A Programmable Policy Engine to Facilitate Time-efficient Science DMZ Management

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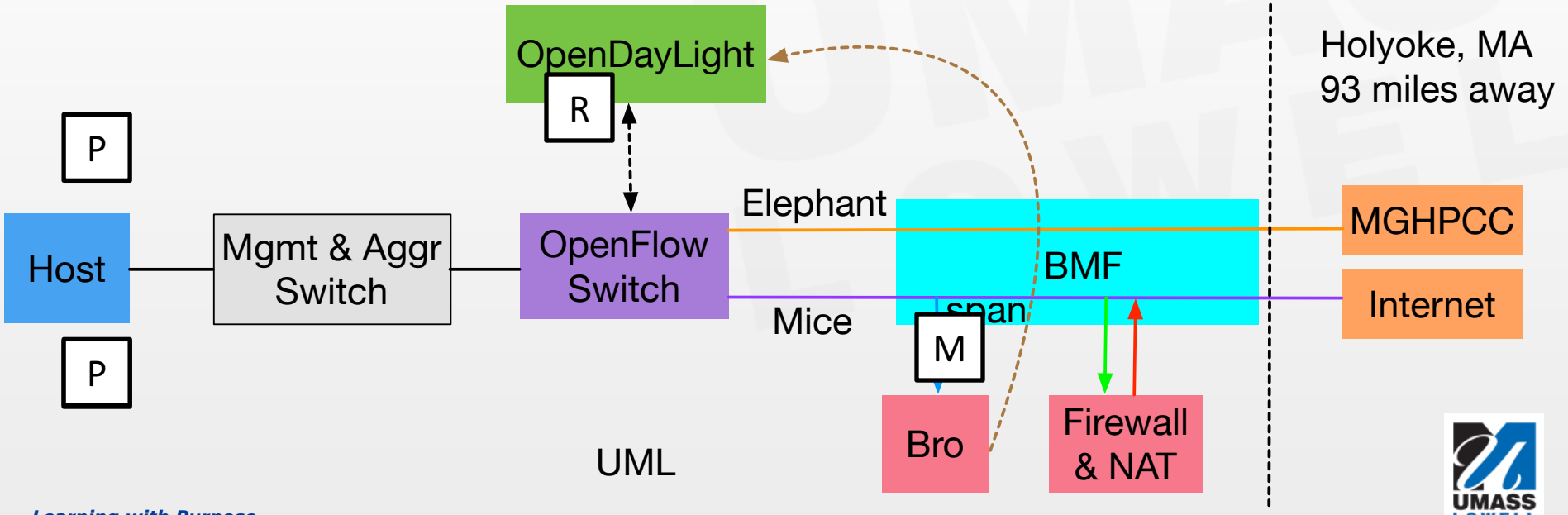
Content

- Background of our FLowell Science DMZ Network
- Existing Problems
- Motivations
- Design of our Policy Engine
- Performance Evaluation
- Conclusion

