Hands-on Workshop on
Open vSwitch and Software-defined Networking

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Applying Load Balancing in SDN

The Needs for Load Balancing

- Cloud data centers (e.g., Google) provide many applications concurrently
- Network engineers seek to make use of their available resources and increase the bandwidth of their networks as much as possible
- One possible costly solution for increasing the bandwidth is to upgrade existing infrastructure with better quality
  - For instance, replace a 1 Gbps Ethernet link with 10 Gbps

Noction, “BGP and equal-cost multipath (ECMP)”. [Online]. Available: https://www.noction.com/blog/equal-cost-multipath-ecmp

Load Balancing

- Nowadays, it is very common to use parallel links to increase bandwidth
- This technique splits network traffic among multiple links to balance the load (i.e., load balancing technique)
- Load balancing techniques include:
  - **Per-packet** load balancing: send successive data packets over different data paths (e.g., using the round-robin method)
  - Drawbacks: Packets to the same destination might arrive out of order

Noction, “BGP and equal-cost multipath (ECMP)”. [Online]. Available: https://www.noction.com/blog/equal-cost-multipath-ecmp

Equal-cost multi-path routing (ECMP)

- ECMP is a routing technique for forwarding packets along multiple paths of equal cost
- One method of selecting which next-hop to use is the hash-threshold approach
  - Traffic is forwarded based on the hash of some header fields (e.g., 5-tuple)

C. Hopps, “Analysis of an equal-cost multi-path algorithm”. RFC 2992, 2000. [Online]. Available: https://www.hjp.at/doc/rfc/rfc2992.html

