EENGM0008: Data Center Networking 2022

Data Center Networking

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Semester 2
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Table of Contents

List of Tables

List of Figures

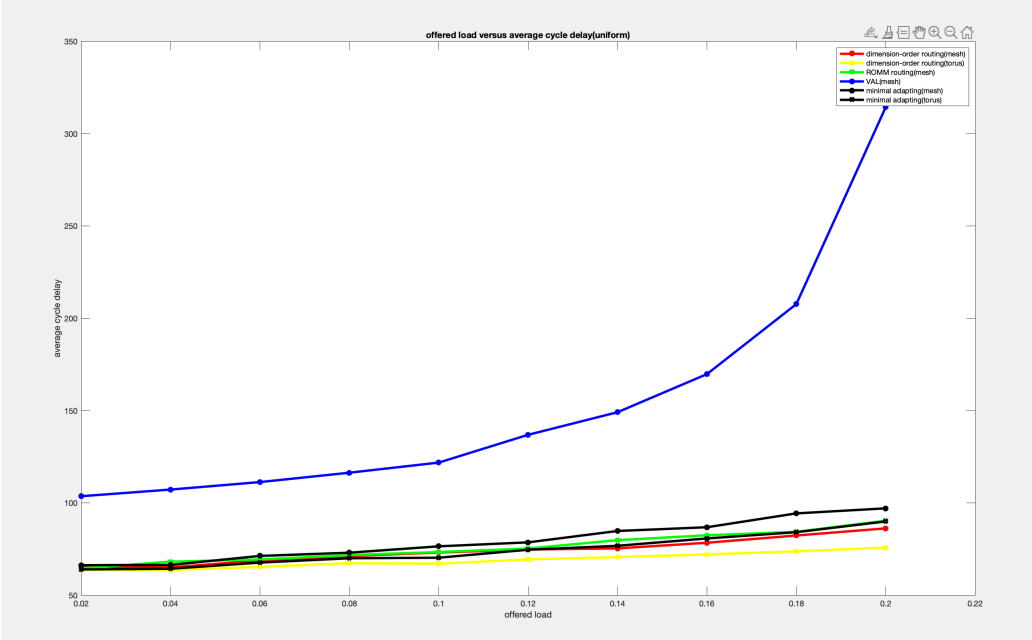
1. Average Packet Delay vs. Offered over head-Assignment 1

In this assignment, the impacts of routing, flow control and network size from a latency perspective will be explored in a chosen network topology. In this assignment, 8-ary 2-cube mesh and torus network will be used for simulation. At low traffic, zero load latency gives an accurate estimate of the simulated latencies. The model uses the time it takes a flit to traverse a channel as the definitions of cycles. The router model has a delay of cycles and the serialisation latency is 20 cycles because the packet length is 20 flits.

Here we will compare the performance of four routing algorithms, dimension-order routing (DOR), the randomized, minimal algorithm (ROMM), Valiant's randomized algorithm (VAL), and a minimal-adaptive routing algorithm. The ROMM algorithm is a minimal version of Valiant's algorithm. You may need to read the code to find the corresponding routing algorithms. Your assignment is to run the simulator to collect enough data points (10 data points for each plot) to be able to create plots of latency (cycles) vs. offered load (aka injection rate*packet length) for different routing algorithms. You may need to change the latency-thres to perform the simulations.

