Software Defined Networking Lab Initiatives

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Agenda

- Introductions
- Marist SDN Lab Overview
- SDN Objectives
- SDN Achievements
- Dynamic Infrastructure
- Project Objectives
- Questions and Answers

MARIST

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Academic/Research

Robert M. Cannistra

Faculty Lead

Ryan Flaherty

Graduate Computer Science Student

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Undergraduate Information Technology Student

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Undergraduate Computer Science Student

Kevin Pietrow

Undergraduate Computer Science Student

Ryan Wallner

Undergraduate Information Technology Student

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Joint Study Project Manager

Casimer DeCusatis

IBM Distinguished Engineer

Marist / IBM Joint Study Relationship

- *A Unique Research Partnership with IBM*
- Marist / IBM Partnership supports students of all disciplines throughout their academic career.
- Marist participates in the IBM Value Chain as both a contributor and as a consumer.
  - Research
  - Teaching and Learning
  - Scalability of Operations and efficiency
- Original research projects started in 1988
  - Provide Leadership, Guidance, and Support to the IBM Academic Initiative through course development, faculty training, faculty research which allows students and faculty access to IBM hardware and software worldwide, and adds to community development.
- Marist College Software-Defined Networking (SDN) Lab
  - Funded by IBM STG University Alliance team faculty grants
    - Kicked off in 4Q11, Funded through YE 2013 ($100 K +)

Marist / IBM Joint Study – Initial SDN Project Objectives

- Compliment IBM software-defined networking research & development
  - Established SDN development lab with IBM System Networking switches
  - Marist contributions to OpenFlow distro, open source tools community
  - Industry “First use” cases
  - Research papers & presentations
- Establish a pipeline of skilled students
  - IBM plans to hire joint study students from Marist this year
  - Interest from vendors such as ADVA, BigSwitch, and EMC in Marist networking internships
  - Student exposure to IBM Somers & Academy of Technology, external conferences…
- Form partnerships with other organizations, companies, and clients

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SDN Project Accomplishments

- September 2012: Marist team received *first place award, IBM Tech Connect;* invited to present at IBM Academy of Technology, Northeast Affiliates meeting, Somers
- Avior (authored by student Jason Parraga)
- *Port Down Reconciliation* solution (authored by student Jason Parraga and Ryan Flaherty) will be released as part of next version of Floodlight
- Quality of Service (authored by student Ryan Wallner) will be available as part of a future release
- Numerous presentations by faculty and student team to conferences, user groups, and online webinars/tutorials
- Collaboratively authored papers submitted and accepted to various conferences such as: IEEE International Conference on Communications 2013

SDN/System Networking Certification Testing Lab

Marist SDN/OpenFlow Project - Certification Testing Lab

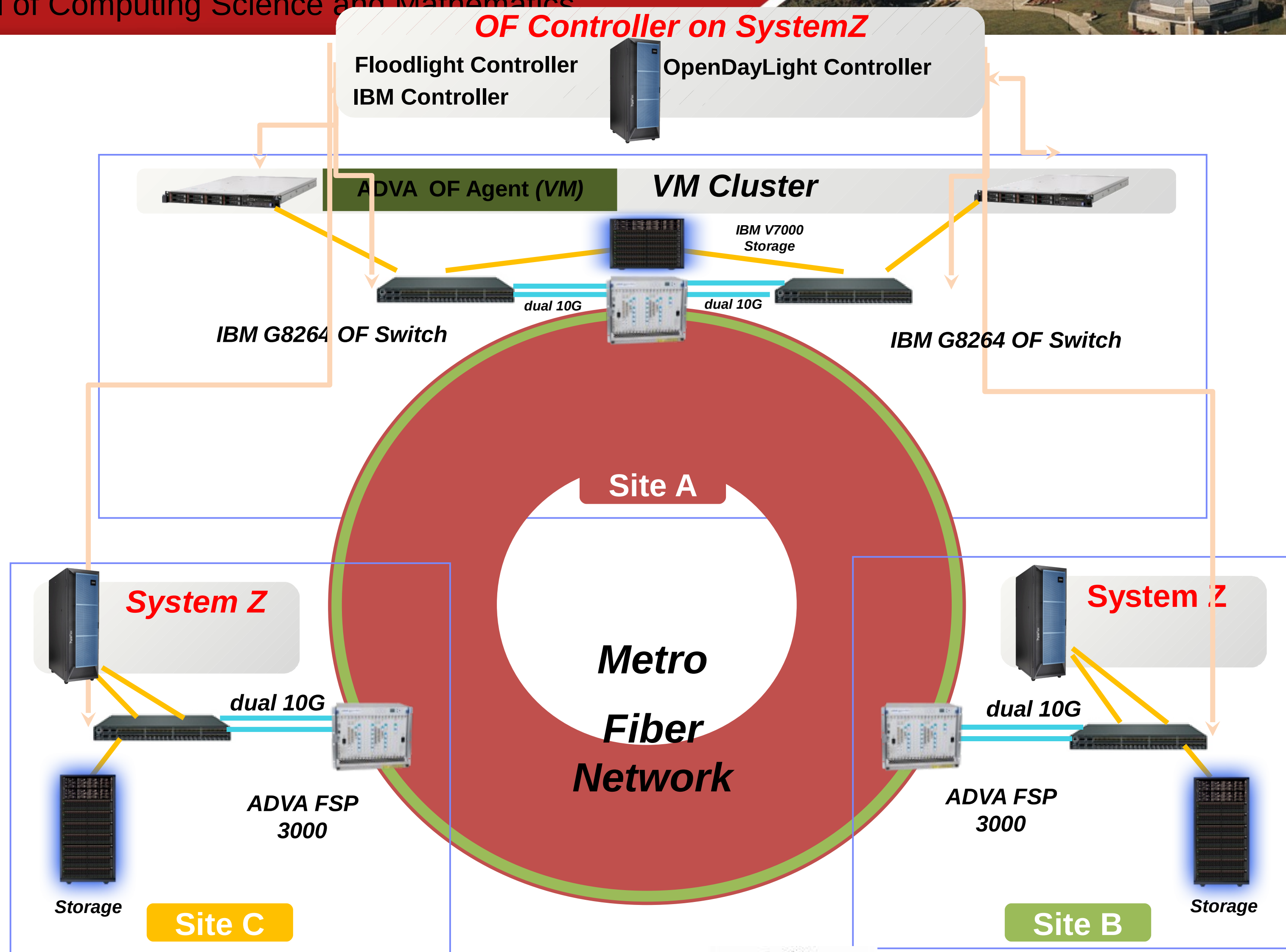
- Goal is to build a self-sustaining OpenFlow certification testing lab at Marist
- Funding provided by IBM STG Alliance - interns, faculty research
- Will complement customer facing interop lab at IBM Poughkeepsie
- Build out of Marist testing lab underway in Hancock Enterprise Computing Research Lab (ECRL)

