February 11, 2011

2011 ORCA Connectivity

Summary

GENI's ORCA Control Framework enables automated and dynamic slicing of substrate resources for its Cluster-D members (UMass Amherst, Ohio State, Wayne State, LEARN [RICE, UH, UTA, TAMU], BEN [Duke, NCSU, UNC, RENCI]). It utilizes layer 2 FrameNet connectivity to stitch together aggregates distributed across multiple domains. Initially, the emphasis has been on establishing intra-cluster connectivity using FrameNet exclusively. With the maturity of GENI's control frameworks and their ability to interoperate, ORCA will increase its collaboration in 2011 by interoperating with protoGENI using iGENI gateway services in Chicago and a BEN ION connection, as a secondary option.

GENI Cluster-D Network Architecture

Cluster-D substrate is resource rich with network, computational and storage facilities that can be sliced to create virtual topologies in support of research and experimentation. Beginning with the Breakable Experimental Network (BEN), there exists a metro-area dark fiber test-bed with PoPs at each of the Triangle Universities (Duke, NCSU, UNC) and RENCI with network resources that can be provisioned without production constraints since it is a research only test-bed. Other Cluster-D members connect to FrameNet through their regional providers. Fig. 1 provides a connectivity diagram to illustrate how Cluster-D is connected using FrameNet.

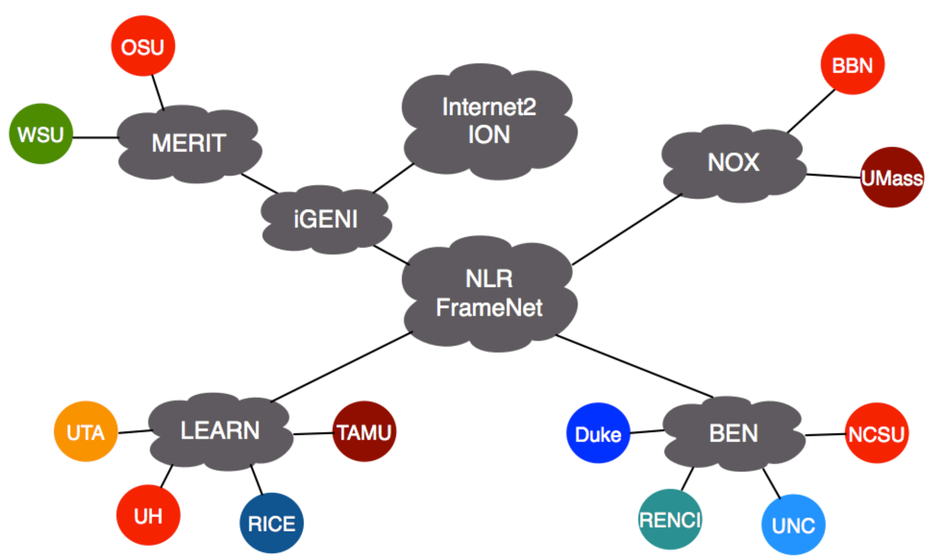

Figure 1. Connectivity diagram of Cluster-D participants. FrameNet provides layer 2 connections between participants

Spatially, Fig. 2 illustrates where on FrameNet's national footprint each regional network and its members attach to the backbone. This representation provides a geo-centric perspective on each Cluster-D member's relative location.