1.1 Task 1.1,use "uniform" traffic pattern.

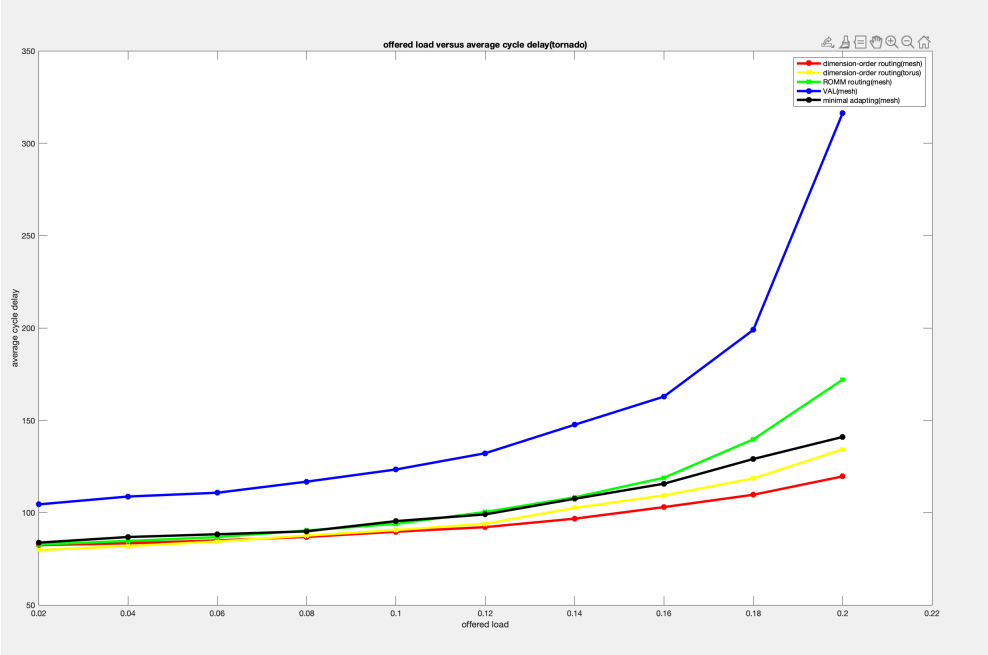
Evaluate all the routing algorithms to get plots of average latency vs. offered load for both the mesh and torus networks. Compare the performance of the two typologies and explain the possible reasons.



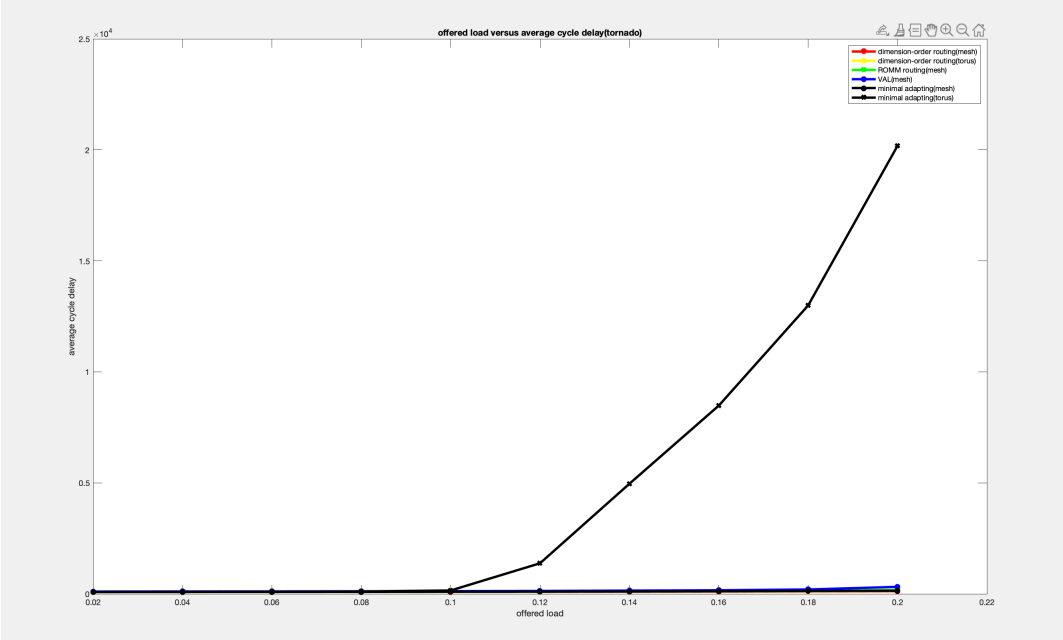
In the uniform traffic pattern, the dimension-order routing algorithms with a torus topology has the best performance.It shows the lowest increase on delay with the incremental injection rate. Meanwhile, the VAL routing algorithm in mesh topology show a exponential increase. Its cycle delay is highly impacted by the incremental injection rate.

1.2 Task 1.2: use ”Tornado” traffic patterns

Evaluate all the routing algorithms to get plots of average latency vs. offered load. Compare the performance of the two typologies and explain the possible reasons.



The delay graph without a minimal-adaptive routing algorithm under torus topology. It is obvious that, under the Tornado traffic pattern, dimension-order routing using a mesh topology has the lowest delay with the increment of injection rate. VAL with mesh topology show a exponentially increase which have higher delay than other 4 mode.



The delay graph with a minimal-adaptive routing algorithm under torus topology. Which can be see, the delay of minimal adaptive routing algorithm has a dramatically increase with the increment of offered load, it show a exponential trend and overtake other line in a large

extent.