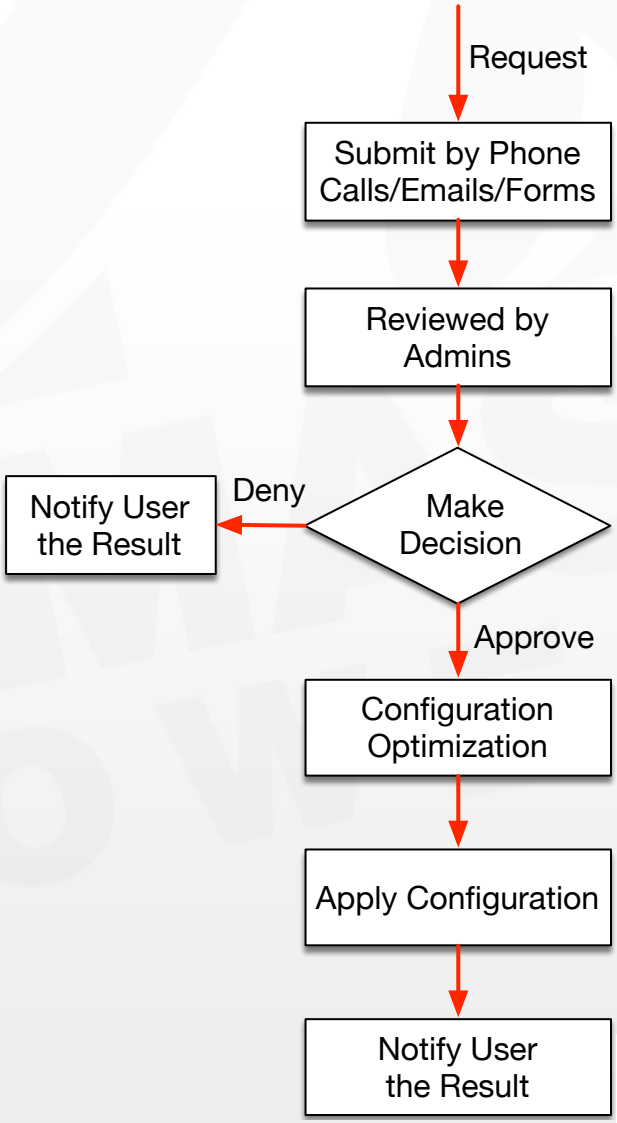
Background

- FLowell Science DMZ network refers to ESnet model to accelerate large data transfers from UML to MGHPCC
  - OpenFlow switch: direct elephant flow & mice flow separately
  - OpenDayLight(ODL): OpenFlow controller
  - Big Monitoring Fabric (BMF): provide service chains
  - Bro: determine if a flow is an elephant flow



Existing Problem

- The entire existing workflow requires *human intervention*.
  - Our ITs review every Thursday
  - Need hours to decide and apply
- Key requirements to accelerate inefficient user-admin interaction
  - Submit user requests and express user intention in a declarative ("what-to") manner
  - Automatic configuration optimization to reduce processing time & labor work
  - Supervised by admins to control risk



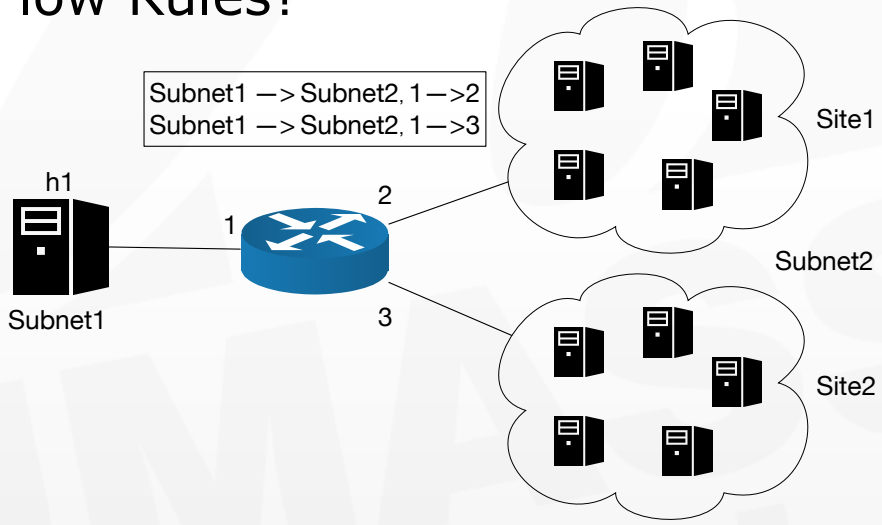
Motivation

- Question 1: How Can We Speedup the Service Delivery Process for an End User's Request?
  - An OpenFlow switch functions as a Layer 2 firewall
  - User must request access from admin for a network resource
  - The user-admin interaction is inefficient and rely on network admins manual work

- Solution
  - We propose a policy engine that enables network users and network admins to work in a time-efficient manner
  - The user can receive an immediate response to their request, depending on whether the request complies with a predefined set of criteria, i.e. a white list

Motivation

- Question 2: Why Not Use OpenFlow Rules?
  - Course-grained
    - Routing conflicts may occur
  - Fine-grained
    - Memory resource limitation
    - Lookup time increases



- Solution
  - A white list is necessary and only necessary flow rules will be installed in the switch later
  - We design a module in our policy engine to check flow conflict dynamically

