UNIVERSITY OF DELAWARE

DEPATMENT OF COMPUTER & INFORMATION SCIENCES

CISC 459/659: Simulation of Computer Networks

Fall Semester, 2007 Adarsh Sethi

Laboratory #2: Ethernet

Introduction

This laboratory assignment introduces the simulation developer to the modeling of Ethernet LANs. Specific OPNET concepts introduced here include Rapid Configuration of LANs, setting up simple traffic generation on Ethernet stations, and examining Ethernet-specific statistics.

Part 1. Creating a Project

Perform the following steps to create a new project in OPNET:

a. Create a new folder named "*Lab02*".
b. Start OPNET software. ***Refer to Appendix*** <**Starting OPNET Software**> ***for more information.***
c. Add folder "*Lab02*" 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.***
d. Create a new OPNET project. Name the project "Lab02_Ethernet" and name the initial scenario "Load1". ***Refer to Appendix*** <**Managing Projects and Scenarios … Creating New Project**> ***for more information.*** In the Startup Wizard, choose an "Empty Scenario", "Office" Network Scale, default Size, and "Ethernet" Technologies.

Part 2. Creating and Configuring the Network Model

The network model is created in the Project Editor workspace by choosing objects from the Object Palette. However, in this laboratory, we will use the Rapid Configuration Tool to quickly and easily create an Ethernet LAN with a large number of nodes.

a. Close the Object Palette. Use the Rapid Configuration Tool to create an Ethernet with a Star topology (hub). ***Refer to Appendix*** <**Creating Network Topology … Rapid Configuration Tool**> ***for more information.*** Select the Center Node Model to be ethernet16_hub, the Periphery Node Model to be ethernet_station, the Link Model to be 10BaseT, the Number of Periphery Nodes to be 12, and default placement and radius. Change the name of the Center Node to "hub".

b. Edit the attributes of all the periphery nodes together. ***Refer to Appendix*** <**Configuring Network Devices and Protocols … Changing Object Properties**> ***and*** <**Configuring Network Devices and Protocols … Changing Properties of Multiple Objects**>***for more information.*** Set the Traffic Generation Parameters on **all** periphery nodes as follows:

- Start Time: constant (0.0)
- ON State Time: constant (1000)

- OFF State Time: constant (0)
- Interarrival Time: exponential (0.006)
- Packet Size (in bytes): constant (100)

Part 3. Setting-up Statistics

To complete this part of the assignment you may want to ***refer to Appendix*** <**Setting-up/Collecting Statistics … Selecting Statistics**> ***for more information.*** Configure your simulation to select the following statistics:

a. Global Statistics: Ethernet -> Delay (sec); Traffic sink -> Traffic Received (bits/sec); Traffic Source -> Traffic Sent (bits/sec).

b. Node Statistics: Ethernet -> Collision Count, Load (bits/sec), Traffic Forwarded (bits/sec), Traffic Received (bits/sec), and Utilization.

Part 4. Running Simulation and Processing Results

a. Run the simulation for a duration of 30 seconds. ***Refer to Appendix*** <**Running/Setting-up Simulation … Configuring/Running a Simulation**> ***for more information.***

b. Examine the statistics that were collected. ***Refer to Appendix*** <**Setting-up/Collecting Statistics … Viewing Collected Results**> ***for more information.***

Part 5. Creating Additional Scenarios

a. Create 4 additional scenarios by duplicating the current scenario. Name the new scenarios "Load2", "Load3", "Load4", and "Load5". Change the attribute "Traffic Generation Parameters -> Interarrival Time" of **all** periphery nodes to exponential with averages 0.004, 0.002, 0.001, and 0.0008 respectively for each of the new scenarios. ***Refer to Appendix*** <**Managing Projects and Scenarios … Working with Scenarios**> ***for more information.***

b. Execute the duplicated scenarios for the same duration used in the first scenario. ***Refer to Appendix*** <**Running/Setting-up Simulation … Running Multiple Simulation Scenarios**> ***for more information.***

c. Examine the statistics collected in each of the scenarios. ***Refer to Appendix*** <**Setting-up/Collecting Statistics … Advanced Viewing Collected Results**> ***for more information.***

Part 6. (FOR CISC 659 STUDENTS ONLY)

a. Duplicate scenario "Load4" to create a new scenario named "Switch". In the new scenario, change the attribute "model" of the center node to "ethernet16_switch" from the pull-down menu (you may have to check the "Advanced" button to do this). Run the simulation for this new scenario and examine the collected statistics.

ASSIGNMENT FOR SUBMISSION

1. Print and submit a copy of the Network Model for the "Load1" scenario. ***Refer to Appendix <Creating Network Topology … Printing Network Map> for more information.***
2. For all the scenarios from "Load1" through "Load5", display the graph for Node statistic "Ethernet -> Utilization" for the hub node in a single panel as "Overlaid Statistics" using the "As Is" display function. Print and submit this graph. ***Refer to Appendix <Setting-up/Collecting Statistics … Printing Graphs> for more information.***
3. Repeat step 2 for the Global statistic "Ethernet -> Delay" and for the Node statistic "Ethernet -> Collision Count" for the hub.
4. For each scenario from "Load1" through "Load5", use the Periphery Node attribute values to calculate the total Load (in Mbps) on the Ethernet placed by the traffic generated by all the nodes. Knowing the capacity of the Ethernet, calculate the expected Utilization of the Ethernet channel for each scenario. Submit a table listing the scenario name, the average inter-arrival time of a node, the total Load, and the Expected Utilization for each scenario.
5. For each scenario from "Load1" through "Load5", determine the observed Utilization and total Load. The total Load is the value of the Global statistic "Traffic Source -> Traffic Sent". For both Load and Utilization, use the "expected value" of the statistic displayed in the "Show Statistic Data" panel when the graph is plotted with "As Is" values. ***Refer to Appendix <Setting-Up/Collecting Statistics … Examining Raw Statistic Data> for more information.*** Submit a table listing the scenario name, the observed Total Load, and the observed Utilization for each scenario.
6. Comment on the differences between the expected and observed values of the Total Load and the Utilization. Hint: The Utilization includes all packets that attempted transmission including those that collided.
7. The Throughput is the total Traffic Received by all the nodes. This is the Global statistic for the Traffic sink. For each scenario, note the "expected value" of this statistic from the "Show Statistic Data" panel when the graph is plotted with "As Is" values. Draw a graph that shows how Throughput varies with Average Inter-arrival Time (you may draw the graph with a tool such as Excel, or you may simply hand-draw the graph). Find the inter-arrival time for which the maximum throughput is achieved. What is the total load corresponding to this inter-arrival time? Why does the throughput stop increasing even when the load is increased further?
8. Draw a graph of the Utilization vs Throughput. How are the two statistics related? Why can't the system reach 100% utilization?
9. Comment on how the Delay varies as inter-arrival time is decreased (and hence the load is increased). Explain the behavior of Delay for scenarios "Load4" and "Load5".

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10. Comment on how the Collision Count varies as inter-arrival time is decreased (and hence the load is increased). How can you explain this behavior?
11. Compare the results for the "Switch" scenario with those of "Load4". Comment on the differences between these scenarios in terms of the Throughput and Delay.