Experiment Services Overview

Cluster D

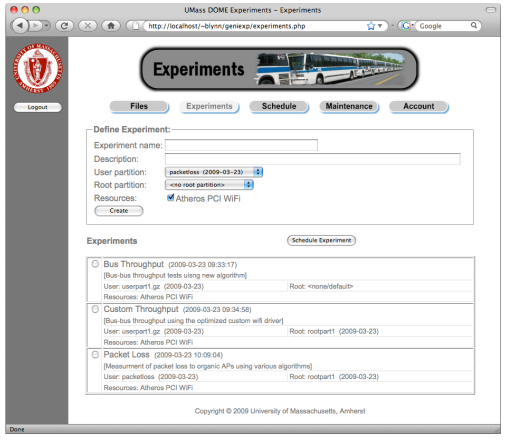
What assumptions might be specific to their control framework?

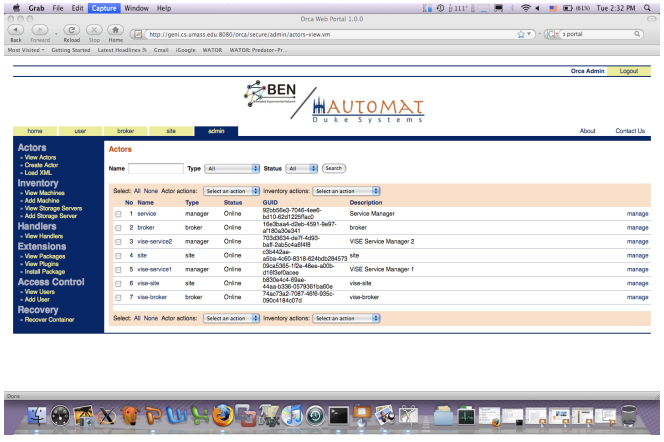
- Radically diverse
  - Devices. Motes, Mobility, Radars, Cameras
  - Networking. Optical, WiFi, Cellular, 802.15.4, WiMax
  - Data. Sensing rates, transmission opportunities

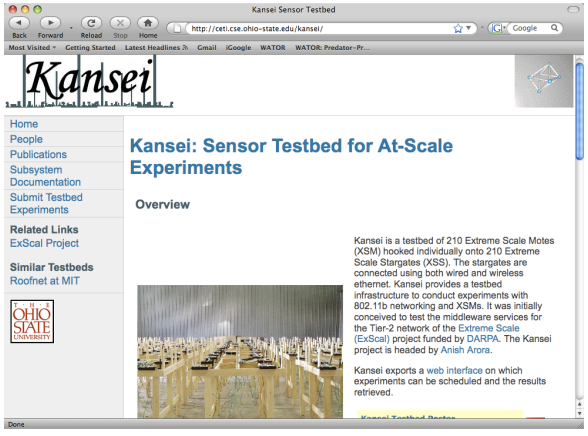
- Given this diversity, what pieces of experiment workflow can still be common?

What assumptions do tools make about the control framework?

- Few Orca-imposed assumptions
  - Just resource leases. Little impact on experiment workflow
  - Rspecs are NDL (or anything you want)
- Aggregate-specific tools in use
  - DOME web portal, delay-tolerant upload/download
  - ViSE using Orca web portal. Looking at Gush.
  - Kansei has data-centric tools for low-power nodes.







What are the declarative and procedural aspects of this specification?

- Declarative
  - Programmatic requests to GENI actors
  - Through custom web portals, external tools
- Procedural
  - Aggregate-specific web portals
  - Procedures embedded in experiments
- Early stages. not combined right now

How is this specification used by the tool chain available to experimenters?

- Declarative
  - Manual requests for resources by researchers at a web portal
  - First step for small-scale experiments
    - Not appropriate for large-scale experiments
- Procedural
  - "Roll-your-own" experiments
  - Capabilities for packaging experiments, data exfiltration/injection, etc.

What are the experimenter tools in one cluster that might be ported to other control frameworks?

