Data Communication Networks
HW4: Network Layer

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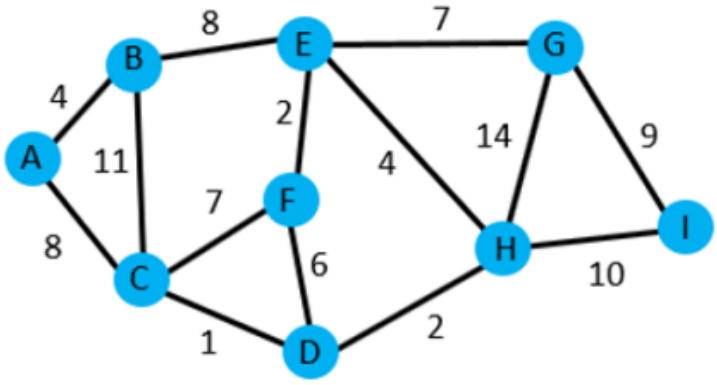
Due on

Problems

Question 1

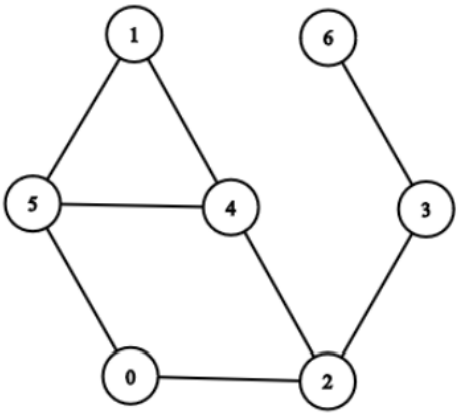
In the graph below, the number on each edge shows the link delay. Assume that the capacity of each link is so large that we can neglet the delay caused by the packet size.



1. Use the Dijkstra algorithm to find the shortest path from A to I.
2. If we run the algorithm from node A, which of the nodes F or H joins the tree?
3. Calculate the broadcast time from node A to all nodes.

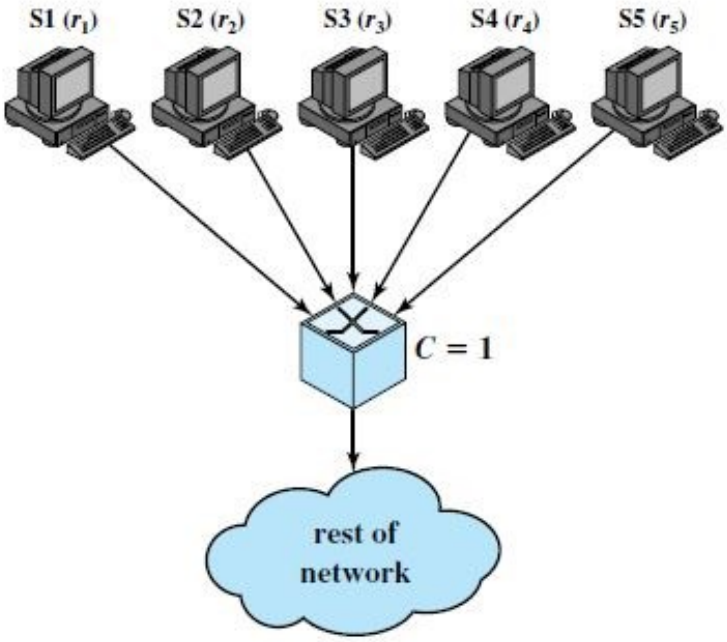
Question 2

Consider the following network, where the time required to send a packet to adjacent nodes is 1ms. In this network, Flooding is employed for communication. What is the maximum time required to send a packet from one node to another?



Question 3

Consider the following network where five computers, S1 to S5, transmit data at normalized rates of $r_1 = 0.1$, $r_2 = 0.2$, $r_3 = 0.4$, $r_4 = 0.4$, and $r_5 = 0.5$ to the central node, which has a normalization capacity of C=1 with the rest of the network. To address congestion in this network, the central node discards the packets received for the i^{th} computer with probability p_i. Determine the values of p_1, p_2, p_3, p_4, and p_5 such that the central node will not experience congestion.



