

## OpenFlow Campus Trials at Clemson University (1833A)

OFCLEM Project Status Report  
Period: 4/1/2010-6/30/2010

### I. Major accomplishments

The project will deploy an OpenFlow testbed on the Clemson University campus and connect with wireless mesh access points and mobile terminals. This trial will conduct OpenFlow experimentation focused on OpenFlow enabled network operation solutions as a precursor to deployment into Clemson research and production networks.

During this period, key achievements include:

- a) Completed campus deployment of six OpenFlow switches (4 HP + 2 Toroki) in three buildings.
- b) Completed functional test of OpenFlow wireless mesh network setup; currently working on resolving observed OpenFlow bottleneck, potentially due to flow table configuration issue.
- c) Completed development of a campus OpenFlow management web portal featuring up-to-date switch configuration status, performance monitoring, and automated user slices request/activation support.
- d) Campus facilities team has procured materials and scheduled fiber installation for small pilot network on one street (S. Palmetto Street in front of Fluor Daniel Building).
- e) Planned three Clemson campus demos and one cross-campus demo with Georgia Tech for GEC8.

### A. Milestones achieved

Two milestones scheduled for this reporting period have not been completed pending inter-campus connectivity to be completed:

1. OFCLEM: S2.c Install GENI software with AM API implementation (Due 04/30/10 (late))
2. OFCLEM: S2.d Begin integration testing with Stanford and BBN (Due 05/31/10 (late))

### B. Deliverables made

- a) Completed campus OpenFlow Ethernet deployment (opt-in users from two ECE labs)
- b) Completed campus OpenFlow management portal
- c) Completed OpenFlow-enabled wireless mesh network solution

## II. Description of work performed during last quarter

### A. Activities and findings

- a) Completed campus OpenFlow Ethernet deployment  
Four HP ProCurve 3500yl-48G switches and two Toroki LS4810 switches, all with OF 0.8.9 firmware, have been deployed in three ECE and CS buildings (topology can be seen at <http://openflow.clemson.edu/trac/wiki/Network>). Two more Toroki switches have been back-ordered. Three VLANs are configured on each switch and mapped consistently across the whole campus: non-OpenFlow VLAN (130.127.39.128/25), OpenFlow production VLAN (130.127.39.0/25), and OpenFlow experimental VLAN (130.127.38.0/24).
- b) Completed campus OpenFlow management portal  
The web portal is accessible to the public at <http://openflow.clemson.edu> to orient and assist new users to understand and request OpenFlow slices for experimentation. With

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admin privilege one can also access the switch configuration database, real-time and historical performance charts, and internal development resources.

### c) Completed OpenFlow-enabled wireless mesh network solution

The wireless mesh network is based on PC Engines with dual radios (one IEEE 802.11b/g, one IEEE 802.11a/b/g). The b/g radio is OpenFlow enabled and runs hostapd to accept client connections as an AP. The a/b/g (a mode used) radio runs OLSR mesh routing protocol to serve as the backbone. A layer 2 tunnel is created for each client to access the campus openflow experimental VLAN over the mesh network. The entire software configuration has been completed and end-to-end connectivity has been validated. Two remaining challenges are being investigated: 1) severe throughput loss due to potential OpenFlow flow table configuration issue, 2) outdoor connectivity is still being investigated using multiple antenna models.

## B. Project participants

The project team members are:

PI: Kuang-Ching Wang, ECE Assistant Professor

Co-PI: Jim Pepin, CTO

IT: Dan Schmiedt, Director of Network Services and Telecommunications

ECE graduate research assistants: Sajindra Pradhananga (MS), Glenn Evans (MS)

ECE undergraduate students: Bradley Collins (senior), Aaron Rosen (senior), Bob Strecansky (senior), Patrick Baxter (junior), Ryan IZard (sophomore)

## C. Publications (individual and organizational)

Not available at this time.

## D. Outreach activities

None in this reporting period.

## E. Collaborations

The project is conducted in collaboration with campuses and backbone providers on the OpenFlow trial. We have so far worked more closely with:

- a) Nick McKeown, Guru Parulkar, Guido Appenzeller and the Stanford OpenFlow group, assisting us in the acquisition, installation, configuration, and testing of OpenFlow software.

## F. Other Contributions

None in this reporting period.