

High Performance Digital Media Network (HPDMnet):  
A Dynamically Provisioned Inter-Domain International  
Service for High Performance Digital Media, With  
Dynamic Optical Multicast

An Experimental Architecture and Prototype Optical Digital Media  
Service – Demonstration of Current Research Status at the 8<sup>th</sup>  
Annual Global LambdaGrid Workshop

**Joe Mambretti, Hervé Guy, and the HPDMnet  
Consortium**

[j-mambretti@northwestern.edu](mailto:j-mambretti@northwestern.edu), [herve.guy@canarie.ca](mailto:herve.guy@canarie.ca)

Seattle, Washington  
Oct 2-3, 2008



- An International Consortium of Research Centers Has Formed a Cooperative Partnership To Address Key Challenges and Opportunities Related to Using Dynamically Provisioned Lightpaths for High Performance Digital Media (HPDM)
- At the Annual Global LambdaGrid Workshop in Seattle, Washington, Demonstrations Showcased the Current Project Status (Not Final Results, Products or Services)
- Multiple Sites Require High Performance/High Volume/High Definition Digital Media Streaming Simultaneously Among All Locations (Multi-Point to Multi-Point)
- Traditional L3 Techniques Cannot Be Used for Many Types of High Definition Media
- Traditional Techniques Were Designed for Many Small Information Flows – Not for Large Scale Flows
- This Consortium Is Designing and Developing New L1/L2 Capabilities That Can Provide Large Scale HPDM Services, Especially for GLIF GOLES

- This Research Consortium Has Designed and Implemented an International HPDM Testbed (HPDMnet)
- HPDMnet Is Being Used for Experiments and Demonstrations
- A Specific Instantiation of the HPDMnet Testbed Was Created For the 2008 Global LambdaGrid Workshop
- Various Architectural Approaches And Technologies, Including Middleware, Are Being Developed and Investigated On Research Testbeds, Including HPDMnet
- Component Technologies Being Showcased Include SOA and IaaS Based Network Middleware, a Scheduler, and Optical Multicast

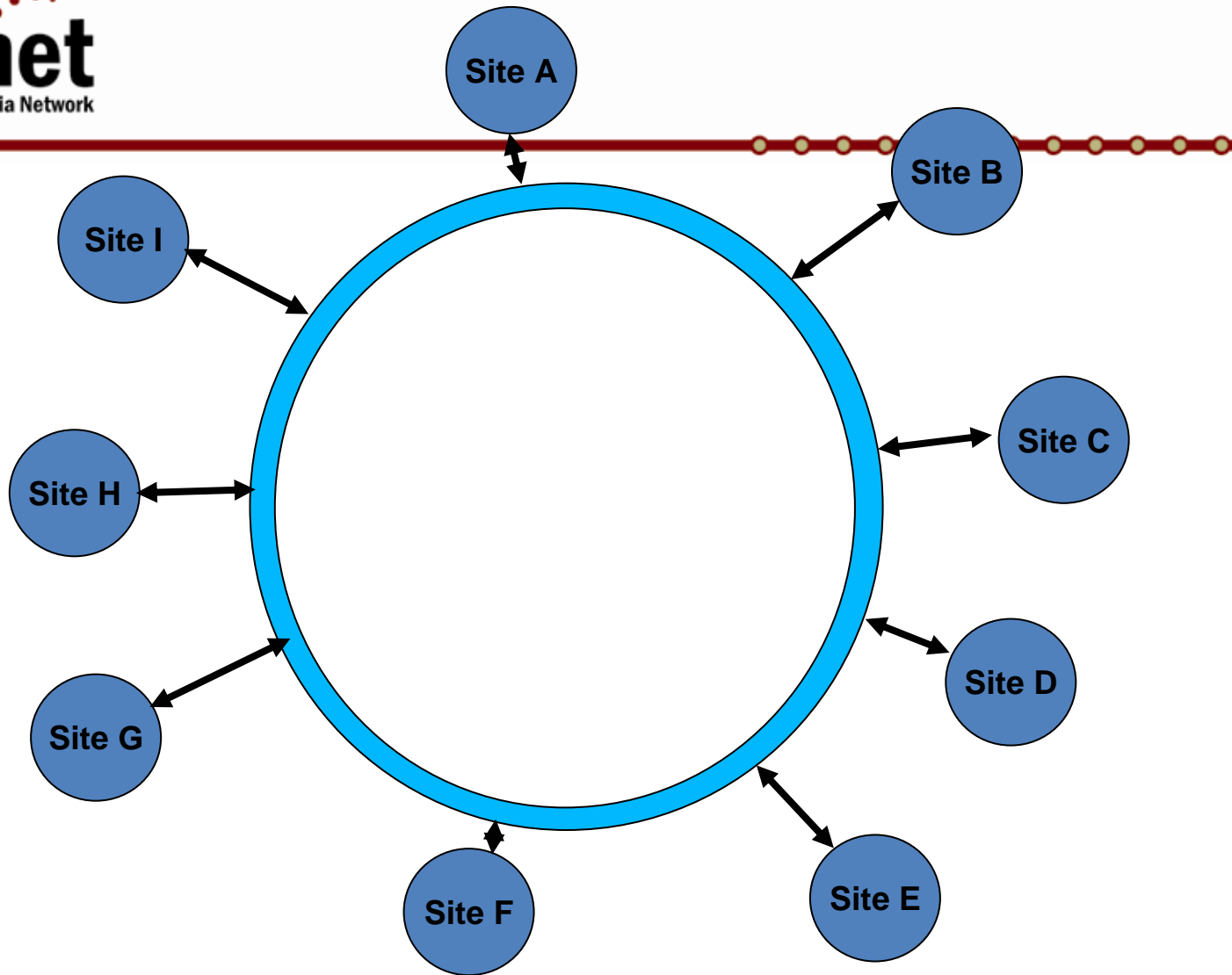
# Selected Demo Techniques Include the Following Items

---

- Dynamic L2 and L1 (Lightpath) Allocation and Adjustment, a Particularly Important Emerging Technique
- Capabilities for Persistent and Dynamic Large Scale L1/L2 Resources, Allocated in Response to Requirements
- Capabilities for Both Scheduled and On-demand Resource Provisioning
- Integrated, Addressable WAN and LAN Paths
- High Level Path Control Capabilities Signalled By Application Processes
- Branching HPDM Streams By Setting Parameters Through the Device Control Systems (“Optical Multicast”)
- Individually Selecting Multiple Path Options Can Be Accomplished To Optimize Stream Flows
- Reliance On an Architectural Framework That Assumes an SOA Context

