COMP3331 – ASSIGNMENT REPORT

Data Structures for the Network Representation

Our graph implementation consists of different classes and data structures to represent the network. To represent the nodes, we have a router class which contains a string for the name of the current router, a double for the distance from the current node to the starting node, a Router which stores the previous Router that was visited, and an ArrayList of Edges which represent the connections that are connected to the current Router. With this information stored, we can quickly identify our routers and view the relevant information needed to perform the Routing Algorithms. Our Edge class represents the connections between Routers. It contains two Routers that represent the Routers that the current edge connects, two Integers to store the propagation delay and the capacity, and a List of Arrays of Doubles to represent the current connections between the two routers. Again, the Edge class contains vital information that the Routing Algorithms use.

Overall, we have an abstract graph implementation that represents the network topology.

Summary to show Comparison of the Performance for the 3 Routing Protocols

	Total number of virtual circuit requests	Total number of packets	Number of successfully routed packets	Percentage of successfully routed packets	Number of blocked packets	Percentage of blocked packets	Average number of hops per circuit	Average cumulative propagation delay per circuit
SHP	8377	259106	234721	90.59	24385	9.41	2.42	152.70
SDP	8377	259106	246763	95.24	12343	4.76	2.79	145.72
LLP	8377	259106	253818	97.96	5288	2.04	2.78	171.35

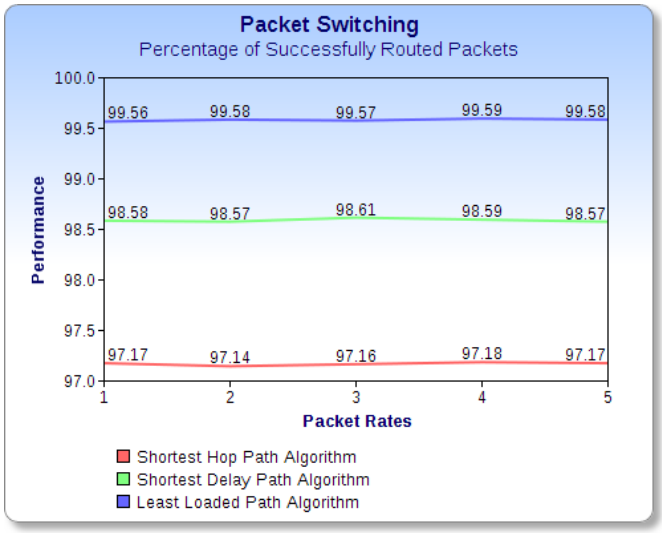
Analysis of Results

The above table allows us to observe and analyse the different routing algorithms over a circuit network with a packet rate of 1. From analysis of the percentages of packet success, we see that the least loaded path (LLP) came 1st in terms of routing packets successfully. We can deduce that this occurs because each time we create a circuit, we make a path with the least amount of connections with respect to the capacity. So the connections are distributed evenly across the network scheme in order to decrease the maximum load on any link and to send as many packets as possible. These observations are also reflected through the percentage of blocked packets as LLP has the lowest percentage of blocked packets. We can also deduce that the shortest hop path (SHP) came last out of the three routing algorithms. We can justify this fact since we know each time we require to make a circuit, SHP will always choose the shortest path to its goal router regardless of delay or load causing congestion on the network and resulting with blocked packets. Now it becomes trivial that the SHP algorithm came in first in terms of the average hop per circuit. This is obvious as we always try to make a circuit on the shortest amount of hops. However we can notice that the difference between the routing algorithms and the average hops are not that significant indicating that regardless the algorithm, the average amount of hops will be quite similar. By observing the average cumulative propagation delay, we see that the Shortest Delay Path (SDP) is a clear winner as the algorithm focuses on minimising the amount of propagation delay in a circuit. Now we can also observe the LLP algorithm did worse in lowering the amount of propagation delay per circuit. This is due to the fact that the LLP algorithm will only cater to the load on the network and not on the delay. So it may produce a path in which packets are experiencing a lot of delay. By comparing circuit and packet, we can see that circuit under performs compared to packet. If we conclude that a connection cannot be made on a path, we label all packets with this connection as blocked as well regardless of when the packet will be sent.

