Simulation of Networks of Queues in NS2

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Linux

Restart the computer and when prompted press L for Linux. To gain some familiarity with Linux. Try some of the following operations.

- Changing folders.

  `cd <folder name>`

- Listing your directories contents.

  `ls`

- Making a new directory.

  `mkdir <folder name>`

- Moving a file and renaming a file.

  `mv <old file name> <new file name>`

- Copying a file.

  `cp <old file name> <new file name>`

- Deleting a file.

  `rm <file name>`

The Lab

- At the Redhat Gnome Login enter your dcs account details. The machine will then enter Linux with the Gnome desktop.
- Right click on the desktop and select `New>Terminal`. A 'terminal' window will then be opened for you in which you can write command line arguments.

- Create a new directory called npalab in your home directory by writing `cd`pressing return and then writing `mkdir npalab`.
- Open a Netscape window using the icon on the desktop and point the browser at `http://www.dcs.shef.ac.uk/~neil/NPA/source.zip`. When the Save As box appears save the file in the directory you have just created.
- Move to the directory with `cd npalab`. Uncompress the `source.zip` file with the command `unzip source.zip`.

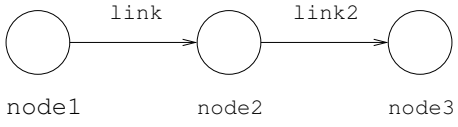
1. Open the file `mm1.tcl` by typing `gedit mm1.tcl &` (the & makes the process run in the background).
   This file contains the simulation of the $M/M/1$ queue.
   Look at the top part of the file. Here the arrival rate is set, `lambda`. The parameter `mu` controls the exponential distribution for the packet lengths.
   Find the part in the file which is commented

   ```
   # Set up the network structure
   ```

   It is here that the network topology is set out. Find and read the parts where the different nodes are created. Also study the line which creates the link between the nodes.

   ```
   set link [$ns simplex-link $node1 $node2 8Kb 0ms DropTail]
   ```

   What do you think the different parts of this line do? What does simplex mean?
   Try running the simulation by typing `ns mm1.tcl`. The queue length will be output to the sreen. You can put the queue length in a file by writing `ns mm1.tcl > qlength.dat`. You can study the results of the simulation by studing them in MATLAB.
   Start MATLAB with `matlab &`. Change to the `npalab` directory and load the file with the command `load qlength.dat`. You can plot the average over time `plot(cumsum(qlength)./(1:length(qlength))' )`. Additionally you can use MATLAB to check the mean of the data.
   Run the simulation for an arrival rate, λ, of 1 and a packet length distribution (in Kb) with a rate of 2. Then run the simulation a second time with the same packet length distribution and an arrival rate of 1.9. Compute the theoretical average queue length in each case and compare with your plotted values.
2. Now you will extend the simulation by adding a third node and a further link and associated queue. The structure of the network you will now create will be as below



First of all use 'Save As' to save your current file with the name `tandemMM1.tcl`.

- After the line

  ```
  set node2 [$ns node]
  ```

  add a new node, called `node3`, by writing

  ```
  set node3 [$ns node]
  ```

- After the line

  ```
  set link [$ns simplex-link $node1 $node2 8Kb 0ms DropTail]
  ```

  add a new link, connecting the new node, called `link2`, by writing:

  ```
  set link2 [$ns simplex-link $node2 $node3 8Kb 0ms DropTail]
  ```

- Now associate a new queue with this link by adding the lines

  ```
  set qu2 [[$ns link $node2 $node3] set queue_]
  $qu2 set limit_ $m
  ```

- You need to change the node where the packets leave the network from `node2` to `node3`. Do this by changing the line

  ```
  $ns attach-agent $node2 $sink
  ```

  to

  ```
  $ns attach-agent $node3 $sink
  ```

- To monitor the queue you need to add this line

  ```
  set qmon2 [$ns monitor-queue $node2 $node3 ""]
  ```

- Finally you need to print the new queue length by changing the lines in the function `outputdata`

  ```
  global ns qmon
  ```

  to

  ```
  global ns qmon qmon2
  ```

  and replace the line

  ```
  puts $NQ
  ```

  with the lines

  ```
  set NQ2 [$qmon2 set pkts_]
  puts -nonewline $NQ
  puts -nonewline ", "
  puts $NQ2
  ```

  You should now be able to plot the results in MATLAB.

3. A more complex network architecture has been prepared for you. Open the file `multipath.tcl`. Read and try to understand the code[1]. Draw the architecture associated with this network.

[1] Note that the duplex links are necessary in order to run the multi-path protocol we are using, however they are not being used as duplex links, traffic is only travelling one way along them.

(a) Use Kleinrock's independence assumption to approximate the expected queue length at each link. Note that the routing command used means that network traffic travels equally down all available paths.

(b) How does the approximation you have computed compare with the real value for the network

i. For light load $\mu = 2$, $\lambda = 2$?

ii. For moderate load $\mu = 2$, $\lambda = 3$?

iii. For heavier load $\mu = 2$, $\lambda = 3.8$?

(c) Reduce the bandwidth of each link to 4Kb, how does the average queue length now compare with the original example?

4. Try modifying the multipath code to

(a) Include a direct route from `node1` to `node4`.

(b) Include another node via which packets travel to get to `node4`.

END OF LAB