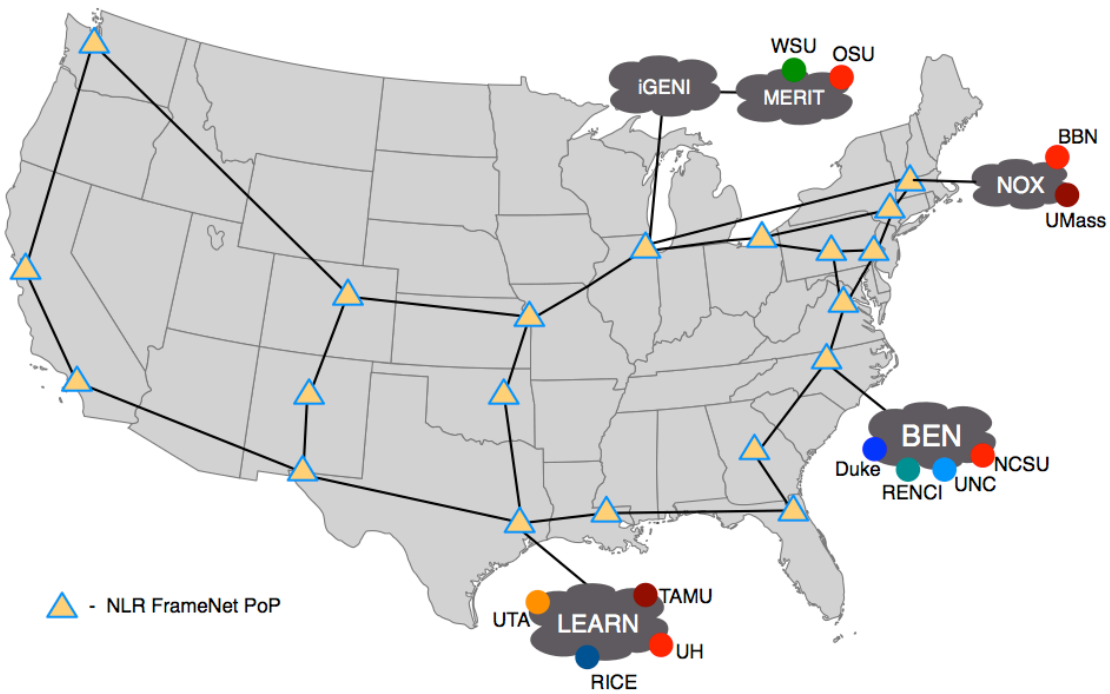

Figure 2. GCDNet Intra-connectivity via FrameNet

Tab. 1 lists Cluster-D regional participant's upstream network connections to FrameNet. It provides an approximation of throughput capabilities for each regional member. The table also indicates whether the substrate aggregate is able to support dynamic vlan assignment. In some cases, static vlans are necessary since campus/regional production networks do not always have the capability to dynamically assign vlan-ids. In the static case, ORCA is able to stitch together two vlans, e.g. static-to-dynamic, using vlan translation.

Substrate Aggregate	Upstream Interface to FrameNet	Vlan Capability
NOX/BBN, UMass	1GbE	Static
BEN, Duke, RENCI, UNC, NCSU	10GbE	Sherpa API (dynamic)
LEARN, UTA, UH, RICE, TAMU	10GbE	Sherpa API (dynamic)
iGENI	10GbE	Sherpa API (dynamic)
MERIT, OSU, WSU	1GbE	Static

Table 1. Describes Cluster-D regional aggregates upstream

FrameNet layer 2 Ethernet connections are created using NLR's Sherpa vlan provisioning tool to generate flat layer 2 topologies within the cluster. Vlans provide ingress/egress interfaces for cluster participants to access FrameNet. They are created using Sherpa's GUI interface, the manual approach, or through an API to automatically create dynamic vlans. By embedding Sherpa API calls within ORCA, the control framework software is able to dynamically provision vlans to connect cluster participants. Each participant needs to coordinate with its regional provider to join the ORCA workgroup within Sherpa, which defines the interface resource pool for establishing vlans between each ingress/egress interface.

ORCA-ProtoGENI Inter-connectivity

iGENI Interconnect Gateway

iGENI will facilitate physical connectivity between ORCA and ProtoGENI using an NLR wave to Salt Lake City, where ProtoGENI is located, and Chicago. This will create a point-to-point circuit between both control frameworks. iGENI will deliver either a 1GgE or 10GbE (TBD) physical interface that will connect to GCDNet's ORCA controlled 6509 located at iCAIR Northwestern University. ORCA and ProtoGENI will use a vlan interface to establish a resource-provisioning context across clusters. Fig. 4 illustrates iGENI's role, which is to establish an interconnect gateway for the two frameworks to demonstrate their interoperability.

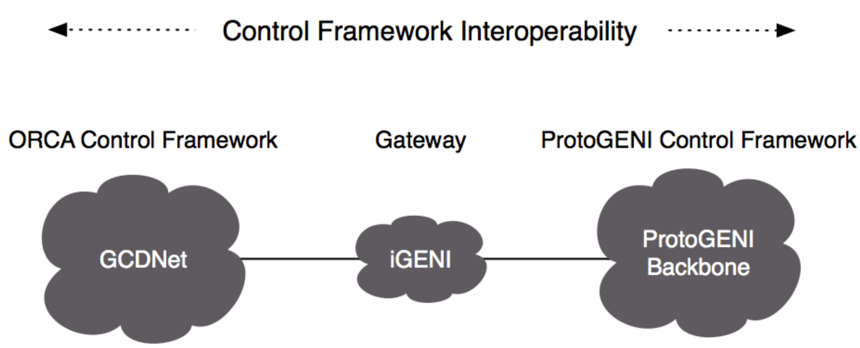

Figure 4. iGENI Interconnect Gateway

Fig. 5 provides a network diagram of a ProtoGENI backbone overlay on top of ORCA's GCDNet footprint. It illustrates the scope of the interoperability testbed between the two control frameworks and shows common points where the two frameworks are collocated at Level3 PoPs.

