=-97 --numPackets=20"
- ./waf --run "wifi-simple-adhoc --rss=-98 --numPackets=20"
- ./waf --run "wifi-simple-adhoc --rss=-99 --numPackets=20"

Drop your script into the scratch directory and it will automatically build and run with Waf

- `./waf --run yoursript.cc`

There are many more [ns3 tutorials online](#) if you need further studies.

2. NS-3 Simulation

Scenario: use the default setting for the PHY layer in NS-3 to set up the following scenario:

- Place a node in the terrain to act as the common receiver.
- Place N wireless transmitter nodes uniformly in the terrain such that all the nodes are within the radio range of each other and that of the common receiver.
- Set up a constant bit rate (CBR) traffic of rate x Mbits/sec from each of the N nodes to the receiver. Use a packet size of 512 bytes. **See the OnOffApplication class in NS-3 for details on how to set up CBR traffic.**
- Assuming that each transmitter node always has packets to send, simulate packet transmissions long enough to get good estimates of the throughput.

Consider 2 cases:

- Case A: minimum backoff window size as 1 and maximum backoff window size as 1023 units of slot times.
- Case B: minimum backoff window size as 63 and maximum backoff window size as 127 units of slot times.
- ***Tips: changing the contention window may require changes in ns3 source code. Please don't hesitate to do so if necessary. In fact, reading and changing the source code may be the easiest way out.***

For each case,

- E1: Increase the offered load by increasing the number of nodes N: Set the data rate to a reasonable value and vary the number of nodes N and calculate the throughput at the receiver for each value of N.
- E2: Increase the offered load by increasing the data rate: Keep the number of nodes fixed at 20 and vary x in sufficiently fine granularity.

3. Evaluation

Metrics (averaged over several runs):

- Total throughput (Throughput v.s. N in E1, and Throughput v.s. X in E2)
- Per-node throughput
- [optional] Average backoff time slots per transmission
- [optional] Collision rate: how many attempts of transmission are failing.

Evaluation

- Case A E1
- Case A E2

- Case B E1
- Case B E2

Discussion

- Please discuss your results with respect to different case configurations

4. Theory calculation

Compare the results obtained by the NS-3 (both ranges of backoff window size) against the numerical calculations based on [Bianchi's 802.11 Saturation Throughput Analysis](#). Use the same scenario as the one used for the NS-3 simulations (specifically, do not change your topology), i.e. same number of stages and backoff window. Vary number of stations N . Plot a graph of total throughput vs number of different stations in the basic case. (You do not have to implement the RTS/CTS case.)

5. Submission

- Please submit your report of all evaluations as a pdf and code as a zip file through blackboard. Please provide a readme file to run your code.

6. Rubric (100 pt)

- (20 pt) Case A E1
 - (10 pt) Throughput v.s. N
 - (10 pt) Per-node throughput v.s. N
- (20 pt) Case A E2
 - (10 pt) Throughput v.s. X
 - (10 pt) Per-node throughput v.s. X
- (20 pt) Case B E1
 - (10 pt) Throughput v.s. N
 - (10 pt) Per-node throughput v.s. N
- (20 pt) Case B E2
 - (10 pt) Throughput v.s. X
 - (10 pt) Per-node throughput v.s. X
- (5 pt) Discussion
- (15 pt) Theoretical analysis for each evaluation of each case
- (Bonus 5 pt) Mean and variance of backoff time slots per transmission v.s. N/X
- (Bonus 5 pt) Collision rate v.s. N/X