Question 4

4096 consecutive IPv4 addresses, starting from 68.152.0.0, are assigned to a company. To route these packages, the company uses 8-cell routing tables, meaning that each router can only route 8 IPv4 addresses.

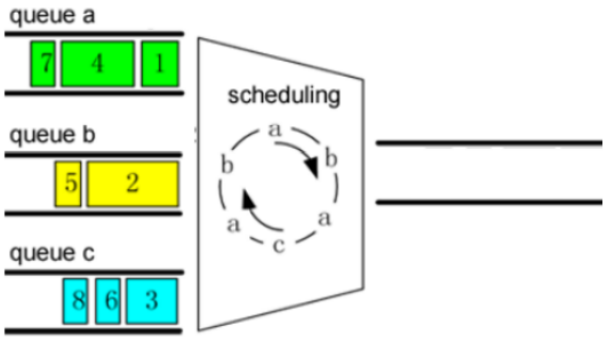
1. How many routers should each package pass through to reach the destination?
2. What is the minimum number of routers required for this routing task?

Question 5

In the table below (Table 1), you can see the size of each packet. It takes 2ms to check each queue, and in each check, we give 500 bits credit. With the link speed of 1Mbps, find the time at which the last bit of seventh packet is sent.

Table 1: Packet sizes

$\#Packet$	1	2	3	4	5	6	7	8
$Size(bit)$	1000	3000	1500	2250	750	750	750	750



Question 6

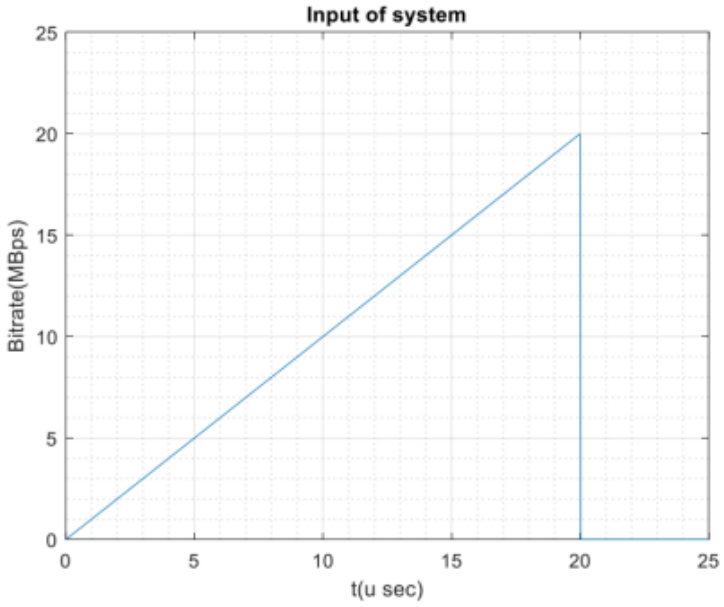
We want to stream apple's WWDC23 event1; the probability distribution of receiving k packets at the time t is as follows:

$$P(n = k) = \frac{(\lambda t)^2}{k!}$$

calculate the critical in which you can play one section of the video containing 50 packets without trouble (freezing, nonstop), with certainty of 90 percent.
Packets lengths are equal to 10000bits and the video play rate is 100Mbps.

Question 7

What is the sending time of leaky bucket and token bucket methods for the following input stream? The sender has not sent any data yet. (Maximum leaky rate = 10MBps, Token rate = 4MBps, Token capacity = 100KB)



Question 8

The average delay time in a network equals 50 microseconds, and the mean processing capacity of the processor is 10^6 $\frac{packets}{sec}$. How much should the mean arrival time be decreased if we want to reduce the average arrival time by 50