- Aside from Rspecs and resource discovery, negotiation, and allocation…
  - Aggregate-specific tools are probably portable
  - Kansei and DOME developed tools independently of Orca

- Although…
  - Aggregate-specific tools probably not useful to other aggregates

Experiment Description Language and Tools

NDL, RDF/OWL, and Transport Networks

Yufeng Xin

Renaissance Computing Institute

yxin@renci.org

Renci
Renaissance Computing Institute

Networking Experiments

- **Many "Internet" experiments assume single transport layer**
  - **Single graph of links and nodes**
  - **Focus on other complicated logic**
- **Transport network researchers need to specify more information inside the link and node: Multi-layered network**
  - **Embedding of higher level networks into lower level networks**
    - Defining proper layer adaptations
    - Path computation becomes a hard problem
      - NP hard

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BEN, ITU G.805, and NDL

- **BEN: Cross-layer transport network testbed**
  - **VLAN->GE Ethernet->10G Ethernet->Lambda->OCG->Fiber**
  - **VLAN->Ethernet->DTN bandwidth pool (bandwidth virtualization)**
  - **Switching: Fiber, OCG, Lambda, Sub-Lambda, Ethernet**
  - **Possible multiple end-to-end paths cross different layers**
  - **So complex that an abstract model is desired**
- **ITU G.805: Network elements <->Functional elements <-> Ontology**
  - **Topology Connectivity and switching capability**
  - **Cross-layer adaptation, aggregation, and capacity**
  - **It's complex and abstract, suitable for ontology**
- **NDL is a set of ontology based on G.805**
  - **Resource description with focuses on connectivity and cross-layer adaptation description**
  - **RDFS/XML**
  - **Logic constraints and cross-layer path computation**
  - **Modular design**

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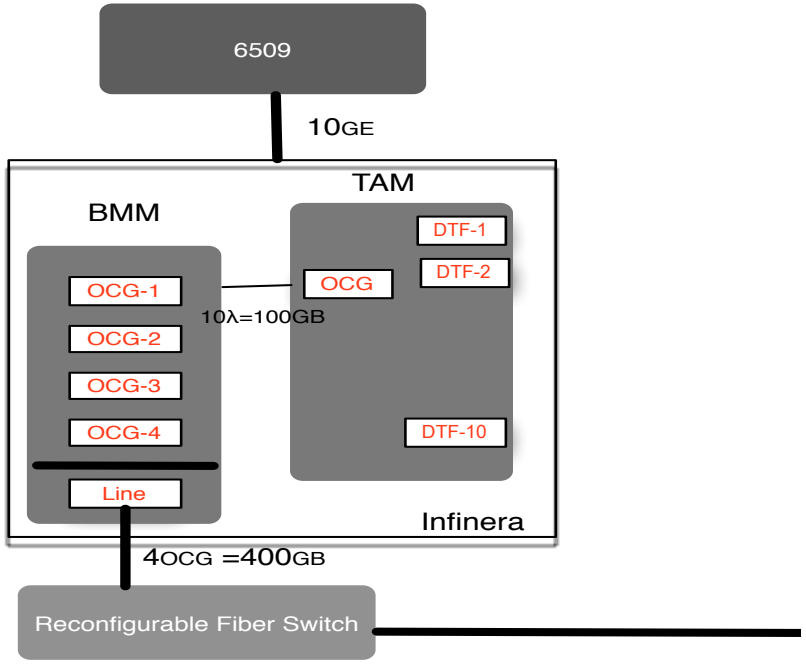
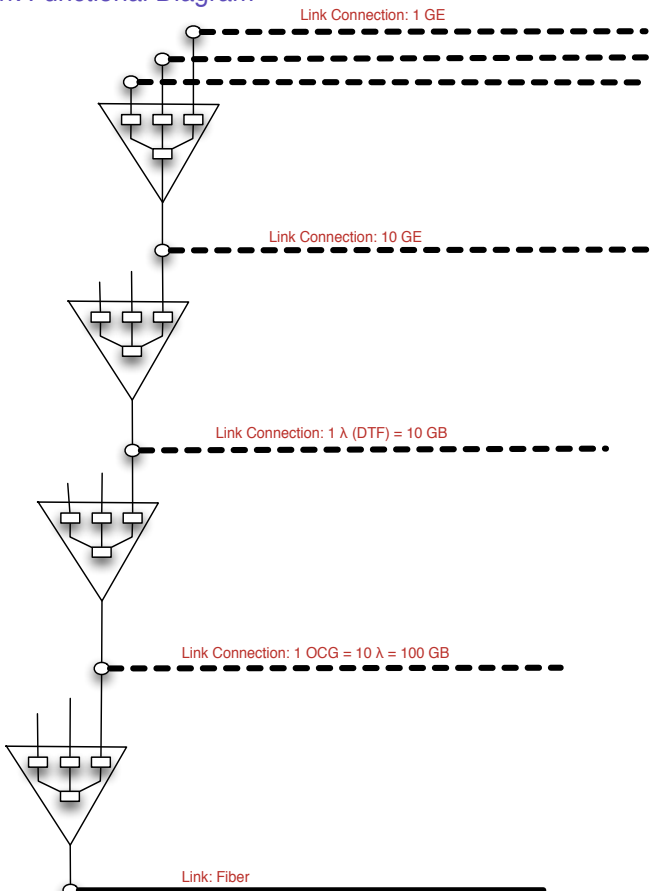
BEN layering