- Annual Membership Fee includes:
  - Client loaner equipment installed and configured and all basic functions enabled
  - Initial interoperability testing completed in Marist SDN environment, including interop testing with other lab equipment under a common SDN controller
  - Lab membership publicity, including listing on Marist website, technical conferences, white papers, marketing collateral, use of Marist lab for client briefings

- Any information pertaining to joint activities between client and Marist would be treated confidentially and only released publicly with joint consent.

N.Y. State Center for Cloud Computing & Analytics – Dynamic Infrastructure Test Bed with IBM System Z

School of Computing Science and Mathematics



Avior

- Avior is an application built outside of floodlight that provides a graphical user interface for network monitoring and testing.
- Avior eliminates the dependency on using python scripts or viewing the restAPI in order to monitor or manipulate the network.
- Avior supports the following features:
  - Static flow entry pusher interface. Add, modify, and delete flows easily
  - Useful error checking and flow verification
  - Detailed controller, switch, device, port, and flow statistics that update in real time
  - Easy to use Logical patch panel
- Real World Use
  - Coraid Demo at VMWorld 2012
  - Arista Networks
  - OpenFlow researchers from across the world

What Problem Does Avior Address?

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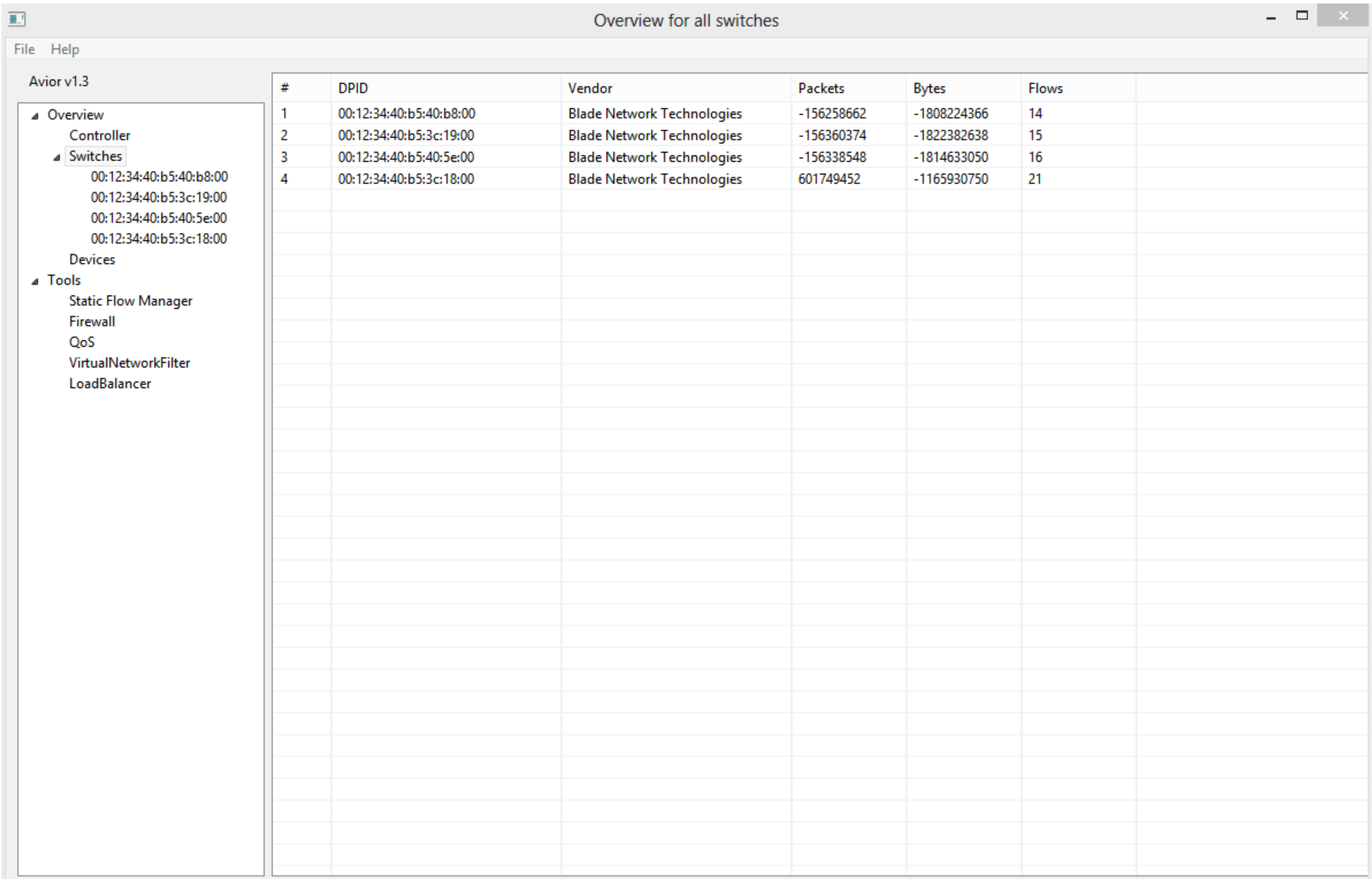
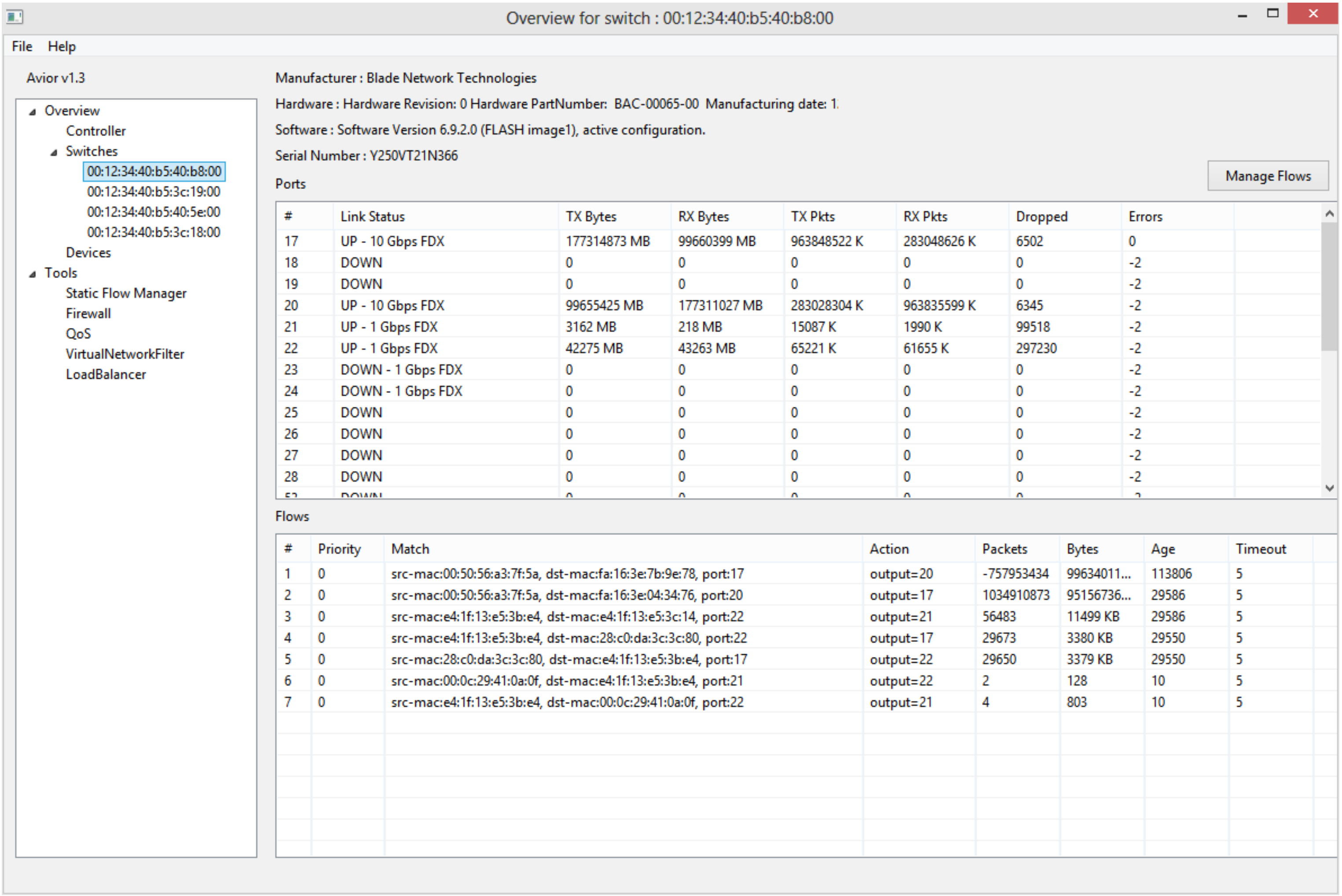
Avior – Overview for all Switches



