ORCA-BEN QSR

Period: Jul. 1, 2009 – Sep. 30, 2009

Overview

ORCA-BEN Project is adapting the existing ORCA (Open Resource Control Architecture) software developed at Duke as a control framework prototype for GENI. It uses BEN (Breakable Experimental Network, https://ben.renci.org) as the networked substrate, which exposes equipment at different layers: optical, circuit, packet as well as edge resources. The main goal for Spiral 1 has been to demonstrate multi-layer slice provisioning on BEN using ORCA. We believe we have achieved that goal with our 07/07/09 demo to the GPO. Technical comments about the demo are included in a separate section at the end of this document.

In the period since the demo we have been primarily concentrating on code cleanup and configuration and usability improvements. We are preparing to make our final ORCA software release for Spiral 1. We have also stood up an ORCA clearinghouse (http://geni.renci.org) and helped the rest of Cluster-D projects integrate their brokers into the clearinghouse. The clearinghouse is now operational.

Activities performed during specified period

Activities

Activity	Description	GPO target milestone
Clearinghouse	Deployed an ORCA clearinghouse	1e (Completed), 1f (Completed)
Cluster-D clearinghouse integration	Assisted Cluster-D projects in integrating their brokers with the ORCA clearinghouse	1e (Completed)
ORCA codebase modifications	Continued debugging and refining the codebase and introducing changes to make it more usable and user- and developer-friendly	1e (Completed), 1f (Completed), 1g
Documentation	Continued improving the on-line documentation for ORCA users	1g
Discussions with GPO	Held a number of on-line discussions with the GPO systems engineers clarifying details of ORCA architecture, implementation and future development roadmap.	1g

Participants

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Outreach activities

- Presented an invited paper 'Unique optical networking facilities and cross-layer research' at IEEE LEOS summer topicals in Newport Beach, CA 07/22-07/24 2009.
- Gave an invited presentation about the ORCA-BEN project describing our approaches to autonomic resource reservation and resource description at Internet 2 Fall Member Meeting in San Antonio, TX 07/10/2009
- Held discussions with ORBIT (Max Ott) on best approaches to resource representation in GENI (advantages of ontologies based on ITU G.805 model over ad hoc XML representations).

Technical comments on the 07/07/09 ORCA-BEN demo

Introduction

This demo showcased the following ORCA capabilities:

- Ability to create slices out of slivers from more than one network substrate provider
    - BEN and NLR
- Ability to create slices using statically provisioned segments
    - NLR VLAN tags were statically provisioned
- Cross-layer slice provisioning
    - VLAN tags, OTN circuits and fiber paths are dynamically provisioned by ORCA
- Multiple network element type integration
    - Cisco 6509 routers, Infinera DTN platforms, Polatis fiber switches.
- NDL integration
    - A slice controller uses an NDL request of the desired slice. BEN site authority uses NDL BEN substrate description and the request to compute the desired configuration.

Demo setup description

Site authorities:

There are several site/transit authorities distributed across multiple containers, as shown in Figure 1. The following table details the types of substrate owned by a specific authority, what it delegates and which container it resides in.

Name	Substrate	Resources delegated to clearinghouse	Container	Description
UNC-CH VM	3 blades (go-[12].unc.ben)	VMs	UNC-CH	Allocate and configure VMs on the substrate using XEN
Duke VM	2 blades (go-[12].duke.ben)	VMs	Duke	Allocate and configure VMs on the substrate using XEN
RENCI VM	3 blades (go-[123].renci.ben)	VMs	RENCI	Allocate and configure VMs on the substrate using XEN
DukeNet	Cisco 6509 at Duke BEN PoP	VLAN tags	RENCI	Allocate VLAN tags, map between NLR tag and BEN tag
BEN	Cisco 6509's, Infinera DTNs and Polatis switches at UNC and RENCI	VLAN tags	RENCI	Configure cross-layer paths between sites, map NLR VLAN tag to BEN VLAN tag
NLR	Null	VLAN tags	RENCI	Holds a number of preconfigured VLAN tags across NLR.

Table 1: Description of site authorities

There are two brokers in the demo – one for VM instances, the other for VLAN tags. Both brokers reside in the RENCI container.

