Lab 2: Improving LAN Performance using VLANs

Objective

In this lab, OPNET's IT Guru Academic Edition advanced modeling software will be used to study LAN performance improvement by implementing VLANs.

You will learn the benefits of configuring VLANs in the network to improve performance, and also learn how to use modeling and simulation software to help make critical decisions to solve real world problems.

Lab Project

Simple-n-Real is a consulting firm with multiple buildings and has recently grown its staff to large numbers as part of their growth strategy. However, the addition of new hires has significantly added to their LAN traffic. You, as their network engineer, are tasked with the job to get the maximum out of the current infrastructure. Simple-n-Real does not want to invest their money into buying network gear until they generate more revenue.

Overview

In this lab, there are 2 scenarios. The first scenario studies the switch performance in a wired switched Ethernet network. The second scenario improves the switch performance by configuring VLANs.

Lab Instructions

Note: Bold marked words indicate menu/clickable options.

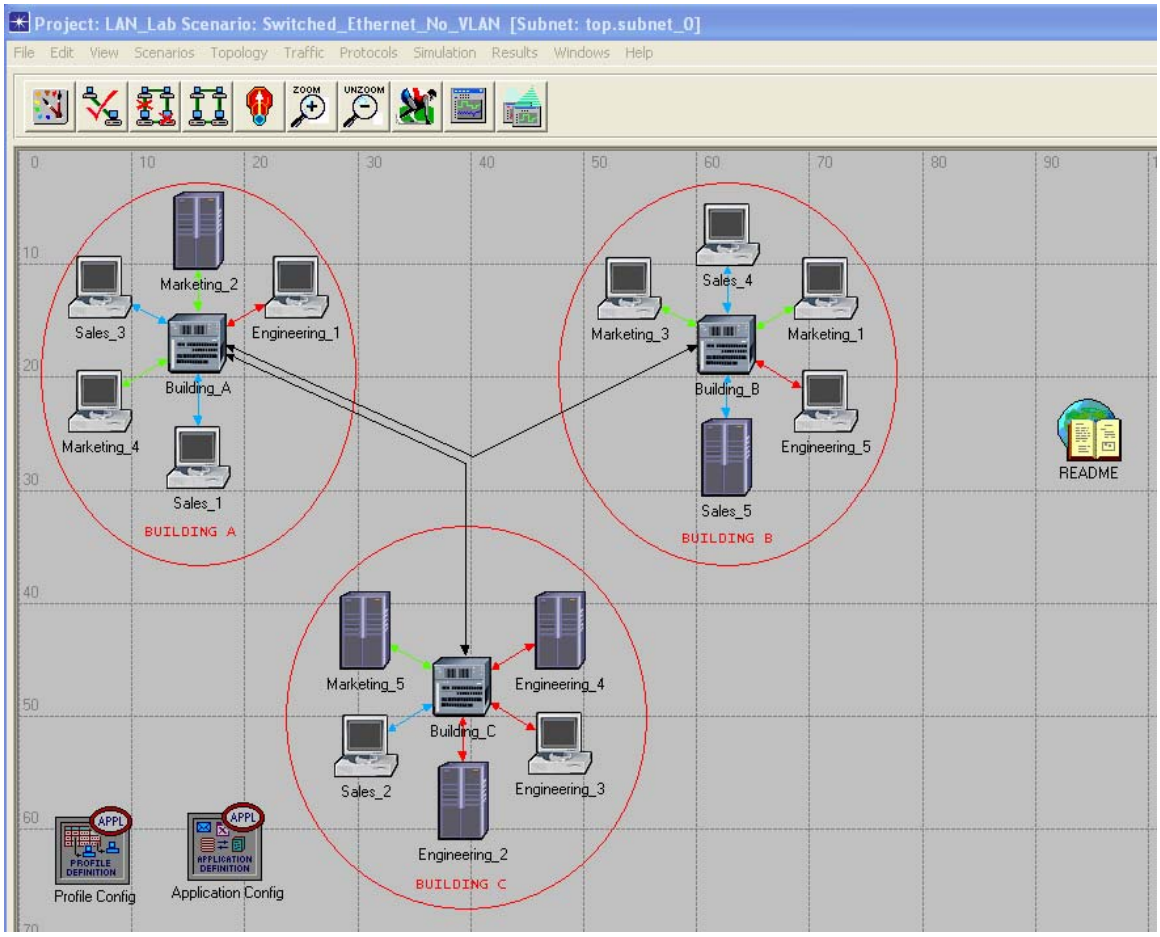
Part 1: Understand the model and modeling environment

1. Start IT Guru Academic Edition 9.1.

2. Select **File** -> **Open…**

3. Scroll to the project named **LAN_Lab_2**, select it and click **OK**. If you do not see this project in the list, it means you have not downloaded and installed the labs properly. For complete instructions, follow the steps on this page: http://opnet.com/services/university/Install_Lab.html.