Avior – Detailed Switch View



Overview for switch : 00:12:34:40:b5:40:b8:00

File Help

Avior v1.3

- Overview
  - Controller
  - Switches
    - 00:12:34:40:b5:40:b8:00
    - 00:12:34:40:b5:3c:19:00
    - 00:12:34:40:b5:40:5e:00
    - 00:12:34:40:b5:3c:18:00
  - Devices
- Tools
  - Static Flow Manager
  - Firewall
  - QoS
  - VirtualNetworkFilter
  - LoadBalancer

Manufacturer : Blade Network Technologies

Hardware : Hardware Revision: 0 Hardware PartNumber: BAC-00065-00 Manufacturing date: 1

Software : Software Version 6.9.2.0 (FLASH image1), active configuration.

Serial Number : Y250VT21N366

Manage Flows

Ports

#	Link Status	TX Bytes	RX Bytes	TX Pkts	RX Pkts	Dropped	Errors
17	UP - 10 Gbps FDX	177314873 MB	99660399 MB	963848522 K	283048626 K	6502	0
18	DOWN	0	0	0	0	0	-2
19	DOWN	0	0	0	0	0	-2
20	UP - 10 Gbps FDX	99655425 MB	177311027 MB	283028304 K	963835599 K	6345	-2
21	UP - 1 Gbps FDX	3162 MB	218 MB	15087 K	1990 K	99518	-2
22	UP - 1 Gbps FDX	42275 MB	43263 MB	65221 K	61655 K	297230	-2
23	DOWN - 1 Gbps FDX	0	0	0	0	0	-2
24	DOWN - 1 Gbps FDX	0	0	0	0	0	-2
25	DOWN	0	0	0	0	0	-2
26	DOWN	0	0	0	0	0	-2
27	DOWN	0	0	0	0	0	-2
28	DOWN	0	0	0	0	0	-2

