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Performance of Load Balancing Algorithms for SDN Controlled Data Center Networks with Leaf-Spine Topology

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ABSTRACT

Traffic in Data Center Networks (DCN) has increased drastically over the years. Software Defined Networking (SDN) increased the information gathered about the network. Apart from SDN, a solution proposed in DCNs to decrease the latency and complexity is using the leaf spine topology. In this paper, the performance of load balancing algorithms are compared for DCN with leaf spine topology, using ONOS as the SDN controller for the first time in the literature. The performance metrics utilized include Round Trip Time (RTT) standard deviation of RTT, instantaneous and average throughput. It has been observed that Least Flow has the smallest average RTT and smallest standard deviation of RTT among the load balancing algorithms. In terms of throughput, Proactive and Laberio give the best results, and among all, Laberio is the only method that responds to the changes which occur after the installation of flow rules to the switches.
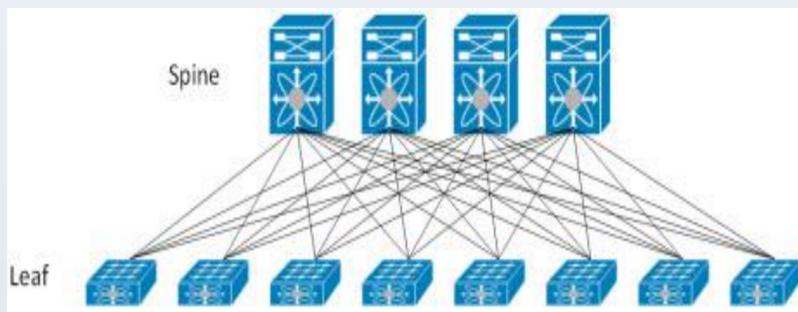
OBJECTIVES

To implement and comparatively analyze the performances of four reactive, namely, random, round robin, least flow, least utilization methods, a proactive and a dynamic load balancing method, namely Laberio on a DCN with leaf-spine network topology.

IMPLEMENTED LOAD BALANCING METHODS

- **Random (Reactive Forwarding Application)**
  - Selects the path whose hop count is smallest
  - ONOS's Reactive Forwarding Application

- **Round Robin**
  - Round Robin fashion on leaf spine switches
  - Distributes flows equally among spine switches.

- **Least Flow**
  - Selects the path whose flow count is smallest
  - Distributes the flows on links equally
  - Decreases the number of idle links
  - Implemented as an ONOS Application

- **Least Utilization**
  - Selects the path whose minimum available link utilization is max
  - Implemented as an ONOS Application

- **Proactive**
  - Computes shortest path between all host pairs beforehand
  - Selects path with respect to link utilization and installs flow rules
  - Repeats the same process at each 60 seconds

- **LABERIO**
  - Dynamic
  - Changes the path of flow on-fly
  - Tries to keep load invariance below a threshold

SIMULATION SCENARIO

Time(sec)	Event
0	h8 starts sending TCP packets to h1
30	h6 starts sending TCP packets to h1
60	h7 starts sending TCP packets to h1
90	h6 stops sending TCP packets to h1
120	h6 starts sending TCP packets to h1
150	h5 starts sending TCP packets to h1
180	h4 starts sending TCP packets to h1
210	h3 starts sending TCP packets to h1
240	The end of Simulation

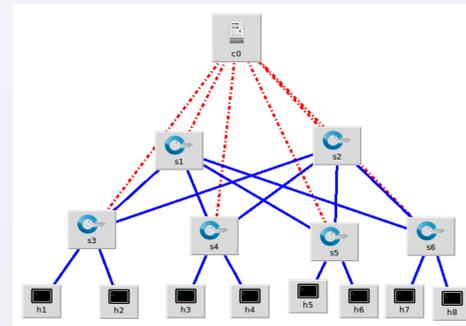## SIMULATION SETUP

Figure 1: Leaf Spine Topology [1]

Figure 2: Onos(Open Network Operating Systems) [2]

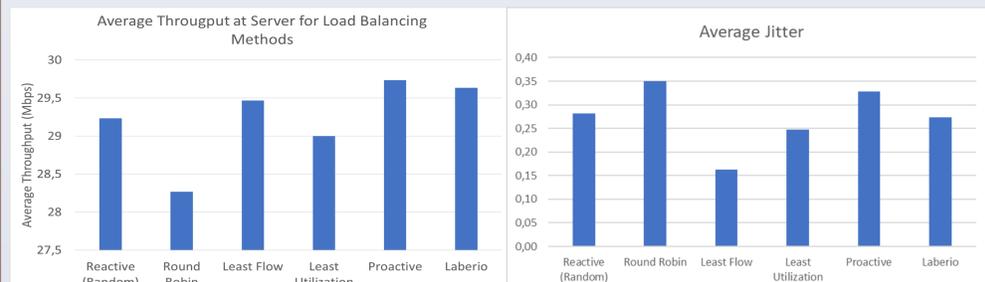## SIMULATION RESULTS

Figure 3:RTT for Load Balancing Methods

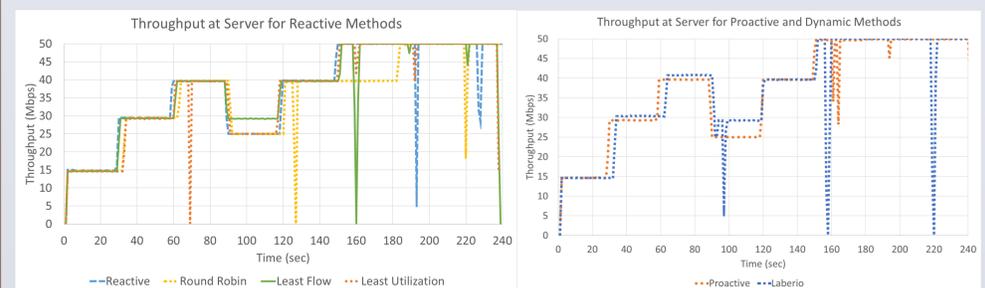*Figure 4:Average Throughput*

Figure 5:Average Jitter

Figure 6: Throughput at server for Load Balancing Methods

CONCLUSIONS

- Least Flow has the smallest standard deviation of RTT.
- Proactive and Laberio has the highest throughput
- Laberio is the only method which responds to load imbalances emerged after the path selection.

In the light of these results it can be said that

- For networks which require stable and small RTT it is better to use Least Flow load balancing method.
- Laberio and Proactive methods suits better to the networks which require higher throughput, at the cost of higher CPU usage.
- For networks which face highly varying flows, Laberio performs best because of its dynamic characteristics.
- This work has been submitted to Balkancom'19 Conference [5].

REFERENCES

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4. Schlebusch, M. R. (2017). Topology Control and Routing in Software Defined Multi-Radio Mesh Networks
5. [5] Okuyucu, A. F., Karatas, C., Gürbüz, Ö, & Levi, A. (2019). Performance of Load Balancing Algorithms for SDN Controlled Data Center Networks with Leaf-Spine Topology.