WAN Virtualization
Looking beyond Point to Point Circuits

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II. Network Virtualization

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Fundamental Network Abstraction: a end-to-end circuit

At all layers of the network
Wavelength, PPP, MPLS LSP, L2TP, GRE, PW …

Switching points, store and forward, transformation …

Simple, Point-to-point, Provisionable
New Network Abstraction: “WAN Virtual Switch”

WAN Virtual Switch

Simple, Multipoint, Programmable

**Configuration** abstraction:
- Expresses desired behavior
- Hides implementation on physical infrastructure

It is not only about the concept, but implementation is key
Thought experiment: Build an N-port virtual switch for a collaboration

| Universities/physics groups | Universities/physics groups | Universities/physics groups | Universities/physics groups | Universities/physics groups | Universities/physics groups | Universities/physics groups | Universities/physics groups | LHC Tier 2 Analysis Centers |

The LHC Open Network Environment (LHCONE)

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Source: Bill Johnston

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Client-driven “Flow Routing” replaces static Routing policies

Science Flow1: $A \rightarrow B$, QoS, Label
Science Flow2: $\{A, \text{VLAN X}\} \rightarrow \{C, \text{VLAN Y}\}$
Science Flow3: $A \rightarrow B, C$

Combine distributed enforcement of Routing Policy to a single logical entity
Dynamic, multiple virtual switches for Cloud and other on-demand applications

Virtual Switches can be as dynamic as your Cloud
Recursive Nature: Horizontally and Vertically
Layer-based representation

- Creation of a programmable network provisioning layer
- Sits on top of the “network OS”
SC12 Demonstration Physical Topology

DTNs: Data Transfer Nodes

Ciena 5410 @Ciena booth
SRS Brocade @SCinet
NEC IP8800 @LBL

@ANL
@BNL

OSCARS virtual circuits
Summary

Motivation

• Powerful network abstraction makes it easier for complex application and collaboration interactions
  • Files/Storage

Simplicity

• Simplicity for the end-site
  • Works with off-the-shelf, open-source controller
  • Topology simplification

• Generic code for the network provider
  • Virtual switch can be layered over optical, routed or switched network elements
  • OpenFlow support needed on edge devices only, core stays same

• Programmability for applications
  • Allows end-sites to innovate and use the WAN effectively

Architecture

• OpenFlow at the edge to start with, can upgrade the core opportunistically