Figure 2 shows the horizontal integration and the communications paths between different entities. Note that the blue path between the Site Authority and handler/driver denotes the Setup/Teardown upcalls, intended to create a sliver of the substrate. The blue path between Service Manager and the driver denotes the Join/Leave upcalls, intended to pass user-configurable parameters into the sliver. In order to enable stitching of slivers, network element drivers are required to support Setup/Teardown upcalls, however they do not respond to Join/Leave operations, as no true slivering of network elements is occurring. Existing BEN network elements can sliver the network capacity, however they are not sliverable themselves.

The Slice Manager slivers network capacity by enacting Join/Leave upcalls and directing the handler/drivers to configure sliver-specific parameters in the network elements (i.e. VLAN tags on specific ports, DWDM circuits or fiber crossconnects).

Figure 1: ORCA-BEN Demo horizontal integration (Duke and UNC are identical)

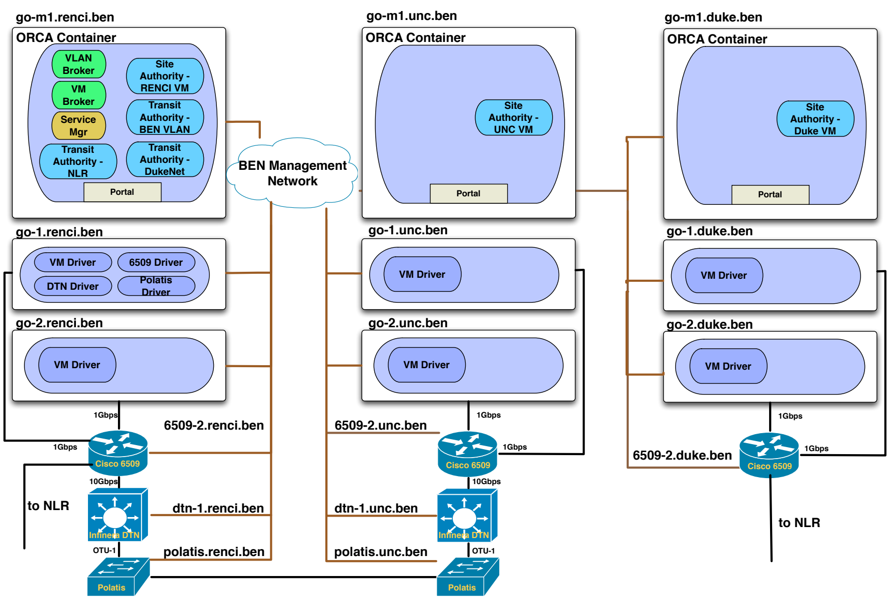
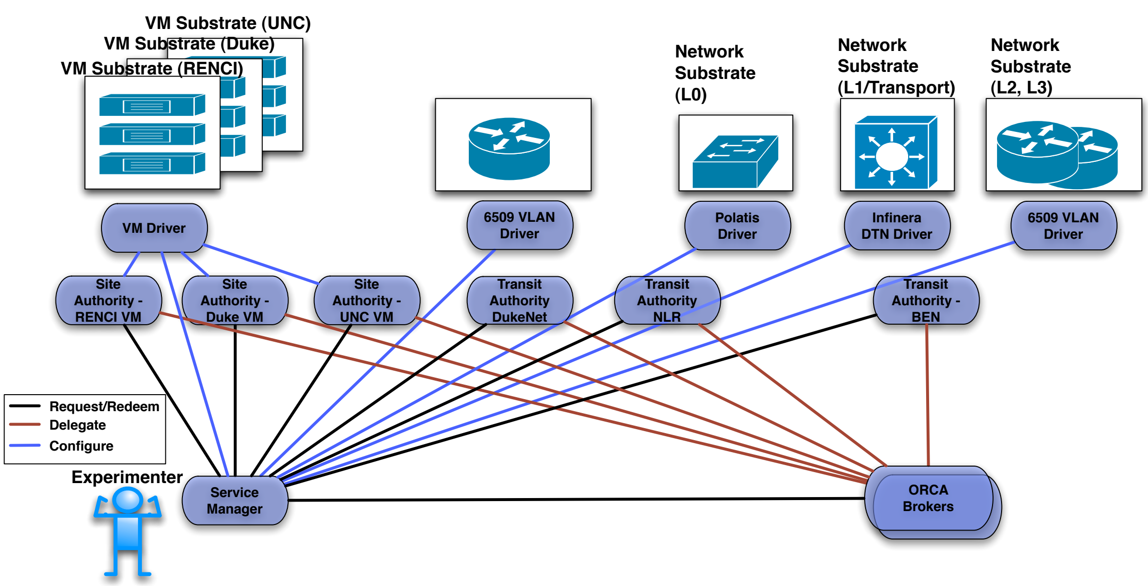


Figure 2: ORCA-BEN vertical integration



VLAN mapping

The demo sets up an end-to-end VLAN between 3 entities: Duke, UNC-CH and RENCI. We do not assume VLAN tag continuity, as there are network elements present, that are capable of remapping one tag to another.