Network Element Diagram



Network Functional Diagram



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Network Description Language (NDL)

- **Origin: Universiteit van Amsterdam**
  - **Ontology**
  - **Cross domain network description**
  - **Static path computation**
- **Under development for several years**
- **In use within GLIF**
- **OGF Network Markup Language Working Group (NML-WG)**
  - **Internet2, ESnet (PerfSONAR model)**
  - **Dante / GN2 JRA3 (cNIS)**
  - **University of Amsterdam (NDL)**
  - **https://forge.gridforum.org/sf/projects/nml-wg**

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How we use/extend NDL in ORCA

- **NDL-OWL extends NDL in OWL: Richer semantics and inference capability**
- **Unified semantic for substrate description, request description, and slice configuration**
- **Dynamic path computation**
- **Existing toolkits:**
  - **Protégé: build and maintain Ontology and RDF**
  - **Jena API library:**
    - Jena: Ontology model (resource, property) creation, modification, and validation
    - ARQ: SPARQL query langauage
  - **Gleen: subGraph query API**

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Request Description

```
<rdf:RDF xml:base=https://geni-orca.renci.org/owl/request-6509.rdf>
<owl:Ontology rdf:about="">
<owl:imports rdf:resource="https://geni-orca.renci.org/owl/request.owl"/>
</owl:Ontology>

<request:Reservation rdf:about="#reservation-renci-unc-vm-1">
<request:StartingTime>2009-07-07T:13:00:00:00Z</request:StartingTime>
<request:EndingTime>2009-07-07T:20:00:00:00Z</request:EndingTime>
<layer:atLayer rdf:resource="https://geni-orca.renci.org/owl/
ethernet.owl#EthernetNetworkElement"/>
</request:Reservation>

<topology:Device rdf:about="https://geni-orca.renci.org/owl/ben.rdf#Renci/
VMSite">
<topology:connectedTo rdf:resource="https://geni-orca.renci.org/owl/
ben.rdf#UNC/VMSite"/>
</topology:Device>
</rdf:RDF>
```

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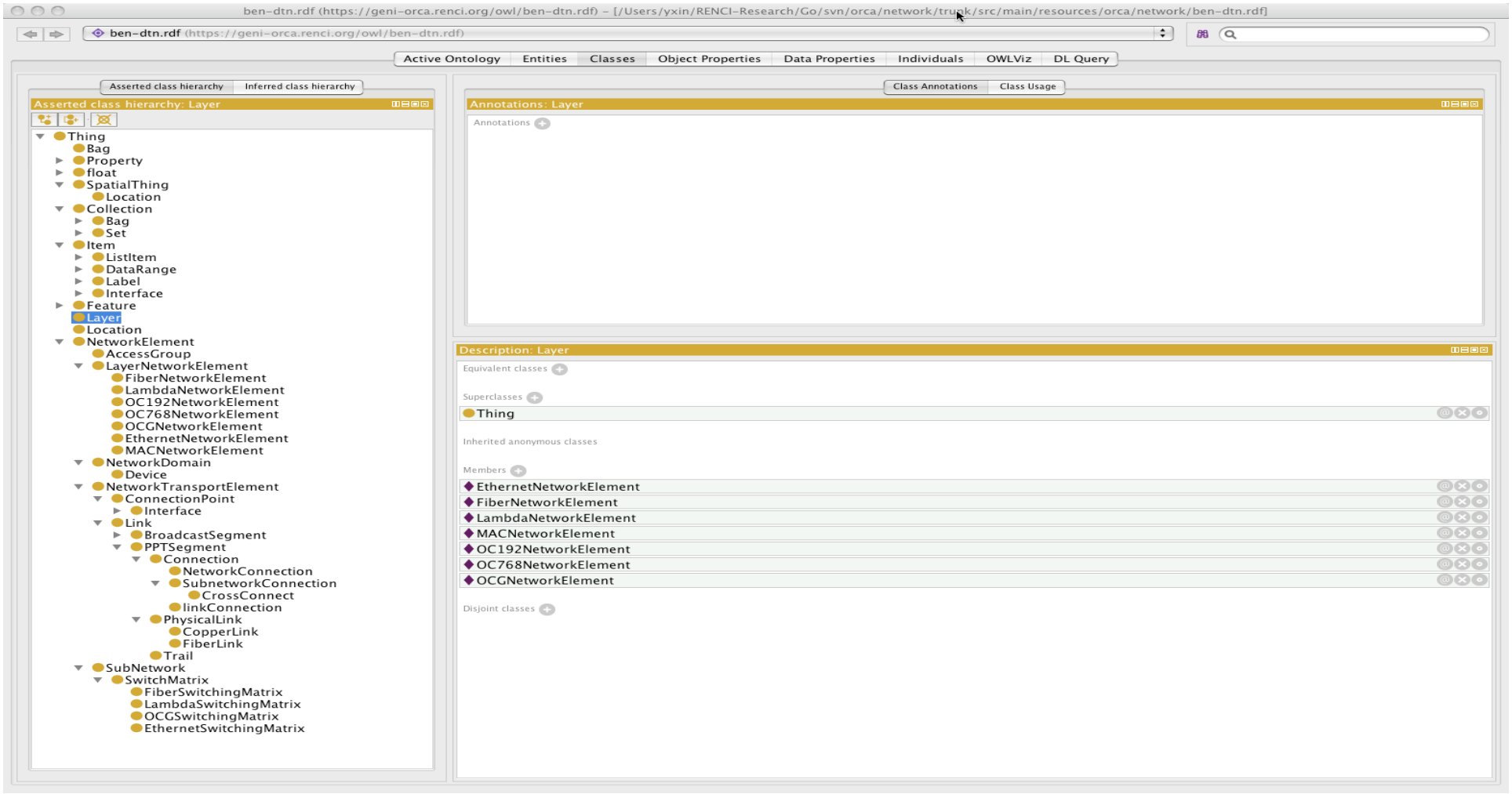
Ontology and RDF tool