1.3 Analysis:

Dimension-order routing (DOR)
When packet is delivered from the origin to the destination, the same path is always chosen. This ignores the diversity of paths and performs poorly in terms of load balancing. In practice, however, this type of algorithm is common, as it is simple to implement and easy to achieve deadlock-free.Feature. It is Easy and inexpensive to implement. There is no deadlocks or live-locks; It will eliminates any path diversity provided by the topology. But it has a poor load balancing which can not be obvious in this simulation.

Valiant's randomized algorithm (VAL):
Selecting a routing policy is independent of the current network state. All patterns appear to be uniform random. The route from s to d, randomly choose intermediate node d' .Valiant's: Load balancing comes at expense of significant hop count increase. When the traffic load increase, it will be obviously impacted on its processing delay. It works extremely well for hierarchical topologies, such as fat tree.

Minimal-adaptive routing algorithm: Routing decisions are made based on information about the current state of the network. The information may include the state of the node or connection, the length of the network resource queue, and the historical channel load.

From the above graph, when the load balance is not considered. The order dimensions routing algorithm shows a better performance. The incremental traffic load impacts less on its packet delay.

And overall, comparing the average delay between Tornado and Uniform, the average latency of "Tornado" traffic pattern is higher than the average latency of "uniform" traffic pattern.

2. Implement your own network topologies and evaluate the performance – Assignment 2

By following guide, build a network topology as shown in Figure 1. The network topology has four routers and 12 end points.