Two types of VLAN tag mappings are assumed: *static* and *dynamic*. Static mapping is considered pre-existing to the demo and known to the CF. The slice manager performs dynamic mappings between VLANs to stitch together slivers of different networks (e.g. BEN and NLR).

NLR VLAN tags have been statically provisioned ahead of time using NLR's Sherpa tool to connect RENCI 6509 BEN router to the edge of the Duke campus cloud. A static mapping is also created for each NLR tag to the Duke cloud tag; the latter is then visible from the Duke BEN 6509. The same NLR VLAN tag can be seen as two different tag numbers due to static remapping across the Duke campus cloud.

If VMs are provisioned at a site, *all* client-side ports on the site's 6509 are provisioned with the same given BEN VLAN tag (the ids of these ports are known to the site authority). Currently we do not limit provisioning VLAN tags to ports to which physical hosts with VMs for this slice are attached to. This is a security enhancement we intend to implement in Spiral 2.

Figure 3: VLAN Mapping example

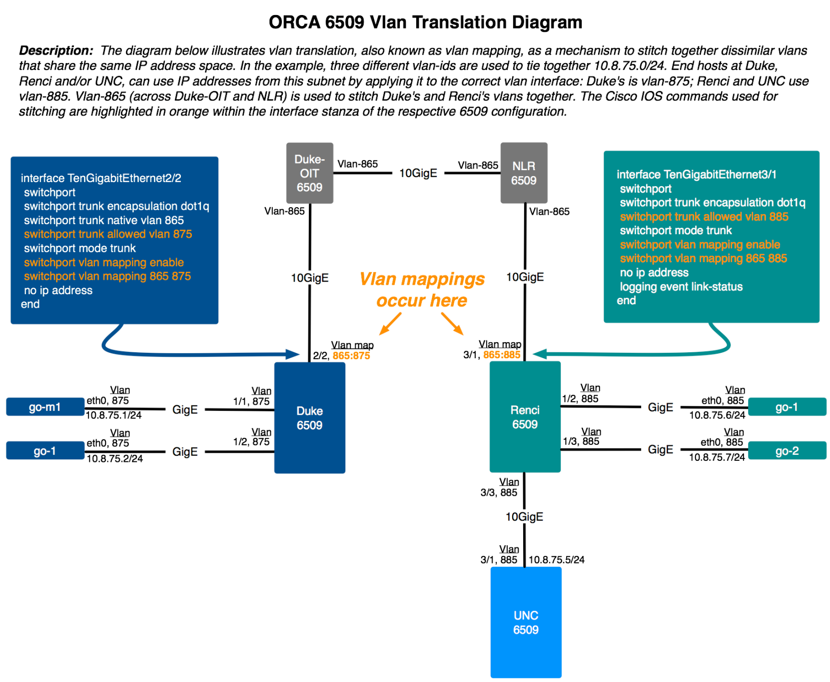
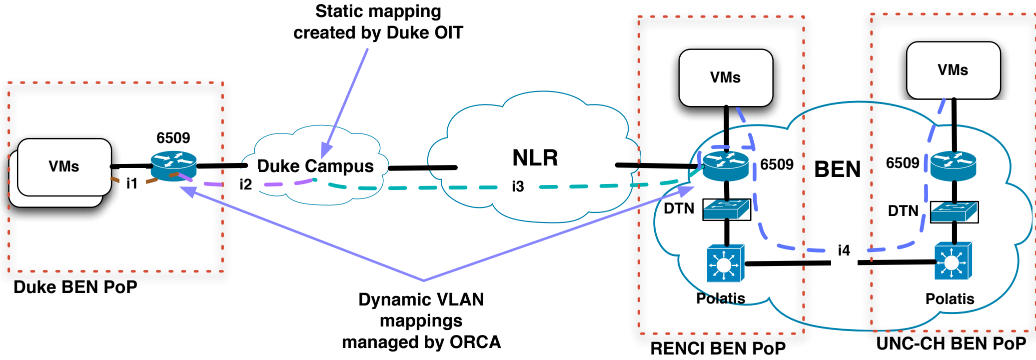


Figure 3 shows a working example of VLAN map operation using NLR and BEN. The port identifiers are the ones that were used in the demo. Note that VLAN remapping takes place at the 10G interfaces due to demo topology.