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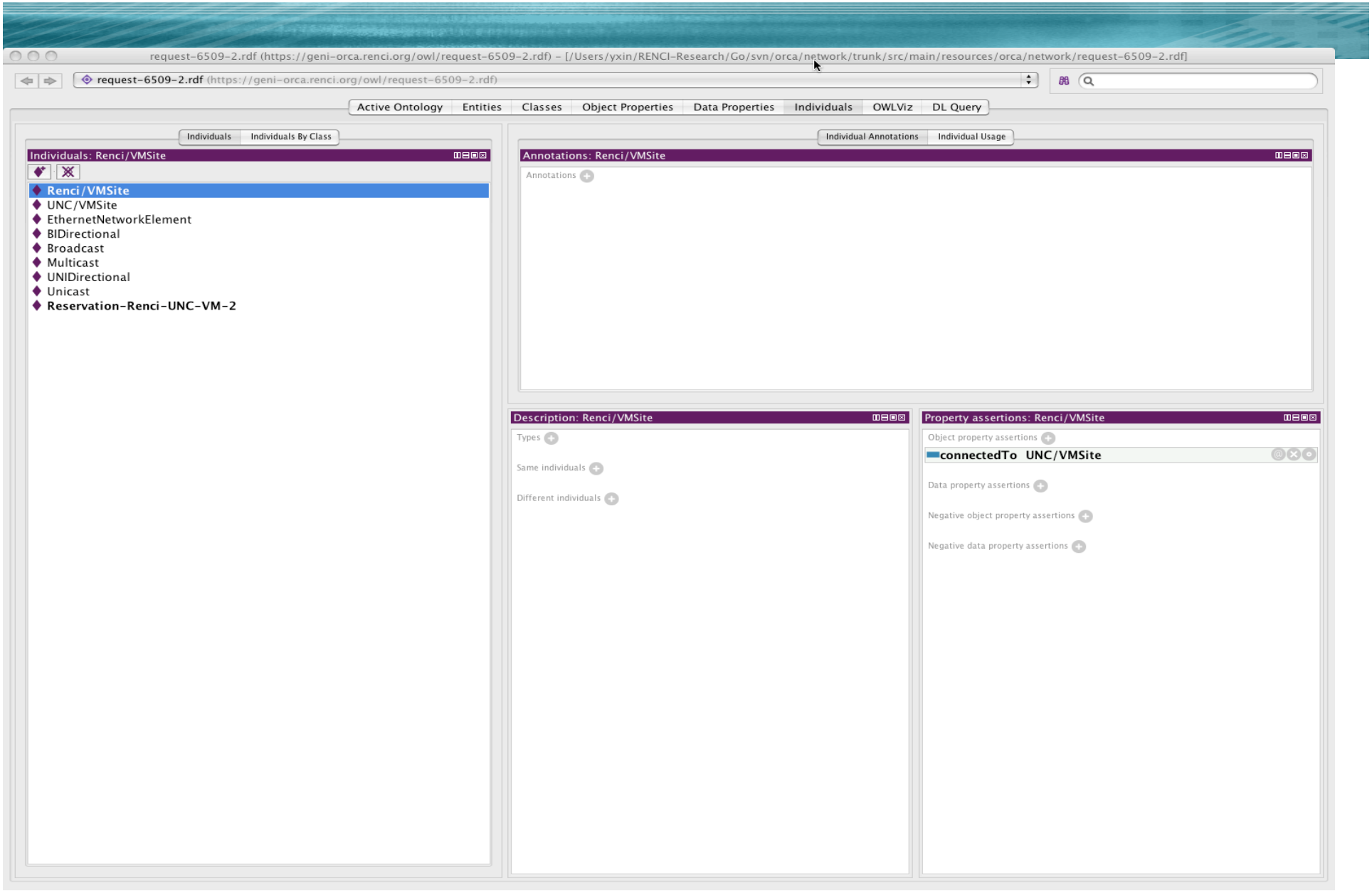