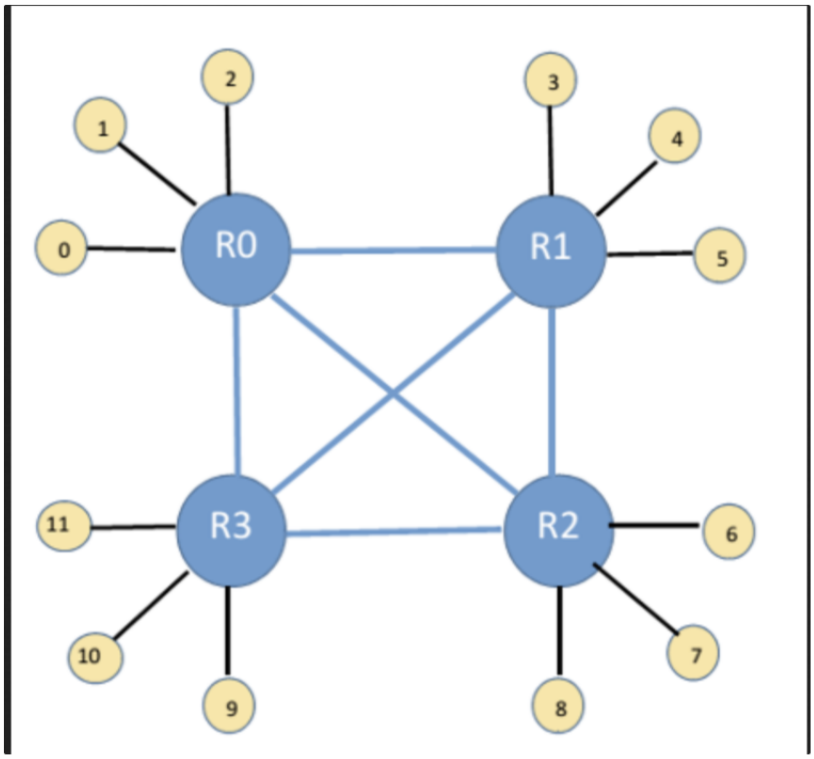


Figure 1: TestNet Network Topology

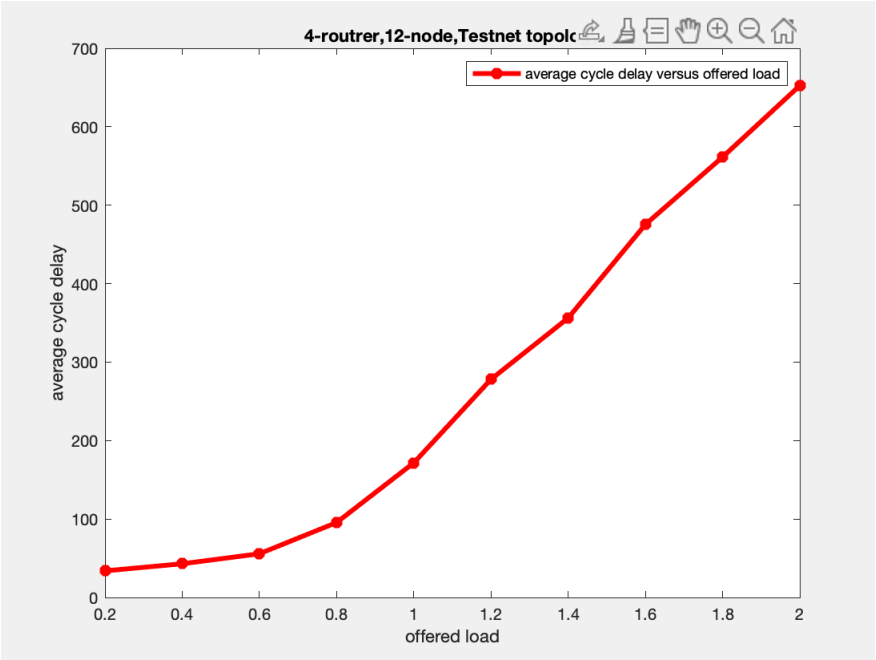
2.1 Task 2.1. Use booksim to evaluate the performance of a network topology designed in the guidance.

- - Define performance metric for the evaluation
- Results and discussion for the evaluation.

Assumption:
Packet Size = 20.
Offered Overload = Packet Size * Injection Rate
Designed metrics:

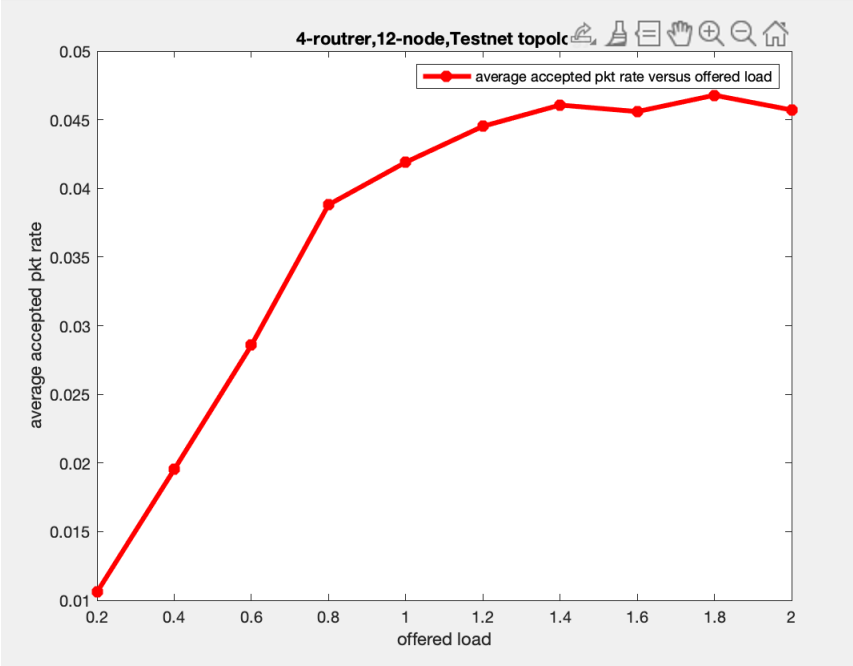
1. Average Packet Latency
2. Accepted packet rate average

2.1.1 Average Packet Latency vs. Offered load



The first metric is the Average Packet Latency. As shown in graph, it shows an linear increase with the raise of traffic load. Compared with the topology in section 1, the performance is not good enough.