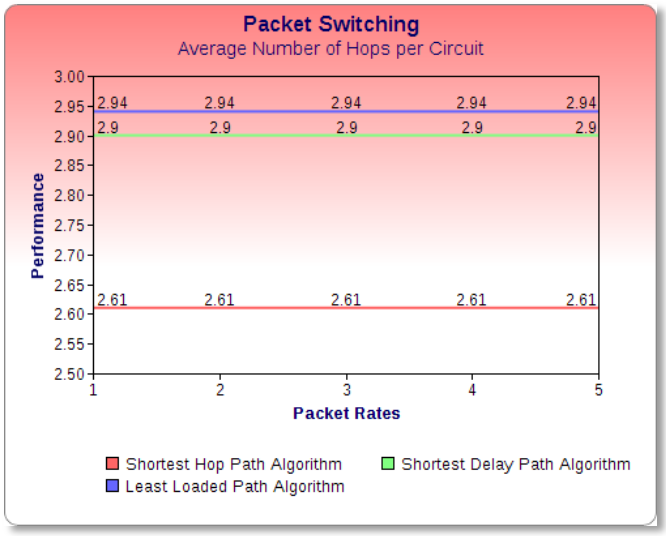
Performance Evaluation of the Virtual Packet Network

Performance and runtime for the SHP and SDP algorithms terminate within a reasonable time. However for the LLP algorithm where the packet rate is greater than or equal to 3 the time taken to output its results can be significant.

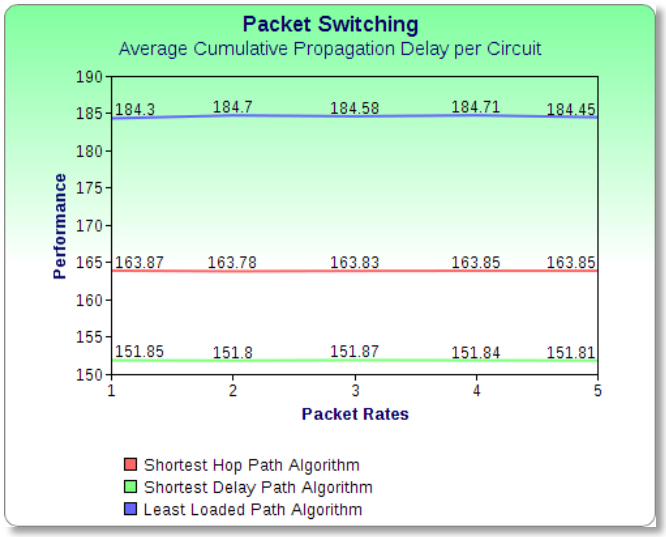
- LLP with Packet Rate = 3 : Approximately 5 minutes
- LLP with Packet Rate = 4 : Approximately 11 minutes
- LLP with Packet Rate = 5 : Approximately 20 minutes



After examining the results, we can determine which routing algorithm successfully routes the most packets. As seen in the graph, the Least Loaded Path Algorithm routes the most packets successfully. This is a result of the even distribution while the packets are being routed. This means that fewer packets are lost due to the decrease in congestion. Also, even if we change the packet rate, the percentage of successfully routed packets only varies slightly. The other algorithms such as the Shortest Hop Path and the Shortest Delay Path focus on finding a path to the destination according to the least amount of hops and propagation delay respectively. This causes those algorithms to have a lower success rate. Again, the results only vary slightly after we change the packet rate for the other routing algorithms.



The results we produced also show which algorithm is the most efficient in terms of hops per circuit. As seen in the graph and as the name suggests, the Shortest Hop Path Algorithm has the least hops per circuit. This is because the algorithm is executed to find the best route according to the hops needed to get to the goal state. On the other hand, the Shortest Delay Path and Least Loaded Path algorithms do not consider the amount of hops to get to the goal state meaning the average number of hops is higher than that of the Shortest Hop Path algorithm. It can also be observed that the values are constant for each of the algorithms no matter what packet rate is used. This is because the Network Scheme is not changed and the algorithms always follow the same path once it's found the optimal path according to its respective rules.



For each of the routing algorithms, the Cumulative Propagation Delay varies as seen in our results. As shown in our graph, the Shortest Delay Path Algorithm executes while minimising the delay for each connection. As expected, this algorithm has the shortest overall delay compared to the other algorithms as they determine the path according to different information. For the Least Loaded Path Algorithm, the cumulative delay is reasonably high as spreading the process over a wider range in the network scheme increases the time taken to route the packets to the destination. It can also be observed that the overall Propagation Delay is not greatly affected even if we change the packet rate.