

UNIVERSITY OF DELAWARE
DEPARTMENT OF COMPUTER & INFORMATION SCIENCES
CISC 459/659: Simulation of Computer Networks

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Adarsh Sethi

Laboratory #1: Introduction to OPNET Software

Getting Started

Follow the steps below to get started with OPNET for the first time:

1. Look at the document “Getting Started with OPNET” on the course web site on MyCourses under “Notes” and follow all the instructions given there. Note that when looking up topics in the Neticpia Wiki on OPNET, you should look under the link “Using IT Guru/Modeler Version 12.0”.
2. Now you are ready to proceed with this lab. Under Part 1 below, you can now skip the part about starting OPNET. You should create the folder “Lab01” as described below, but you don’t need to do “Adding Model Directories” again, since you should have done that in the “Getting Started” step. All references below to the “Appendix” are to topics available on the Neticpia Wiki.
3. The Lab01.zip file is available in MyCourses under “Labs”. It can also be directly copied, once you are logged in to hplab-lx.acad.cis.udel.edu, from ~sethi/Labs.

Introduction

This laboratory assignment introduces the simulation developer to the graphical user interface and basic features of OPNET software. In particular, this lab introduces such OPNET concepts as projects and scenarios, running a simulation, setting-up and displaying simulation statistics, and others. If you have used OPNET software before, you may skip this laboratory assignment.

Part 1. Opening Existing Project

In this assignment you will modify and update an already created simulation model. Perform the following steps to open an already existing project in OPNET:

- Retrieve the **Lab01.zip** file.
- Put **Lab01.zip** into a separate directory named “*Lab01*” and then uncompress it.
- Start OPNET software. *Refer to Appendix <[Starting OPNET Software](#)> for more information.*
- Add folder “*Lab01*” to the list of OPNET’s model directories and make this folder your default directory for this assignment. *Refer to Appendix <[Configuring OPNET Software ... Adding Model Directories](#)> for more information.* This step may be omitted in OPNET version 12.0 or later if a parent directory of “*Lab01*” has been previously included (along with all subdirectories).
- Open the **Lab_01** OPNET project. *Refer to Appendix <[Managing Projects and Scenarios ... Opening Existing Project](#)> for more information.*

Part 2. Understanding the Project Model

The project model shows you a model of the network to be simulated. You may want to *refer to Appendix <[Configuring Network Devices and Protocols ... Changing Object Properties](#)> for more information* to answer the following questions:

- a. The simulated network has two objects that represent client workstations on a LAN. What are the names of these objects? How many workstations does each one have? (Hint: examine the attributes of these objects in the “LAN” category).
- b. There are three objects which are the gateways to the Internet for their respective local networks. What is the “type” of these objects, and what is the name of the “object model” used for them? (Hint: examine the attributes of these objects; the “type” is displayed at the top of the Attributes window. Then select the “Advanced” box in the lower right of this window; you can now see the value of the “model” attribute).
- c. Change the name of “Gateway 02” to “Server Gateway”.
- d. Examine the three links that join the three gateways to the Internet. What are the names of the “object models” for these links (in the case of links, the Attribute window displays the model even without selecting “Advanced”)? What are the data rates of these links? Specify these data rates in bits/sec.

Part 3. Setting-up Statistics

In this portion of the assignment, you will learn how to specify the statistics you want to collect during the simulation. Some of the statistics have already been pre-selected for you. To complete this part of the assignment you may want to *refer to Appendix <[Setting-up/Collecting Statistics ... Selecting Statistics](#)> for more information.*

- e. What is the difference between global, node, and link statistics?
- f. Configure your simulation to select the following statistics:
 - i. All global statistics for the E-mail application
 - ii. Node statistics: What client statistics have been selected in this category?
 - iii. Link Statistics: *point-to-point: utilization (in both directions)*
- g. What is the difference between the following statistics:
 - *Global statistic: Email: Download Response Time* and
 - *Node statistic: Client Email: Download Response Time*

Part 4. Running Simulation and Processing Results

In this portion of the assignment, you will learn how to run the simulation, re-run the simulation with different parameters, as well as display and compare collected statistics.

- a. Run the simulation with the following attribute values. *Refer to Appendix <[Running/Setting-up Simulation ... Configuring/Running a Simulation](#)> for more information.*
 - i. “Seed” = 101
 - ii. “Duration” = 20 minutes

- b. Examine the following individual statistics: [Refer to Appendix <Setting-up/Collecting Statistics ... Viewing Collected Results> for more information.](#)

- *THE INTERNET <-> Server Gateway: point-to-point. throughput (packets/sec) ->*
- *THE INTERNET <-> Server Gateway: point-to-point. throughput (bits/sec)->*

Display these statistics as follows:

- i. In separate panels using “average” display function
 - ii. In a single panel as “Stacked Statistics” using “As Is” display function
 - iii. In a single panel as “Overlaid Statistics” using “As Is” display function
- c. Looking at the throughput from the Internet to the Server Gateway above, what is the peak value of the throughput, and at what time is it observed? Be sure to observe it in “As Is” mode. Knowing the data rate of this link, calculate the utilization of this link. Now examine the statistic for *utilization* on this link. Is your calculation consistent with the statistic value observed in the simulation?
- d. Display the following statistics in a single panel as “Overlaid Statistics” using “As Is” display mode.
- *Global statistic: Client Email. Traffic Sent (bytes/sec)*
 - *Object Statistics: Office Network: New Offices: Client Email. Traffic Sent (bytes/sec)*

Did you observe any difference between the displayed graphs? Why or why not?

- e. Repeat part d for the Client Email Download Response Time statistic except use the “Average” display mode.
- f. Duplicate the current scenario and name it “10nodes_T1_Delay.” In the new scenario, change the attribute “Average Latency” of the Internet cloud to 0.1 seconds. Execute the duplicated scenario with the same seed and duration used in the first scenario. [Refer to Appendix <Managing Projects and Scenarios ... Working with Scenarios> for more information.](#)
- g. Compare the statistic “Object Statistics: Office Network: New Offices: Client DB Query. Response Time (sec)” for scenarios “10nodes_T1” and “10nodes_T1_Delay”. Display the graphs in a single panel as “Overlaid Statistics” using “As Is” display function. Explain why the results for these scenarios look different.
- h. Examine the raw data of the graph and list the following data values. [Refer to Appendix <Setting-up/Collecting Statistics ... Examining Raw Statistic Data> for more information.](#)
- i. “Expected value” for displayed scenario “10nodes_T1” statistic
 - ii. “Expected value” for displayed scenario “10nodes_T1_Delay” statistic
 - iii. Value at time 324 seconds for displayed scenario “10nodes_T1” statistic
 - iv. Value at time 324 seconds for displayed scenario “10nodes_T1_Delay” statistic