4. The first scenario is named "Switched_Ethernet_No_VLAN". You can verify the project and scenario by observing the title bar (see screenshot below).



In this scenario, groups of users belonging to different divisions - engineering, marketing, and sales – are connected to Ethernet LAN switches which use this icon: 

. The switches are named Building_A, Building_B and Building_C - one in each building. Groups of users  hit a variety of servers  running file, database, HTTP and Email services. This lab simulates users running these various applications between their workstations and the servers.

For input in this study, the groups of users are configured to run Email and FTP applications.

For output, OPNET software provides many types of output performance statistics; low level statistics such as link bit error rate, switch queuing delays, and switch throughput, and high-level statistics like end-user application response times.

5. Read the “Read Me” file by double-clicking the 

icon. Then, click the  icon in the toolbar to return to the topology in the project workspace,

Explore the attributes values of the following objects: Application Config 

, Profile Config 

, and Workstation  . These attributes define the traffic that will get generated for the network (they are numerous and detailed and are beyond the scope of this lab).

The attribute values configure an object’s behavior and act as input to the simulation engine. Click **Cancel** whenever you wish to get out of any dialog box without changing the attribute values.

For purposes of this lab, the attribute values have been tuned to ensure correct results and conclusions. Any change in these values may alter the results significantly.

Understanding the network infrastructure: Here you will understand your network infrastructure, namely switches and links.

6. Right click on one of the switches labeled Building_A, Building_B, or Building_C, and click **Edit Attributes.**

7. Expand **Switch Port Configuration**, and then, expand **row 0** (or any row) to see other details. Scroll to the bottom of the window and expand **VLAN Parameters** – verify the Scheme field is set to **No VLANs**. This indicates no VLANs have been configured in the network. Click **Cancel** to return.

8. Right click on the links between Building_A & Building_C, and Building_A & Building_B. Click **Edit Attributes** and note the data rate of the link. The units are in bits/sec.

By now, you should have a feel of how to navigate the project workspace, and have an understanding of this scenario. You are now set to run the simulation.

Part 2: Configure and Run the Simulation

The goal is to evaluate the network performance for a simulated 8 hours of the day by running a high-fidelity Discrete Event Simulation.

1. Click on the **configure/run simulation** toolbar button.  .

2. Make sure the Simulation **Duration** is set to **8** hours.

3. Click **Run.** Monitor the progress bar as the simulation proceeds.

4. When the simulation completes, Click **Close**.

Part 3: View Results

View output results: Application Response Times for Email and FTP applications as observed by end-user, and Switch throughput statistics. It is important to note their values because we will compare the LAN performance improvement in the next scenario where VLANs are configured.

1. Click on **Results->View Results**.

View Application Response Times:

2. Expand **Global Statistics, Email** and **FTP**.

3. Select **Download Response Time (sec)** and **Upload Response Time (sec)** for both Email and FTP. The selected graphs will be plotted on the right-side of the frame. On the lower-right side, make sure the settings are **Stacked Statistics**, **This Scenario** and **As Is**. Click **Show**. A window is created with the graphs containing the raw data for the Email and FTP application response times.

4. Click the **As Is** drop-down menu and select **average**. This will convert the raw data into an average curve. Click **Add** and then click on the top-most graph of the window that you created in step 3. Now you have both the raw data and average graphs for Email and FTP application response times.

Note: If you did not follow the underlined instructions above, you may have mismatched raw data and average graphs, so close the graph, choose **Delete** and go through steps 3 and 4 again.

You may place the resulting window anywhere on your project workspace by dragging its header bar.

View Switch Throughput Statistics:

5. Go back to the 'View Results' window and unselect the previously selected choices for **Email** and **FTP**.

6. Now expand **Object Statistics** and then expand **subnet_0**

7. Expand **Building_A**, and then expand **Switch**.

8. Select **Traffic Received (bits/sec)** and **Traffic Forwarded (bits/sec)**.

9. On the lower-right side, make sure the settings are **Stacked Statistics**, and **This Scenario**. Click the **average** drop-down menu and select **As Is**.