- The HPDM Initiative Is Designing and Developing a GLIF Service, Instantiated at GOLEs That Will be Usable By Any Large Scale Digital Media Application, Or Other Data Intensive Application
- The Service Can Be Customized for a Wide Range of Specialized Applications
- Digital Media Can Include Visualization, Animation, Simulation, Video, Imaging, and Other Modalities
- Media Can Be of Any Size or Type
- The Basic Service Is Media Protocol Coding/Decoding Agnostic
- Audio Channels and Interactivity Are Also Considerations
- This Service Provides Capabilities That Allow For the Highest Possible Quality Service

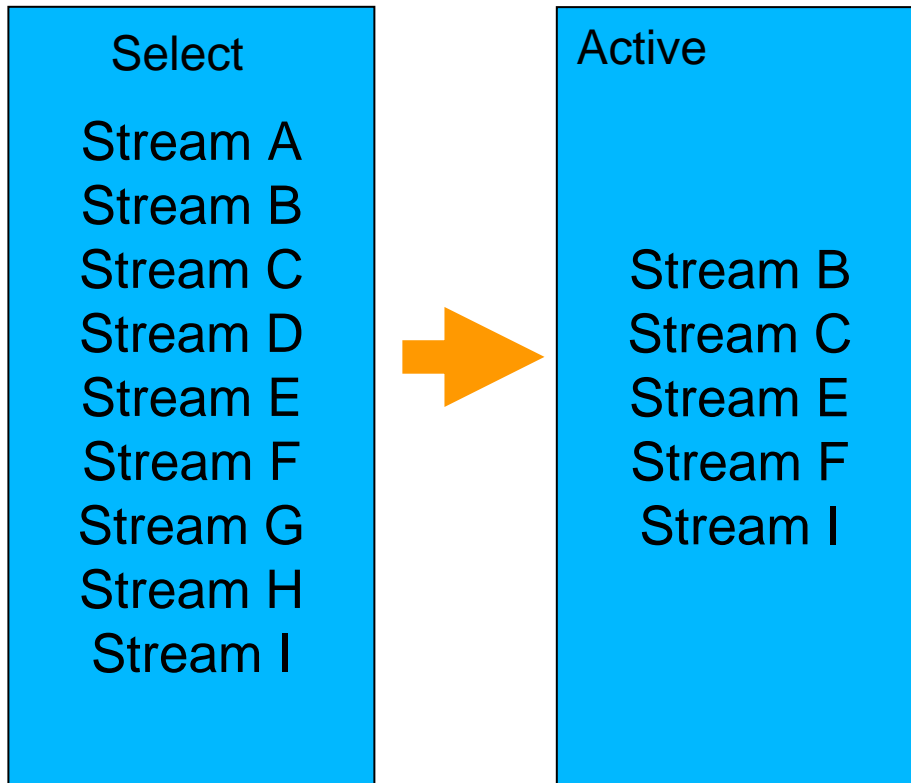
- Application Signaling
- GLIF Digital Media Service Discovery, Including Topology Considerations
- Service Use, with Monitoring and Performance Guarantees
- Service Termination
- Analysis/Reporting
- APIs for Integration Into Other GLIF SOA Compliant Frameworks.



Logical View 1

Each site can send and receive multiple streams

Note that each site can manage multiple bi-directional streams  
The streams need not be on bi-directional links