simulation

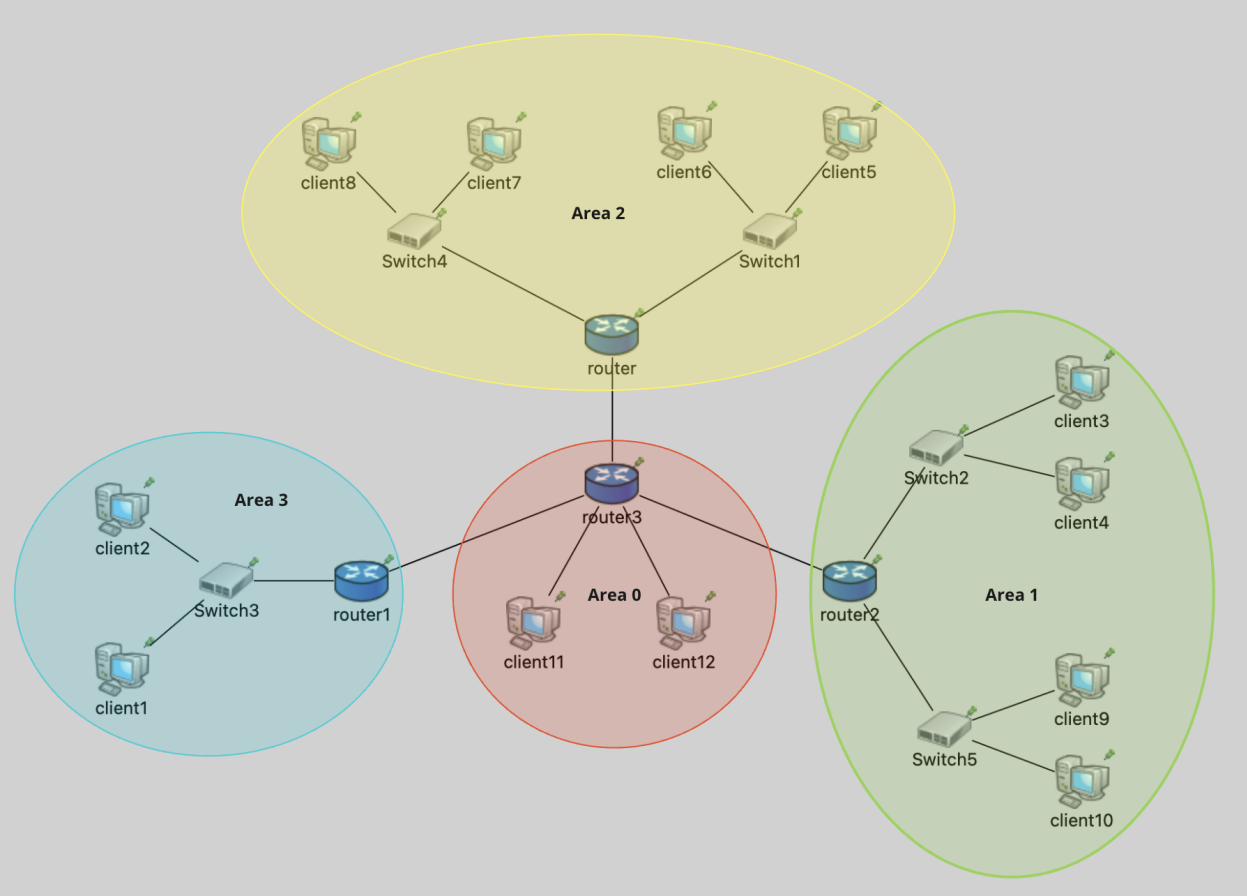
Simulation of OSPF Network Using OMNeT++

The assignment involves the simulation of an OSPF network through the OMNeT++ framework. OSPF, a widely utilized interior gateway protocol, has been designed for the efficient routing of traffic within an autonomous system.

- Provide a comprehensive explanation of OSPF's operational principles and delineate its inherent advantages and disadvantages.
- Investigate the reasoning behind splitting a network into various areas in the OSPF protocol. Clarify the importance and benefits of this strategic segmentation, discussing its role in enhancing the overall efficiency and scalability of the OSPF-based network.

Given the network topology depicted in the provided image, the objective is to configure routers using INET so that each pair of PCs can successfully ping each other.

- Include screenshots demonstrating these connections (pc1->pc10, pc5->pc11, pc2->pc7)



Visualizing Network Layer Activity

In HW2 you practiced data link layer activity visualization using *DataLinkVisualizer*. In this question, we want to learn about visualizing network layer activity. This showcase from the INET documentation focuses on the *NetworkRouteVisualizer*, which graphically displays network layer traffic in the form of polyline arrows along the path that fade as the traffic ceases.

For each section, add proper logs to your simulation and provide enough screenshots from your logs and simulation model to explain how the model is working properly. You can also read this guide for more information.

