Quality-of-Service (QoS) Estimation in Software-Defined Networks

CS544 Project Report
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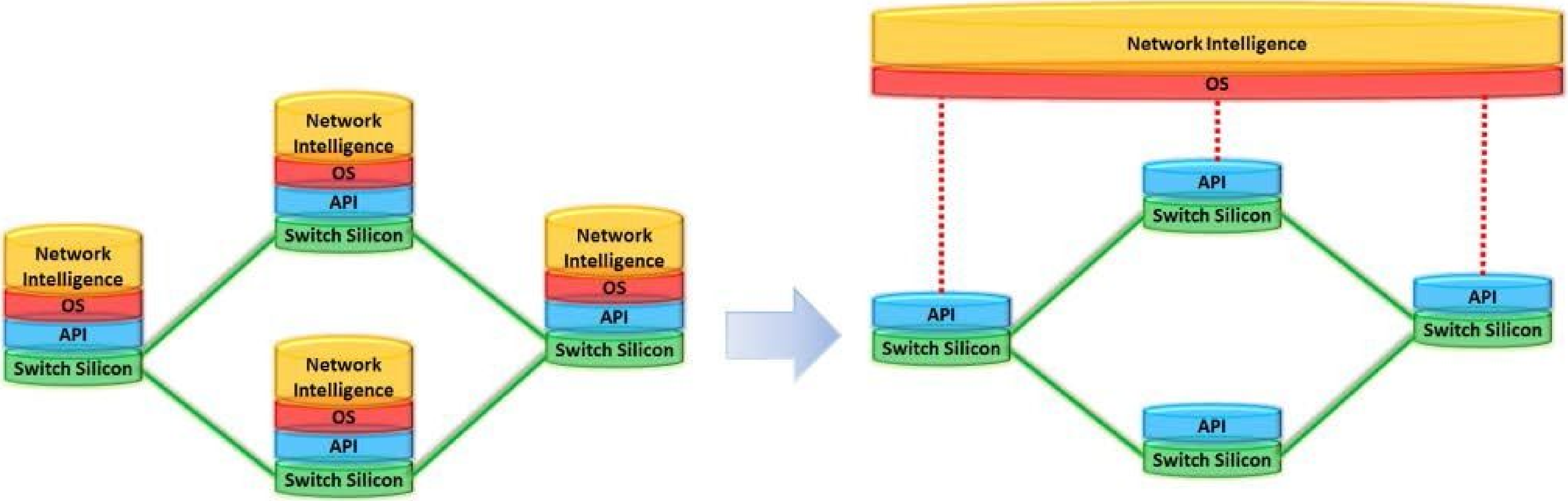
Background

- Multimedia applications has strict requirements of QoS
  - Throughput
  - Latency
  - …
- It’s difficult to measure QoS parameters at run time
  - Multiplexed flows at intermediate nodes
  - Best-effort forwarding

