

# CS 252 Spring 2020- Lab Quiz 2

Feb 18th, 2020. Time: Upto 4:45 pm (SAFE quiz starts at 4:30pm, NO EXTENSIONS UNLESS SYSTEM ISSUES)

4 marks per question. In SAFE for multiple choice, there will be -1 negative marks for wrong answer, no negative marks for fill-in-the-blanks.

*This lab quiz will proceed in **two phases**.*

- 1) *First, you will be given time to write and run your code, answer the questions, and type your answers below the questions, in this odt file.*
- 2) *You **MUST export your ODT to PDF and SUBMIT the PDF file and code on BodhiTree. Your SAFE marks will not be considered valid without submission of the typed answers with explanations where required. Your pdf submission will also be your ONLY recourse if you want to ask for any review of marks given in SAFE.***
- 3) *For ease of grading, however, we will be giving a quiz in SAFE of the same questions in this file. The SAFE quiz will open from 4:30pm to 5:00pm.*

## **A) Given ns3 Code Comprehension:**

Start with the labquiz2-ns3.cc. file given to you. Study this file and answer the following questions.

1. How many nodes are there in the network?  
4
2. What is the physical layer medium through which they are connected?  
Wifi
3. Which IEEE wifi standard is the medium set to?  
802.11a
4. What is the PHY data rate ("bandwidth" or "transmission rate") of the medium set to ?  
54 Mbps
5. What is the node topology implemented in the given file? (which node is physically connected to which node(s))  
Every node is connected with other node
6. What application(s) are running on the node(s)? In the terminology used in the ns3 code, which represent(s) "constant bit rate" (CBR) flow and which one represent(s) "file transfer" (FTP) flow (if any)?  
OnOffHelper and BulkSendHelper
7. What are their transport layers?  
UDP for CBR and TCP for FTP
8. Based on your theory+ Lab04/05 knowledge - which app+transport layer

combination performs RDT (Reliable Data Transmission)?

TCP

9. Based on your theory+ Lab04/05 knowledge - which app+transport layer combination does not provide RDT?

UDP

10. What are the input traffic parameters of the FTP source (data rate, maximum packet size, bulk data maximum bytes, window size etc as applicable.) ?

Max packet size=600000 sws = 1100

11. What are the input traffic parameters of the CBR source (data rate, maximum packet size, bulk data maximum bytes, window size etc as applicable.) ?

Payloadsize=2200 dataRate=10Mbps

12. For the applications configured in the code, write down the source and destination port numbers, if they are possible to be determined from just studying the simulation code (not running it). If it cannot be determined, write "Cannot be determined from the code".

13. What are the approximate start times of the sources (round to integer)?

1,1

#### **B) Given ns3 simulation experiment baseline.**

Run the given ns3 simulation code. Answer the following questions. (Copy paste from terminal is ok. Ctrl-Ins for copy, Shift-Ins for paste).

14. How many flows are reported by Flow Monitor?

3

15. Explain what each flow represents. (Write/copy-paste the IP address, port parameters, and describe briefly what that flow is).

Flow 1 (10.0.0.3, 49153 -> 10.0.0.4, 54321)

FTP flow

Flow 2 (10.0.0.1, 49153 -> 10.0.0.2, 12345)

CBR flow

Flow 3 (10.0.0.4, 54321 -> 10.0.0.3, 49153)

ACKs

16. In case you could not determine some port numbers from just looking at the code, write down the port numbers now, stating which port numbers they are. (E.g. "nnnnnn: Destination port of source XYZ running on Node N with IP address a.b.c.d)

Flow 1 (10.0.0.3, 49153 -> 10.0.0.4, 54321)

FTP flow

Flow 2 (10.0.0.1, 49153 -> 10.0.0.2, 12345)

CBR flow

Flow 3 (10.0.0.4, 54321 -> 10.0.0.3, 49153)

ACKs

17. What is the observed throughput and how does it differ from the offered data rate (Input load) for the CBR flow?

Observed is 9.675Mbps which is less than offered rate i.e 10Mbps because the

total bandwidth has to be shared with ftp flow

18. What is the observed throughput for the FTP flow?

7.952Mbps

19. What is the file transfer delay for the FTP flow? (This metric is not being calculated, you have to add this calculation in your code. See the code for hint).