1. **Enabling Visualization of Network Layer Activity**:

   In INET, network path activity can be visualized by including a *NetworkRouteVisualizer* module in the simulation. Adding an *IntegratedVisualizer* module is also an option because it also contains a *NetworkRouteVisualizer* module. Network path activity visualization is disabled by default; it can be enabled by setting the visualizer's *displayRoutes* parameter to true.

   NetworkRouteVisualizer observes packets that pass through the network layer (i.e. carry data from/to higher layers), but not those that are internal to the operation of the network layer protocol. That is, packets such as ARP, although potentially useful, will not trigger the visualization.

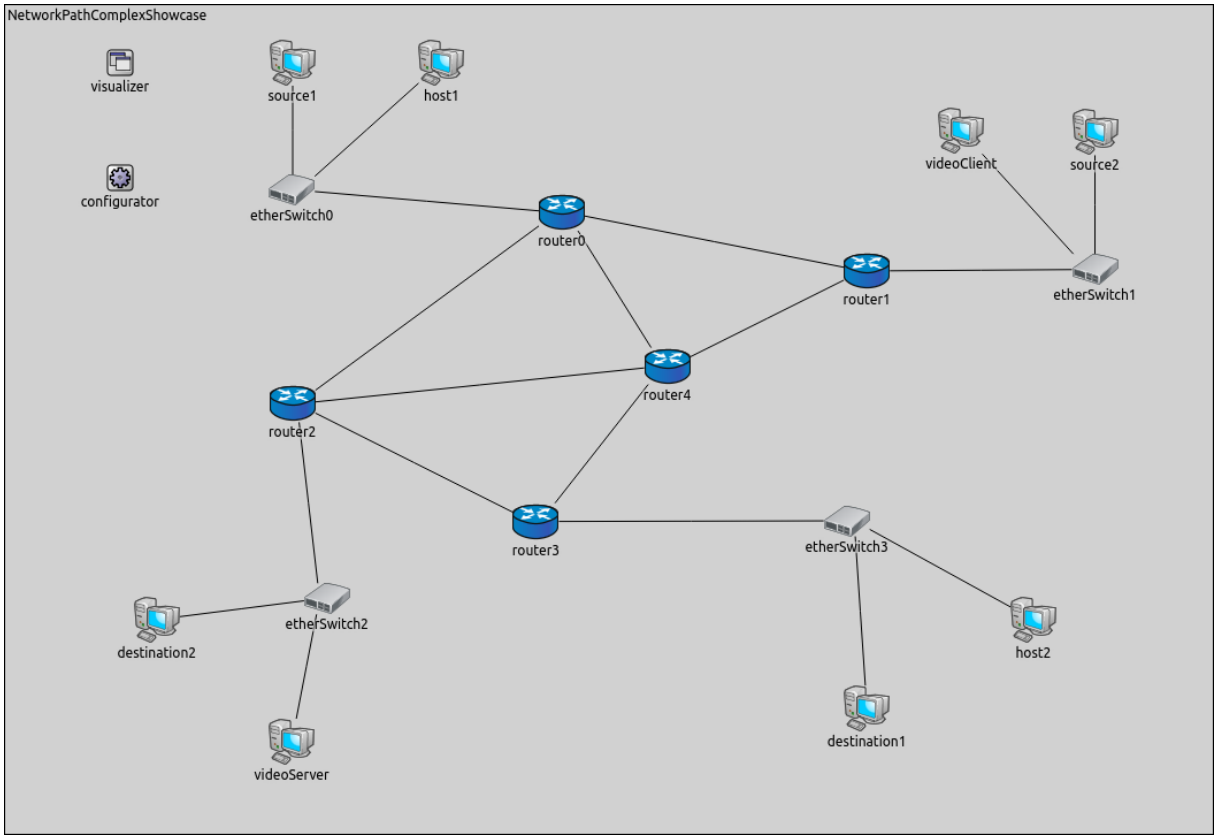
   Now we want to practice enabling the network path activity visualization with its default settings.

Configure a simulation for a wired network that contains two *StandardHosts* as *source* and *destination*. In this configuration, the *source* will be pinging the *destination*. The *pathVisualizer*'s type should be *NetworkRouteVisualizer*

2. **Filtering Network Path Activity**:

   In complex networks where many nodes are placed and several protocols are used, it is often useful to be able to filter network traffic to visualize only the part of the network traffic we are interested in. By default, all packets and nodes are considered for the visualization. This selection can be narrowed with the visualizer's *packetFilter* and *nodeFilter* parameters.