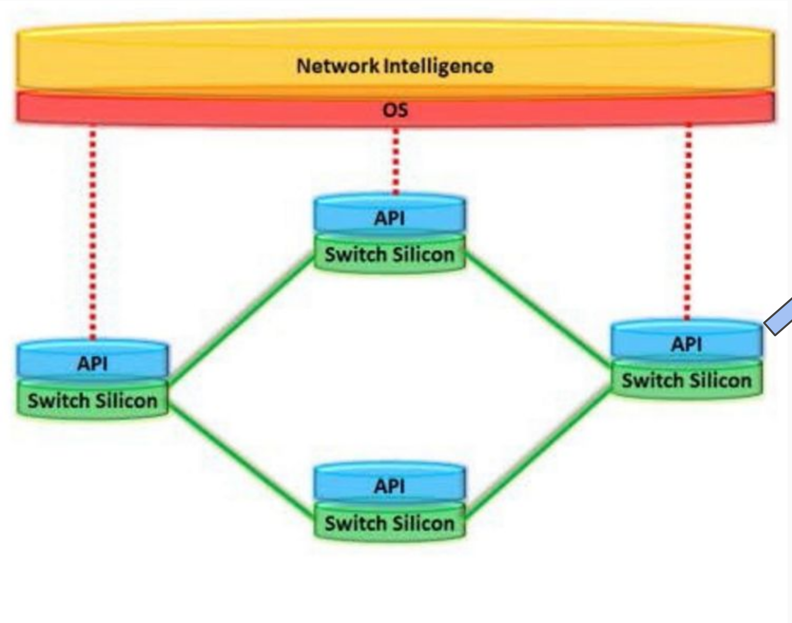
Software-Defined Networks

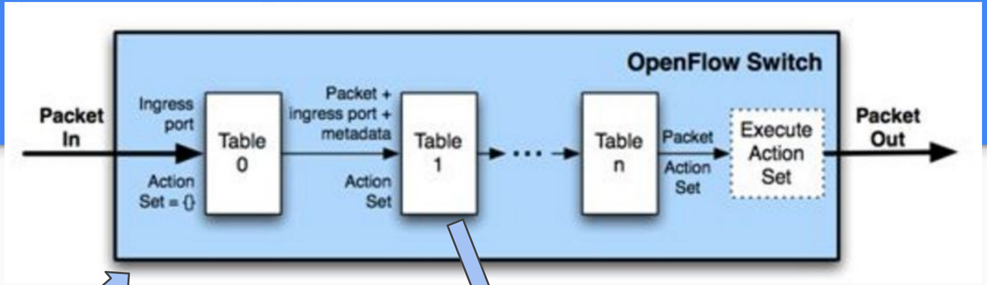
- Separate packet forwarding and control logic
  - Centralized view
  - Dynamic configuration
  - Open standard interface

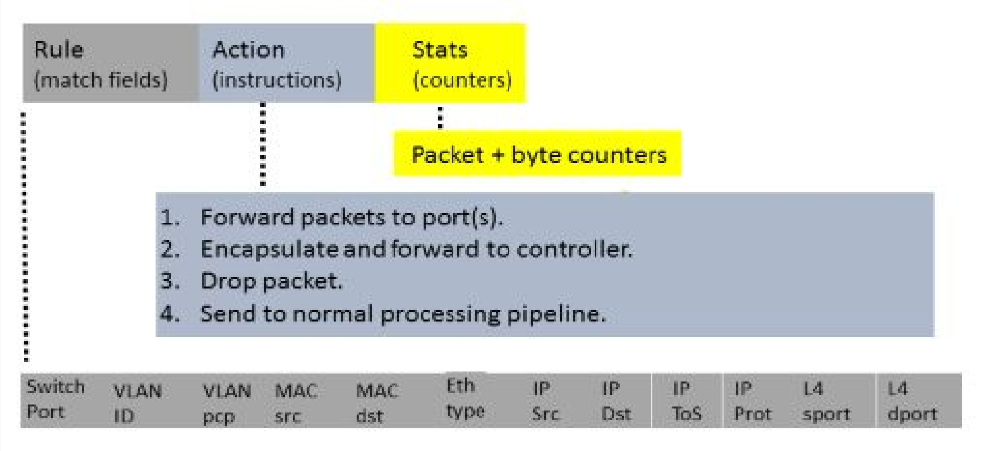
Software-Defined Networks



OpenFlow Protocol







Rule (match fields)	Action (instructions)	Stats (counters)

