Discrete Network Simulation for Topology Verification

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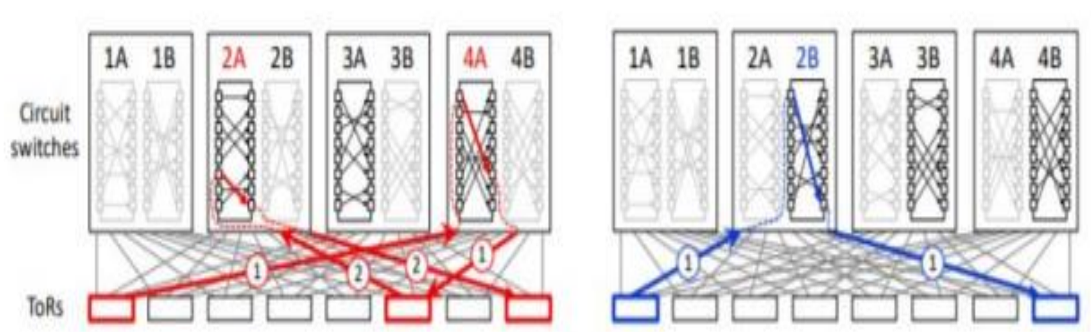
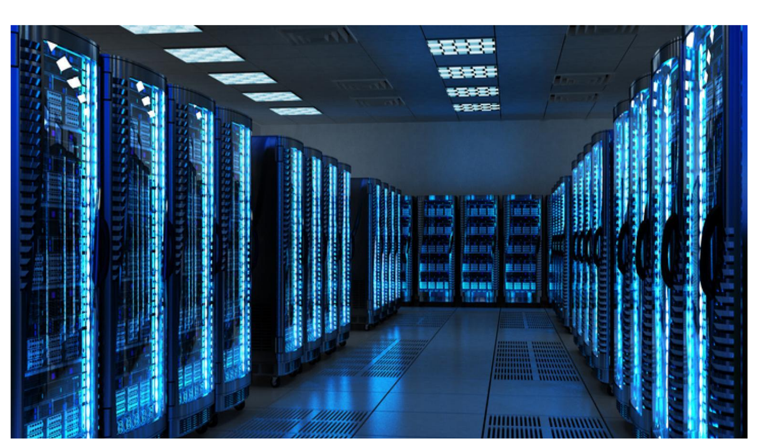
Background

- Opera is a proposed large scale network solution that targets power consumption
- Low Latency routing: Indirect traffic routing, data is routed through longer, less-efficient paths
- High-bandwidth routing: buffers traffic until the network reconfigures and makes a direct path from the source to the destination

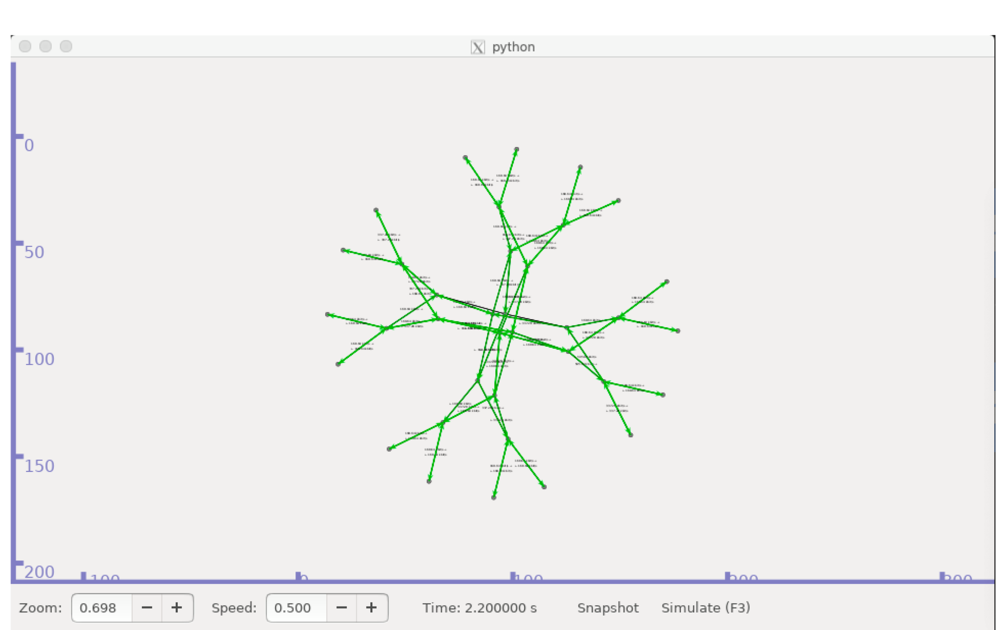


(a) Indirect path (b) Direct path



Motivation

- Validate the results from the Opera paper
- Reproduce the performance using a more realistic simulation tool



