1. **Explanation on the data structures used for the internal representation of the network topology.**

Insert explanation here

1. **Comparison of performance metrics for 3 routing protocols over the virtual circuit.**

The following results are based off a PACKET RATE = 1.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Metrics** | **SHP** | **SDP** | **LLP** |
| Total number of virtual circuit requests | 5884 | 5884 | 5884 |
| Total number of packets | 176067 | 176067 | 176067 |
| Number of successfully routed packets | 160292 | 159927 | 172278 |
| percentage of successfully routed packets | 91.04 | 90.83 | 97.85 |
| number of blocked packets | 15775 | 16140 | 3789 |
| percentage of blocked packets | 8.96 | 9.17 | 2.15 |
| average number of hops per circuit | 3.66 | 4.31 | 5.3 |
| average cumulative propagation delay per circuit | 166.93 | 140.21 | 265.87 |

1. **Analysis of performance results**
2. **Performance evaluation of Virtual Circuit network with varying packet rates + Plots**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Percentage of successfully routed packets | | | | | |
|  | 1 | 2 | 3 | 4 | 5 |
| SHP | 91.48 | 91.21 | 91.05 | 91.31 | 91.07 |
| SDP | 90.83 | 90.84 | 90.84 | 90.84 | 90.84 |
| LLP | 98.04 | 98.5 | 97.87 | 97.14 | 98.48 |
|  |  |  |  |  |  |
| Average number of hops per circuit | | | | | |
|  | 1 | 2 | 3 | 4 | 5 |
| SHP | 3.66 | 3.66 | 3.66 | 3.66 | 3.66 |
| SDP | 4.31 | 4.31 | 4.31 | 4.31 | 4.31 |
| LLP | 5.25 | 5.3 | 5.28 | 5.31 | 5.28 |
|  |  |  |  |  |  |
| Average cumulative propagation delay per circuit | | | | | |
|  | 1 | 2 | 3 | 4 | 5 |
| SHP | 165.78 | 166.56 | 166.72 | 166.97 | 166.85 |
| SDP | 140.21 | 140.21 | 140.21 | 140.21 | 140.21 |
| LLP | 264.67 | 266.86 | 263.42 | 267.48 | 265.28 |

**Analysis on percentage of successfully routed packets.**

The Least Loaded Path algorithm is observed to have the highest rate of success when routing packets compared to Shortest Hop Path and Shortest Delay Path, which block roughly 5-6% more packets. The main difference between LLP and the two other algorithms is that it focuses on link load as a cost rather than the number of hops or propagation delay. Because of this focus, link loads (on average) across the network would be less “congested” as the algorithm chooses paths with the least load, resulting in links that stay open for longer thus increasing the rate of success for routing packets. With varying packet rates, routing success with LLP seems to fluctuate across a ~2% band, whereas in the case of SHP and SDP there is very minimal or even no change.

**Analysis on average number of hops per circuit.**

The Shortest Hop Path has the smallest average number of hops per circuit, followed by the Shortest Delay Path and the Least Loaded Path with the highest average number. Between each algorithm, there is a ~1-2 hop difference proportional to each other. SHP clearly results in the least hops, as the algorithm disregards propagation delay and link load as a cost and instead focuses on reducing the number of hops it takes along the path. SDP comes second, taking into account propagation delay. Inherently, this would mean a trade-off with an increased amount of hops in return for a lower total delay across the path. **Lastly, LLP has the highest average number of hops per circuit as it purely addresses lowering link load and completely disregards hops and delay costs. (maybe some further insight?).** The varying packet rates have very little to no effect on the average number of hops.

**Analysis on average cumulative propagation delay per circuit.**

The Shortest Delay Path algorithm has the smallest average cumulative propagation delay per circuit, with Shortest Hop Path following closely by and the Least Loaded Path producing the highest delay figures. The SDP results display the lowest figures, as its algorithm takes into account primarily the propagation delay of each link and tries to generate a path which minimises delay. As a result, it would have the lowest average cumulative delay per circuit. SHP has the next lowest delay per circuit since it focuses on reducing the number of hops along a path. Inherently, this would lead to a lowered average cumulative delay as packets would traverse the smallest number of paths possible. But taking into account that some paths may have an abnormally high delay cost, SHP on average would not fare as well as SDP with finding a path with the least propagation delay. Finally, LLP is observed to have the highest average cumulative propagation delay per circuit, with approximately 100-150ms difference from results generated by the other two algorithms. This is because LLP addresses only link load as a cost, which means that a packet may have to traverse through nodes which aren’t necessarily towards the direction of the destination node in order to minimise link load thus increasing its delay cost. Similar to average number of hops, average delay per circuit has very little relevance to varying packet rates.