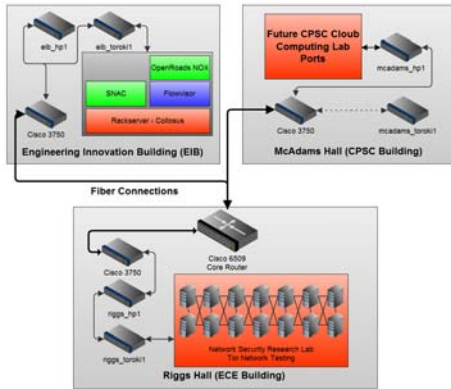


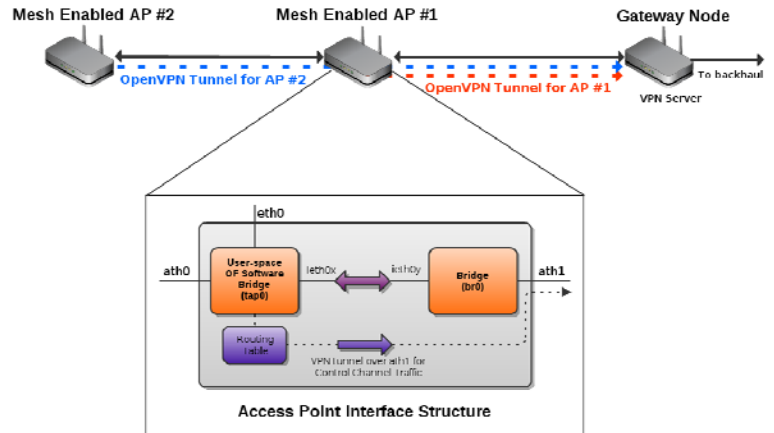
Wired Network Architecture

- 6 OpenFlow switches deployed (all running OF v. 0.8.9r2):
 - 3 HP Procurve 3500yl, 3 Toroki LS 4810
- 3 Campus buildings wired:
 - OpenFlow Research Offices / Lab (~10 computers)
 - ECE Security Lab (~15 Tor Nodes)
 - CPSC Cloud Computing Lab
- Controller Setup:
 - Production: SNAC w/ pyswitch
 - Experimental: Flowvisor w/ OpenRoads NOX (pyswitch)



Wireless Network Architecture

- 9 PC Engine APs (all running UserSpace OF v. 0.8.9r2):
 - 5 Deployed on Poles (1 Gateway, 4 Mesh)
 - 4 Used for Lab Testing (1 Gateway, 2 Mesh, 1 Testing)
- OLSR used for mesh networking (Private subnet)
- Control traffic sent over OpenVPN L2 tunnels
- Datapath traffic uses virtual interfaces to provide interconnectivity between OF and Mesh interfaces



Cross-campus Interconnectivity using OpenVPN

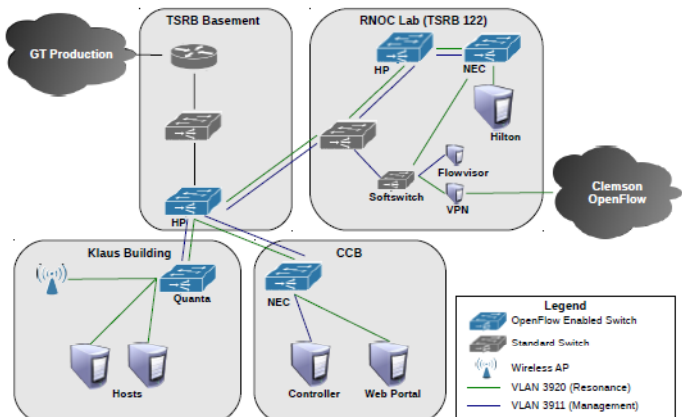
- Current Implementation:
 - GT and Clemson connect via two L2 tunnels provided by OpenVPN.
 - Each campus has publicly accessible computer that acts as both an OpenVPN client and server.
 - Bridges are configured to allow for virtual L2 connectivity from one campus to the other.