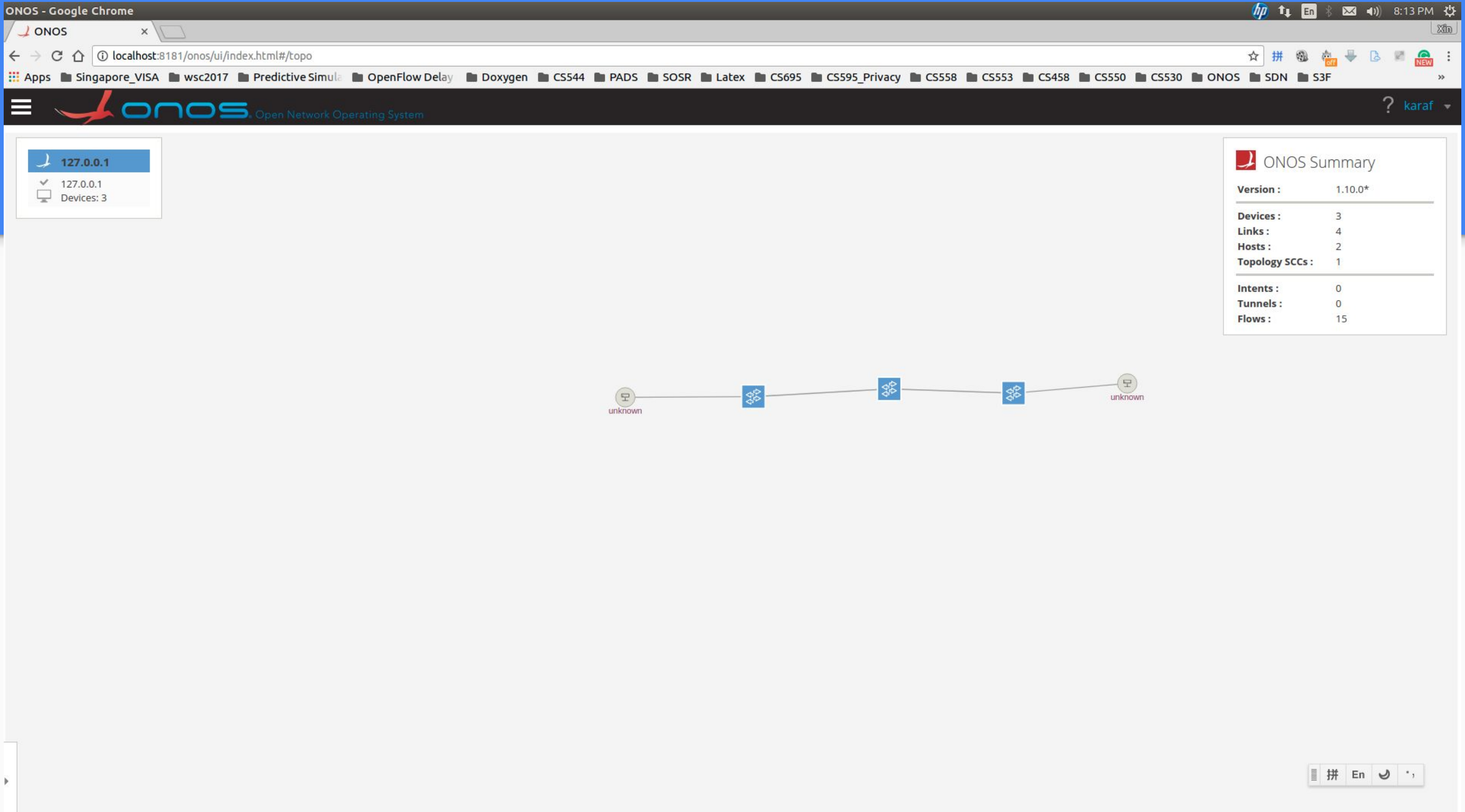
Packet + byte counters

1. Forward packets to port(s).
2. Encapsulate and forward to controller.
3. Drop packet.
4. Send to normal processing pipeline.

Switch Port	VLAN ID	VLAN pcp	MAC src	MAC dst	Eth type	IP Src	IP Dst	IP ToS	IP Prot	L4 sport	L4 dport

OpenFlow Protocol

- Controller action
  - Add / delete / modify table entries
  - Pull table entry stats
    - # packets processed
    - # bytes processed