Flows

#	Priority	Match	Action	Packets	Bytes	Age	Timeout
1	0	src-mac:00:50:56:a3:7f:5a, dst-mac:fa:16:3e:7b:9e:78, port:17	output=20	-757953434	99634011...	113806	5
2	0	src-mac:00:50:56:a3:7f:5a, dst-mac:fa:16:3e:04:34:76, port:20	output=17	1034910873	95156736...	29586	5
3	0	src-mac:e4:1f:13:e5:3b:e4, dst-mac:e4:1f:13:e5:3c:14, port:22	output=21	56483	11499 KB	29586	5
4	0	src-mac:e4:1f:13:e5:3b:e4, dst-mac:28:c0:da:3c:3c:80, port:22	output=17	29673	3380 KB	29550	5
5	0	src-mac:28:c0:da:3c:3c:80, dst-mac:e4:1f:13:e5:3b:e4, port:17	output=22	29650	3379 KB	29550	5
6	0	src-mac:00:0c:29:41:0a:0f, dst-mac:e4:1f:13:e5:3b:e4, port:21	output=22	2	128	10	5
7	0	src-mac:e4:1f:13:e5:3b:e4, dst-mac:00:0c:29:41:0a:0f, port:22	output=21	4	803	10	5

Avior – Device View

Overview for switch : 00:12:34:40:b5:40:b8:00

File Help

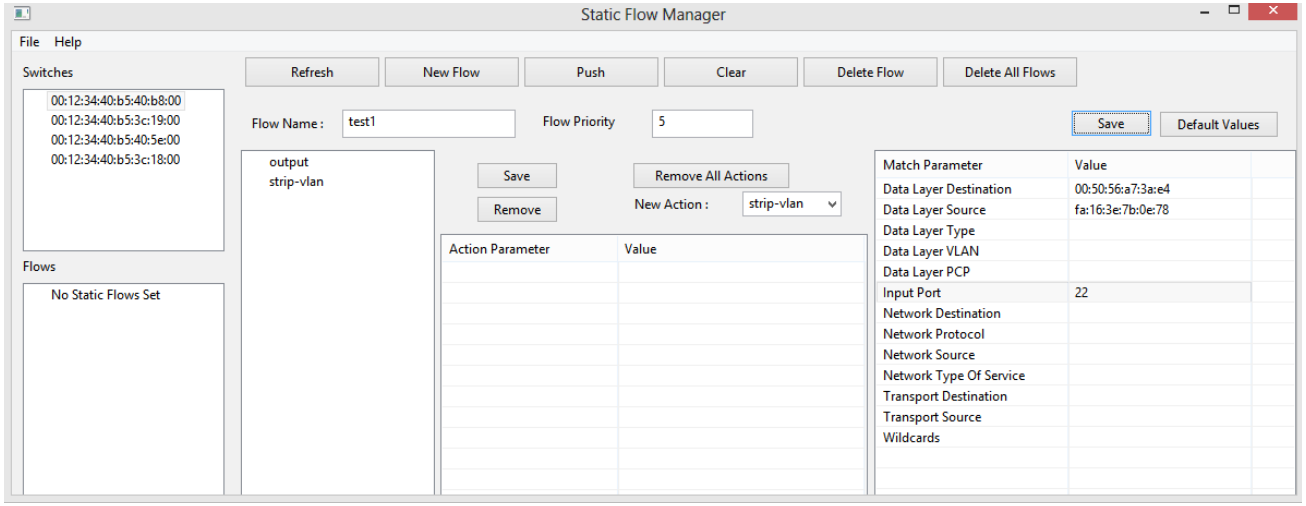
Avior v1.3

- Overview
  - Controller
  - Switches
    - 00:12:34:40:b5:40:b8:00
    - 00:12:34:40:b5:3c:19:00
    - 00:12:34:40:b5:40:5e:00
    - 00:12:34:40:b5:3c:18:00
  - Devices
- Tools
  - Static Flow Manager
  - Firewall
  - QoS
  - VirtualNetworkFilter
  - LoadBalancer

#	MAC	IP	Attached Switch	Switch Port	Last Seen
1	00:50:56:a7:3a:e4	10.11.18.55	00:12:34:40:b5:3c:18:00	22	Tue Mar 12 21:35:26 EDT 2013
2	fa:16:3e:7b:9e:78	None	00:12:34:40:b5:40:5e:00	22	Tue Mar 12 21:35:33 EDT 2013
3	00:50:56:a3:02:59	None	00:12:34:40:b5:40:5e:00	21	Tue Mar 12 21:35:53 EDT 2013
4	00:50:56:a7:2e:80	10.11.18.52	00:12:34:40:b5:3c:18:00	22	Tue Mar 12 21:36:10 EDT 2013
5	00:50:56:a7:45:6c	None	00:12:34:40:b5:40:b8:00	22	Tue Mar 12 21:35:23 EDT 2013
6	00:50:56:a3:02:5b	None	00:12:34:40:b5:40:5e:00	21	Tue Mar 12 21:35:53 EDT 2013
7	00:50:56:a7:45:6b	192.168.251.251	00:12:34:40:b5:40:b8:00	22	Tue Mar 12 21:36:13 EDT 2013
8	00:0c:29:41:0a:0f	10.11.18.50	00:12:34:40:b5:40:b8:00	21	Tue Mar 12 21:35:14 EDT 2013
9	00:50:56:a7:45:6a	None	00:12:34:40:b5:3c:18:00	22	Tue Mar 12 21:35:24 EDT 2013
10	00:50:56:a3:02:5e	None	00:12:34:40:b5:3c:19:00	21	Tue Mar 12 21:35:53 EDT 2013
11	e4:1f:13:e5:3b:90	10.11.18.103	00:12:34:40:b5:40:5e:00	22	Tue Mar 12 21:35:56 EDT 2013
12	00:50:56:a3:02:60	None	00:12:34:40:b5:3c:19:00	22	Tue Mar 12 21:35:53 EDT 2013
13	00:50:56:a3:7f:5a	10.11.18.200	00:12:34:40:b5:40:5e:00	22	Tue Mar 12 21:35:53 EDT 2013
14	00:50:56:a7:07:ff	10.11.18.53	00:12:34:40:b5:3c:18:00	21	Tue Mar 12 21:35:52 EDT 2013
15	00:50:56:a7:32:a3	10.11.18.51	00:12:34:40:b5:40:b8:00	22	Tue Mar 12 21:36:10 EDT 2013
16	fa:16:3e:c2:a3:1e	None	00:12:34:40:b5:40:5e:00	22	Tue Mar 12 21:35:14 EDT 2013
17	fa:16:3e:fd:f2:a9	None	00:12:34:40:b5:40:5e:00	22	Tue Mar 12 21:36:09 EDT 2013
18	00:50:56:a7:48:fd	10.11.18.99	00:12:34:40:b5:40:b8:00	21	Tue Mar 12 21:35:53 EDT 2013
19	00:50:56:a7:3a:c8	None	00:12:34:40:b5:3c:18:00	21	Tue Mar 12 21:35:23 EDT 2013
20	e4:1f:13:e5:3b:e4	10.11.18.101	00:12:34:40:b5:40:b8:00	22	Tue Mar 12 21:36:05 EDT 2013
21	fa:16:3e:04:34:76	None	00:12:34:40:b5:40:5e:00	22	Tue Mar 12 21:35:36 EDT 2013
22	e4:1f:13:e5:3e:c4	10.11.18.104	00:12:34:40:b5:40:5e:00	21	Tue Mar 12 21:35:51 EDT 2013
23	e4:1f:13:e5:3c:14	10.11.18.102	00:12:34:40:b5:3c:18:00	21	Tue Mar 12 21:36:13 EDT 2013
24	28:c0:da:3c:3c:80	10.11.18.1	00:12:34:40:b5:3c:18:00	18	Tue Mar 12 21:35:56 EDT 2013