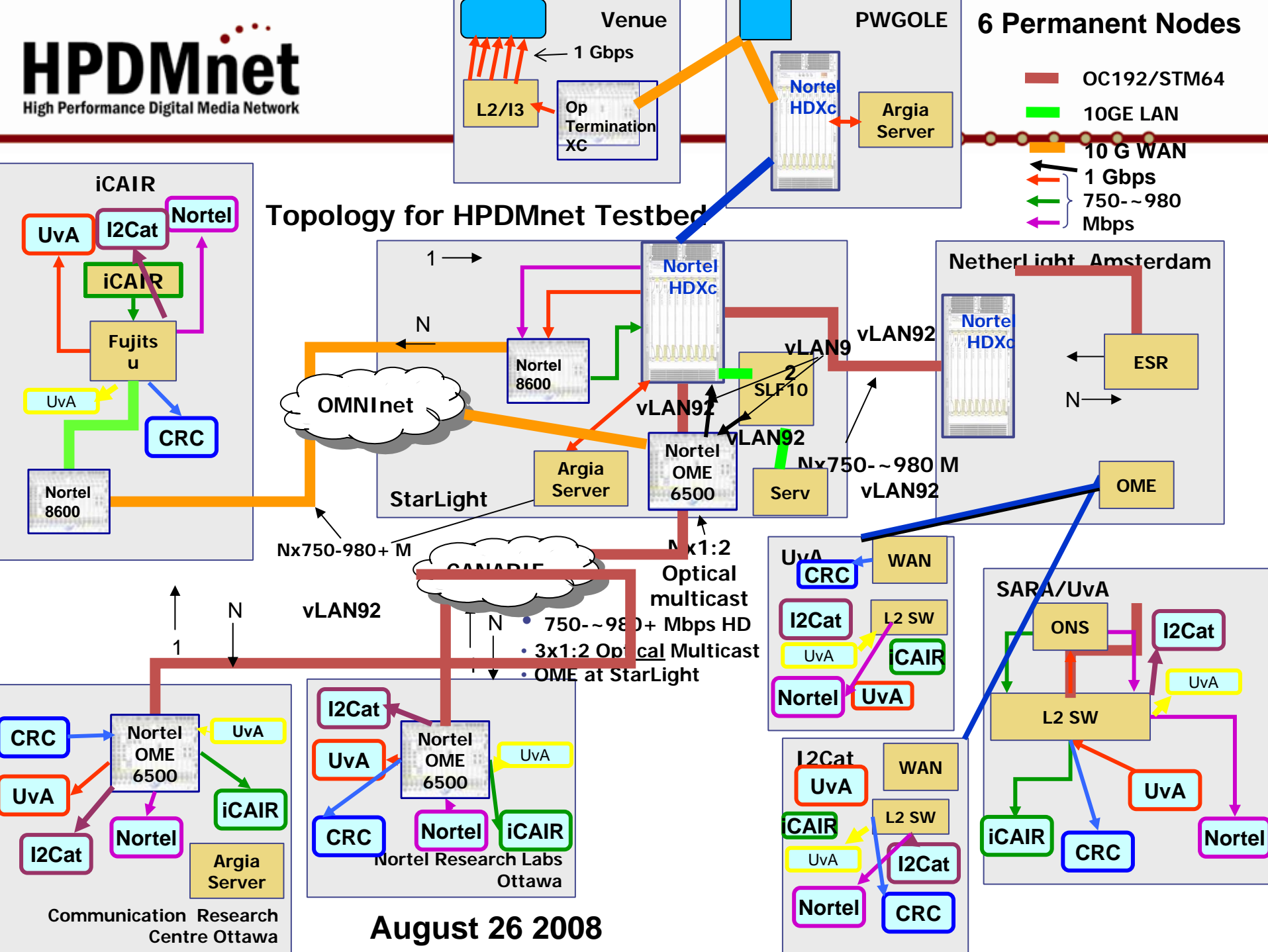


**Note “Stream” – Not Site –  
Each Site Can Support  
Many-to-Many**



- OC192/STM64
- 10GE LAN
- 10 G WAN
- ← 1 Gbps
- ← 750~980
- ← Mbps

### Topology for HPDMnet Testbed



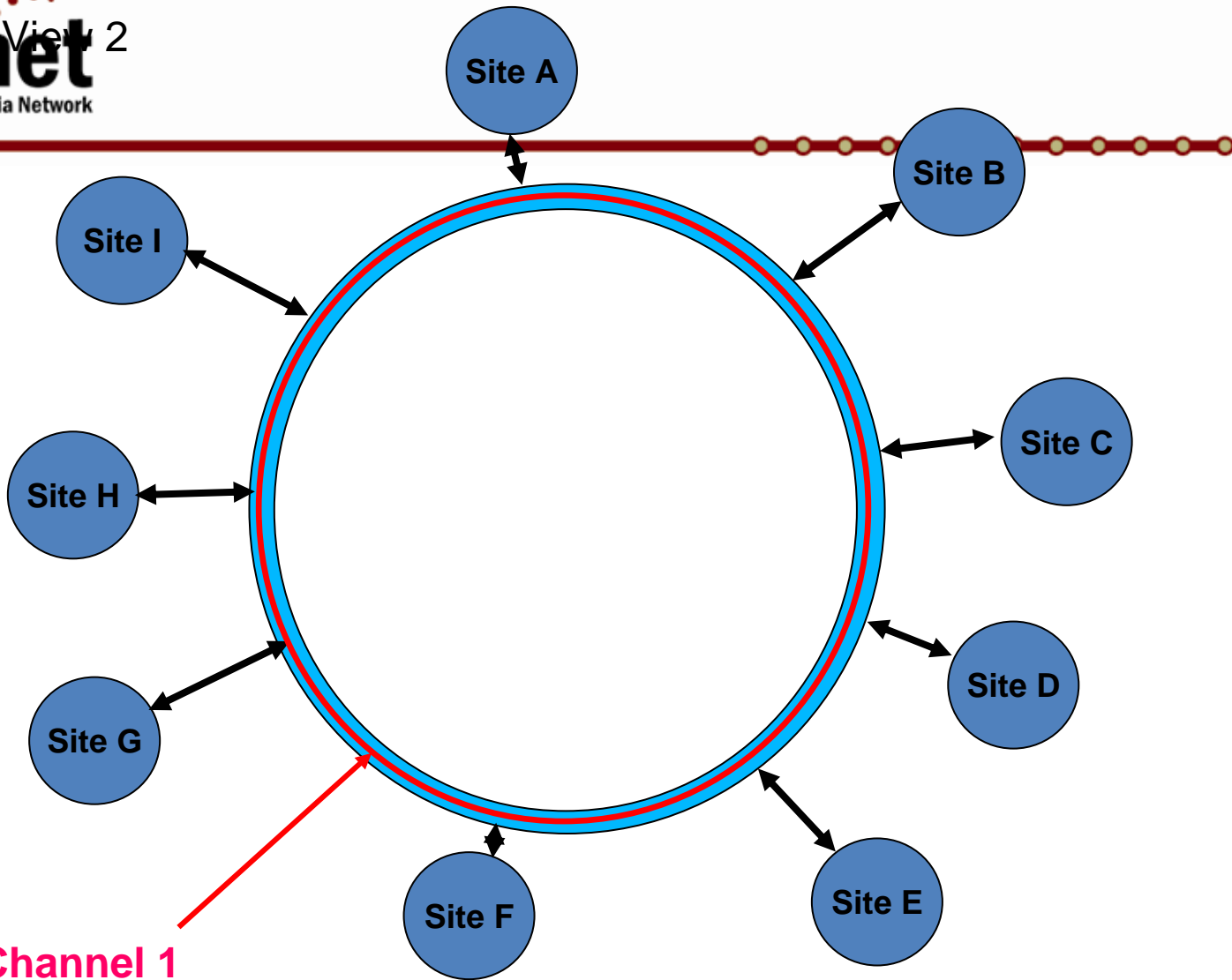
- Networks Can Be Virtualized – Such That They Appear As a Set of Software Resources That Are Accessed by Grid Services
- The Virtual Resources Approach Can Be Used To Partition a Network into Multiple Sub-Networks That Can Be Provisioned and Re-configured Within a Single Domain or Across Multiple, Independently Managed Domains
- Import Resources From Other Network Domains To Create End-to-End Solutions
- Export Resources To External Environments --
- Network Administrators Can Create Subsets of Their Network and Give Control of Those Resources To Other Network Providers Or To Their End users
- Users Can Also Join or Divide Lightpaths and Give Control and Management of These Private Sub-Networks to Other Users or Organizations
- Using the Virtual Resources, These Networks Can Be Reconfigured By the End-User Without Any Interaction By the Network Manager

***Does Software Exist That Can Accomplish These Objectives? –Yes  
(Demonstrated at GLIF 2008)***



- Argia is a production grade version of UCLP
- Argia is middleware that allows end-users (people or applications) to treat network resources as software objects and provision and re-configure lightpaths within a single domain or across multiple, independently managed domains
- Users can also join or divide lightpaths and hand off control and management of these private sub-networks to other users or organizations
- Argia enables the virtualization of a network that can be reconfigured by the end-user without any interaction by the optical network manager
- <http://www.inocybe.ca>





