

OpenFlow Campus Trials at Indiana University Quarterly Report

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Summary

- *HP Procurve 6600 purchase*
- *Expansion of testlab with purchased and existing equipment*
- *Deployment of NOX, SNAC and Flowvisor controllers and OpenFlow VLANs*
- *Deployment of OpenFlow equipment on production switches*
- *Demo showing integration with IU GpENI cluster*

Major Accomplishments

Milestones Achieved

Equipment Purchase: *We purchased 4 HP Procurve 6600 and deployed all 4 in our Bloomington Data Center. We have connected them together in a tree using SFP+ direct connect cables*

Campus Small Deployment: *We have created a small campus deployment consisting of both testlab and production switches. The testlab has 4 HP 6600 and 1 HP 5406. We have also installed OpenFlow 0.89 on two production switches, a HP 3500 and a HP 5406. These switches are used everyday by the Network Engineering group. OpenFlow VLANs have been created on these switches and can be controlled by SNAC or any tool through a FlowVisor instance.*



HP ProCurve 6600s in Bloomington Data Center Test Lab



Bloomington Data Center

Deliverables Made

GpENI integration: We have integrated the IU GpENI cluster into the OpenFlow testlab topology. This allows researchers with access to GpENI to deploy experiments on the Planetlab or VINI servers in the GpENI cluster and integrate OpenFlow switches into the experiment. Initially we are using the fixed topology shown in the IU OpenFlow deployment figure. Once the OpenFlow Aggregate Manager is deployed is expected that a researcher would be able to reserve a sliver on the IU GpENI cluster and configure a topology of switches using OpenFlow for their experiment.

Production Deployment: Two switches used in production have been configured with OpenFlow firmware and OpenFlow VLANs. There are currently 3-4 regular users who have been switched to primary use the OpenFlow VLANs. We expect to shortly increase that number to the entire GlobalNOC Engineering team in Bloomington (~40 users) once we make some minor management VLAN changes. We also will need to expand to new switches to add that number of users.

Testlab additions: We have added the 4 HP 6600 switches in this quarter. We have also added a number of shared servers to use for load testing and other purposes. This includes 4 1U servers, with 1 capable of doing 10 Gigabit/sec tests. We also have installed 2 Xena Compact testers (<http://www.xenanetworks.com/html/xenacompact.html>) for formal load testing.

Controllers deployed: We have deployed SNAC, a separate NOX instance, OpenFlow software and a FlowVisor instance on two separate physical servers. These controllers are currently serving both the switches deployed in the testlab and in production.

Operational Tools: Create initial sample tools to allow for the management and capture of measurement data. These tools are add-ons to the Open-source Nagios and SNAPP tools. The Nagios plug-in allows administrators to receive alarms when an OpenFlow switch exceeds a set threshold. The current Nagios software allows for thresholds of flow table hit rate or total number of flow entries. We will greatly expand the options in future releases. The SNAPP add-on allows for the capture of measurement data. We are currently only storing SNMP data currently but plan on expanding the tool to use the OpenFlow protocol to query the switches and obtain data from any counter available through OpenFlow

Purchase of a Virtualization Server: We have placed an order for a Dell PowerEdge R510 to host a number of Virtual Machines in the testlab to be used

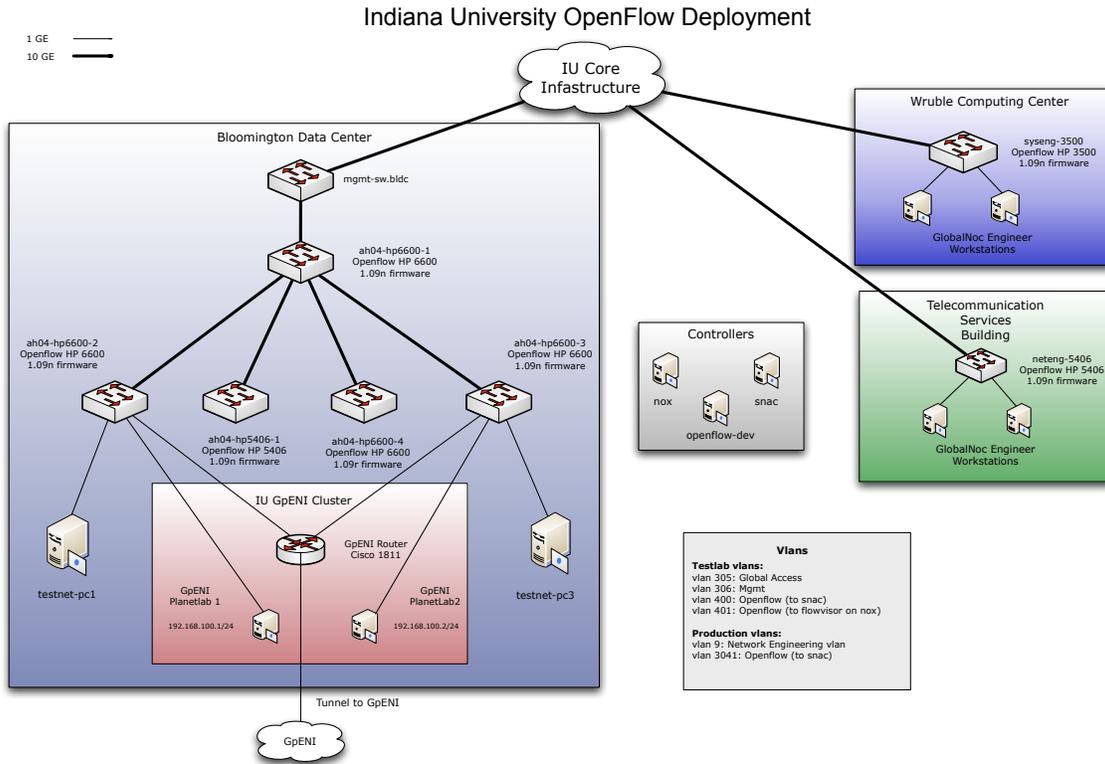
to host additional controllers, testing software or instances of openVswitch. The server is expected to arrive around April 15th