Static Flows

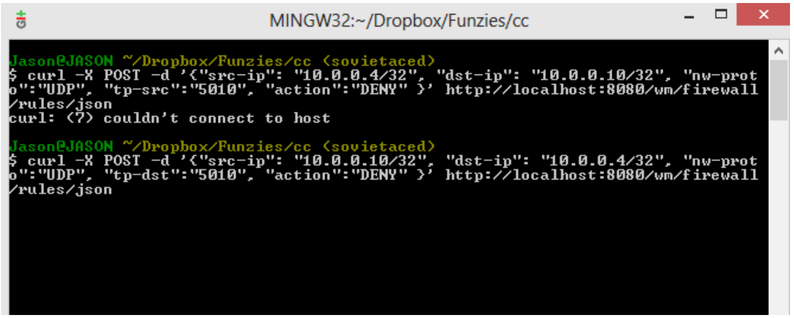
Avior: Static Flow Manager



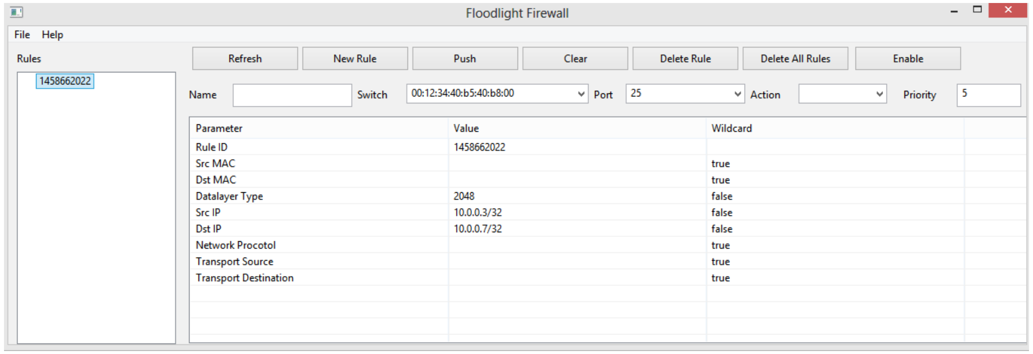
Firewall

- Enforces behavior with flows against proactive Firewall rules
  - Allow - Normal forwarding
  - Deny - Drop Flow (No action)

BEFORE



AFTER



Avior’s Future

Avior is now being redeveloped into a web application

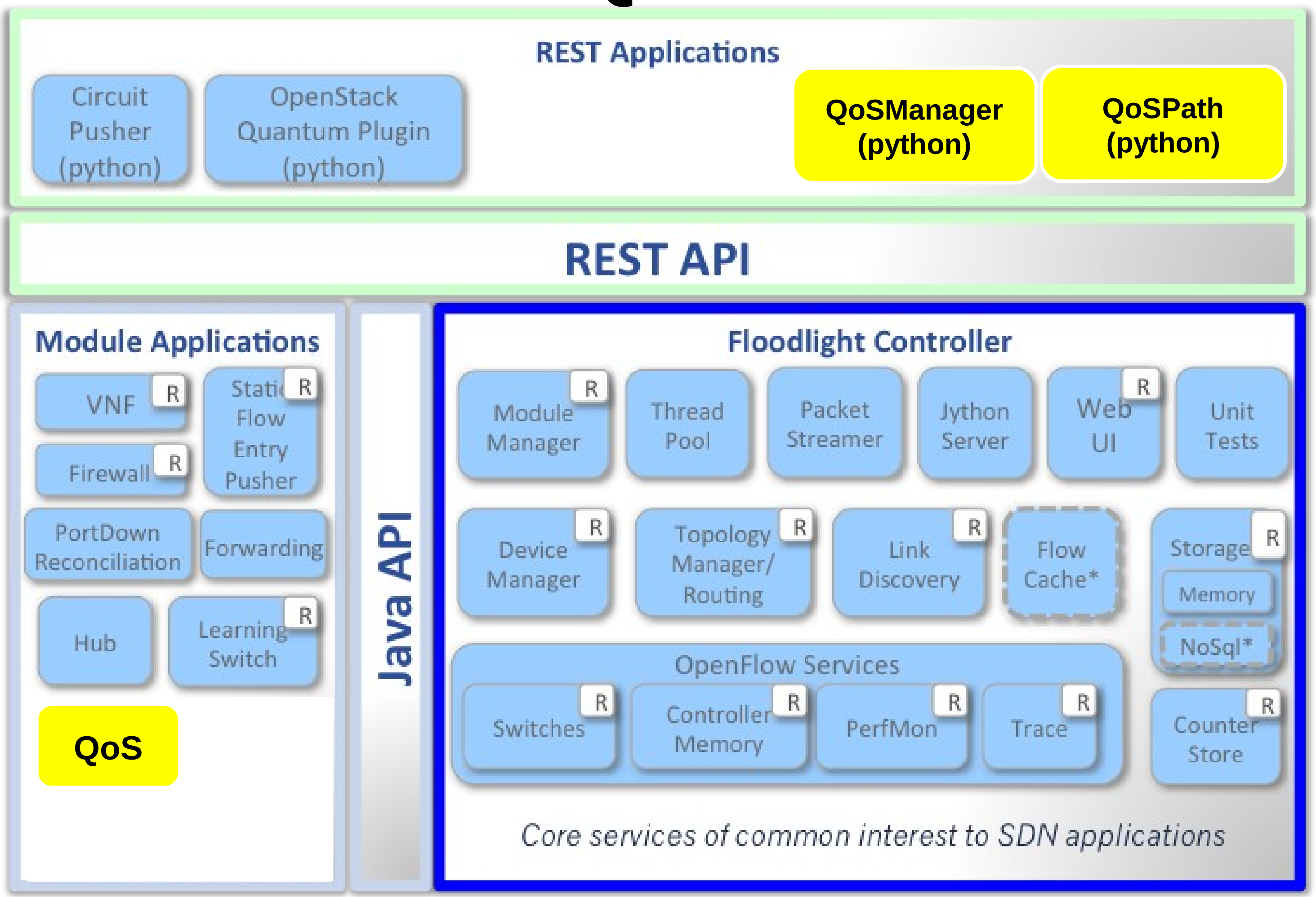
This will allow for access by smart phones, tablets, and other devices