**Control Channel 1  
Using Argia**

# The RMS Concept

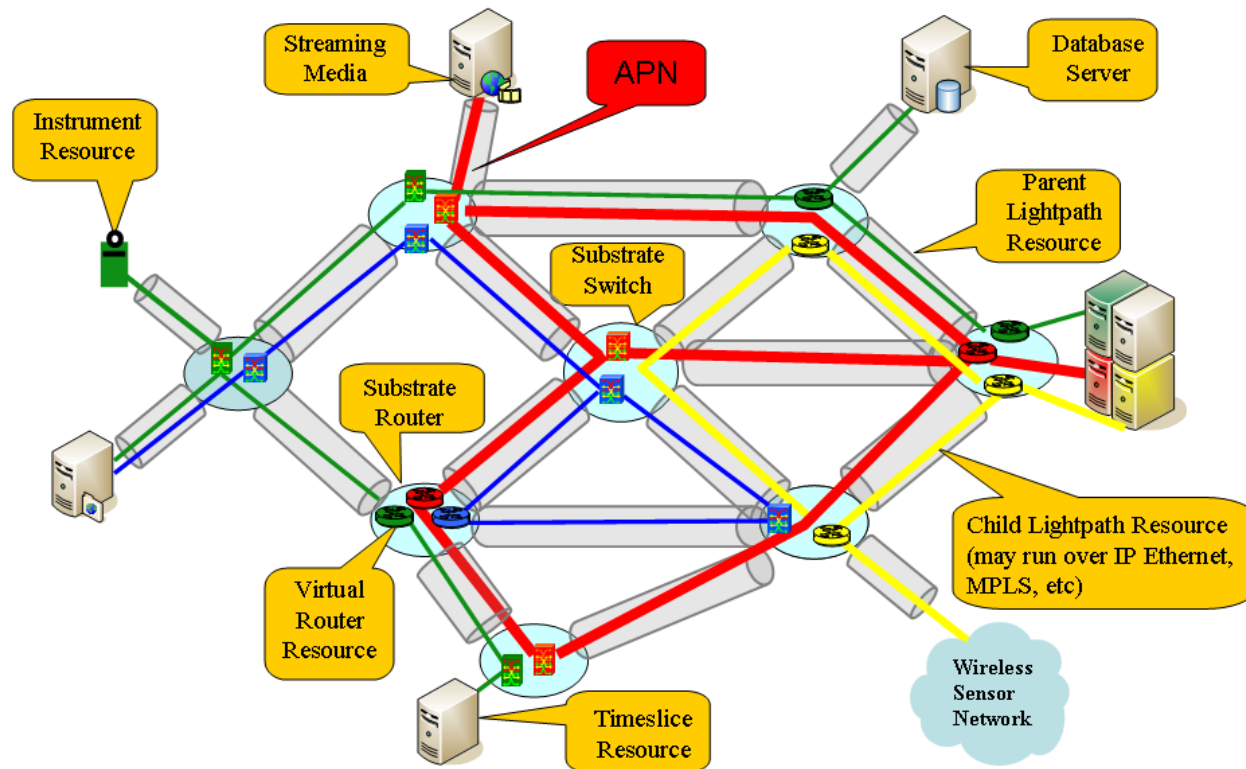
Using SOA and Web 2.0 technologies, Inocybe is bringing forward the first **Resource Management System** (RMS) to help Infrastructure as a Service (IaaS) providers manage their shared infrastructures

An RMS is essential to the next generation networks as it provides functionalities that are available in traditional network management systems but also has an easy to use interface for managing the virtualized entities, their ownership and pricing

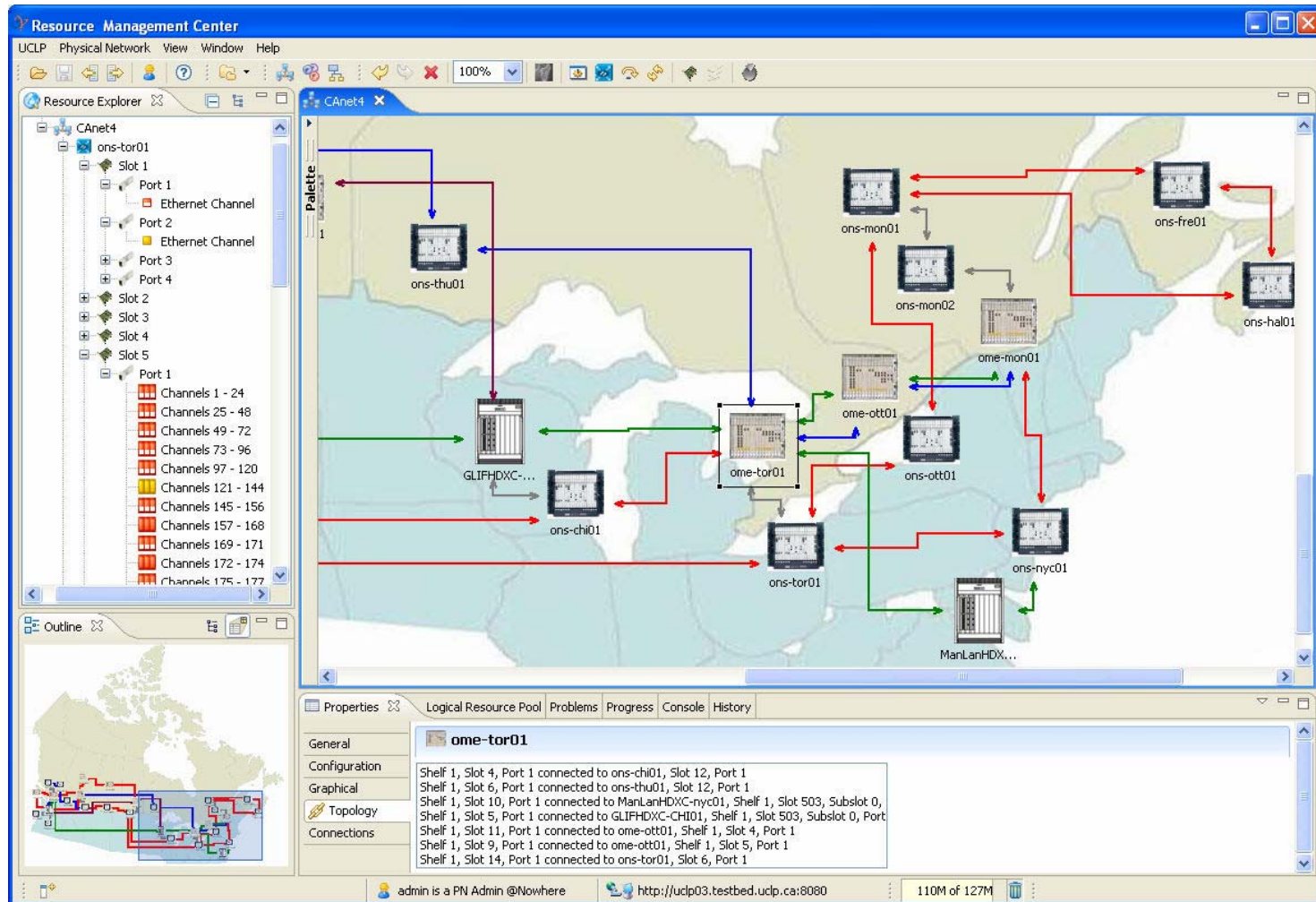
Argia™, the descendant of the UCLP Open Source Software, can be used for **virtualization and control of optical networks**