- GT Resonance System:
 - Provides GT researchers located at Clemson University the ability to securely connect via Clemson's OpenFlow network as though they were located on GT's campus.
 - Tested and verified correct operation of Resonance System for simulated GT researchers at Clemson.



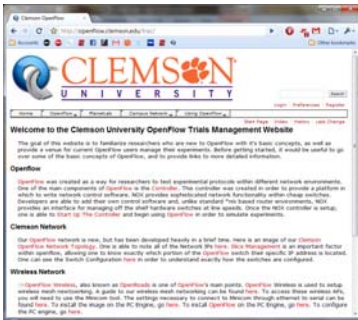
- Future Implementation:
 - Direct L2 VLAN connectivity between campuses.
 - Campus IT discussion of OpenFlow-based remote authentication.

GT Resonance Network



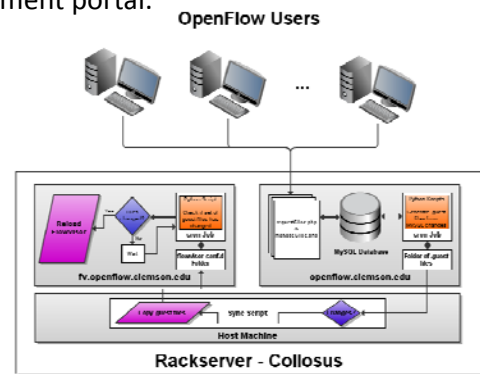
Clemson OpenFlow Website

- **Trac-based Installation:**
 - Provides wiki, ticket system, milestones, etc.
 - Allows Clemson OF users to add information and provides links to external OF knowledge bases.
 - Gives new users basic OF understanding, tutorials for NOX installation and slice creation.
 - User-facing slice management engine
 - Allows users to manage their slices (via secure page)
 - ONAP interface for network management



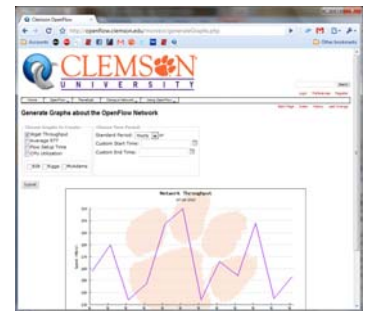
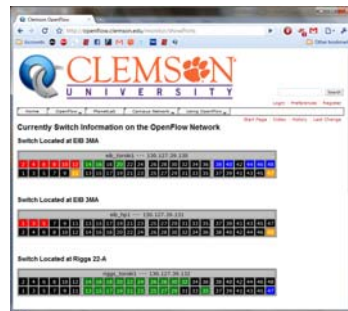
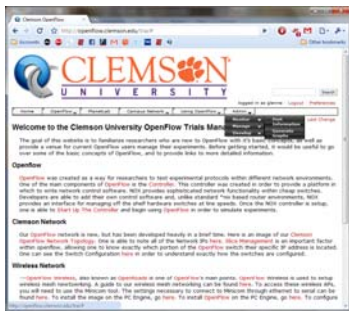
User-facing Slice Management

- **User Management Portal:**
 - Users request a slice via openflow.clemson.edu.
 - MySQL database is updated and a confirmation email is sent to the user containing a passcode.
 - Scripts on the server generate the .guest file and load it into Flowvisor (slicing via MAC address).
 - Users can later update slice information, disable the slice, or add additional computers via the user slice management portal.



OpenFlow Network Administration Portal and Features

- **ONAP Architecture:**
 - Custom PHP pages interface to MySQL database backend.
 - Administration pages are only available to authenticated users.
 - Integrates fully with Trac installation for one-stop management and information collection.
- **Administration Portal Features:**
 - Monitor Port Usage
 - Wall port to switch port mapping and VLAN association
 - Generate network performance graphs
 - Network throughput, RTT, Switch CPU Utilization, etc.
 - Manage MySQL database containing:
 - Currently running slices
 - Deployed switches with port information



Administration Portal and Examples