127.0.0.1

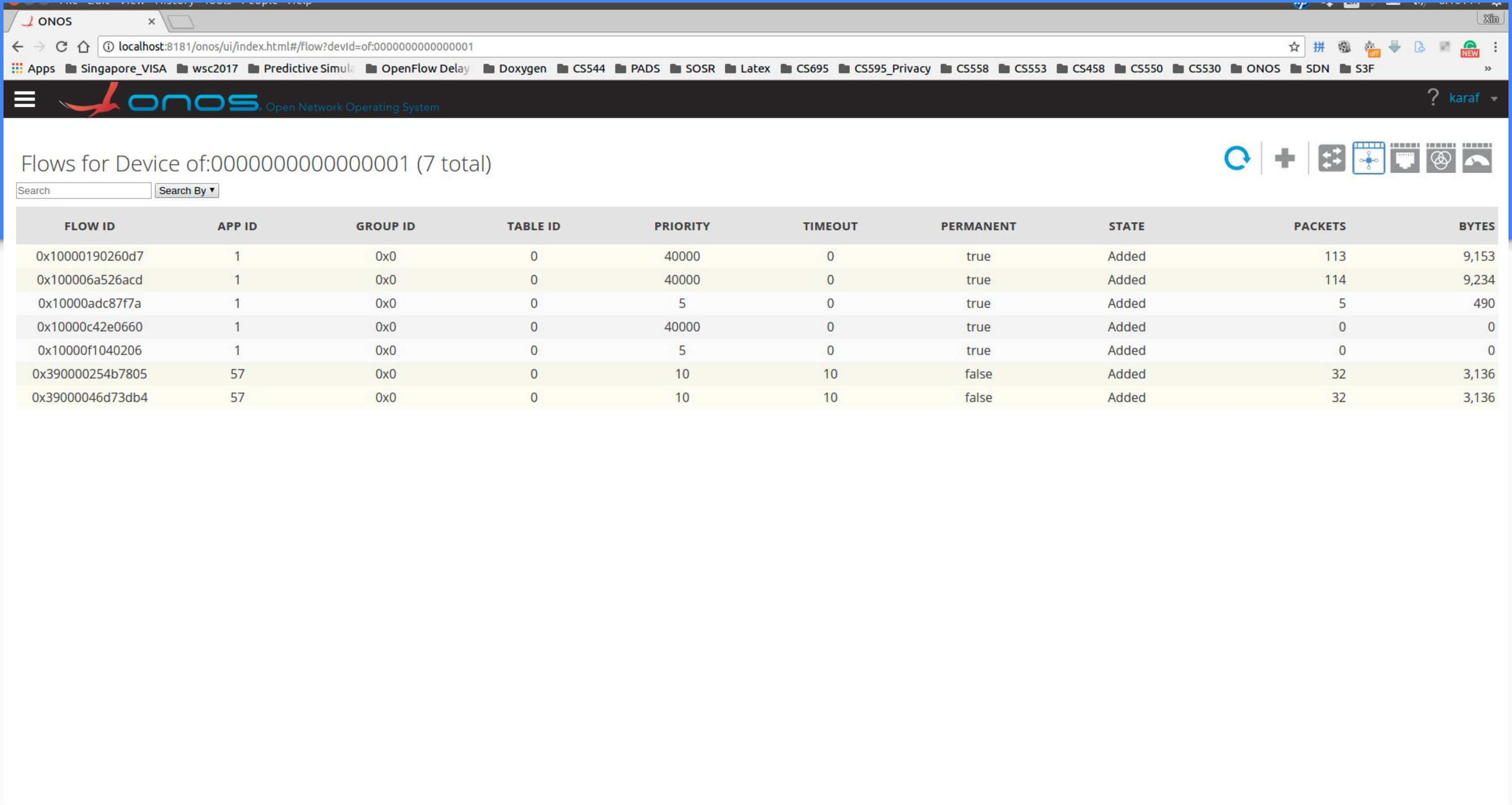
127.0.0.1
Devices: 3

ONOS Summary

Version : 1.10.0*

Devices : 3
Links : 4
Hosts : 2
Topology SCCs : 1

Intents : 0
Tunnels : 0
Flows : 15



Flows for Device of:0000000000000001 (7 total)