## Networks Capable Platforms

- A set of dedicated resources (Network, Instruments, Sensors) that can be manipulated through a web services interface
- Create several parallel application specific networks from a single physical network



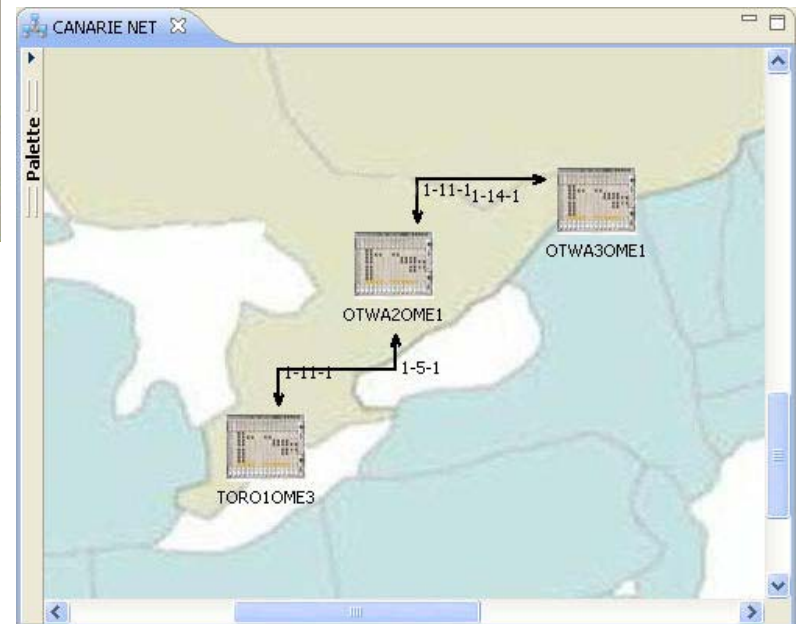
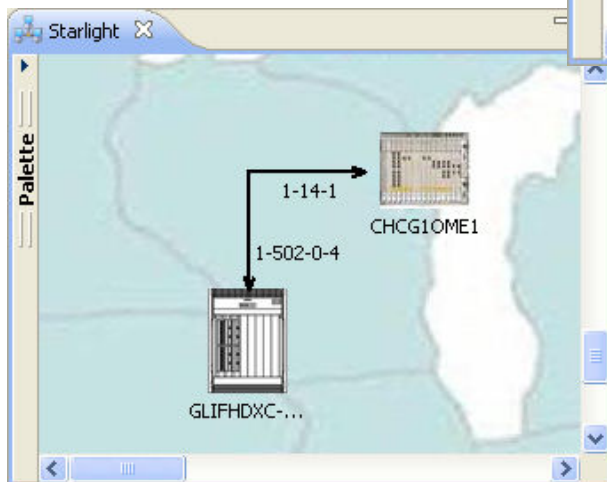
- Manage Networks With Traditional NMS Functionalities





## Multi-Domain Control

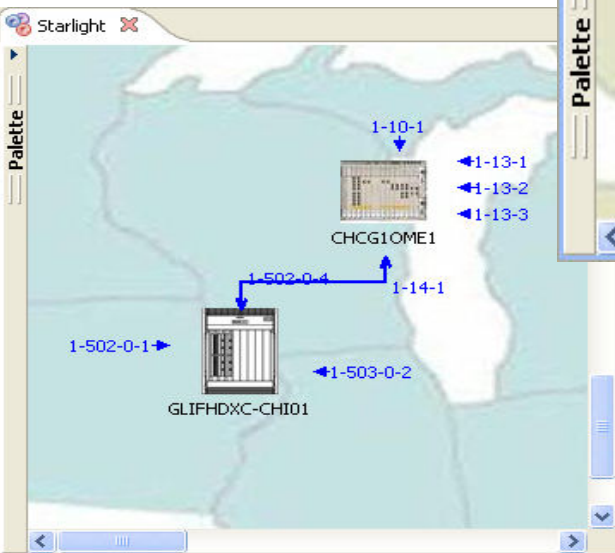
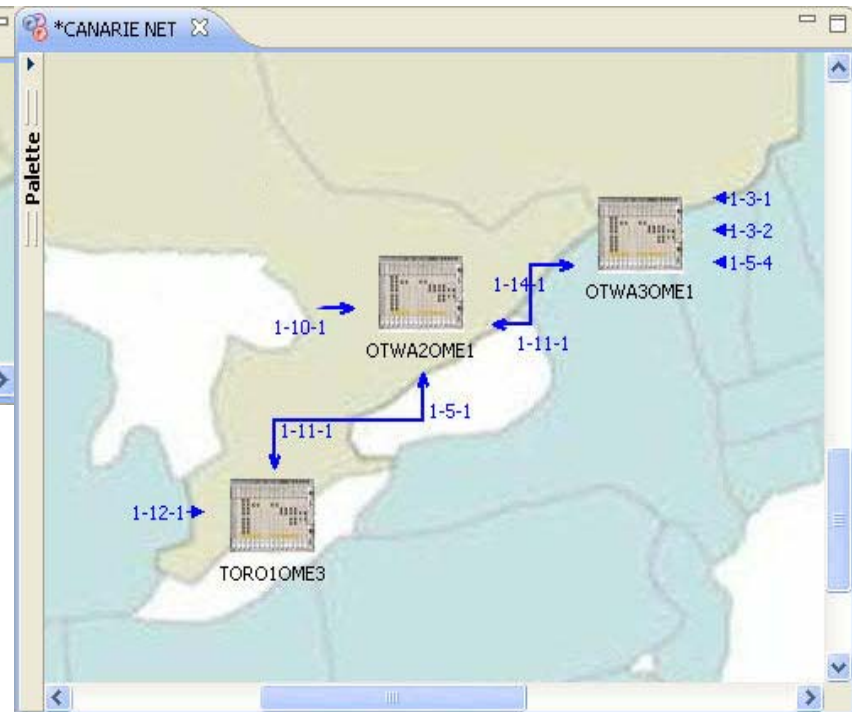
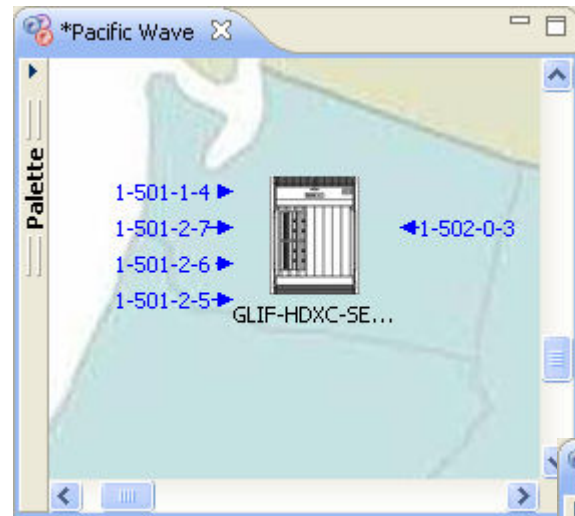
- The Network Admins must first create the physical network for their domain.
- There are four domains in the HPDMnet under the control of Argia.
  - Pacific Wave GOLE, STARLight GOLE, CANARIE Net and Nortel Networks



