CS 558: Computer Systems Lab

(January-May 2021)

Assignment – 2: Network Simulation using Cooja

Submission Deadline: 11:55 pm on Tuesday, 16th February 2021 (hard deadline)

In this assignment you need to simulate an IoT network for a given application using the discrete event network simulator **Cooja**. You can download the software and documentation of the simulator from the Internet.

The assignment will be solved in groups where each group, comprised of 3-4 members, needs to work on an application assigned to it. The group membership information is given at the end of this document or given separately. The applications' network specifications, the required experiments, and related questions are given below. Follow the general instructions given below and any specific instructions mentioned in the application description.

General Instructions:

1. Each group needs to simulate one application assigned to it and make one single submission on Moodle/MSTeams whichever is used by the instructor. **Only one member** from a group needs to make the submission. The information about the allocation of applications to groups is contained in **Table 1** given below.
2. Install the simulator on your computer, write programs and simulate the network described in the given application assigned to you, perform the required experiments, and answer the given questions.
3. Submit your set of **source code files**, and your **report** containing the graphs and required answers, for the assigned application as a zipped file on Moodle/MSTeams (maximum file size is 1 MB) by the deadline.
4. The **ZIP file's name should be the same as your group number**, for example, "Group_4.zip", or "Group_4.rar", or "Group_4.tar.gz".
5. The assignment will be evaluated offline as well as through viva voce in your lab during your lab session on **Friday, 19th February 2021 (9:00 am to 11:55 am)** where you also need to explain your source codes and execute them before the evaluator (Evaluation schedule and TA allocation will be notified in due time).
6. **Write your own source codes and do not copy from any source. Plagiarism and use of unfair means will be penalised by awarding NEGATIVE marks (equal to the maximum marks for the assignment).**

Table 1: Allocation of applications to groups

Question/Application No.	Assigned Group No.
1	1, 5, 9, 13, 17
2	2, 6, 10, 14
3	3, 7, 11, 15
4	4, 8, 12, 16

Questions:

Q1. In Time Slotted Channel Hopping (TSCH) and Routing over Low Power and Lossy Networks (RPL) based Low power and Lossy Networks (LLN), new nodes (pledges) join the network one by one. At the beginning, this kind of network formation is started by the RPL root node or TSCH coordinator node. The pledges need to receive network advertisement information carrying Enhanced Beacon (EB) frame to get synchronized with the TSCH network. Similarly, pledges complete their joining process once they receive routing information carrying RPL DIO packet. Pledges are called 6TiSCH joined node once they complete their joining process (i.e., receive both the EB and DIO packets successfully). Both the TSCH joining/ synchronization time and 6TiSCH joining time is very much important for resource constrained LLN devices. In this assignment, both the joining times (i.e., TSCH synchronization time and 6TiSCH joining time) need to be calculated using the Contiki-NG based Cooja Simulator. The results can be obtained using the already available code: *contiki-ng/examples/6tisch/Simple-node*. For this experiment, you have to use the following settings for other parameters.

Slotframe Length (SF)	31, 101
Timeslot duration	10 ms
RPL version	RPL Lite
Number of Channels	16
Topology	5 x 5 grid topology (25 nodes)
Radio Distance between two nodes (X,Y)	150
Radio Range	50 meter
Interference Range	75 meter
Scheduling Function	6TiSCH Minimal configuration Scheduling

Results should be obtained by varying both the slotframe length (SF) and EB generation interval as follows:

<Slotframe length (SF), EB generation interval>

<SF, 2 SF>, <SF, 4 SF>, <SF, 6 SF>, <SF, 8 SF>, <SF, EB sending probability per slotframe = 0.1>

Do the experiment for both the given values of SF.

Q2. In Time Slotted Channel Hopping (TSCH) and Routing over Low Power and Lossy Networks (RPL) based Low power and Lossy Networks (LLN), new nodes (pledges) join the network one by one. At the beginning, this kind of network formation is started by the RPL root node or TSCH coordinator node. The pledges need to receive network advertisement information carrying Enhanced Beacon (EB) frame to get synchronized with the TSCH network. Similarly, pledges complete their joining process once they receive routing information carrying RPL DIO packet. Pledges are called 6TiSCH joined node once they complete their joining process (i.e., receive both the EB and DIO packets successfully). Both the TSCH joining/ synchronization time and 6TiSCH joining time is very much important for resource constrained LLN devices. In this assignment, both the joining times (i.e., TSCH synchronization time and 6TiSCH joining time) need to be calculated using the Contiki-NG based Cooja Simulator. The results can be obtained using the already available code: *contiki-ng/examples/6tisch/Simple-node*. For this experiment, you have to use the following settings for other parameters.

