Deploy International OpenFlow/SDN Testbed with Delegation and Data Awareness in Mind

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What we expect from the Testbed

• **Support nested virtualization**
  – Provide just enough functions and leave deployment choice open

• **Users can bring in their own devices: ‘alien’ controllers**

• **Offer heterogeneous network services (QoS, resiliency, virtual networks) across many providers/domains**

• **Separate resource management from provisioning**
  – Split off coordination of resource allocation on long term scale from short-term provisioning
Delegation vs. Virtualization

• Things FlowVisor can not do well:
  – Virtual topology management

  – Address Management
    • Virtualization users share the same address space without knowing the existence of other users
    • Address Management resolves collisions
Implementing virtual networks using SDN

• Requirements:
  – Provide multi-tenancy with isolation (logical and performance-based) and explicit **programmable** control
  – In order to provide performance isolation network resources must be **accountable**.
  – Provide access for **customer** controllers to virtualized infrastructure.

• Two ways
  A. Use packet header ‘shims’ not controlled by tenants to separate one tenant from the other
  B. Make the tenant explicitly aware of the label spaces they control

• The difference is the tradeoff in awareness of the infrastructure vs. privacy/simplicity
  – Delegation exposes the network resources and constraints while Virtualization hides them
  – A typically means the shim header is fixed
    • What if VLAN header is used as the shim but the user wants to work on VLANs?
  – If you can do B, you can do A
Treat it as a resource management problem

- Each connection occupies some label space that is implicitly given to it by the domain owner
- Labels, bandwidth, flow spaces are all allocatable resources
- These resources represent *volumes* in discrete spaces
- A *delegation* of these resources represents a partition of the original volume
- An owner (e.g. controller) of a volume should be able to operate on packets within it and be assured that no one else is operating within it
- An owner of a volume should be able to further partition it to create a sub-delegation
Architecture for the delegation framework
Graph Models

- Graph DB and property graphs
  - Vertex and edge attributes
  - Can be translated to RDF and vice versa
- Port mode vs. Node mode
  - Virtualization has problems – is a big virtual switch non-blocking?

User request:
need 2 labels between switches A and E vs. need 2 labels Between ports A.1 and E.1
The Problem Formulation

• **Constraints:**
  – Connectivity
  – Resource availability (labels)
  – Label translation capability
  – QoS future work: Outgoing bandwidth, Buffer space, Flow table space

• **Objectives:**
  – Label usage
  – Port usage
  – Load balance

• **ILP and heuristics**
Data Awareness in SDN (1)

• More on labels
  – Generalize VLANs, MAC addresses, IP addresses, can be MPLS labels, time slots, wavelengths, etc
  – Does not have to be contiguous: Interpretation only matters at peering points between dissimilar providers.
  – SDN does not have to have layers!

• Future Internet Architecture (FIA)
  – Data is the first citizen
  – Data grids and networks are emerging (we believe)
Data Awareness in SDN (2)

• Move compute and storage resources from edge to the core of network
  – In-network storage and processing

• Networking, storage and compute resources management should work together
Data Awareness in SDN (3)

• Taking advantages of the data awareness in SDN
  – Optimized data movement
  – Data caching/processing
  – Parallel data transfer
  – P2P-like data transfer
  – …