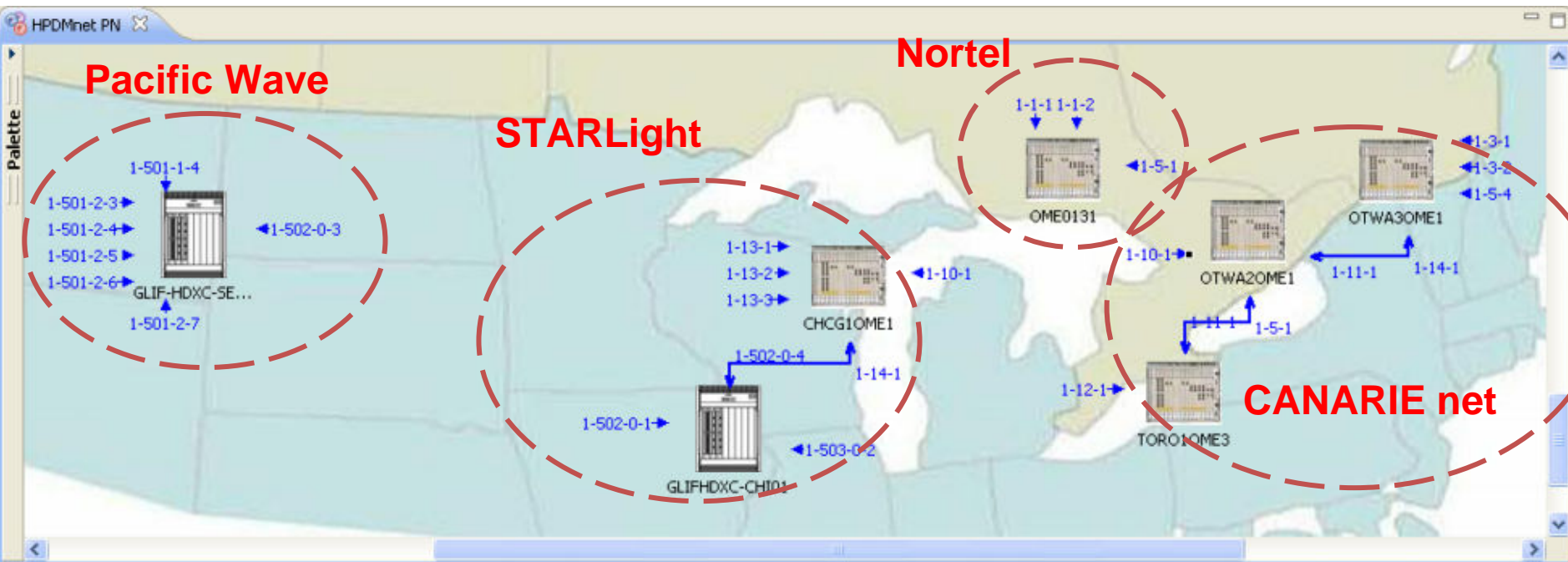


## Create Virtual Resources

- Resources are virtualized so they can be given away to other organizations to use at their own will
- The resources from the different independent domains will be exported to iCAIR to be used to create the HPDMnet

