Term Project: Riverbed Modeler WAN Simulation

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1. Instructions

This assignment is a follow up to the previous Modeler homework. You have to develop a WAN topology, evaluate performance for several protocols using multiple simulation scenarios, and write a report analyzing the results.

The "Introduction to WAN Modeling" (File *opnet-WAN.pdf*) slides posted on BB provide useful instructions for how to set up a WAN topology using subnets.

Please follow the instructions listed next.

2. Create the Prototype Scenario

Create a new scenario using the USA map. Call this scenario "WAN0".

3. Configure the Applications and the Profile

This network will be used by a large corporation with a strong presence in a few large US cities. The network will be used by the employees to run several applications: HTTP web browsing, VOIP, email, and database transactions.

Add to the WAN0 scenario an *Application Configuration* object and a *Profile Configuration* object.

Edit the HTTP Application Configuration to have the following parameters:

- page interarrival time: exponential with a mean of 60 s
- in the page properties, set the page to have one object of size (constant, 20000 bytes) and 10 other objects of size (uniform, with range 5000-30000 bytes).

Leave the other application configurations to defaults. Create application definitions for email (High Load), Voice (IP Telephony with silence suppression), Database (High Load).

Create a user Profile Configuration that has all the applications mentioned above, running them simultaneously (set "operation mode" attribute accordingly). All applications should begin at a time distributed uniformly between 100 and 200 s from the simulation start. Name the profile you created "User". All client computers will run this profile.

4. Build the Topology

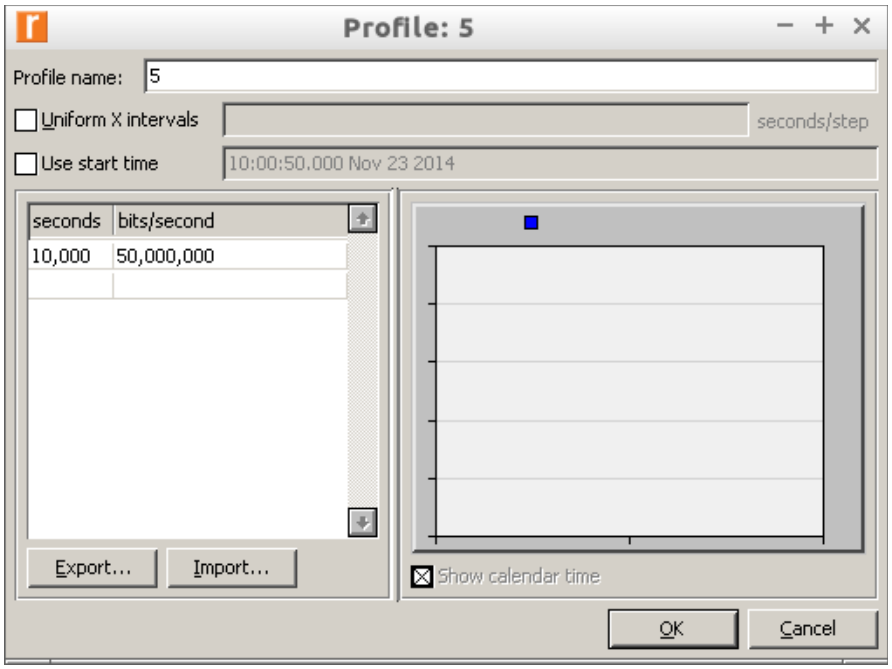
4.1 Backbone network

The network has a backbone with Cisco 7600 routers located in Miami, Atlanta, New York (NY), and San Francisco (SF). These nodes have to be placed on a map at the right location, so when you create the initial scenario, pick the USA map. Change the routers' name to the city name.

Create the following links of type “PPP Sonet OC-3” from the *links* palette between the following routers:

Miami – Atlanta, Atlanta – NY, SF – Atlanta, SF – NY. The OC-3 data rate is about 155 Mbit/s.

Set the background utilization for all links to 50 Mbps: select all OC3 links, right-click on one, Edit Attributes, check “Apply to selected objects”; then edit “Traffic Information”: enter 1 for Number of Rows, then in both directions edit in “Traffic Load” a profile with 10000 seconds and 50000000 bits/second:



4.2 LAN Nodes

A prototype LAN will be designed inside a subnet. Use the subnet node from the palette, shown here on the right. Drop it close to the Miami router. Double click on it to add additional objects to the subnet as follows.

Add one *1000BaseX_LAN* node from the internet_toolbox palette to the Miami subnet. Edit its properties: change name to LAN0, select Applications / Supported Profiles to profile User, LAN / Number of Workstations to 40. Zoom out of the subnet (click on) and connect the Miami router with the LAN0 object with a *1000BaseX* link.

Select the Miami subnet, than copy-paste it twice near the SF and NY routers. Connect the LAN nodes in these two subnets with the closes routers using *1000BaseX* links.

4.3 SF Server Node

Add an *ethernet_server* node from the *internet_toolbox* palette in the SF subnet. Name it *server0* and change its configuration to support all services: edit its attributes, click on Applications/Supported Services, and select "All".

Edit its *CPU Resource Parameters*: set its *Processing Speed Multiplier* attribute to 10 and change *Number of Resources* to 4, to bring its CPU speed to the level of current hardware. Connect the SF *server0* node to the SF Cisco router with a 1000BaseX link. This server will be used by all clients in the network.

5. Statistics Report and Metrics

Create a *statistics report:* click DES/Configure, then click on the Reports Tab, then on "Define Statistics Report" button. Select New Report and select the following metrics:

Email Download Response Time, HTTP Page Response Time, and Voice Application Packet End-to-End Delay

Save the statistics report with a name *WAN0*.