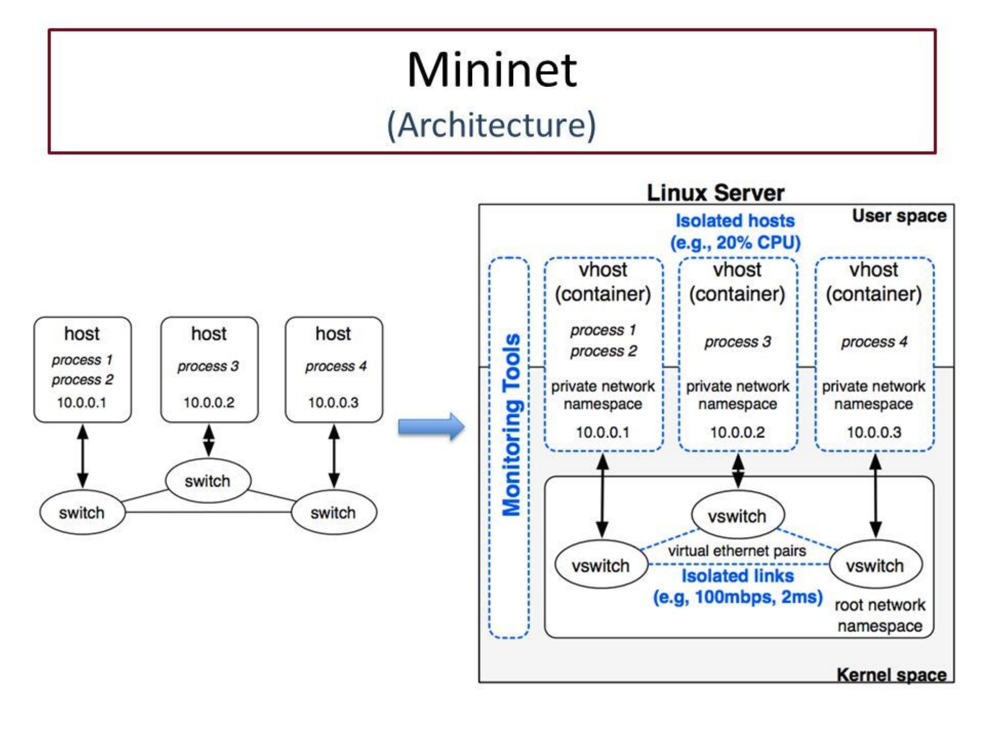
FLOW ID	APP ID	GROUP ID	TABLE ID	PRIORITY	TIMEOUT	PERMANENT	STATE	PACKETS	BYTES
0x10000190260d7	1	0x0	0	40000	0	true	Added	113	9,153
0x100006a526acd	1	0x0	0	40000	0	true	Added	114	9,234
0x10000adc87f7a	1	0x0	0	5	0	true	Added	5	490
0x10000c42e0660	1	0x0	0	40000	0	true	Added	0	0
0x10000f1040206	1	0x0	0	5	0	true	Added	0	0
0x390000254b7805	57	0x0	0	10	10	false	Added	32	3,136
0x39000046d73db4	57	0x0	0	10	10	false	Added	32	3,136

Throughput Estimation

- Assume a flow has stats
  - X bytes processed
  - The flow has been installed t seconds
  - Throughput = (X * 8) / t bits/sec

Validation Using Emulation

- Mininet emulator
  - Each virtual host is a Linux process
    - Generate real traffic
  - Software switch
    - Process real packets
  - TC link
    - Limit bandwidth and delay