Figure 4: Demo scenario



Demo sequence

1. Site authorities delegate resources to the ORCA-BEN clearinghouse:
    a. RENCI, Duke and UNC-CH VM site authorities delegate a fixed number of VM instances they are able to create to the VM broker located in the RENCI container. RENCI delegation is built into the configuration file. UNC and Duke delegation is performed by hand at demo time (due to UNC and Duke VM authorities residing in a different container from the VM broker).
    b. BEN transit authority delegates a fixed range of dynamic VLAN tags available for connecting sites on BEN to the VLAN broker located in the RENCI container.
    c. NLR transit authority similarly delegates a fixed range of statically pre-allocated VLAN tags available for traversing NLR. These tags have been pre-created using Sherpa and statically remapped through the Duke campus network to reach BEN 6509 at Duke.
    d. DukeNet transit authority delegates a range of VLAN tags.
2. Demo-specific slice manager passes a request to the two brokers (VM and VLAN) for
    a. Number of VMs to be created at UNC, Duke and RENCI
    b. VLAN tags from DukeNet, NLR and BEN
3. Brokers inside ORCA-BEN clearinghouse grant tickets for
    a. A single NLR VLAN tag
    b. A single BEN VLAN tag
    c. A DukeNet VLAN tag
    d. A requested number of VMs to be created at Duke
    e. A requested number of VMs to be created at RENCI
    f. A requested number of VMs to be created at UNC-CH
4. The redeem order of the tickets (from the slice) to the respective authorities is important as it allows us simplify the 'stitching' problem between slivers. Earlier steps service as information 'sources' for later steps, which serve as information 'sinks'. Redeem calls are performed by the slice manager to individual site/transit authorities:

a. NLR transit authority. The redeem provides the slice manager with one of the available tags across NLR.
b. BEN transit authority. With the redeem the slice manager passes to the authority
    i. an NDL-formatted request to create a multi-layer sliver across BEN
    ii. a previously allocated NLR tag to which the BEN tag can now be mapped to in the RENCI 6509.
        - Prerequisite: step(a)
c. DukeNet transit authority. It also passes a previously allocated NLR tag to the authority to which the Duke 6509 can remap its internally allocated VLAN tag
    - Prerequisite: step (a)
d. RENCI VM site authority. It passes the BEN VLAN tag to the authority so that the created VMs can be attached to this tag.
    - Prerequisite: step (b)
e. Duke VM site authority. It passes the DukeNet VLAN tag to the authority so that the created VMs can be attached to this tag.
    - Prerequisite: step (c)
f. UNC-CH VM site authority. It passes the BEN VLAN tag to the authority so that the created VMs can be attached to this tag.
    - Prerequisite: step (b)

The use of NDL

We do not use NDL in the demo to provide the broker or site authority with resource accounting information – this is a Spiral 2 enhancement. In this demo the NDL request describing a desired BEN connection is passed from the Slice Manager directly to the BEN Transit Authority as part of the *redeem procedure*. The Slice Manager first acquires a VLAN tag ticket from the VLAN broker and attaches the NDL to this ticket before passing it to the BEN Transit Authority. The BEN Transit Authority then validates the ticket and uses the NDL description of the request to compute the cross-layer path across BEN. Here NDL is also used in the form of the BEN catalogue. The BEN Transit Authority relies on the contents of the catalogue to compute the cross-layer path (i.e. which network elements need to be configured) and provide handler/drivers with necessary configuration information. This NDL catalogue is pre-loaded into the Jena ontology engine at the start of the demo.

Because the contents of the ontology is dynamically updated during the demo, the BEN Transit Authority path computation algorithm is intelligent enough to take advantage of the existing links whenever possible (existing links are added to the ontology as the demo progresses). For example, in the case of two slices, the first slice across BEN establishes a fiber connection between respective fiber switches and a DWDM connection between Infinera DTNs. The second slice, aware of the existence of these links based on the contents of the ontology, does not require any fiber switch or Infinera configuration steps and simply configures another VLAN in the 6509 over the existing DWDM connection.