A scenario that is duplicated will inherit the use of the same report.

6. Simulation Configurations

Set the *Values per Statistic* parameter to 200.

Run scenarios for at least 8 minutes simulation time. Keep in mind that the Modeler academic license may limit simulation scenario runs 50 million events, so your simulation may end before the specified simulation time. This is acceptable and will have little impact on the performance results.

7. Research Tasks

Perform the following research tasks.

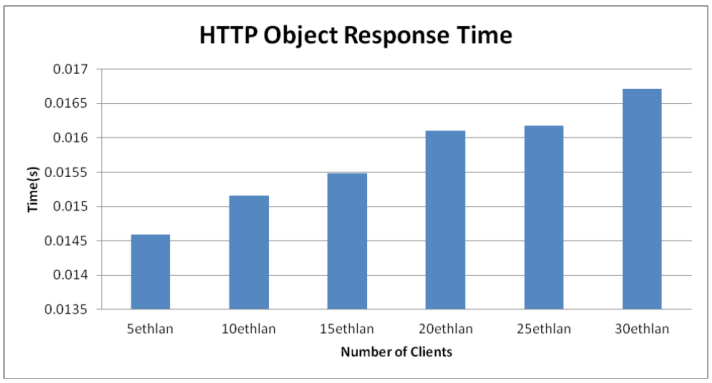
7.1 Impact of Location on Protocol Performance

For this task you will analyze the performance of individual protocols depending on where the users are located.

Run a simulation for scenario WAN0. Compare the performance for all applications configured, using the metrics in Section 5. Analyze how the metrics depend on the location of the subnet, i.e. where the LAN is located (Miami, NY, or SF).

a) Create a separate chart for each metric showing the CDF overlaid for the three LANs.

b) Create bar charts in Excel comparing the average value of the metrics for the three locations. Here is a sample bar chart:



In this case, there should be a chart for each performance metric and in each chart, a bar for each location. The numbers used for a bar's size is the average value of a metric for that scenario.

c) Write a paragraph summarizing your conclusions.

7.2 Internet Connection for Miami Subnet

Study the protocol performance for the Miami subnet clients after the Atlanta router is replaced with an *ip32_cloud* node from the *internet_toolbox* palette in a scenario duplicated from the first. The new scenario should be named *internet_cloud*.

The *ip32_cloud* node simulates the internet as a whole. The Miami LAN clients will access the server in SF using an internet connection instead of a private network. The links between the internet cloud node, the SF node, the Miami node, and the NY nodes should be of type PPP_SONET_OC1 instead of OC3. Keep the background utilization on these links to 50Mbps.

Configure the internet cloud node's “Performance Metrics” attributes: set a *Packet Discard Ratio* of 0.05 % and a *Packet Latency* having an exponential distribution with a mean of 0.07 s. Run the new scenario with the same parameters as WAN0.

a) Compare all metrics referred from Section 5 for the Miami LAN clients with the results from the original WAN0 scenario. Create the same charts as in Section 5, but each showing the corresponding metric for both scenarios. Use the *Compare Results* menu command and select the two scenarios. Write a paragraph with your conclusion.

b) Compare the HTTP protocol performance (page delay) for the NY clients between scenarios WAN0 and internet_cloud. Create the CDF chart for the HTTP metric. Write a paragraph with your conclusion.

7.3 Impact of Internet Packet Loss

Add to the statistics report the global metrics *TCP Segment Delay* and *TCP Retransmission Count*.

Create a duplicate of the *internet_cloud* scenario from Section 7.2 for each value of the *Packet Discard Ratio* attribute of the *ip32_cloud* in the set {0%, 0.1%, 0.5%, 1%, 2%, 5%, 10%, 20%}. Name the cloned scenarios in a meaningful way, such as internet_cloud_01 for the case where the discard ratio is 0.1%.

Compare the performance for all metrics listed in Section 5 for clients on the Miami LAN, for the scenarios with different packet discard ratios. Also, compare the *TCP Retransmission Count* (average) and the *TCP Segment Delay* (CDF) depending on the *Packet Discard Ratio* variable. Write a paragraph with your analysis on how different packet loss ratios affect the performance of different applications. Analyze the effect of TCP retransmission count on the applications that rely on the TCP protocols.

8. Report Format and Submission

The report should have the following outline:

- Title
- Course name
- Student name
- Section 1. Introduction. Write what the project is about. Summarize the main results.
- Section 2. Network Topologies, Performance Metrics, and Other Simulation Parameters. Describe them, including the topology screenshots for scenarios WAN0 and internet_cloud.
- Section 3. Research Tasks.
    - Section 3.1 Impact of Location on Protocol Performance. Write material as required in Section 7.1
    - Section 3.2 Internet Connection for Miami Subnet.Write material as required in Section 7.2
    - Section 3.3 Impact of Internet Packet Loss.Write material as required in Section 7.3
- Section 4. Conclusions. Write 1/3 page with the main conclusions.

Convert the document to a PDF file. Submit the PDF file following the instructions on the Project BB page.

9. Grading

The weight of this assignment from the total course grade will be as indicated on the Syllabus posted on BB.

Total 100 points

10% Topology screenshots for scenarios WAN0 and internet_cloud
For each task (Sections 7.1, 7.2, 7.3):

- 20% Charts and graphics
- 10% Correct analysis and conclusions based on results

Points will be deducted if the document format and charts do not comply with the requirements or if the conclusion does not match the simulation results. If in doubt, contact the instructor.
Check out the Project Discussion Board Q & A forum.