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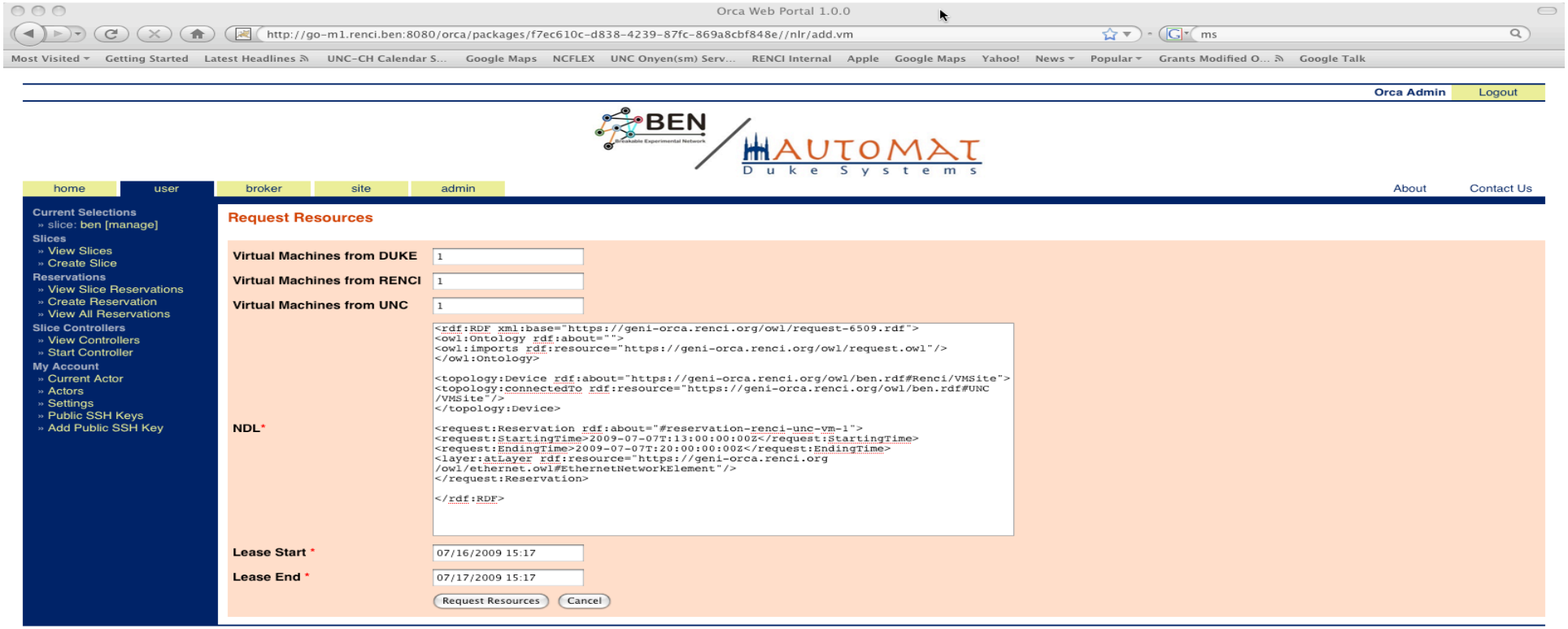
Reserve a Slice in ORCA



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Notes and future

- **Semantic web and ontology approach is both an advantage to the schema author, who is forced to develop an abstract model, as well as for users, who may use the meaning to define things and leverage the information.**
  - Family of xDL schemas:
    - X = M for Measurement
    - X = W for Wireless
    - X = C for Cloud
  - Together they help define experiment environment
- **Potential to specify a complete experimental workflow**
- **ORCA Automat as a generic experimental platform**

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