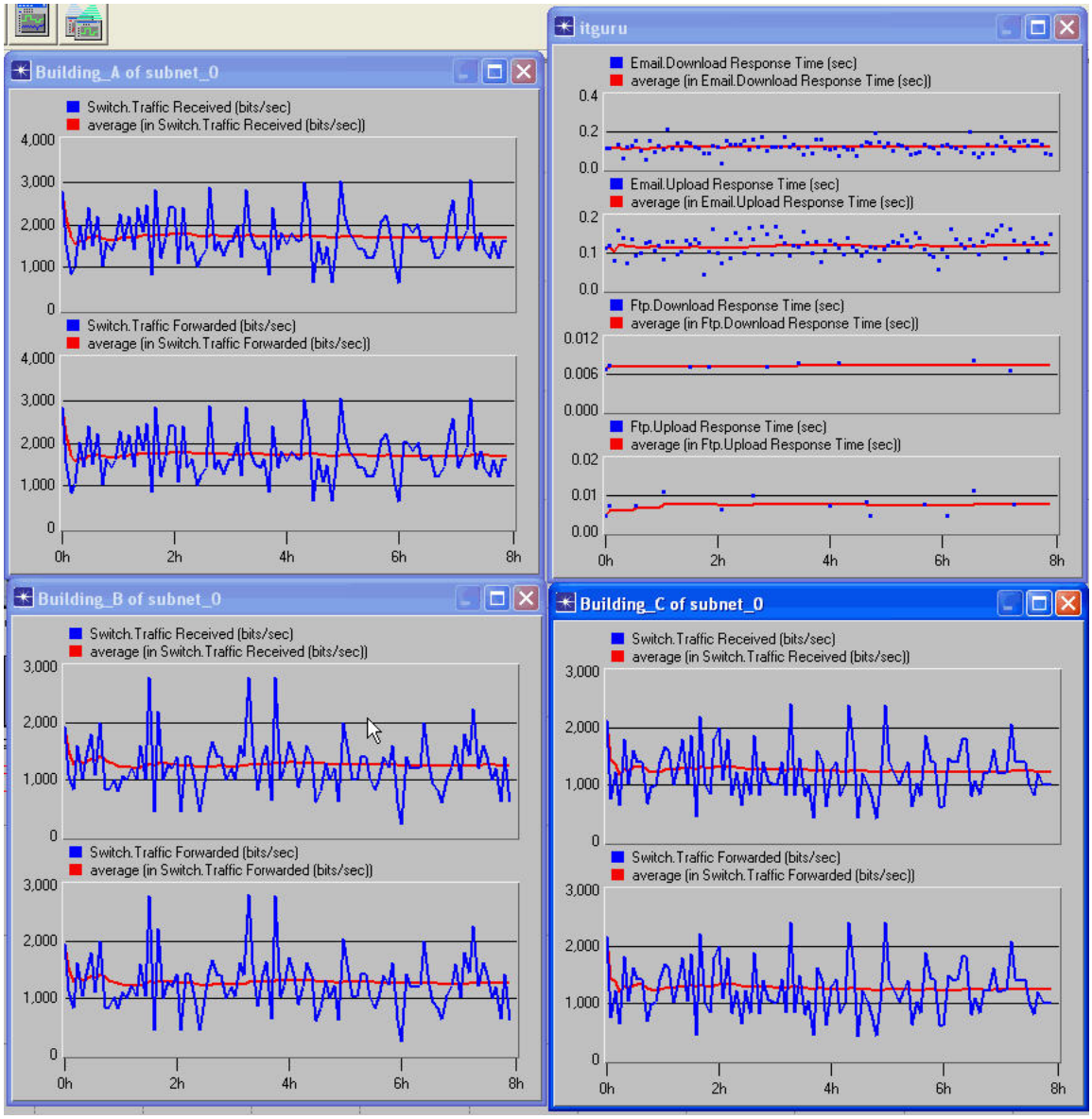
10. Click **Show**.

11. Click the **As Is** drop-down menu and select **average**. This will convert the raw data into an average curve. Click **Add** and then click on the top-most graph of the window that you created in step 10. The graph shows values of the traffic that switch Building_A sent and received due to the application traffic.

12. Deselect all selections in the 'View Results' window and execute steps 7-11 for the switches **Building_B** and **Building_C**.

Note: To toggle the graphs on and off, use the **hide or show all graphs** button. 

You should now have 4 windows with graphs – the first one for Email and FTP application response times and the other 3 windows graphic the Switch Traffic statistics for Buildings A, B, and C. You may move the windows around to suit your display needs.