Expand and promote functionality

QoS Module

- Provide a way to Manage, Apply, and Monitor QoS flows within an OpenFlow enabled network.
- OF 1.0 Support
- Functions:
  - Enable, Disable, View, Add(create), Delete, Modify
- Features:
  - QoS Path: Rate-Limiting circuits(paths) within a cluster of OF nodes.
- Highly dependent on underlay network, Queues/DiffServ policies must exist in switches prior to implementation. (*ovs-add-queues.py*, currently does this in our example)
  - OF-Config aims to solve this, module can setup and tear down queues and QoS setting in the switch on the creation/deletion of policies.

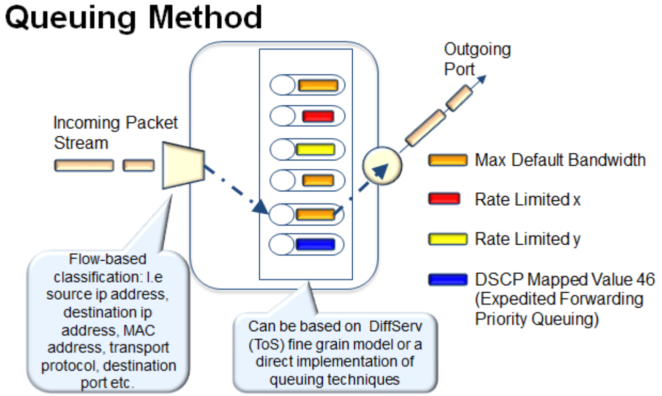
QoS



* Interfaces defined only & not implemented: FlowCache, NoSql

QoS

- Dependent on Physical/Underlay Network
- OpenFlow 1.0 *(QoS Module Supports)*
  - Queues
  - ToS (DiffServ Model)

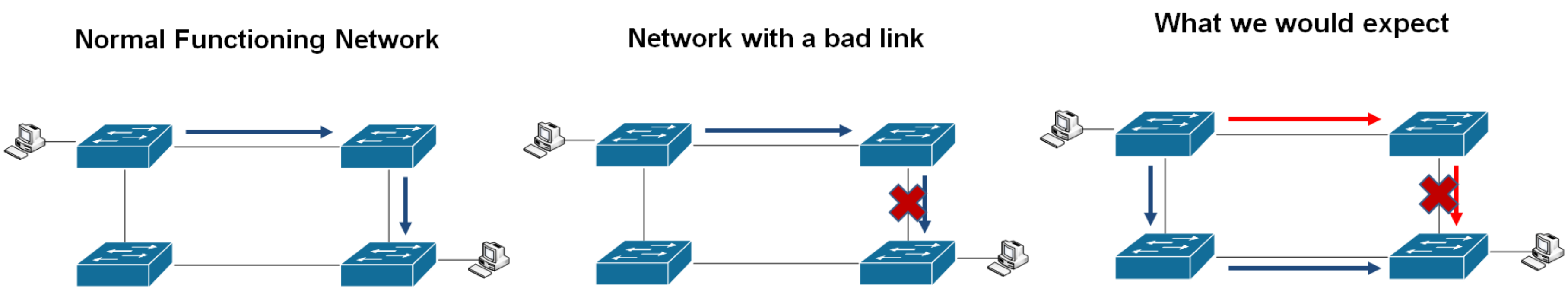


- OpenFlow 1.3
  - Meter Tables
  - Hybrid Traditional L2/L3 QoS processing

Video Tutorial: http://youtu.be/Appirzk42QU

Port Down Reconciliation

- Handling link failure with the floodlight controller
- When a link fails, floodlight doesn't do anything.
  - Data is lost when the link failure occurs.
- What does happen?
  - We found out while doing network convergence tests.



Controller Failover with IBM G8264

- OpenFlow 1.0 does not have a way to use multiple controllers with a single switch.
- The G8264 does have a way to use a list of backup controllers however.
- We tested the time to recovery after a controller failure and got some interesting results.

Controller Failover with IBM G8264

- Interesting results:
  - It takes 7.265 seconds from controller failure to when the secondary controller takes over.
  - But it takes only 0.2 seconds to fail from secondary.
- Why?
  - Controllers are tried in *sequence* and only after the hello timeout passes is the next controller attempted.
- Additional *Interesting* results:
  - During this failure, the network is *mostly* functional
  - Afterwards all flows are deleted
  - Network is fully functional after that

Host Aware Networking Module

Objective: Provide real-time intelligence to the software-defined network using SDN techniques and distributed-monitoring.