Problem Statement

- Opera initially tested with “htsim”, a "flow-level" simulator: not representative of actual packet flow
  - Performance of individual packets
  - Dropped packets

Flow-Level	Packet-Level
• Easier implementation • Faster to Simulate and Compute Performance • Measures General Performance of entire traffic flow • Less Precise • “F=ma”	• Complicated Implementation • Slower Simulation • Measures Performance of Each Packet in traffic flow • More Precise • “Fluid Dynamics”

Simulator/Tool

- Utilize ns-3 network model libraries

Step 1: Replicate Optical Matchings

- Model rotating matchings with a new ns-3 module
  - Backed by adjacency matrix and ns-3 time implementation

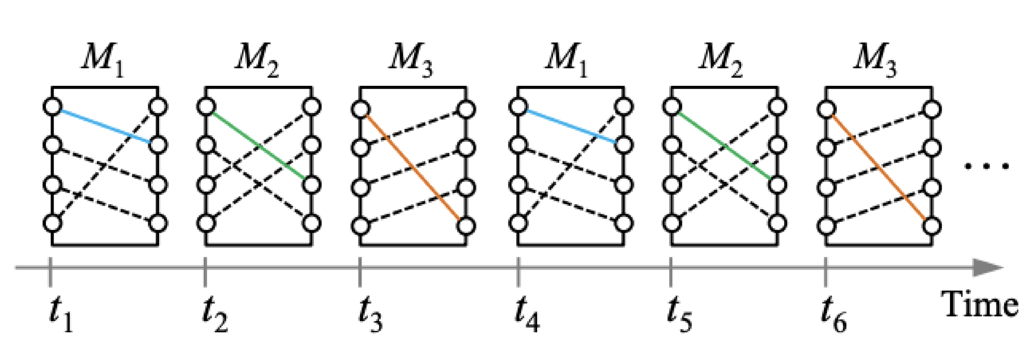


Figure 3: Rotor switches move through a static, round-robin set of configurations, or matchings, spending an equal amount of time in each matching.

Step 2: Routing Table

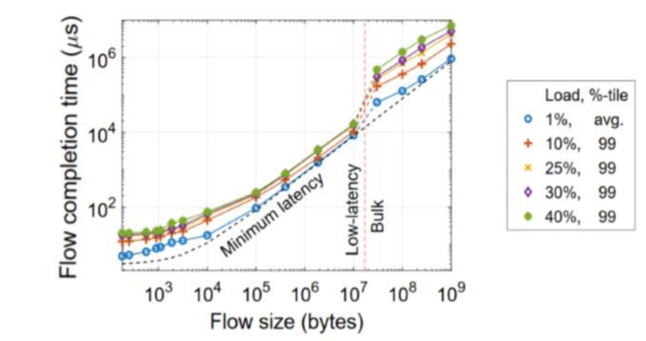
- Connect matching module to ns-3
  - Insert matching module into a custom routing protocol

Step 3: Automate Data Collection

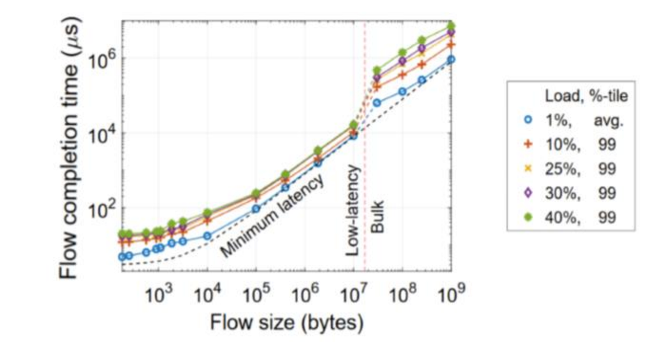
- Bash Script to simulate workloads and plot performance data in Matplotlib

Results

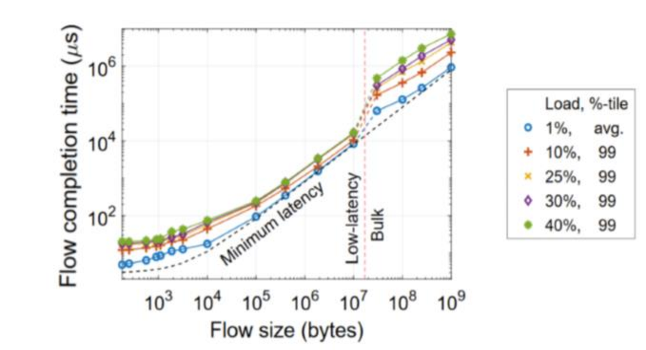
Opera:



Clos/Fat-tree:



RotorNet:



Conclusion

Opera's performance is viable in comparison to other prevalent networks
- Comparable latency
- Comparable bandwidth

- Possible Extension:
  - Increase the scale of the network and revalidate results
  - Measure throughput and flow completion time
  - Simulate more stressful workloads

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