By looking at the graphs, write values for application response times and switch traffic. You will use these numbers as a basis to compare with other scenarios.

Email Download Response Time:
Min_____ Max _____ Avg _____

Email Upload Response Time:
Min_____ Max _____ Avg _____

FTP Download Response Time:
Min_____ Max _____ Avg _____

FTP Upload Response Time:
Min_____ Max _____ Avg _____

Switch Building_A:
Traffic Received: Min _____ Max_____ Avg _____
Traffic Forwarded: Min _____ Max_____ Avg _____

Switch Building_B:
Traffic Received: Min _____ Max _____ Avg _____
Traffic Forwarded: Min _____ Max _____ Avg _____

Switch Building_C:
Traffic Received: Min _____ Max _____ Avg _____
Traffic Forwarded: Min _____ Max _____ Avg _____

Optional: Graph the link throughput and queuing delay for the links between building switches.

Part 4: Switch scenarios to simulate the same network with VLANs

1. Click on **Scenarios ->Switch Scenarios**.

2. Choose **3_VLANs** scenario.

3. To examine the change in attributes configuring VLANs, right click on any of the three switches (Building_A, Building_B or Building_C) and click **Edit Attributes**.

4. Expand the last entry **VLAN Parameters**. Note the Scheme is **Port-Based VLAN** as opposed to **No VLANs** in the previous scenario. This means that VLANs have been configured on the switch.

5. Click the **(…)** across the **Supported VLANs** field. Click **Edit**. Note the 3 VIDs (VLAN IDs) defined - 10, 20 and 30. Click **Cancel** twice on the two windows to exit the dialog boxes.

6. The topology, application and profiles defined are the same for this scenario.

7. Run the simulation for the **3_VLANs** scenario. Follow the 4 steps outlined in **Part 2: Configure and Run the Simulation** section.

8. To view results, follow steps 1-12 in **Part 3: View Results** section. Note the switch throughput values in Building_A, Building_B and Building_C and the application response times for Email and FTP. What do you observe?

Email Download Response Time:
Min_____ Max _____ Avg _____

Email Upload Response Time:
Min_____ Max _____ Avg _____

FTP Download Response Time:
Min_____ Max _____ Avg _____

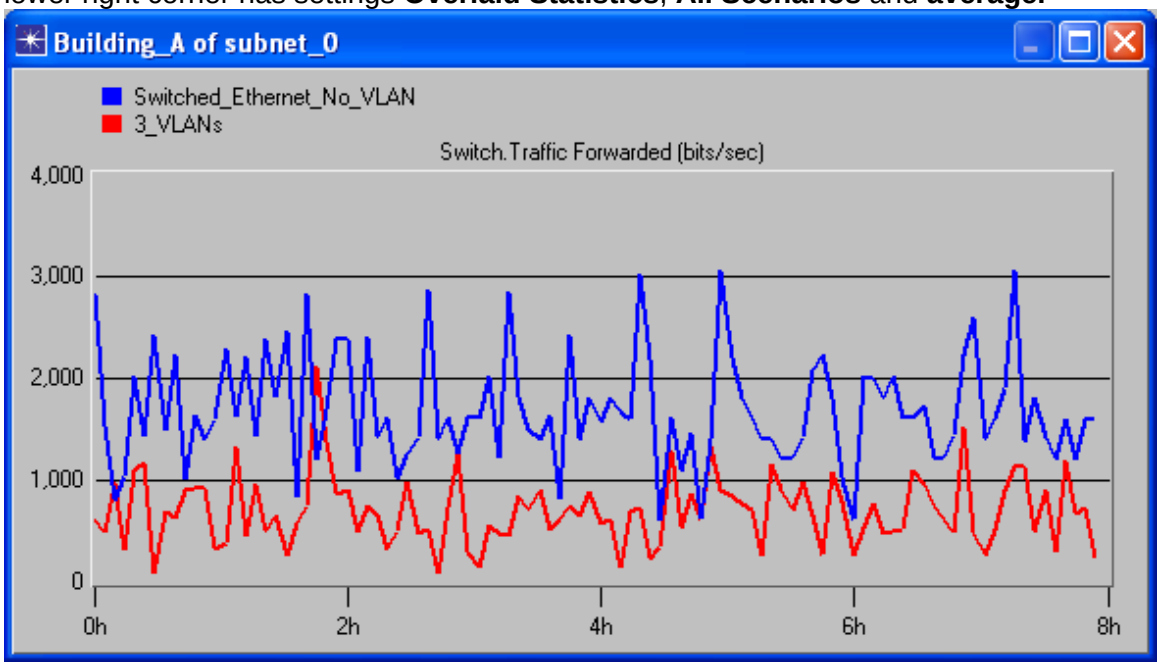
FTP Upload Response Time:
Min_____ Max _____ Avg _____