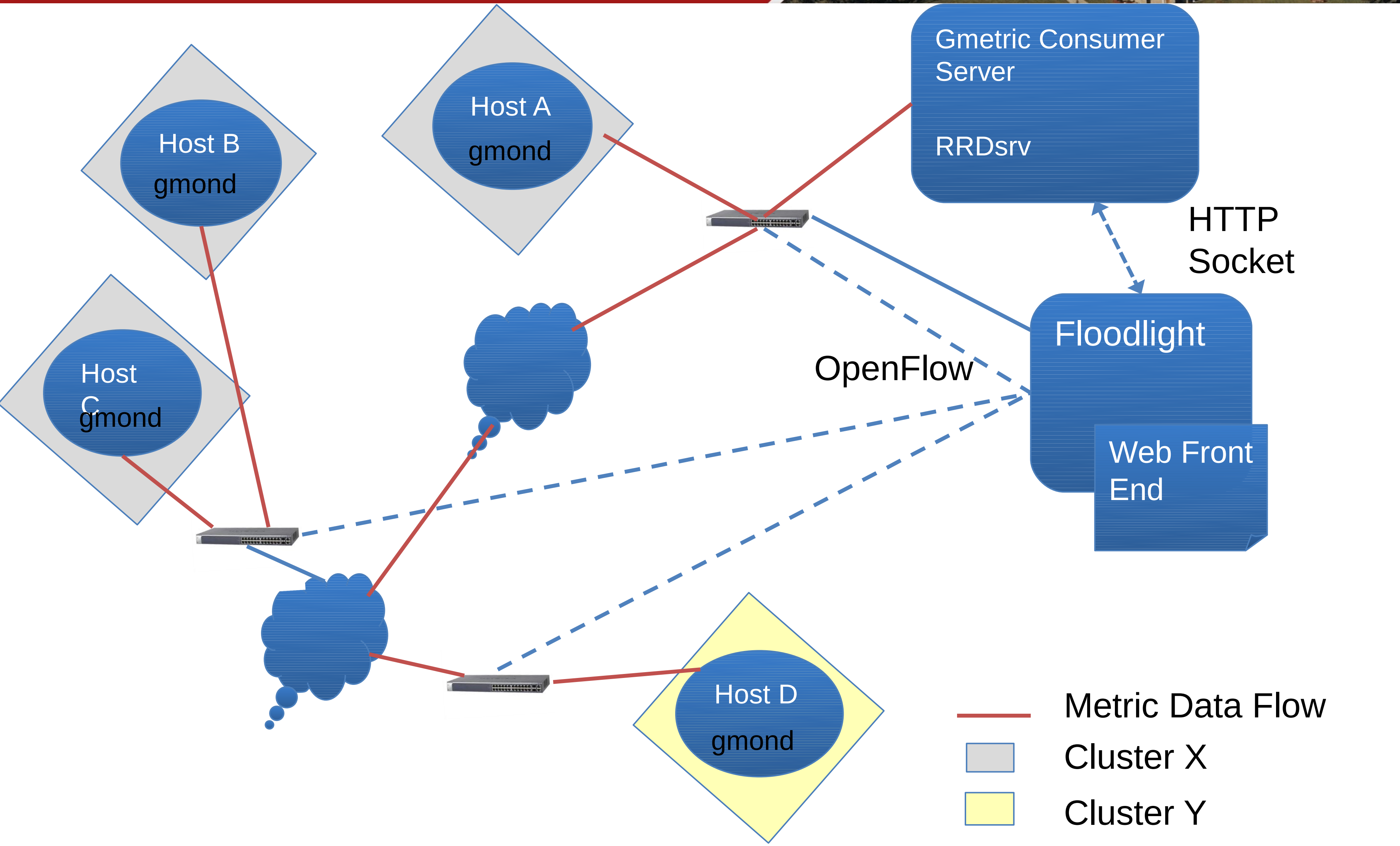
Provide a rule such as…

- If metric A is greater than / less than B% , do C

<u>Example:</u> “*If RAM on host A in Cluster X is > 90% and Incoming network exceeds B, firewall off the host and inform administrator*.”

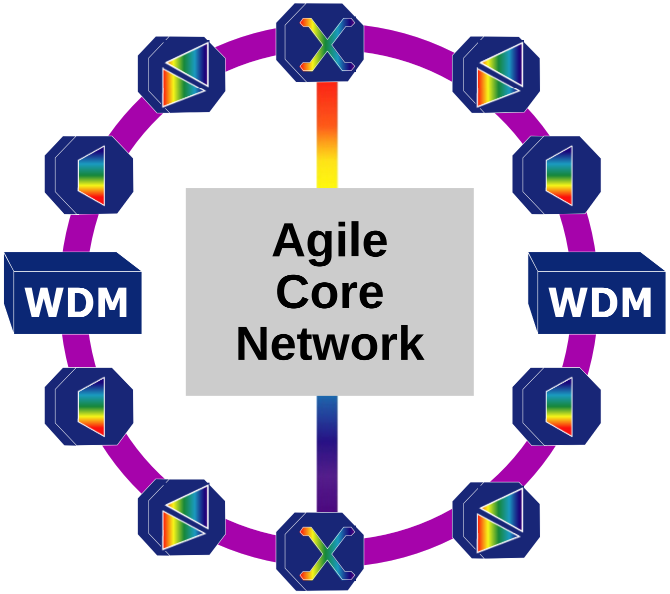
- Floodlight w/ Ganglia can monitor end host’s
    - Network Usage
    - Disk % Full
    - System Load
    - Database table size
    - Codebase Size
    - Signups
    - And more, custom metrics are endless.

*Host Aware Networking Module will automatically carry out such intelligence in your network.