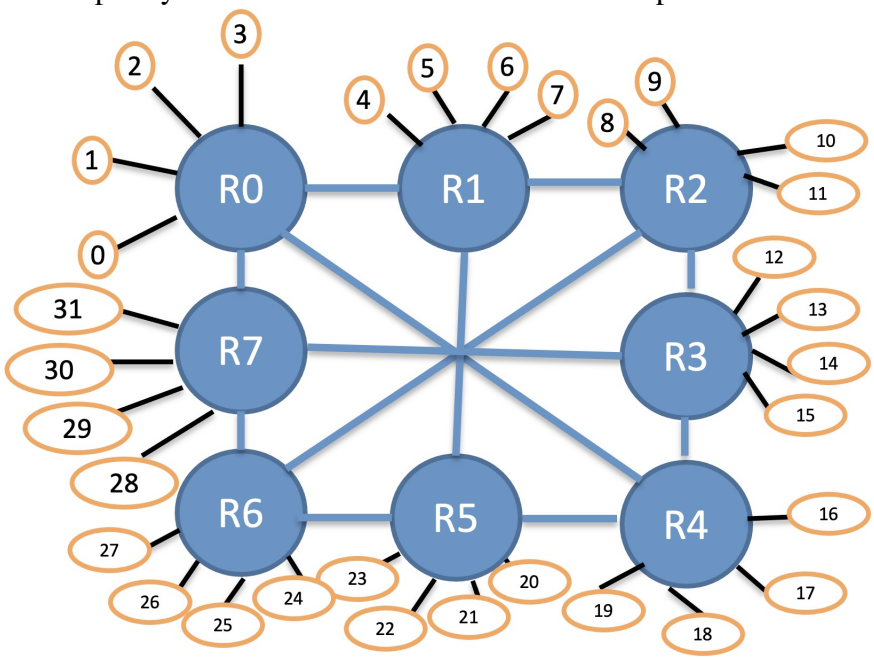
2.1.2 Accepted packet rate average vs.Offered load



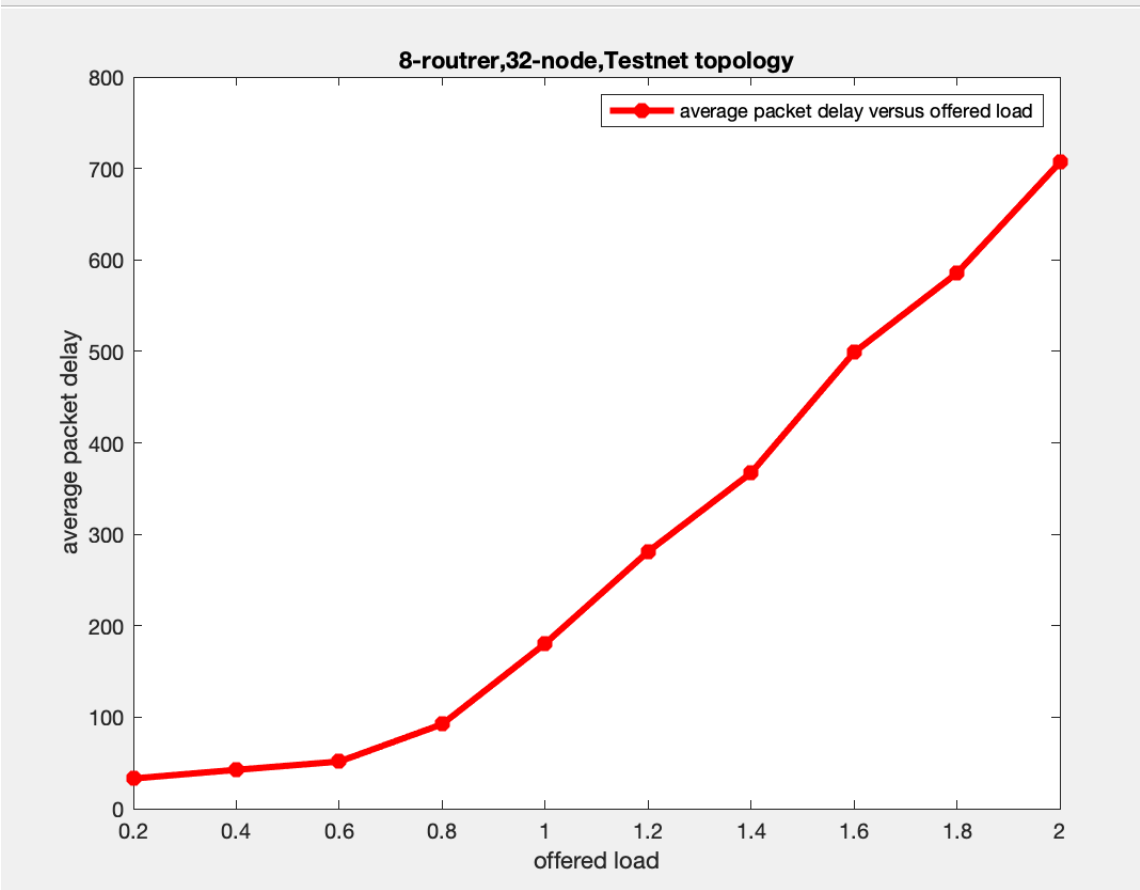
The second metric is the accepted packet rate for testing its reliability. The trend in this graph shows, with the increase of the packet injection rate, the accepted packets rate gradually become stable.