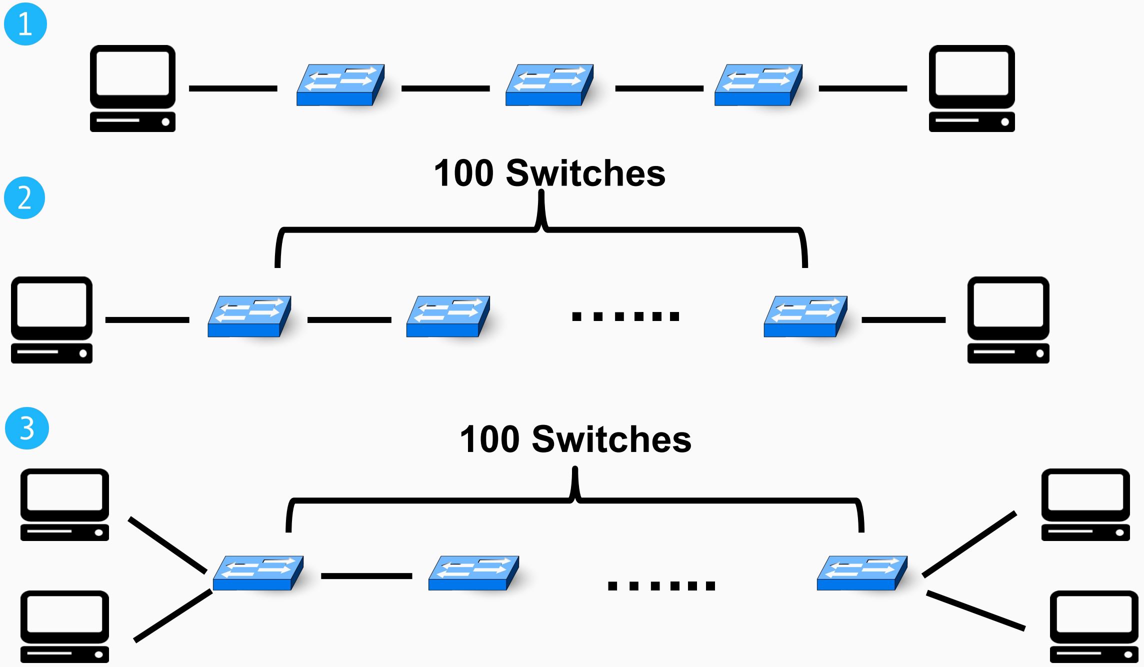


Mininet
(Architecture)

Experiment Setup

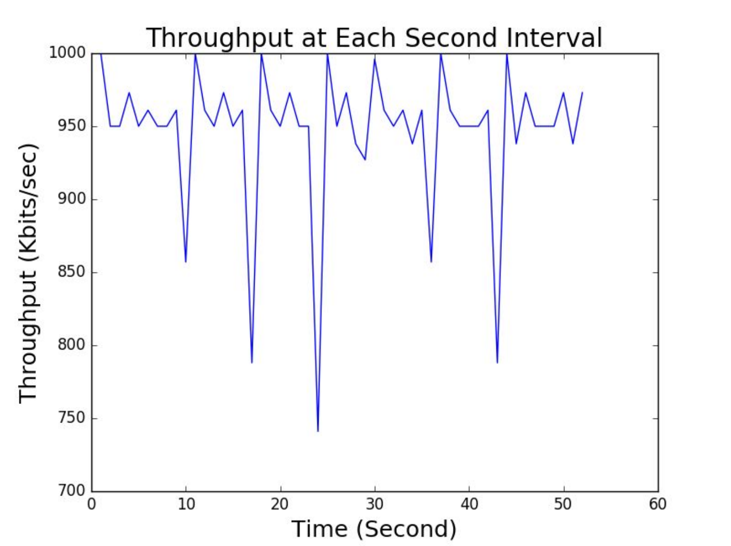
- Objective
  - measured end-to-end throughput
    - Run iperf client / server
  - Calculated throughput
    - Stats from ingress/egress switch
  - Three scenarios
    - Linear-5
    - Linear-100
    - Linear-100 with contention
  - All Links has 1 Mbps bandwidth
  - Repeated 10 times