.631 sec

**(Make a copy of the given code for backup, or make any change only by commenting code)**

*Now disable **only FTP** flow and answer the following questions:*

20. Find the maximum throughput possible for one CBR flow when there's nothing else on the network. Do this by increasing the CBR data rate parameter.

24.6644

*Now disable **only CBR** flow and answer the following questions:*

21. For a given file size (600000bytes), and given link+phy layer what parameter of the FTP flow in this code can you change to give you better throughput and smaller file transfer delay? (Study the code comments and answer this properly.)

SenderWindowSize

22. What's the maximum throughput you were able to get for this file size? (Round to single decimal point)

13.1475 Mbps

23. What's the minimum file transfer delay you were able to get for this file size? (Round to single decimal point)

.399343 sec

### **C) Modified n3 wifi simulation for configurable scale.**

Now modify the given simulation so that you have multiple simultaneous FTP and CBR flows in the following topology. Suppose you have  $M$  nodes (assume  $M$  will be a multiple of 4).  $M/2$  nodes will be involved in CBR traffic,  $M/2$  in FTP. Among the  $M/2$  nodes of CBR there will be  $M/4$  source-destination pairs, and similarly for FTP. E.g. for an 8 node simulation, nodes  $n_0$ - $n_3$  could be CBR nodes,  $n_4$ - $n_7$  could be FTP nodes. In this example  $(n_0, n_1)$  and  $(n_2, n_3)$  could be two CBR source-destination pairs and  $(n_4, n_5)$  and  $(n_6, n_7)$  could be two FTP source-destination pairs. Note that how you number the nodes for your programming convenience is **your choice**. You only have to make sure the numbers and topology of flows is correct.

Now let the file size for FTP transfer as was given (600KB), other parameters set to the value that gave you the maximum throughput and minimum delay when only one FTP flow was using the network. **Shut off the CBR flows**. Find metrics as a function of increasing  $M_{ftp}$  (Search from 1 to 4 only), the number of **FTP data sources**. *Ensure you set  $M$  properly to get your desired  $M_{ftp}$*

24. For this scenario, what is the maximum total channel throughput you got?

17.8206Mbps

25. What was the smallest  $M_{ftp}$  you got this maximum at?  
3 and total number of nodes as 12
26. At this  $M_{ftp}$ , what was the average file transfer delay over all the flows?  
2.92952 seconds  
Now set the data rate of the CBR flow to 2Mbps. **Shut off the FTP flows.** Find metrics as a function of increasing  $M_{cbr}$ , the number of **CBR data sources** (search from 9 to 12 only). *Ensure you set M properly to get your desired  $M_{ftp}$*
27. For this scenario, what is the maximum total channel throughput you got?  
20.8972Mbps
28. What was the smallest  $M_{cbr}$  you got it at?  
11
29. At this  $M_{cbr}$ , what was the average throughput per flow?  
1.89975Mbps

**D) ns3 wifi simulation with high CBR and FTP traffic.** Now turn on all flows, in the ratios mentioned earlier (Half CBR pairs, Half FTP pairs), with parameters as before (Ftp file size = 600000 bytes, CBR data rate = 2 Mbps, and keep increasing M and noting metrics. (Just try from M = 28 to 36, multiples of 4)

30. What is the smallest M that gives you the maximum *total* channel throughput?  
36
31. What was the maximum *total* channel throughput?  
Total channel throughput = 17.3542Mbps
32. What was the **average file transfer delay for FTP flows only?**  
**Average File Transfer Delay = 4.62194 seconds**
33. How does this maximum throughput compare with the maximum achieved by only multiple CBR flows and only multiple FTP flows?  
Lesser than both the cases
34. At this maximum level, what percent of the total channel throughput is used by all of the FTP data flows?  
16.64%
35. What is the average file transfer delay?
36. What's the factor difference of the file transfer delay (X) from the best (lowest) delay that you got from the single flow experiment (Y)? If  $X = f * Y$ , write f.  
1.577
37. What is the total CBR throughput over all sources?  
14.3968Mbps
38. What's the factor difference from the best (highest) throughput (X) that you got from the single flow experiment (Y)? If  $X = f * Y$ , write f.  
.688

**D) Concluding remarks, may be graded subjectively, TA time permitting.**

Write your general conclusions from this experiment.

Avg Delay must increase because of increased congestion.

Max Thropughput also decreases for the same reason

**Submit your code and this file (as pdf) by tarring it into a file labquiz2.tar and upload on Bodhitree.**

**Next, enter these answers in the SAFE quiz.**