2.2 Task 2.1

Build a network with the name as DesignNet. It includes 8 routers and 32 nodes. Between routers, the links drawn in the figures are bidirectional links. Here we assume a fully connected network is setup between all routers. Some links between routers are omitted for simplicity. Create the network and evaluate the performance.

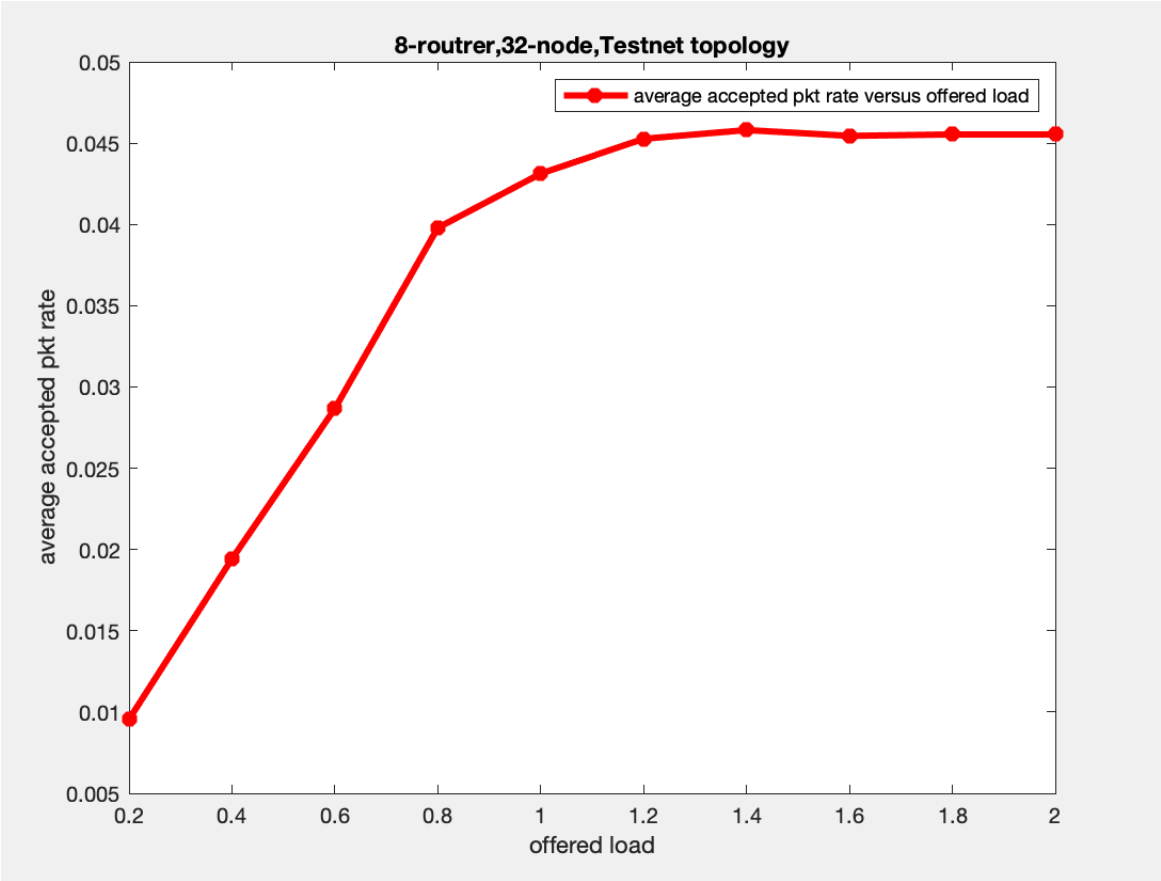


2.2.1 Average Packet Latency vs. Offered load



Compared with 2.1,the overall performance in the delay of this topology with more links and routers is similar to the previous one. It shows an expoenetially increase with the traffic load.

2.2.2 Accepted packet rate average vs.Offered load



Compared with 2.1, the accepted packets rate is earlier to converge to plain. It shows that when the links and routers increased, the network can provide more reliable service.

Code List

The code attachment includes files: Configuration files and topology codes.

Reference

Shuangyi Yan. ”Lab Note for Data Center Networking” (2022)