TD1 - Networks and protocols

TI602

In this tutorial we will study the first general concepts presented in the course with a simple case study in order to understand the links between them and have a clearer vision of the OSI layered model and in particular a part of the physical layer.

Case study

We are interested in an online shooter video game platform where players control characters and compete in 3D space. Characters can interact with the environment and with other characters by attacking each other. This platform runs on a local network infrastructure, each player accesses the game on a machine on which his client application is running. A central server manages the synchronization of the game's views and actions: a client application sends data to the servers at a fairly high frequency on the position of the player's character, movements and the actions executed by the latter (in particular on the other players characters). The server after receiving this information, made a computation based on the actions and movements done (received) and distributes the updates to the other machines so that everyone can see everyone's state almost in real time locally on their machine. In this kind of games, the speed of the messages as well as the optimization of resources is very important in order to guarantee an optimal gaming experience (maximum data transmitted correctly and low latency for a view close to real time).

Part 1

Definition - hub: a hub is a layer 1-physical equipment that allows the interconnection of different machines of the same physical network using wired connections.

1. Assuming that the server application is located on a player's machine (host). Propose a topology of the local network using a hub.

2. What are the functions provided by this interconnection device according to the layered architecture description seen during the course?

3. Show with a diagram and explanations the path taken by a message from a client (player) machine to the server.

4. Is the use of a hub as an interconnection equipment a problem in our case? if so why?

5. Propose another solution for better optimization.

6. How does your solution improve the network performance to guarantee a better experience?

7. Show with a diagram and explanations the path of a message from a client machine to the server with the general transformations undergone at each layer (encapsulation)

8. What does the final data transmitted from a machine correspond to?

9. Assuming that we are using Manchester encoding for data transmission. Represent the signal transmitted to to the following 3 bytes as part of a frame: 011001010011100011110001

Part 2

The latency of a client is defined by the time a message takes to go from a player (client) machine to the server and go back to the player machine (round-trip time).

Bellow some network transmission parameters definitions:

Propagation time is the time a signal takes to cross a given medium of a given length, limited by its propagation speed (depends on the type of the medium) and its length.

Data emission rate is the amount of data provided by a computer in a given time unit before the transmission, limited by the capacity of this later and its network card.

Emission time is the time necessary for the emission of a given amount of data, limited by the data emission rate

Data transfer rate is the amount of data that is moved from a source to a destination in a given time unit, limited by the bandwidth of the medium and the data emission rate.

Transfer time is the time necessary for the transfer of a given amount of data, limited by the data transfer rate

1. How these parameters can affect a client's latency?

2. Which player has the best latency in our network?

3. What kind of problems could this configuration (a server on a client machine) cause?

4. How to make the game fairer by changing the network?

5. We want to simulate a latency with a program (which artificially delays transmission time to increase latency for machines with much lower latency compared to others) for a better balance without changing the network. At what layer and on which machine should we integrate our program? why?

Part 3

We now want to make it possible to create games between two different distant networks.

1. Propose a new topology that fulfill the need above with maximum (latency) fairness.

2. We use a broadband (analog signal) link to connect our two distant networks, which techniques should be used to encode the information transmitted to the server?

3. Represent the signal transmitted to send the previous 3 bytes on this broadband line using a method of your choice.

4. Show the path and the general encapsulation process of a message sent from a client machine to the server.