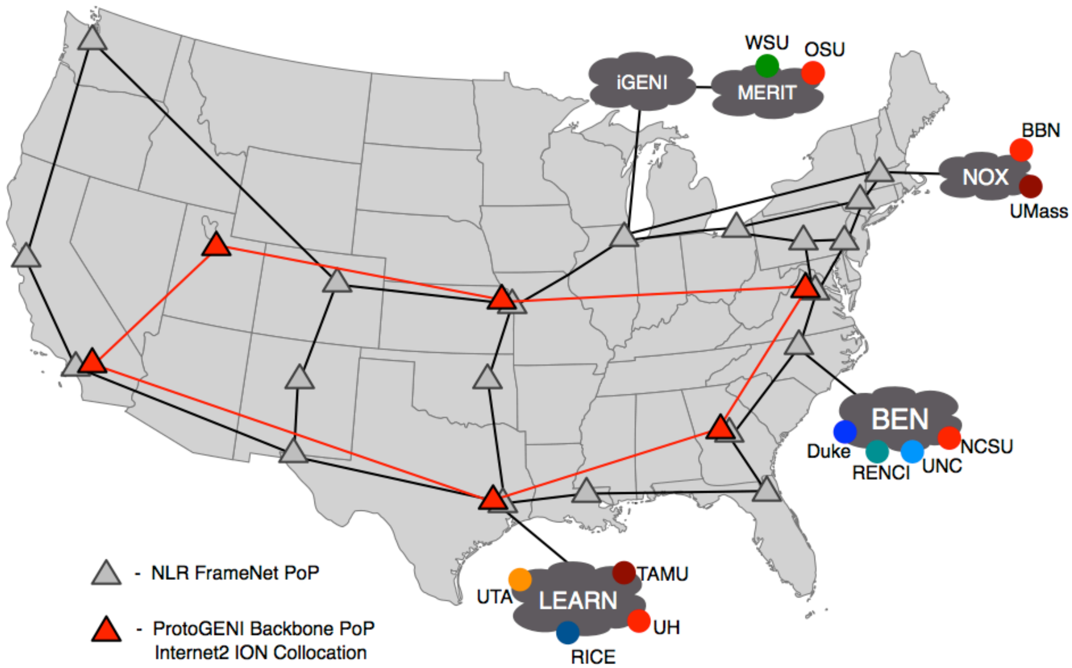

Figure 5. ORCA-ProtoGENI Interoperability Testbed – 2011

BEN Connection to ION

As a second option for connecting to ProtoGENI, we will establish an ION connection through NCREN to ProtoGENI's backbone node where they are collocated with Internet2 at Level3's Washington PoP. This is a two-phase process. The first includes adding a Juniper EX3200 Ethernet switch to the PoP in Raleigh where BEN is collocated with NCREN. This will enable ORCA to have simultaneous connections to ION and FrameNet. For the second phase, NCREN will provide a 250Mbps MPLS backhaul service from Raleigh to Washington that will connect to Internet2's ION service. Longer term, NCREN will look to increase the backhaul service to 1Gbps. The MPLS layer 2 VPN will be configured with support for one VLAN. Similar to the iGENI implementation, ORCA and ProtoGENI will use a vlan interface to establish a resource-provisioning context across clusters. From an operational perspective, NCREN will be responsible for supporting the optical and MPLS transport including the fiber between RENCI's data center and Level3's PoP in Raleigh. Internet2 is responsible for maintenance and operation of ION.

Fig. 6 provides a diagram of BEN's gateway connectivity to both ION and FrameNet. BEN will use the existing 10G transponder pair that it currently uses to access FrameNet from Chapel Hill back to Raleigh. The Polatis OXC in Raleigh enables ORCA to dynamically create cross-connects to establish a physical path to ION and FrameNet (or C-Wave). This implementation can support simultaneous connections to both ION and FrameNet by configuring separate vlans in the Juniper EX3200 switch, as illustrated in Fig. 6's insert of the EX3200.