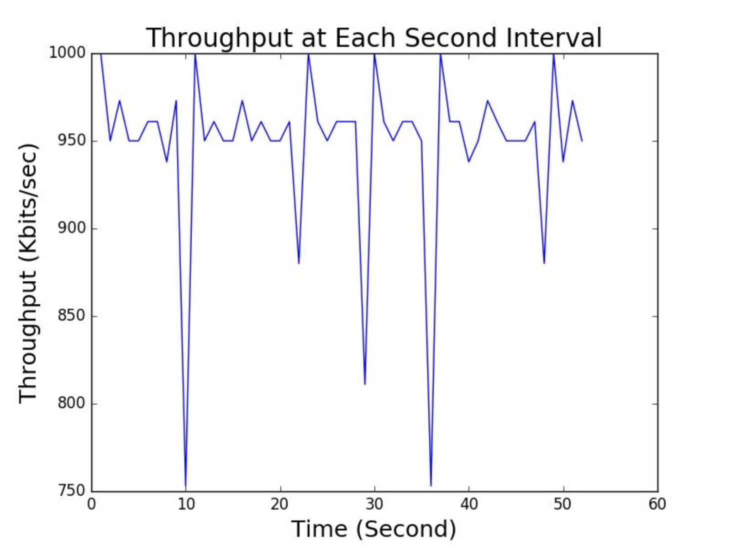
Experiment Setup



Experiment Result

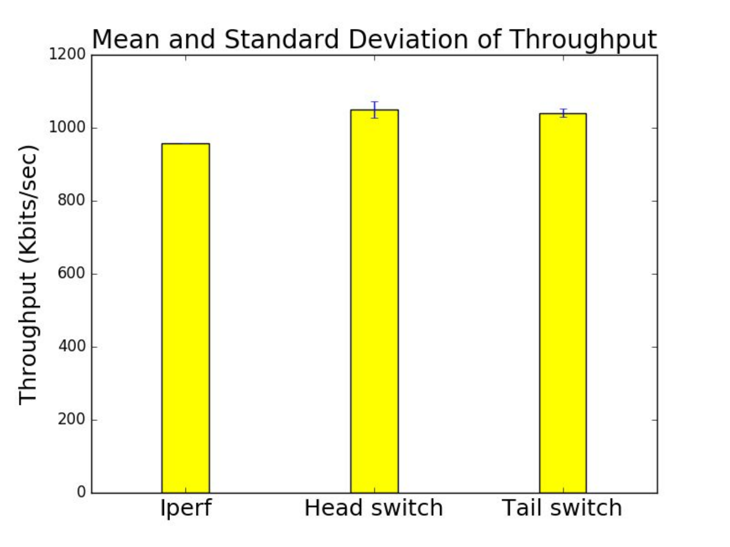
- Compare Linear-5 and Linear-100

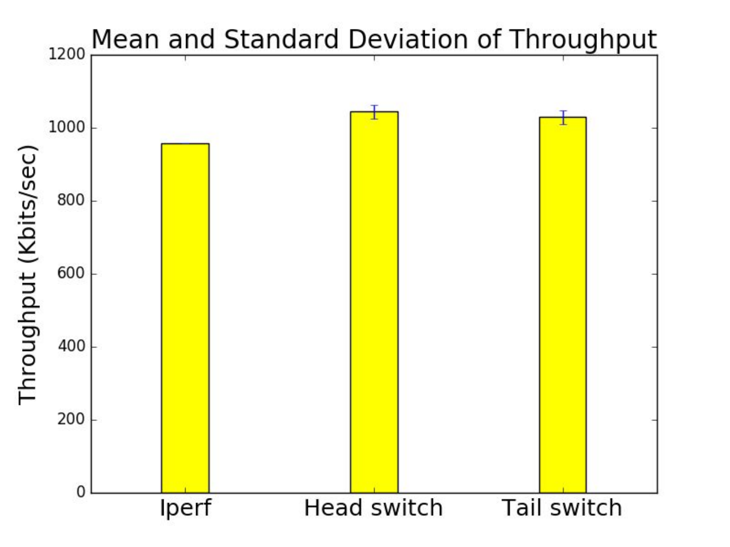




Experiment Result

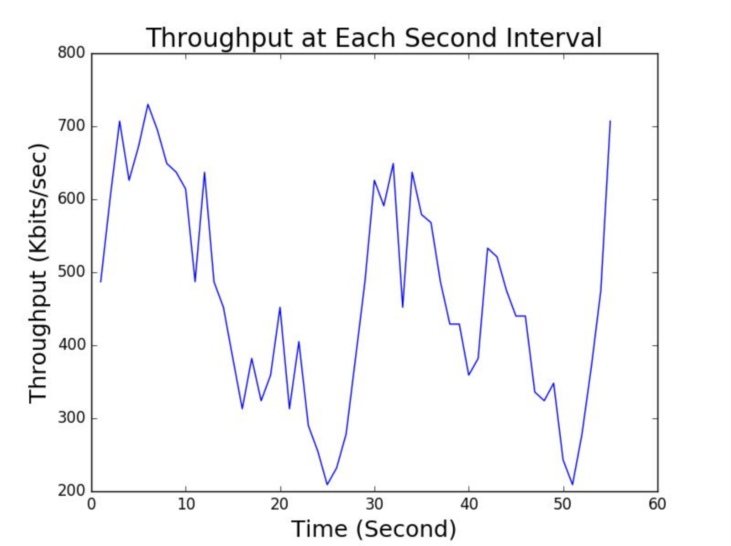
- Compare Linear-5 and Linear-100

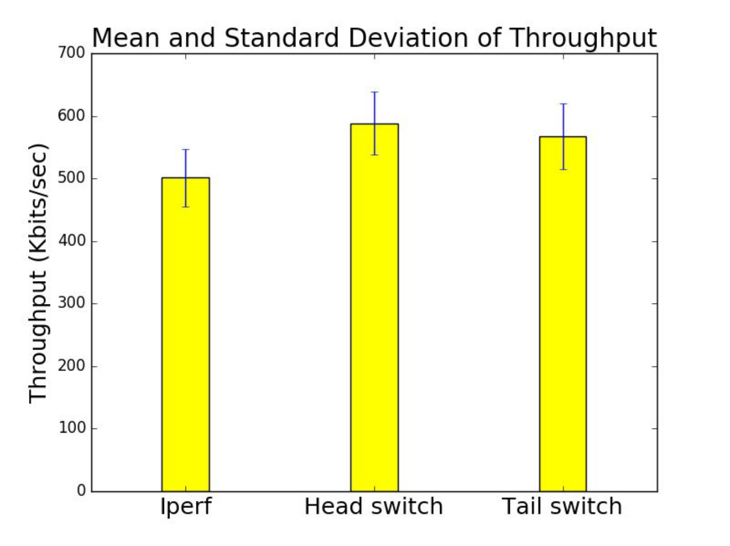




Experiment Result

