# CS 224 Home Assignment 01 - Option 1

# Wireless networks + FTP/CBR through ns3

## Oct 13th, 2020.

## *This lab\* will proceed in the following* ***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 remain open a day or two before the submission deadline.*
4. *A* ***viva*** *will be scheduled separately for each team member. Final marks are almost entirely based on the viva*

***\*Please do Background Lab 1 and 2 before coming here.***

### [Instructions for running ns3 on CSE machines from CSE Sysads](#_b02h6u2gvn4x)

1. **Given ns3 Code Comprehension:**

Start with the assignment1-ns3.cc. file given to you. Study this file and answer the following questions.

1. How many nodes are there in the network?
2. What is the physical layer medium through which they are connected?
3. Which IEEE wifi standard is the medium set to?
4. What is the PHY data rate (“bandwidth” or “transmission rate”) of the medium set to ?
5. What is the node topology implemented in the given file? (which node is physically connected to which node(s))
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)?
7. What are their transport layers?
8. Based on your theory+ previous labs knowledge - which app+transport layer combination performs RDT (Reliable Data Transmission)?
9. Based on your theory+ previous labs knowledge - which app+transport layer combination does not provide RDT?
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.) ?
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.) ?
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)?

**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).

1. How many flows are reported by Flow Monitor?
2. Explain what each flow represents. (Write/copy-paste the IP address, port parameters, and describe briefly what that flow is).
3. 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)
4. What is the observed throughput and how does it differ from the offered data rate (Input load) for the CBR flow?
5. What is the observed throughput for the FTP flow?
6. 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).

**(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:*

1. 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.

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

1. 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.)
2. What’s the maximum throughput you were able to get for this file size? (Round to single decimal point)
3. What’s the minimum file transfer delay you were able to get for this file size? (Round to single decimal point)

**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 n0-n3 could be CBR nodes, n4-n7 could be FTP nodes. In this example (n0,n1) and (n2, n3) could be two CBR source-destination pairs and (n4,n5) and (n6,n7) 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 Mftp , the number of **FTP** **data sources.** *Ensure you set M properly to get your desired*  Mftp

1. For this scenario, what is the maximum total channel throughput you got?
2. What was the smallest Mftp you got this maximum at?
3. At this Mftp, what was the average file transfer delay over all the flows?

Now set the data rate of the CBR flow to 2Mbps. Shut off the FTP flows. Find metrics as a function of increasing Mcbr, the number of **CBR data sources**. *Ensure you set M properly to get your desired*  Mftp

1. For this scenario, what is the maximum total channel throughput you got?
2. What was the smallest Mcbr you got it at?
3. At this Mcbr, what was the average throughput per flow?

**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 date rate = 2 Mbps, and keep increasing M and noting metrics.

1. What is the smallest M that gives you the maximum *total* channel throughput?
2. What was the maximum *total* channel throughput?
3. What was the **average file transfer delay for FTP flows only?**
4. How does this maximum throughput compare with the maximum achieved by only multiple CBR flows and only multiple FTP flows?
5. At this maximum level, what percent of the total channel throughput is used by all of the FTP data flows?
6. What is the average file transfer delay?
7. 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.
8. What is the total CBR throughput over all sources?
9. 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.

## Submit your code and this file (as pdf) by tarring it into a file assignment01.tar and upload on Bodhitree.

## Next, enter these answers in the SAFE quiz. Grading will be manual but we need this for efficient evaluation.

## Uploading the answer pdf AND SAFE quiz submission is compulsory for viva eligibility. SAFE quiz submission should by done by each team member.

### Instructions for running ns3 from CSE Sysads

Installation path of ns3 : /opt/ns-allinone-3.30/ns-3.30

Here are the instructions for students to login into sl2 lab machines and run

ns3 programs.

With VPN:

1) Open up terminal or CMD

2) Login to sl2 lab machines using cse\_username@sl2-machineno@cse.iitb.ac.in

where cse\_username is your cse ldap and sl2-machineno is the machine which you

want to login to.

Eg: If my cse ldap is shailendra and I want to login to sl2-20 then the above

command will be shailendra@sl2-20.cse.iitb.ac.in

3) To run a sample ns3 program, run the below commands.

cd /opt/ns-allinone-3.30/ns-3.30

./waf --run hello-simulator

If you get output like below then you have successfully executed ns3 sample

program

'build' finished successfully (1.374s)

Hello Simulator

Without VPN:

Login to login server using ssh cse\_username@login.iitb.ac.in -p 5022 where

cse\_username is your cse ldap. Rest of the steps are same step 2 and step 3

with VPN

You can login to any of the below sl2 machines

[ sl2-10 , sl2-13 , sl2-15 , sl2-17 , sl2-20 , sl2-24 , sl2-25 , sl2-26 ,

sl2-27 , sl2-37 , sl2-39 , sl2-40 , sl2-43 , sl2-45 , sl2-46 , sl2-47 , sl2-48

, sl2-49 , sl2-50 , sl2-51 , sl2-52 , sl2-54 , sl2-55 , sl2-58 , sl2-59 ,

sl2-60 , sl2-61 , sl2-63 , sl2-64 , sl2-66 , sl2-67 , sl2-69 , sl2-72 , sl2-73

, sl2-74 , sl2-75 , sl2-79 , sl2-80 , sl2-81 , sl2-84 , sl2-86 , sl2-87 , sl2-9

, sl2-91 , sl2-93 , sl2-96 , sl2-97 , sl2-98 , , sl2-101 , sl2-103 , sl2-105 ,

sl2-107 , sl2-108 , sl2-109 , sl2-11 , sl2-110 , sl2-112 , sl2-114 , sl2-115 ,

sl2-116 , sl2-117 , sl2-118 , sl2-119 , sl2-12 , sl2-120 , sl2-121 , sl2-122 ,

sl2-123 , sl2-124 , sl2-125 , sl2-126 , sl2-127 , sl2-128 , sl2-129 , sl2-130 ,

sl2-132 ]