Slotframe Length (SF)	49, 67
Timeslot duration	10 ms
RPL version	RPL Lite
Number of Channels	16
Topology	5 x 5 grid topology (25 nodes)
Radio Distance between two nodes (X,Y)	150
Radio Range	50 meter
Interference Range	75 meter
Scheduling Function	6TiSCH Minimal configuration Scheduling

Results should be obtained by varying both the slotframe length (SF) and EB generation interval as follows: <Slotframe length (SF), EB generation interval>

<SF, 2 SF>, <SF, 4 SF>, <SF, 6 SF>, <SF, 8 SF>, <SF, EB sending probability per slotframe = 0.1>

Do the experiment for both the given values of SF.

Q3 In Time Slotted Channel Hopping (TSCH) and Routing over Low Power and Lossy Networks (RPL) based Low power and Lossy Networks (LLN), new nodes (pledges) join the network one by one. At the beginning, this kind of network formation is started by the RPL root node or TSCH coordinator node. The pledges need to receive network advertisement information carrying Enhanced Beacon (EB) frame to get synchronized with the TSCH network. Similarly, pledges complete their joining process once they receive routing information carrying RPL DIO packet. Pledges are called 6TiSCH joined node once they complete their joining process (i.e., receive both the EB and DIO packets successfully). Both the TSCH joining/ synchronization time and 6TiSCH joining time is very much important for resource constrained LLN devices. In this assignment, both the joining times (i.e., TSCH synchronization time and 6TiSCH joining time) need to be calculated using the Contiki-NG based Cooja Simulator. The results can be obtained using the already available code: *contiki-ng/examples/6tisch/Simple-node*. For this experiment, you have to use the following settings for other parameters.

Slotframe Length (SF)	101, 31
Timeslot duration	10 ms
RPL version	RPL Lite
Number of Channels	16
Topology	5 x 5 grid topology (25 nodes)
Radio Distance between two nodes (X,Y)	150
Radio Range	50 meter
Interference Range	75 meter
EB transmission rate	Default
Scheduling Function	6TiSCH Minimal configuration Scheduling

Results should be obtained by varying both the slotframe length (SF) and minimum DIO sending interval as follows: <Slotframe length (SF), minimum DIO sending interval >

<SF, 512ms>, <SF, 1024ms>, <SF, 2048ms>, <SF, 4096ms>, <SF, 8192ms>

Do the experiment for both the given values of SF.

Q4 In Time Slotted Channel Hopping (TSCH) and Routing over Low Power and Lossy Networks (RPL) based Low power and Lossy Networks (LLN), new nodes (pledges) join the network one by one. At the beginning, this kind of network formation is started by the RPL root node or TSCH coordinator node. The pledges need to receive network advertisement information carrying Enhanced Beacon (EB) frame to get synchronized with the TSCH network. Similarly, pledges complete their joining process once they receive routing information carrying RPL DIO packet. Pledges are called 6TiSCH joined node once they complete their joining process (i.e., receive both the EB and DIO packets successfully). Both the TSCH joining/ synchronization time and 6TiSCH joining time is very much important for resource constrained LLN devices. In this assignment, both the joining times (i.e., TSCH synchronization time and 6TiSCH joining time) need to be calculated using the Contiki-NG based Cooja Simulator. The results can be obtained using the already available code: *contiki-ng/examples/6tisch/Simple-node*. For this experiment, you have to use the following settings for other parameters.

Slotframe Length (SF)	101, 31
Timeslot duration	10 ms
RPL version	RPL Lite
Number of Channels	16
Topology	5 x 5 grid topology (25 nodes)
Radio Distance between two nodes (X,Y)	150
Radio Range	50 meter
Interference Range	75 meter
EB transmission rate	Default
Scheduling Function	6TiSCH Minimal configuration Scheduling

Results should be obtained by varying both the number of shared cells per slotframe. The number of shared cells per slotframe should be as follows: 1, 2, 4, 8, 10. Also count the number of transmitted EB and DIO packets by all the nodes till the formation of the network with each setting.