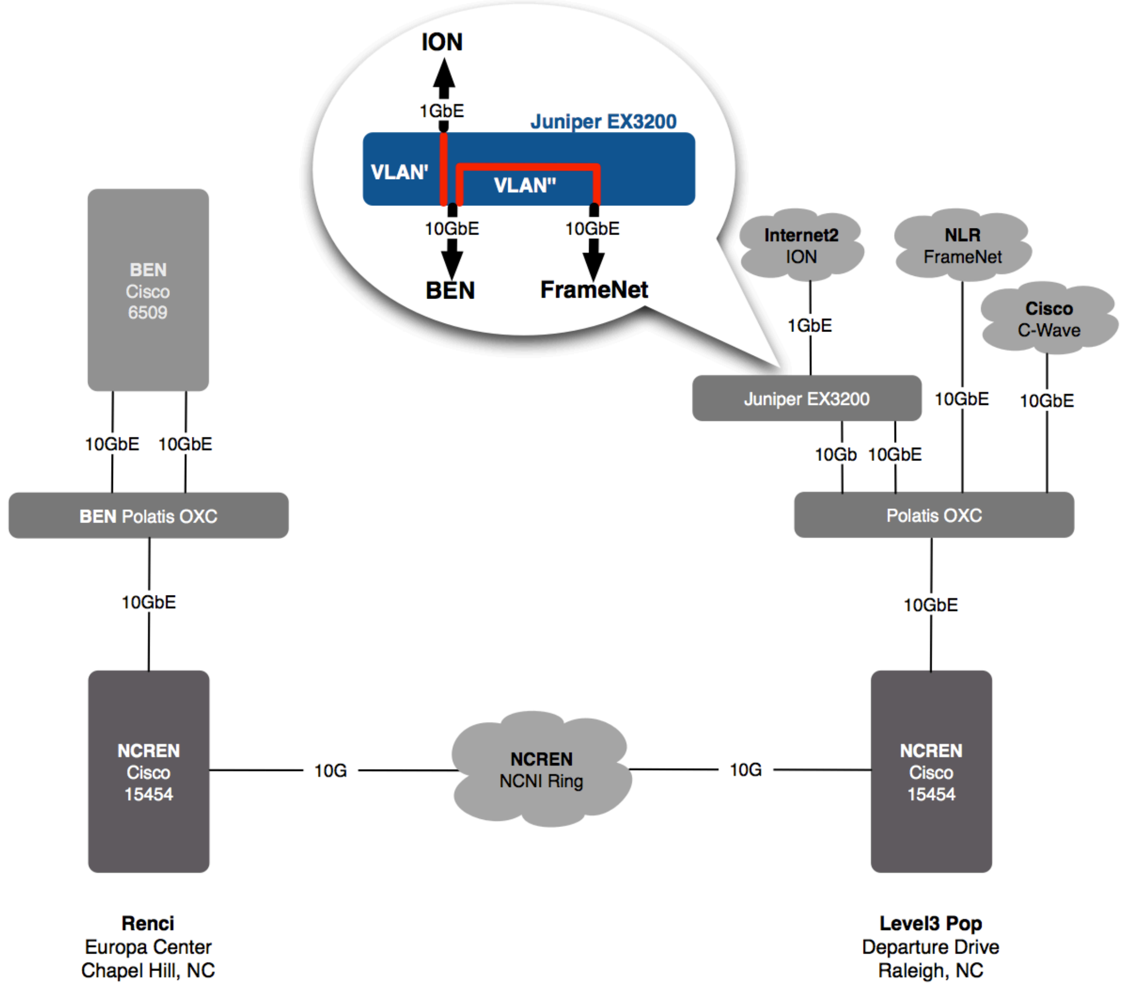

Figure 6. BEN gateway connectivity to both ION and FrameNet

Costs/fees

Tab. 2 below lists the price of the necessary components for upgrading an existing EX3200 switch. It is necessary for connectivity to ION.

Part No.	Description	Qty	Unit Price	Extended Price
EX-UM-2X4SFP	SFP uplink module	1	$1,335.00	$1,335.00
EX-SFP-10GE-LR	SFP+ 10GBase-LR 10GbE Optics	2	$2,670.00	$5,340.00
EX-PWR-190-DC	EX3200 190W power supply	1	$600.00	$600.00
			TOTAL	**$7,275**

Table 2. EX3200 upgrade costs for ION connectivity

Schedule

iGENI Interconnect Gateway	Completion date:	1Q2011
BEN Connection to ION	Completion date:	1Q2011