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Programmable Networking Experiments on GENI

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Applied Research

- A new concept in programmable networking
- Test, validate, and enable research using a real-life network
- Create benchmarking methods
- -- *future opt-in users on the product platform*
- My overlapping interest:
  - MS students: project/thesis within 2 years, hands-on experience (College of Technology), fast job placement
  - R & D lab in a university setting with GENI as a live testbed
  - Teaching Classes: network programming, network security, network management, sensor networks, *optical networks*

Teaching Network Programming

- Project assignments based on OpenVSwitch configuration examples:
  - QoS rate-limiting and sFlow congestion monitoring → active networking
  - OFConfig implementation → management vs control plane
  - Network connectivity in SDN → *define* "connectivity" in SDN vs current networking practices
  - Hop-limited flooding → implement in an OpenFlow network
  - VLANs for VMs → compare emerging SDN vs current practices

Project setup, tasks, resources

- Virtualization through VMWare Workstation in students' PCs and a computer lab
- OpenFlow tutorial with mininet
- OFConfig implementation
  - Xen server, OVS, configuration point considerations
- Network connectivity in SDN
  - Current connectivity setup vs SDN connectivity
  - Protocols involved in simple connection scenarios
- VLANs for VMs
  - Legacy VLAN setup
  - SDN steps in VLAN assignment for VMs

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ExoGENI: Experiments

- ExoGENI racks for OpenFlow-based experiments:
  - https://wiki.exogeni.net/doku.php?id=public:experimenters:start
  - Great! Bare metal and VMs are possible
  - Got to contact GPO for a user certificate – ok
- Need to modify my images to be compatible with ORCA: https://geni-orca.renci.org/trac/wiki/virtual-machines
- Intra-rack slicing: Good to know – maybe deploy on one physical location first to try how it works and then expand to WAN
- Inter-rack slicing and OpenFlow – the ultimate goal

ExoGENI: Experiments

- Inter-rack slicing and OpenFlow
  - Request my slice through Flukes: install Flukes, create my topology, and then submit the request to ExoSM
- OpenFlow and flow control:
  - Designate OpenFlow controllers to direct network traffic within the virtual network topology that makes up the slice's dataplane.
    - Allow GENI experimenters to program the OpenFlow datapaths as separate aggregates (using FOAM), with manual approval by GENI administrators.
  - From ExoGENI tutorial yesterday: create a slice with my controller and then point my (second slice) OF network to the controller in the first slice

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Programmable Network Experiments

What do I understand from programmability?

- Change, configure, provision, and manipulate network
  - Logical Topology
  - QoS
  - Path Computation and Assignment
- Based on application and service requirements
  - Against congestion
  - Security: encryption, application profiling
  - Mobility
  - VM migration
- And, resources on the network
  - Bandwidth
  - Network element resources
  - Compute resources

Experiment within virtualized lab resources FIRST

Custom VMs

Custom network devices *inline*

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Sample Experiments: Emergency Management

- Purpose: Dynamic network provisioning to enable emergency applications to experience high quality transmission
- Hypothesis: Automated application layer network provisioning will help emergency management achieve faster information retrieval
- Plan of experiment: Compare the overhead in network provisioning and setup (flow setup/push) with the time scale of a typical network-engineer initiated configuration workflow
  - Reservations: metrics for measurement are not well-defined; network provisioning on demand requires slices to have multiple paths between the same end points; management plane plays any role in this setup
- Necessary resources: VMs with applications to generate traffic in addition to emergency management app– multiple paths to choose from – OpenFlow controller - Measurements

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Sample Experiments: Programmable Network Nodes

- Purpose: Create applications that would run on actual network nodes
- Hypothesis: An application that performs TCP-SYN attack detection will be more effective than the end point counterpart
- Plan of experiment: Run various scenarios (topologies with multiple paths to the same attack destination) with attacks and detect at end point and intermediate nodes and measure the time to detection
  - Reservations: metrics for measurement are not well-defined; attacking applications may be too obvious; insert a new hardware into the GENI infrastructure for this experiment
- Necessary resources: VMs with applications to generate TCP SYN attack– deploy end point detection app for TCP SYN attack – OpenFlow controller – Measurements (to be defined as resources are allocated)

Project in collaboration with DELL and FLOW RESEARCH

Thank you!

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