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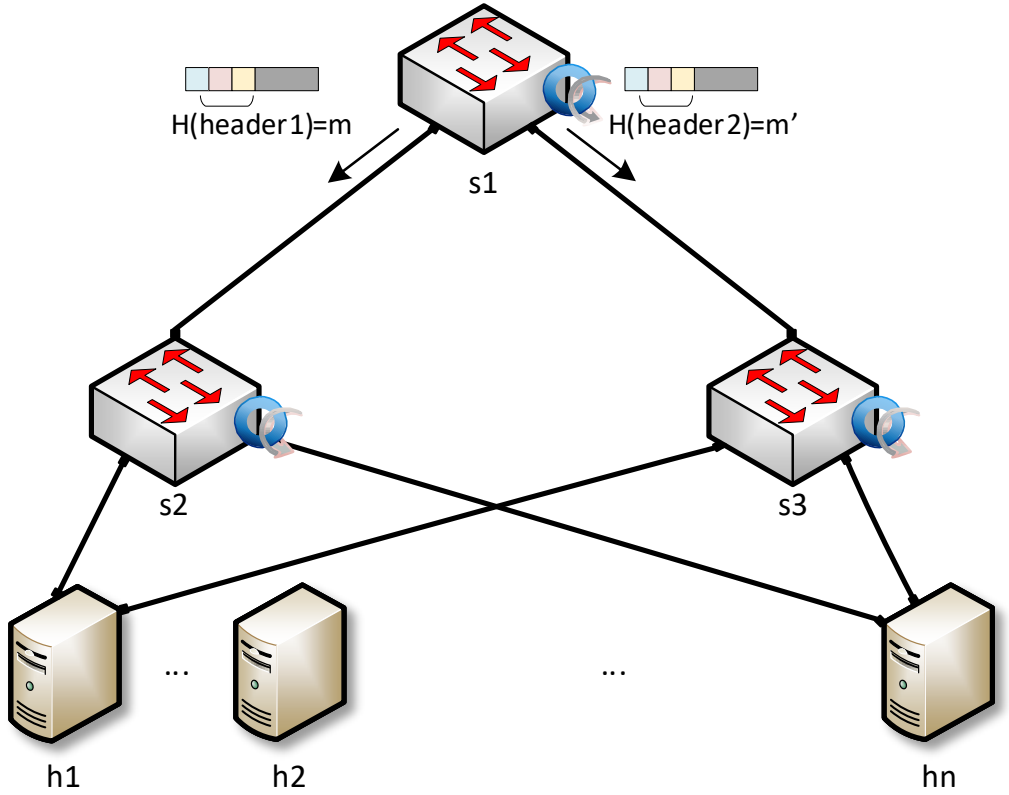
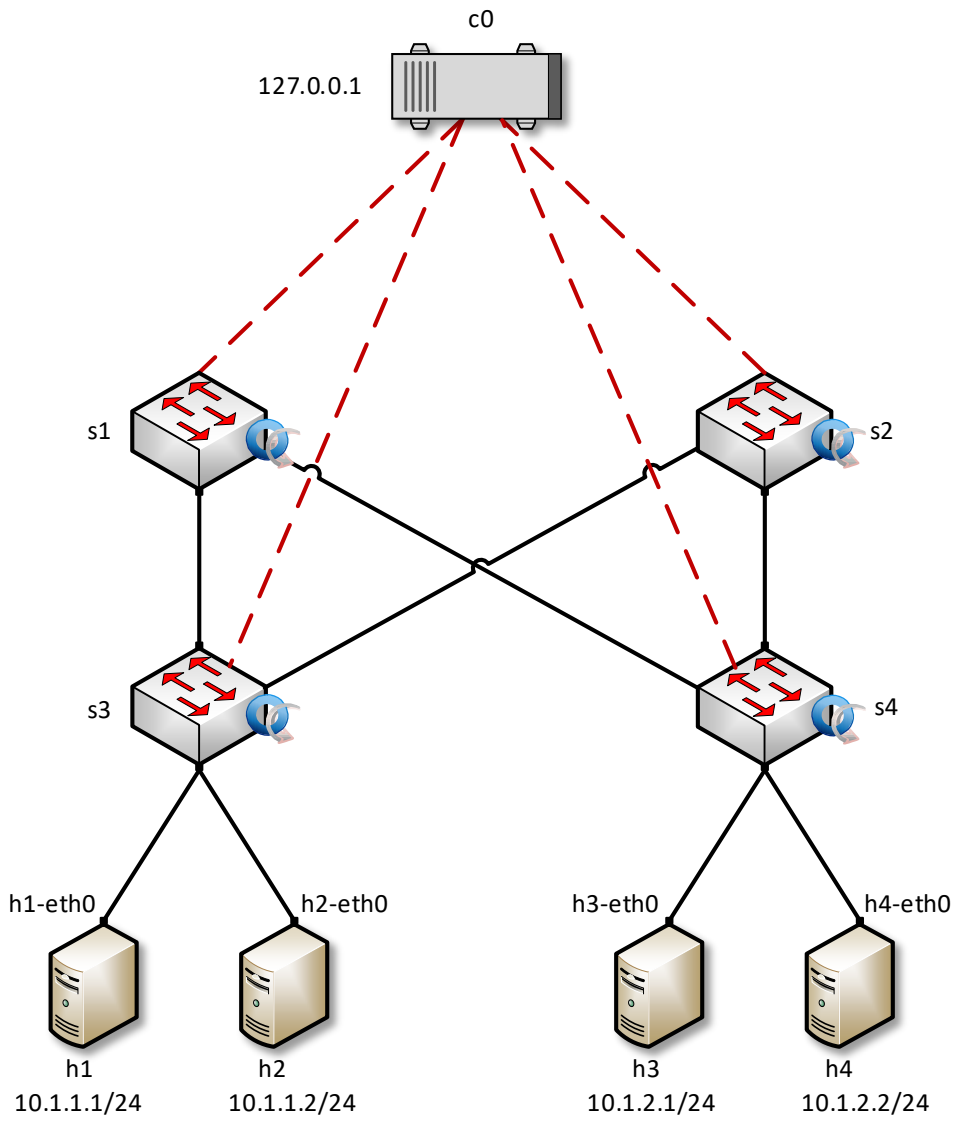


Lab 10: Applying Equal-cost Multi-path Protocol (ECMP) within SDN networks

Lab 10: Applying ECMP within SDN Networks

- Topology consists of four OpenFlow switches, four hosts, and one ONOS controller
- Hosts h1 and h2 and in network 1 (10.1.1.0/24)
- Hosts h3 and h4 and in network 2 (10.1.2.0/24)
- There are two paths from network 1 to network 2
- Configure the ONOS application “segment routing” to balance the load among the two networks
- Use sFlow to visualize the traffic
- Launch several flows between hosts and verify the load balancing operation