Gmetric Consumer Server
RRDsrv
Host B
gmond
Host A
gmond
Host C
gmond
HTTP Socket
Floodlight
OpenFlow
Web Front End
Host D
gmond
Metric Data Flow
Cluster X
Cluster Y

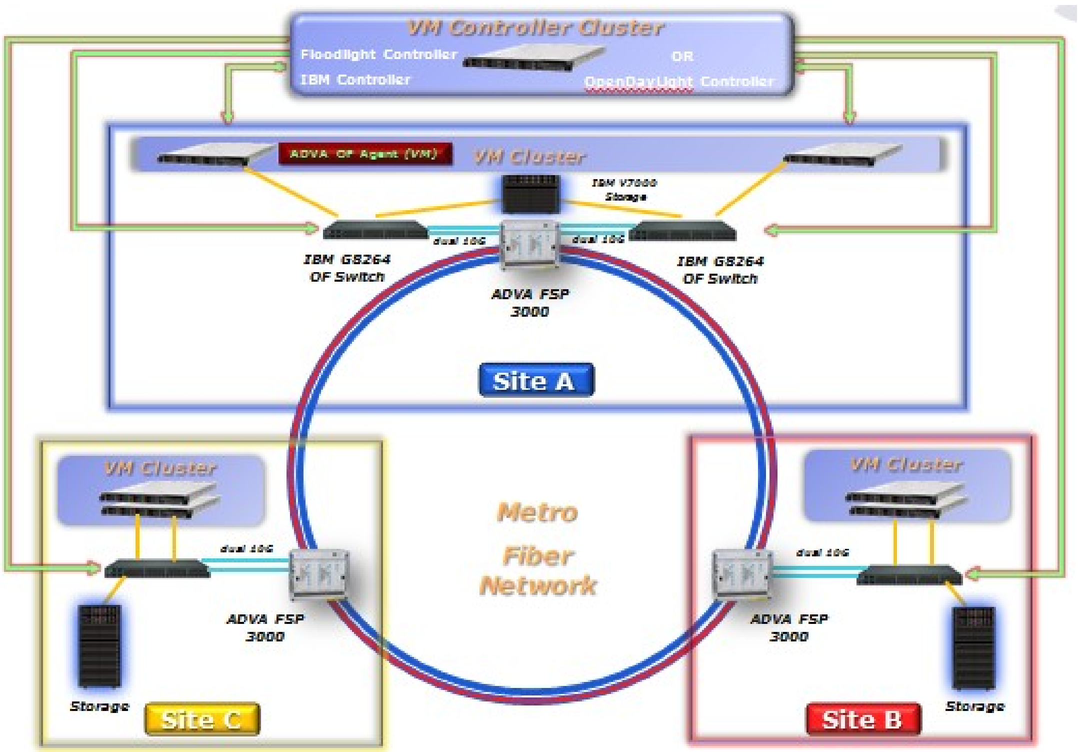
Dynamic Infrastructure

- What is it?
- What is the need?
- Abstraction…
- Orchestration…



Dynamic Infrastructure – What's Needed

- Let's build an Application Aware LAN/WAN!
  - ADVA FSP3000
  - IBM G8264
  - VM Clusters
  - Storage
  - OF Controller
    - Floodlight
    - IBM
    - OpenDaylight

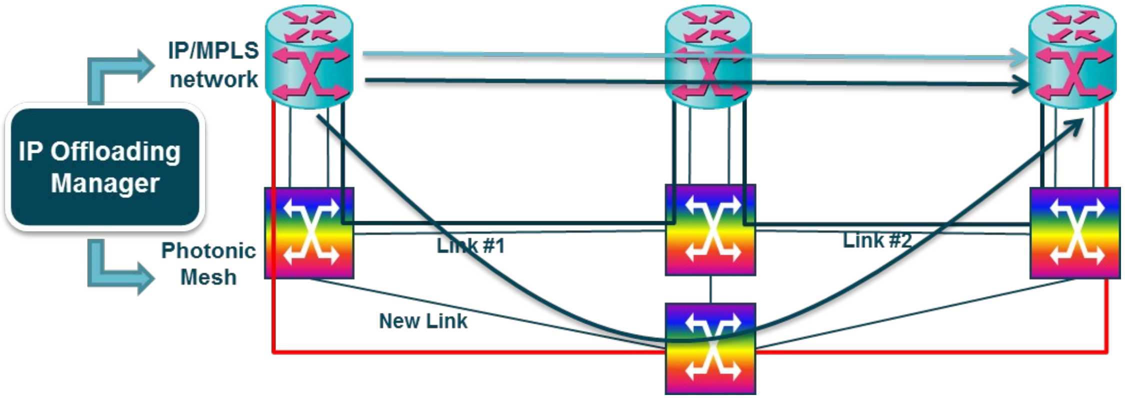


Project Objectives

1. Demonstrate basic functionality of an SDN-enabled Service Provider Network

2. Demonstrate dynamic provisioning

3. Demonstrate automation across network layers



Real World Use Cases

- Bandwidth, Bandwidth, Bandwidth…
  - How long does it take to provision a new wavelength today?
  - How long will it take with an SDN-enabled Service Provider Network?

The possibilities are endless!

Contributions and Special Thanks

Floodlight

ONF
OPEN NETWORKING FOUNDATION

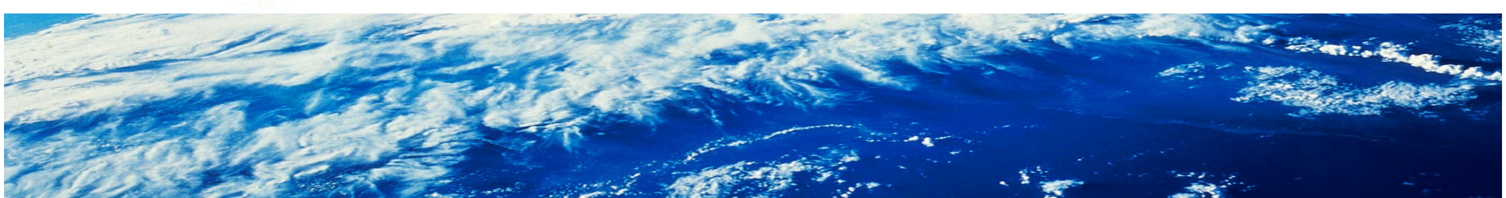
IBM

INTERNET 2

ADVA Optical Networking

OpenFlow

big switch networks




ANY QUESTIONS ?

THANK YOU for Attending!!!

Don’t forget to Attend the Openflow BoF Tonight

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