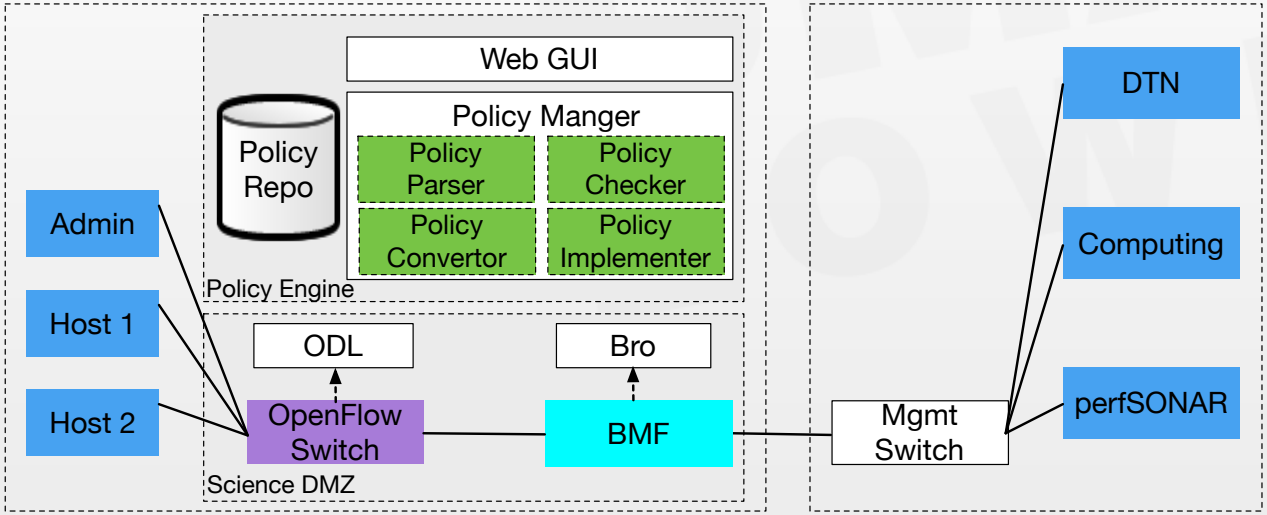
Motivation

- Question 3: How Can We Map an End User's Request to a Set of Network Rules?
  - An end user typically has no prior knowledge regarding network operation and network hardware configurations
  - Simply submit a network resource request and have the system determine the necessary optimal path

- Solution
  - We provide a set of policy rules to help express the user's intention
  - We design a policy manager inside a policy engine in order to parse the intentions from users as well as to generate the final set of OpenFlow rules

Design

- Policy Engine
  - Web GUI: create & implement policy rules & check results
  - Policy Manager: receive policies, parse the policies, check for conflicts, determine the shortest forwarding paths, generate the necessary OpenFlow rules, and store the rules to the policy repository
  - Policy Repo
    - WL: predefined permitted paths by network admins
    - Flow array: paths can be approved by WL as well as flow info
    - Pending array: paths not allowed by WL



Design

- Policy Rule
  - Intuitive while expressive

Keywords	Value
Src _IP	IP address of the end host
Dst_IP	IP address of network resource
Flow_OP	install, remove

  - Use cases:
    - User1 requests to have access to DTN from host1
    - Admin1 requests to have access to perfSONAR2 from perfSONAR1
    - Admin2 requests to remove user1's request