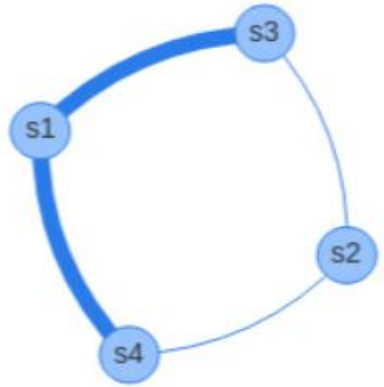


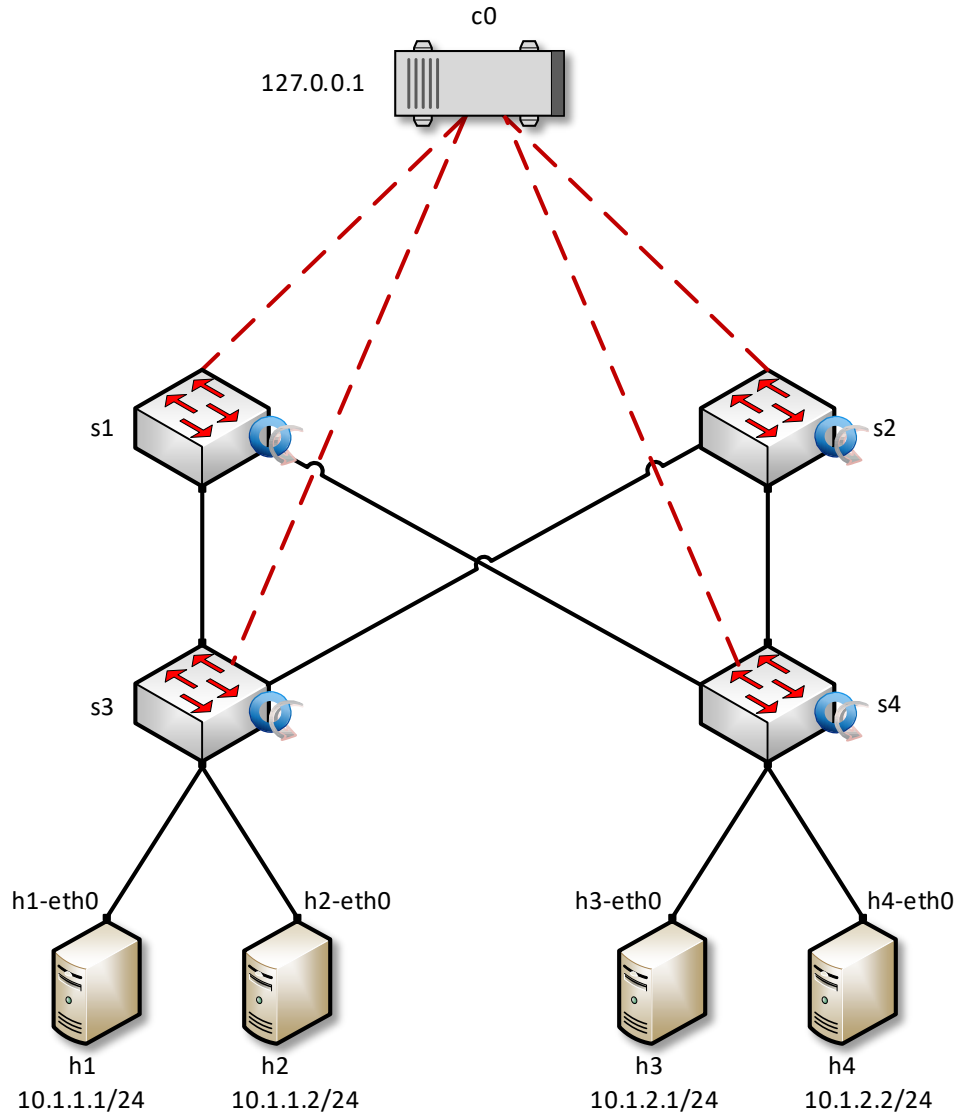
Lab 10: Applying ECMP within SDN Networks

Traffic is generated from host h1 to host h3

```
"Host: h1"
root@admin:~# iperf3 -c 10.1.2.1 -u -t 120 -b 10gbits
Connecting to host 10.1.2.1, port 5201
[  7] local 10.1.1.1 port 49224 connected to 10.1.2.1 port 5201
[ ID] Interval           Transfer     Bitrate         Total Datagrams
[  7]   0.00-1.00   sec   149 MBytes  1.25 Gbits/sec  107743
[  7]   1.00-2.00   sec   157 MBytes  1.31 Gbits/sec  113333
```

sFlow view





Lab 10: Applying ECMP within SDN Networks

Traffic is generated from host h1 to host h3 (multiple flows)

```
"Host: h1"
root@admin:~# iperf3 -c 10.1.2.1 -u -t 120 -b 10gbits -P 20
Connecting to host 10.1.2.1, port 5201
[  7] local 10.1.1.1 port 37903 connected to 10.1.2.1 port 5201
[  9] local 10.1.1.1 port 40398 connected to 10.1.2.1 port 5201
[ 11] local 10.1.1.1 port 46457 connected to 10.1.2.1 port 5201
```

sFlow view