Demo: At GEC7 we create a simple test of integration of the GpENI cluster and the OpenFlow switches. We utilized two of the PlanetLab servers in the IU GpENI cluster, 3 of the HP 6600 switches in the testlab and the SNAC controller to demonstrate the construction of policy rules that would block or enable traffic between the two PlanetLab hosts. We also showed the Nagios monitoring interface and how it was monitoring all switches use in the demonstration.

Description of Work Performed During Last Quarter

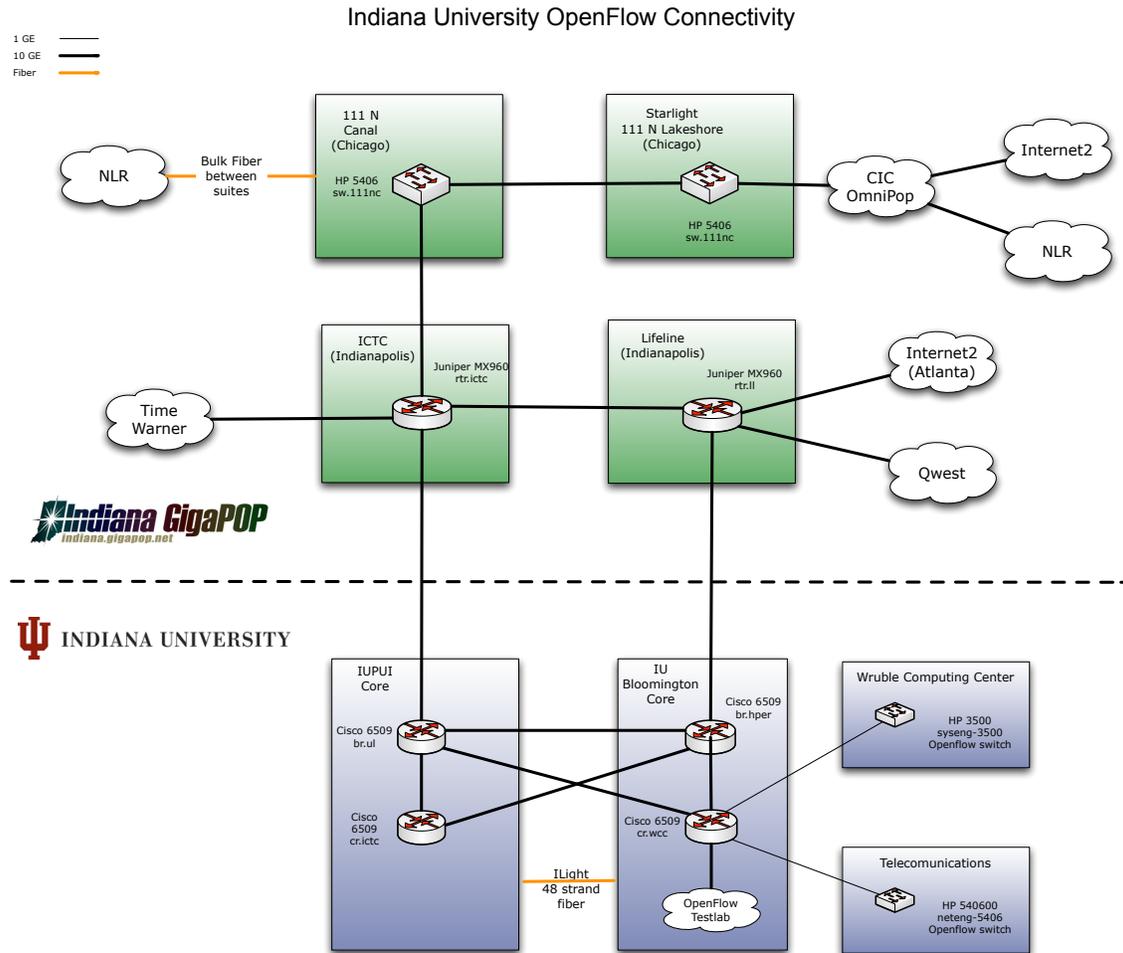
Activities and Findings

Deployments: Diagram of current hardware deployments



Wide Area Connectivity: Discussed options for connectivity to OpenFlow enabled infrastructure on the Internet2 and NLR backbones. Looking at possible ways to interconnect campus and national OpenFlow regions through dynamic

provisioning tools over the regional networks. Initially planning on getting access to the NLR infrastructure through a direct connection between the Indiana Gigapop and NLR in Chicago. A static VLAN would be plumbed through the Indiana Gigapop and the IU/IUPUI campus network back to the OpenFlow testlab. Dynamic Provisioning and /or OpenFlow enabled switches may be added to the path over time.



FutureGrid High Performance Computing: Discussions to test an OpenFlow enabled network in the IU FutureGrid project. The FutureGrid project aims to construct a testbed to study cutting-edge Grid computing architecture. Looking to find funding to purchase any few additional OpenFlow capable switches to test the use of OpenFlow as a mechanism to provide control and high capacity switching in a Grid cluster.

Project Participants

During this time, key participants in the OpenFlow campus trial included:

Christopher Small, PI
Matthew Davy, Co-PI
Ian Bobbitt
Ed Furia

Publications & Documents

Small, C. (2010, Mar 16) *Indiana University OpenFlow Campus Trials Poster*
Presented at GEC7 Demo session

http://groups.geni.net/geni/attachment/wiki/OFIU/IU_Openflow-GEC7.pdf

Small, C. (2010, Mar 17) *The Indiana University OpenFlow Campus Trials*
Presented to OpenFlow Planning Meeting at GEC7

http://groups.geni.net/geni/attachment/wiki/OFIU/GRNOC_OF_GEC7.pdf

Small, C. (2010, Mar 31) *Indiana University OpenFlow Diagram*

http://groups.geni.net/geni/attachment/wiki/OFIU/IU_Openflow_All3.pdf

Small, C. (2010, Mar 31) *Indiana University OpenFlow Connectivity Diagram*

