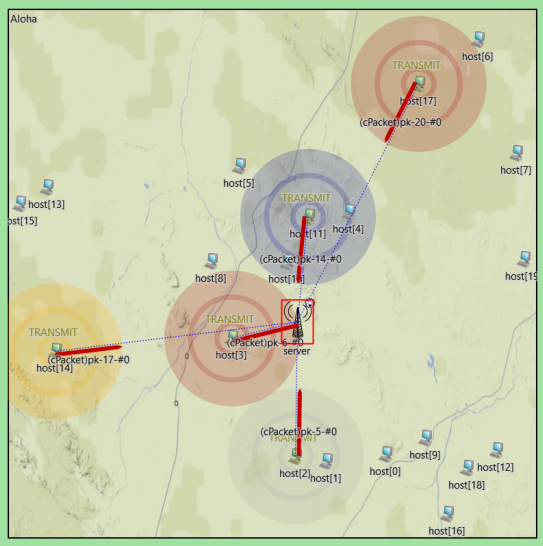
METU EE444 Introduction to Computer Networks

HW3 - OMNeT++



You are going to submit your homework via **ODTUCLASS** as a **.zip** file containing the relevant source files (Only the project files that you created, **NOT** your whole workspace) and your PDF report. Name your file as "EE444_HW3_studentid.zip". Using code directly taken from any kind of resource, except those provided in ODTUCLASS, is prohibited. You can verbally discuss the homework with your friends but you should not exchange codes with each other or write your codes together. **Cheating and Plagiarism will result in zero grade, whereas disciplinary actions may also be taken. Late submissions are not allowed.** You are allowed to reference the example code given by OMNeT++ and/or INET provided that the appropriate citation is given.

1 Installation & Preparation

Please go to the following link `https://omnetpp.org/` and download OMNeT++ 6.0. To complete the installation, you need to follow the instructions given in the "doc/InstallGuide". Please note that you need to compile OMNeT++ which takes time. After the compilation, open a workspace using OMNeT++ IDE and import INET using the prompt that appeared. You can create new projects for the solutions to the homework.

An OMNeT++ project consists of a .ned file that defines the network that will be simulated and a .ini file that defines simulation parameters. You can read the documentation to learn how to format these files. To familiarize yourself with OMNeT++, it is recommended for you to follow Tictoc tutorial `https://docs.omnetpp.org/tutorials/tictoc/` but is not required.

Your homework consists of two parts. In the first part, you are going to simulate an Ethernet network with a shared medium. In the second part, you are going to simulate TCP traffic. Create multiple projects for each question. To be able to use INET, you need to reference the INET project in project properties.

2 Data-Link Layer – Ethernet (50% Credits)

1. For this question, you are going to create an Ethernet network that uses a common bus.

   (a) Create a .ned file for your network. Define a parameter for node count and arrays for EthernetHost and WireJunction. WireJunction will be used for creating a bus. Connect WireJunctions serially using an Eth10M link. Then connect each EthernetHost to a WireJunction.

   (b) Create a .ini file to configure your simulation. Designate destination addresses, request length and response length. Set your send interval as exponential.

   (c) Simulate your network for different node counts of 2, 4, 8, 16, 32, 64 and 128. Plot the node count vs channel efficiency graph. Channel efficiency is defined as how much payload is sent through the channel per second per physical rate (10Mbps for our case). **Comment** on your results. Required parameters for your calculations are generated automatically in the Results folder.

   (d) Using 16 nodes, simulate for different frame lengths of 64, 128, 256, 512 and 1024. **Plot** the channel efficiency vs frame length graph. **Comment** on your results.

   (e) Using 16 nodes, divide the exponential parameter for your send interval by 2 and simulate. Compare the efficiency with your previous simulation with 32 nodes. **Comment** on your results.

2. Add a switch to divide the bus into two equal-size collision domains and repeat the same simulations in Question 1. **Comment** on the different results.

3 Transport Layer – TCP (50% Credits)

For this question, you are going to simulate and analyze various topologies that use TCP.

1. Create one standard host as a client and another standard host as a server. Create one router with a queue size of 10 packets. Connect the client to the router with a 100kbps line. Connect the server to the router with a 1Mbps line. Use ThruputMeteringChannel for connections with bandwidth measuring mode. For the client, use TcpSessionApp with a large byte count to simulate a continuous stream. Use TcpSinkApp for the server.
   (a) What is the mean bandwidth that is used on the connection between the client and the router? Is this the expected result?
   (b) Plot data rate vs time graph. Describe what you observe. **Comment** on your results.
   (c) What is the sender window size? What is the round trip time? Calculate the mean data rate using W and RTT. Do your findings match the measured results? Explain.
   (d) Plot congestion window vs time graph. Describe what you observe. **Comment** on your results.
2. Copy the same topology from Question 1. Change the bandwidth of the connection between the router and server to 50kbps.
   (a) What is the mean bandwidth that is used on the connection between client and router? Is this the expected result?
   (b) Plot data rate vs time graph. Describe what you observe. **Comment** on your results.
   (c) What is the sender window size? What is the round trip time? Calculate the mean data rate using W and RTT. Do your findings match the measured results? Explain.
   (d) Plot congestion window vs time graph. Describe what you observe. **Comment** on your results.
   (e) Compare your results with the previous question. Explain the differences in your findings.
3. Create two standard hosts as clients and another standard host as a server. Create one router with a queue size of 100 packets. Connect one client to the router with a 100kbps line. Connect the other client to the router with a 200kbps line. Connect the server to the router with a 100kbps line. Use ThruputMeteringChannel for connections with bandwidth measuring mode. For clients, use TcpSessionApp with a large byte count to simulate a continuous stream. Use TcpSinkApp for the server.

(a) What is the mean bandwidth that is used on the connection between client and router? Is this the expected result?

(b) Plot data rate vs time graph for each client. Describe what you observe. **Comment** on your results.

4. Copy the same topology from Question 3. Change the bandwidth of the connection between the router and server to 240kbps.

   (a) What is the mean bandwidth that is used on the connection between client and router? Is this the expected result? Explain the changes from the previous question.

   (b) Plot data rate vs time graph for each client. Describe what you observe. **Comment** on your results.

5. Copy the same topology from Question 4. Now, make the client with the higher bandwidth run two apps instead of one.

   (a) What is the mean bandwidth that is used on the connection between client and router? Is this the expected result? Explain the changes from the previous question.

   (b) Is the obtained result fair? What are the consequences of running multiple apps?

   (c) Plot data rate vs time graph for each client. Describe what you observe. **Comment** on your results.