User1:
Src_IP: 10.0.0.1,
Dst_IP: 10.0.0.240,
Flow_OP: install

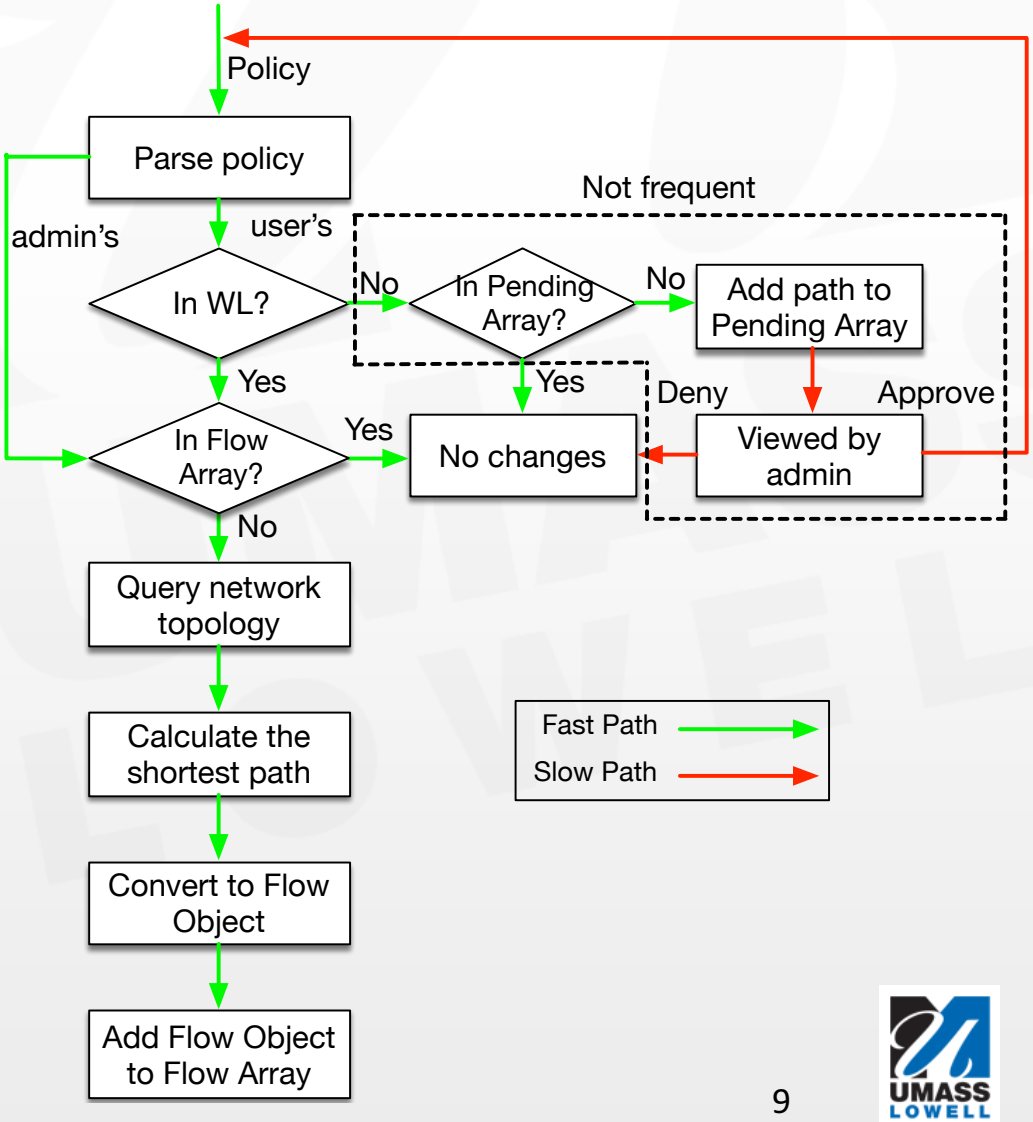
Admin1:
Src_IP: 10.0.0.200,
Dst_IP: 10.0.0.201,
Flow_OP: install