Switch Building_A:
Traffic Received: Min _____ Max _____ Avg _____
Traffic Forwarded: Min _____ Max _____ Avg _____

Switch Building_B:
Traffic Received: Min _____ Max _____ Avg _____
Traffic Forwarded: Min _____ Max _____ Avg _____

Switch Building_C:
Traffic Received: Min _____ Max _____ Avg _____
Traffic Forwarded: Min _____ Max _____ Avg _____

Compare the graphs with the previous scenario.
Note: You can compare results in a graphical way using. Click **Results -> Compare Results** and choose the statistics you want (for example, **Object Statistics / subnet_0 / Building_A / Switch / Traffic Forwarded (bits/sec)**) and click **Show**. Make sure the lower right corner has settings **Overlaid Statistics**, **All Scenarios** and **average.**

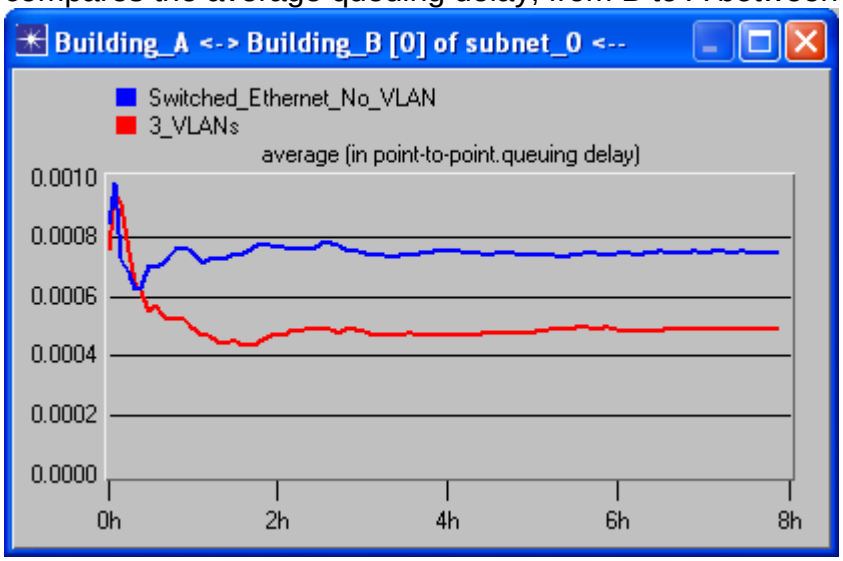


a) Switch throughput has reduced significantly due to VLAN configuration. Read the “READ ME” by double-clicking the icon to understand the reason behind it.

b) However, the overall application response times for Email and FTP tasks have not changed by much despite switches experiencing lower throughput. What might be the reason behind it?

Before we go into the reasons, convince yourself that the amount of data sent by workstations in both scenarios were the same - the application & profile configuration were identical across the two scenarios. The real reason lies in the link queuing delays.

9. Right click on the link connecting the two switches Building_A and Building_B. Select **Compare Results**. Click on the **+** sign to expand **point-to-point**. Select **queuing delay <--**. On the lower-right side, make sure the settings are **Overlaid Statistics**, **All Scenarios** and **average**. Click **Show**. The resultant window compares the average queuing delay, from B to A between the two scenarios:



10. Do step 9 for **Building_C to Building_A** link and plot the average queuing delay.

Is there a difference in the value? How much is the difference? How does it compare to the application response time?

Answer: Yes, there is a difference in the queuing delays across the scenarios but the difference is very small compared to the overall application response times. In this case, the small changes in the link queuing delays do not impact much the overall application response time.

The queuing delays are so small to begin with because the queues in the switches are not filled up to cause packet dropping. If the queue levels (and hence queuing delays) were large, then having VLAN configuration would make a greater impact on the application response time in addition to reducing to switch throughput. The purpose of these exercises is to illustrate the benefits of VLAN, which are improving the bandwidth utilization and providing security and administration by supporting a virtual organization.

Note: Components of Network Delays are Bandwidth Delay, Protocol Delay, Delay due to Latency, and Congestion Delay. Delay due Bandwidth and Latency are typically not found in LAN. Queuing delay falls within Congestion Delay category.