http://groups.geni.net/geni/attachment/wiki/OFIU/IU_Openflow_connections.pdf

GENI Documents:

None

Outreach Activities

None

Collaborations

Preliminary discussions with GpENI about use of the IU OpenFlow infrastructure to test and expand the GpENI software to integrate with OpenFlow.

Worked with OpenFlow Internet 2 and NLR about possible backbone projects on possible groups to deploy hardware to be co-located in the Internet2 network.

Preliminary discussion with NetKarma project to capture provenance data. Much of the relevant data will only be available when the Aggregate manager is deployed. Integration will probably not begin until after Oct 1 2010.

Planning with GMOC to allow any measurement and status information collected by the OpenFlow campus trial to be pushed to the GMOC database.

Discussions with HP Labs about OpenFlow 1.0 and the use of Procurve One cards for use in an OpenFlow network as a distributed test device or controller. Possible use of OpenCirrus software in FutureGrid was also discussed.

Bi-weekly calls with Stanford on campus trial status and issues.

Planned Activities for 2010 Q2

Wireless Deployment: Plan on creating an OpenFlow SSID to allow user opt-in to an OpenFlow enabled network. Initial plan will be for a small local deployment in a few buildings but may be deployed campus-wide in IU Bloomington and IUPUI.

Multi-Campus deployment: Deployment of one of the HP 6600 currently in the testlab to IUPUI. A pair of Ciena Core Directors in the Bloomington Data Center and IUPUI Machine Room may provide the connectivity between campuses. One pair in the 48 pair I-Light fiber bundle between Bloomington and Indianapolis currently connects these Core Directors.

Connectivity to other networks: Connectivity to NLR OpenFlow deployment in Chicago. Use NLR Wavenet/Framenet network to reach other OpenFlow campuses and Internet2.

Additional production wired switch deployment: Deploy OpenFlow firmware on additional HP production switches. Add GlobalNOC engineers to the OpenFlow VLANs.

Test hardware: Deploy UNIX servers to allow for further testing. Additional 1U servers used for sparing may be available for test purposes. Deploy "virtualization" server.

Operational tool integration: We deploy and expand Operational tools such as the Nagios and SNAPP add-ons. Will look at additional operational tools to integrate OpenFlow support.