DEPARTMENT OF INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Master Practical Course
Computer Network Simulation

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Assignment 2
Part 1 - Theoretical Questions

Group 2

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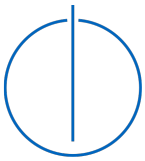

Question-1: What motivated you to select the transport layer protocol that you are using for your application? Could your application benefit from transport layer protocols that are currently unsupported or have limited support in OMNeT++? Motivate your answer.

We have decided not to use a connection-based protocol for our application because it does not require any session requirements or the need to send packets in sequence. Our application is able to send data at any time, which is included in individual IP packets. Therefore, we have decided that using UDP will be sufficient. In addition, the existing network infrastructure is provided through wired connections, so the likelihood of packet loss is low. Since individual packets are sufficient for our needs, we also have a low need for reliability. Taking all of this into consideration, we believe that UDP will be sufficient.

Our application could also potentially use newer protocols such as QUIC. It is based on UDP but includes additional features such as improved reliability, multiplexing, and encryption. Using QUIC, the application could potentially achieve even better performance and reliability than with UDP alone.

However, it is important to note that QUIC is still a relatively new protocol and may not be widely supported by all network infrastructure and devices.

Additionally, using a newer, less established protocol may introduce additional complexity and potential compatibility issues. Therefore, the decision to use QUIC or any other newer protocol would need to be carefully considered in the context of the specific requirements and capabilities of the application and the network.

Question-2: What tools (apart from OMNeT++) would you use to prepare an evaluation pipeline for your application? What data formats would you consider for exported data? Outline your evaluation pipeline and justify your choices.

We used the python script that we wrote to run our simulation in cmdenv mode. With this script, we ran the simulation with different settings. We used a python script to run our simulation in cmdenv mode. With this script, we ran the simulation with different settings. Then used the "opp_scavetool" tool from OMNet++ in this script to convert the collected statistics to JSON. After that, we opened these JSON files with the script, extracted the necessary data from them, and saved them to other JSON files. Finally, we used mathplotlib to plot the data from these JSON files and saved the plots as PNG files.

We have not used it currently, but we have seen examples in OMNet++ where the simulated network traffic can be saved as a PCAP file. However, we learned that this requires the payloads to be properly serialized/deserialized and the FCS values to be calculated. Therefore, we did not use this mechanism. However, it might be interesting to save the traffic in this way and examine it later using a tool like Wireshark, which could help us with our analysis.

Question-3: What would be the relevant numerical and statistical measures for evaluating obtained measurement results (e.g. delay)? Explain briefly.

There are several numerical and statistical measures that can be used to evaluate measurement results, such as the mean, median, mode, and standard deviation. The mean is the average of the results, and can be calculated by adding up all the measurements and dividing by the number of measurements. The median is the middle value when the measurements are sorted in ascending or descending order. The mode is the most common value among the measurements. Standard deviation is a measure of how spread out the results are, and can be calculated by taking the square root of the variance. There are other metrics that can be used to evaluate the performance of a computer network. For example, the packet loss rate is the percentage of packets that fail to reach their destination, and can be calculated by dividing the number of lost packets by the total number of packets sent. The throughput is the amount of data that can be transferred over the network in a given amount of time, and is usually measured in bits or bytes per second. The round-trip time (RTT) is the time it takes for a packet to be sent from its source to its destination and back again, and is typically measured in milliseconds.

Question-4: Imagine you are a network engineer working for TUM. You are tasked with a design a campus-wide network that must support the needs of 50000 students at once. To verify the functionality of your network you decide to model it first with a simulation in OMNeT++. During development, you realize that your network is permanently congested. You want to diagnose the reasons for poor network performance. Which metrics would you look at? From where would you collect the data? Based on the information you obtain; how would you circumvent the congestion in the network?

As network engineers working for TUM, we would look at a few key metrics to diagnose the reasons for poor network performance in our network simulation. These metrics would include the network throughput, the number of packets transmitted, the number of packets dropped, and the number of retransmissions. To collect this data, we would use OMNeT++ to run simulations of our network design and collect the necessary metrics. We would also use tools within OMNeT++ to visualize the data and better understand how the network is functioning.

Based on the information we collect, we would look for patterns in the data that suggest congestion in the network. For example, if we see a high number of packets dropped or re-transmitted, this could indicate congestion in the network. In this case, we would need to find ways to alleviate the congestion, such as by adding more bandwidth or implementing a better routing algorithm.

We would also need to look at how the network as a whole is functioning. This could include analyzing the network topology and the routing algorithms used to determine how traffic is flowing through the network.

To observe how traffic is flowing through the network, we would collect data from different points in the network topology, particularly at the intersections where different sub-networks are connected. Collecting data at switches and routers that connect these sub-networks would be particularly useful. It is necessary to analyze the network by dividing it into different parts in order to identify the bottlenecks that are causing congestion. By doing this, we can see these areas more clearly and make changes to address the problem. For example, we can increase bandwidth at these points, use better routers, or redirect traffic to other routes. In the end, if we see a high number of packets dropped or re-transmitted, this could indicate a bottleneck in the network.

Overall, the key to circumventing congestion in the network would be to carefully analyze the data and identify the root causes of the congestion. By doing this, we would be able to make informed decisions about how to improve the performance of the network and ensure that it can support the needs of all 50000 students.