Admin2:
Src_IP: 10.0.0.1,
Dst_IP: 10.0.0.240,
Flow_OP: remove

Design

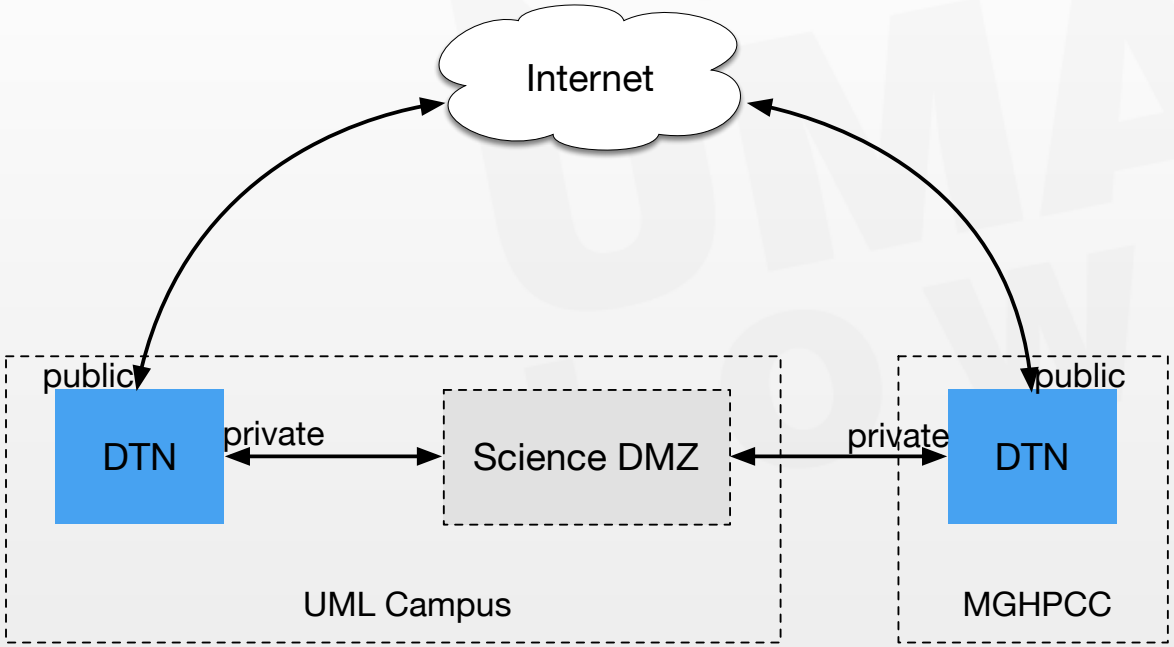
- Policy Manager Workflow

- Goals:
  - Reduce human intervention as much as we can.
    - Full automation for end user
    - The only manual step for admin is dealing with pending paths
  - Automatic path configuration calculation
  - Automatic conversion from policies to OpenFlow rules.



Evaluation

- Scenario 1
  - Evaluate the network performance to illustrate the advantages of the Science DMZ infrastructure
    - Compare **latency** & **throughput** on private & public network



Evaluation

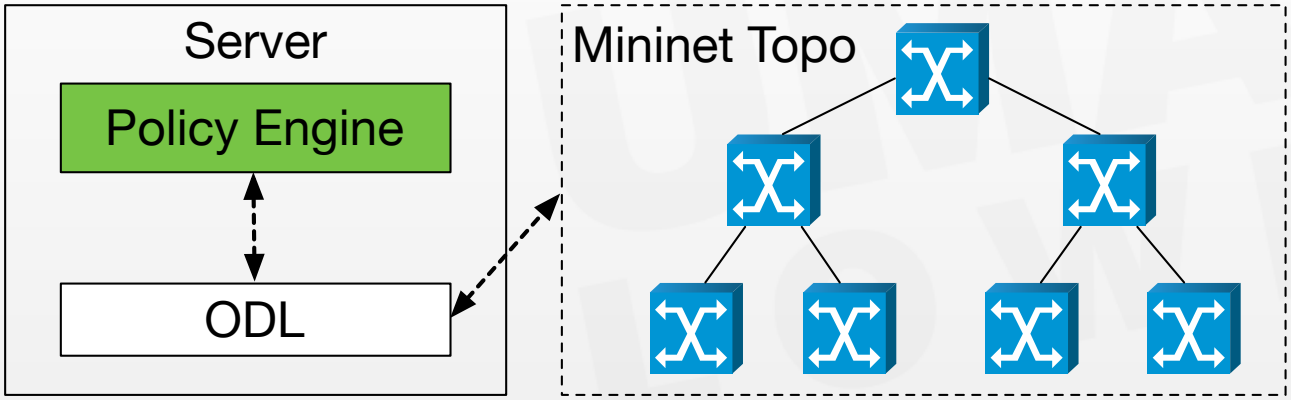
- Latency (RTT)
  - Public network w/o Science DMZ: 5.424ms
  - Private w/ Science DMZ: 3.483ms

- Throughput

Tool	w/DMZ	File Size	Parallelism	Ave Throughput
iperf	No	N/A	4	95.6 Mbps
iperf	Yes	N/A	4	9.40 Gbps
FDT	No	10 GB	1	91.605 Mbps
FDT	Yes	10 GB	1	6.681 Gbps
FDT	No	10 GB	4	91.792 Mbps
FDT	Yes	10 GB	4	9.191 Gbps