   Configure a network based on the below image that consists of five *routers* (*router0*, ..., *router4*), four *etherSwitches* (*etherSwitch0*, ..., *etherSwitch3*) and eight *StandardHost*'s. There are two source hosts, *source1* and *source2*, which will be pinging the two destination hosts, *destination1* and *destination2*. The *videoServer* node streams a video to the *videoClient* node. The remaining two endpoints (*host1* and *host2*) are inactive in this simulation.

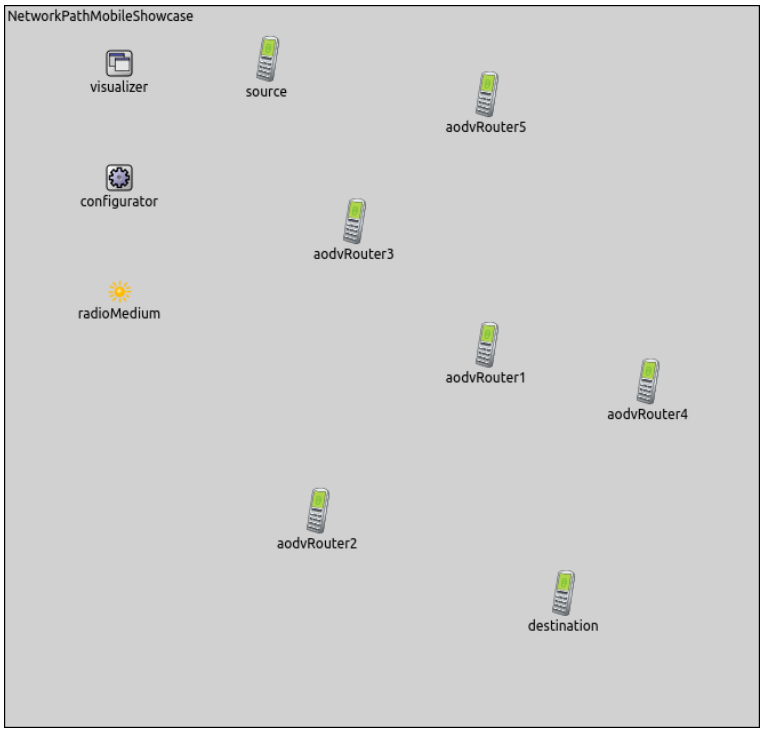


   Filter the network path visualization to display only ping traffic. The video stream packets shouldn't be visualized by the network path activity visualizer. Adjust the *fadeOutMode* and *fadeOutTime* parameters such that the network path activity arrow does not fade out completely before the next ping packet arrives.

   Record a video from the screen to show the network path activity arrows. In your report, briefly explain how the model works.

3. **Visualizing Network Path Activity in a Mobile Ad-Hoc Network**:

   In this part, we want to simulate a Mobile Ad-Hoc network and follow dynamically changing network path activity in the wireless environment. First Configure the network shown in below image:



   Nodes are of the type *AodvRouter*, and should be placed randomly on the scene. One of the nodes is the source node which will be pinging the destination node. The communication ranges of the nodes should be chosen such that the network is connected, but nodes can typically only communicate by using multi-hop paths. The nodes will also randomly roam within predefined borders.
   The routing protocol is AODV, a reactive (on-demand) MANET routing protocol. AODV operates with RREQ and RRES messages, but these messages do not appear in the visualization because they do not pass through the network layer.

   Record a video from the screen to show the network path activity arrows. In your report, briefly explain how the model works.

What Should I Do?

You must upload (.cc/.ned/omnetpp.ini) files in a folder named Part1 for Simulation of OSPF Network and Part2 for Visualizing Network Layer Activity. You should also add wanted screenshots and videos and answer the questions in your report. Report should include

- brief explanation of how your code works
- screenshots and videos from networks and logs to justify every step

Compress all files and rename the compressed file to STUDENT_ID_HW4.zip.
If you have any questions regarding the problem statement or understanding the concept, feel free to ask in Telegram.