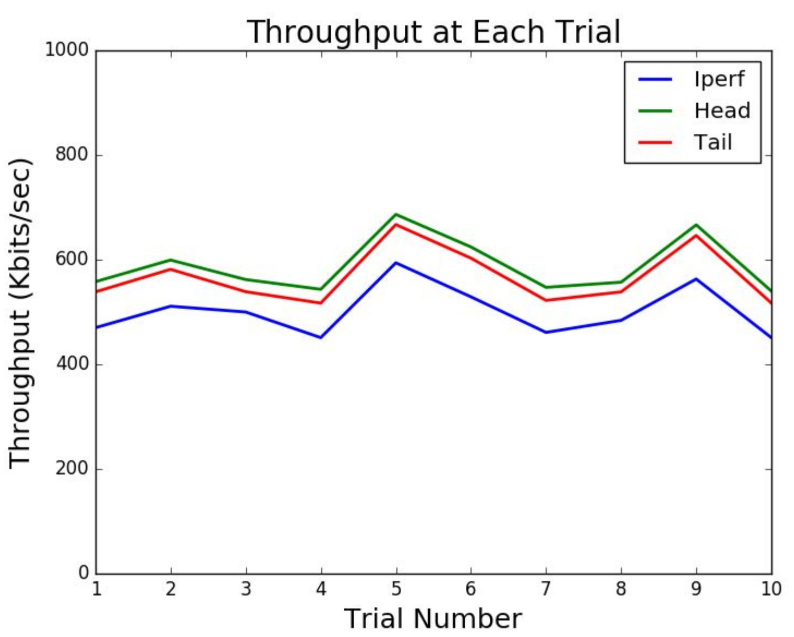
- Compare Linear-100 with contention





Experiment Result

- Compare Each Trial
  - Three values are close
  - Tail is closer to iperf data



Conclusion

- Simple calculation works in linear topology
    - Switch close to sink has better estimation
- Large-scale network?
    - How to choose which switches to monitor, to achieve optimal estimation?