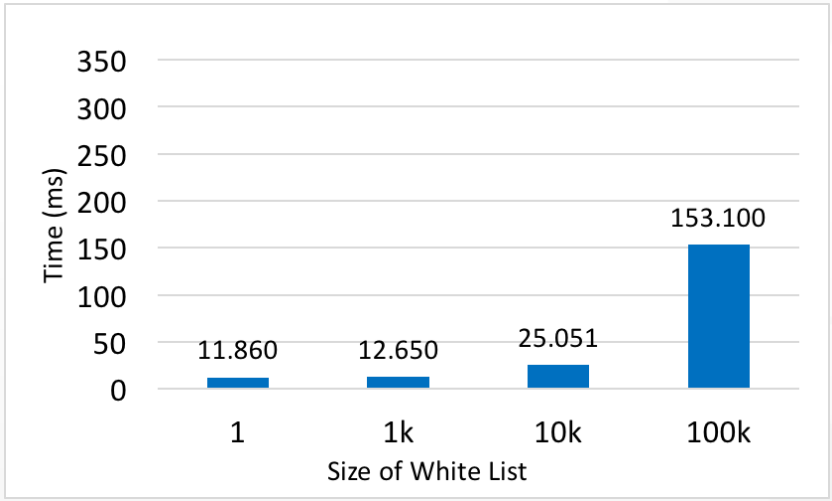
Evaluation

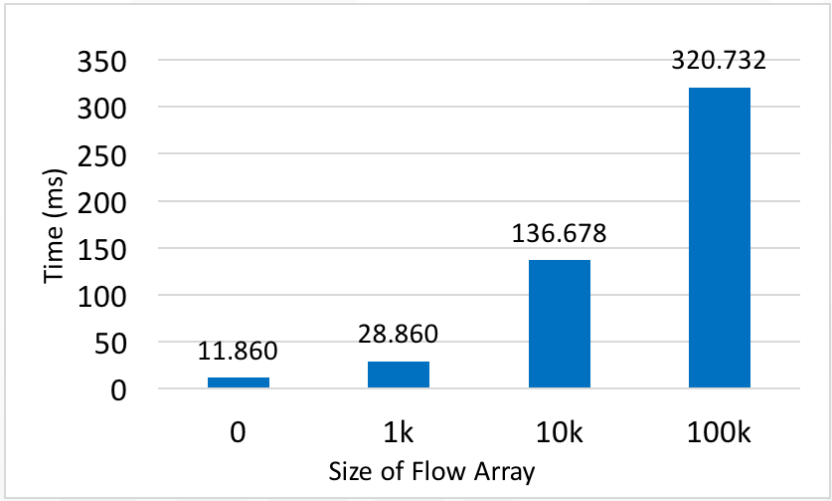
- Scenario 2
  - Evaluate the performance and overhead of the policy manager
    - **Policy manager response time** with different size of white list, Flow array and number of switches

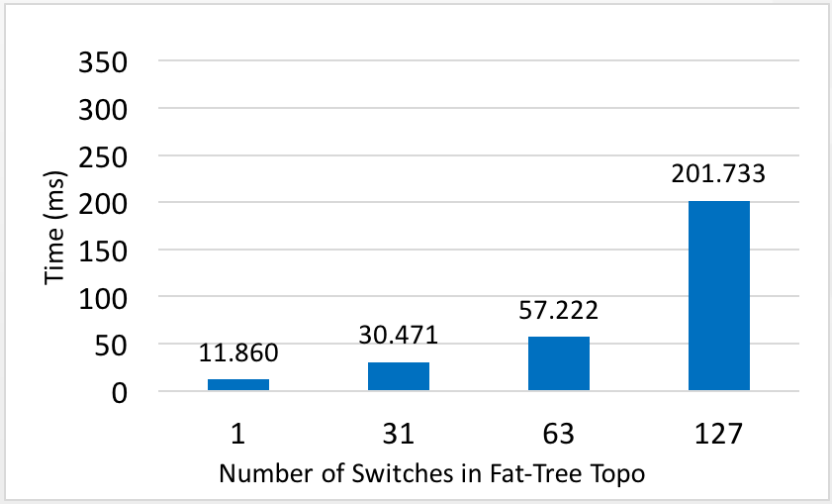


Evaluation

- Policy Manager Response Time







- Worst Case
  - 100k entries in WL and Flow array, 7-layer fat-tree topology
  - Time: 619.561 ms
- Good Scalability
- Immediately respond to a user's request

Conclusion

- FLowell Science DMZ infrastructure
  - Accelerate large-volume data transfers
    - Reduce latency from 5.4 ms to 3.5 ms
    - Increase throughput from 91.8 Mbps to 9.2 Gbps
- Policy engine on top of the network control plane
  - Enables network users to submit demands for network resources
  - User to administrator interactions are simplified and can be finished in 1 second
  - Enable network admins to manage the data paths within the network

Questions?