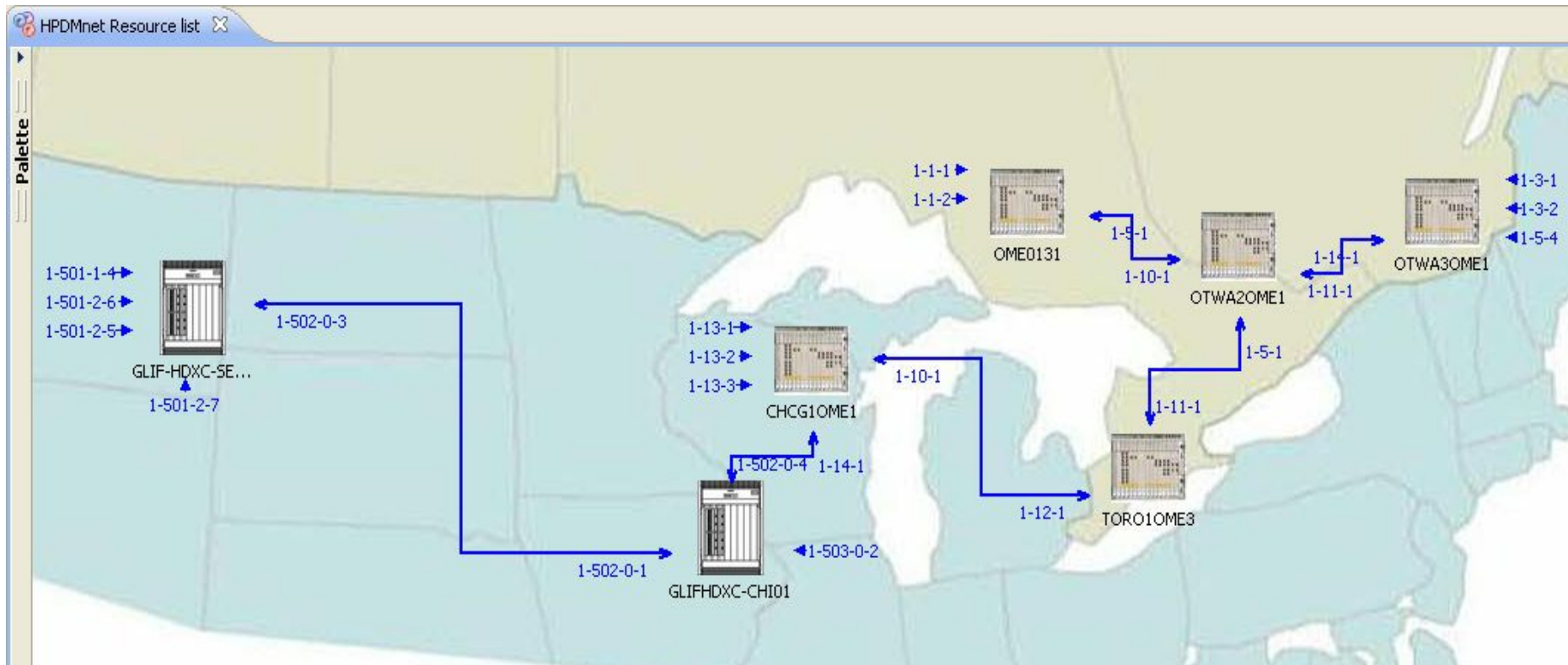


- Resources are imported by the Argia Administrator at iCAIR



## Complete the Resource List

- Links are created between the edge interfaces of each domain to create the final HPDMnet Resource List
- Users of the HPDMnet can create connections, reserve resources via Chronos, partition or bond resources, etc., all without having to contact the network administrators from each domain



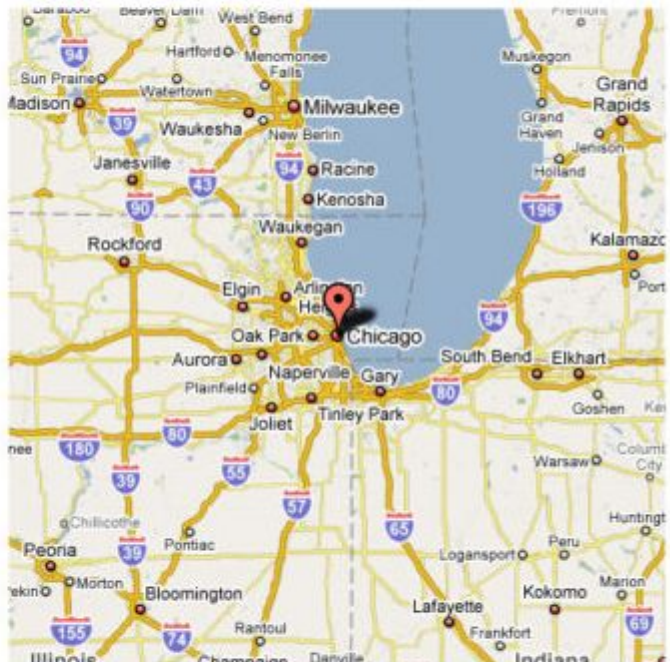
Reservations    Jobs    Draft Reservations    **Endpoints**

**All**    [Reload Network](#)

Endpoint IP: 10.0.1.37  
Endpoint IP: 10.0.1.36  
**Endpoint IP: 10.0.1.35**  
Endpoint IP: 10.0.1.25  
Endpoint IP: 10.0.1.48  
Endpoint IP: 10.0.1.40  
Endpoint IP: 10.0.1.28  
Endpoint IP: 10.0.1.11  
Endpoint IP: 10.0.1.10

**Information**

Endpoint IP:  Interface Type:   
Name:  Description:



The map shows the Chicago metropolitan area and surrounding regions in Illinois and Indiana. Major highways like I-94, I-55, I-80, and I-180 are visible. A red location pin is placed on Chicago, with a black shadow underneath it. The map includes labels for various cities and towns such as Milwaukee, Madison, Rockford, Aurora, Naperville, and Gary.



The screenshot displays the Chronos Resource Scheduler interface. At the top, there are four main tabs: Reservations (selected), Jobs, Draft Reservations, and Endpoints. Below these, there are six sub-tabs for reservation status: All (selected), Active, Pending, Cancelled by User, Cancelled by System, and Completed. A dropdown menu shows 'all' for 'Show reservations made:'. The main content area is titled 'All the Reservations' and contains a tree view of reservation details:

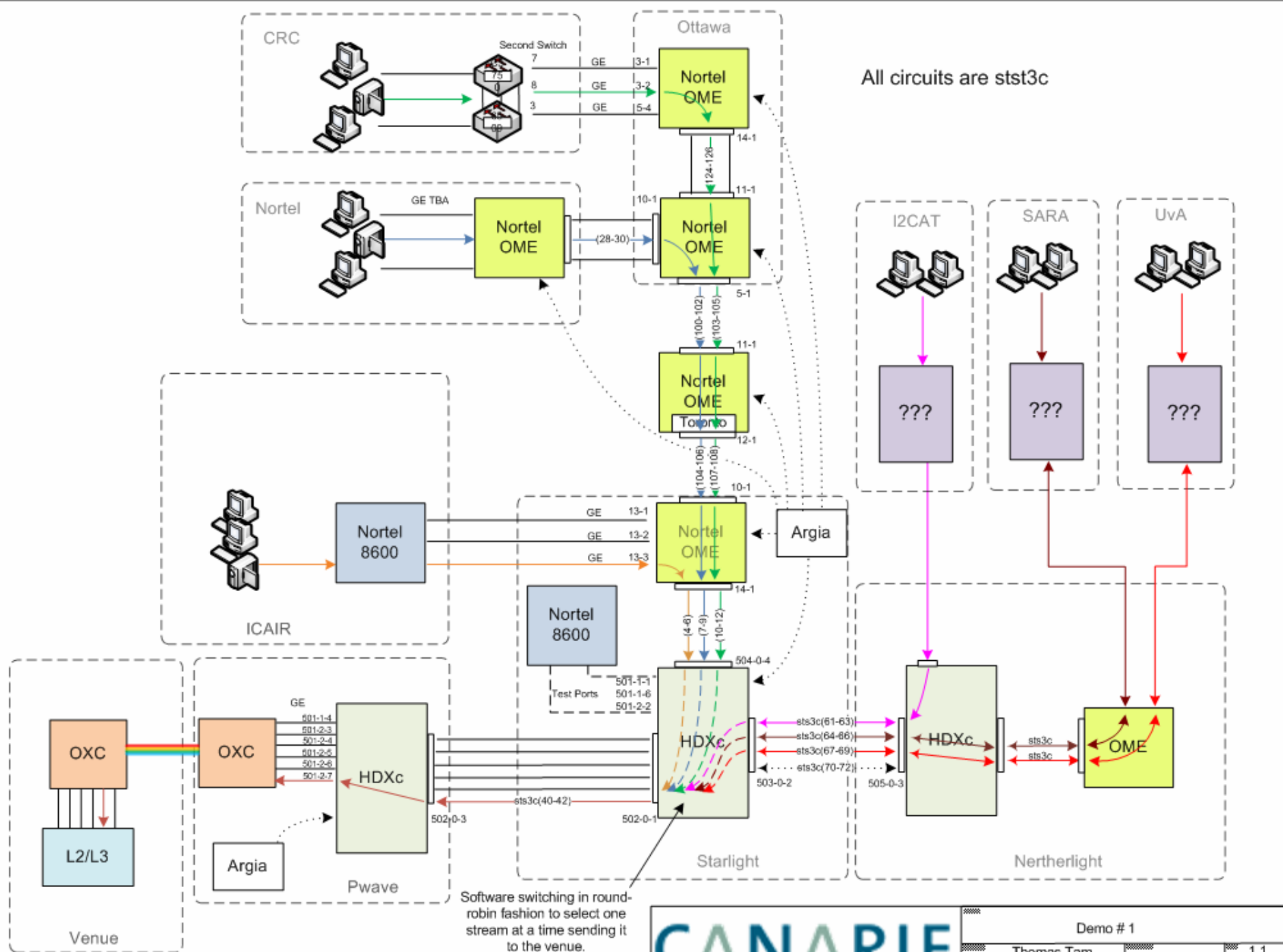
- Reservation ID: 3
  - Service ID: 1
    - Connection ID: 1
      - Endpoint IP: 10.0.1.1
      - Endpoint IP: 10.0.1.2
- Reservation ID: 2
  - Service ID: 1

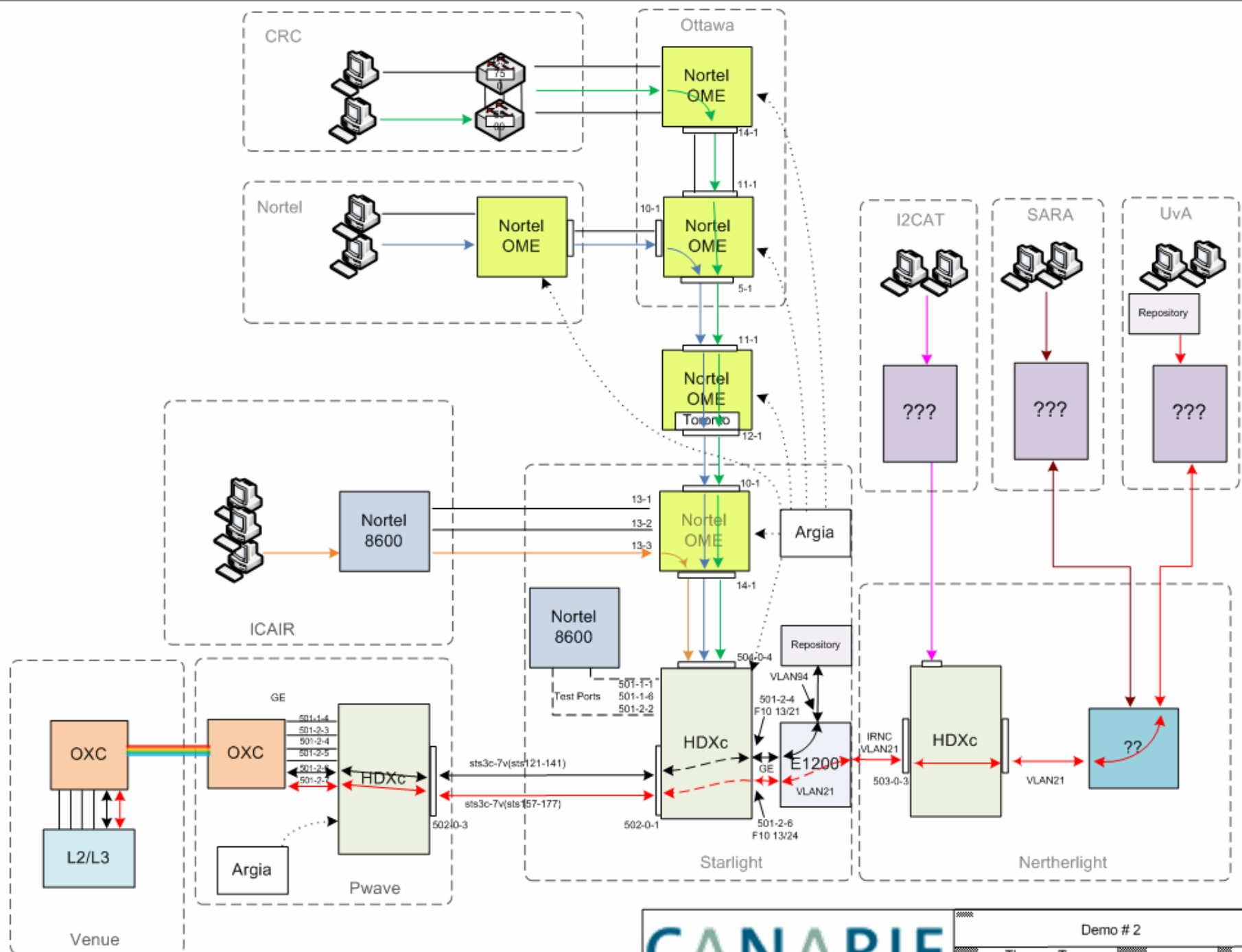
On the right side, there is a list of management actions:

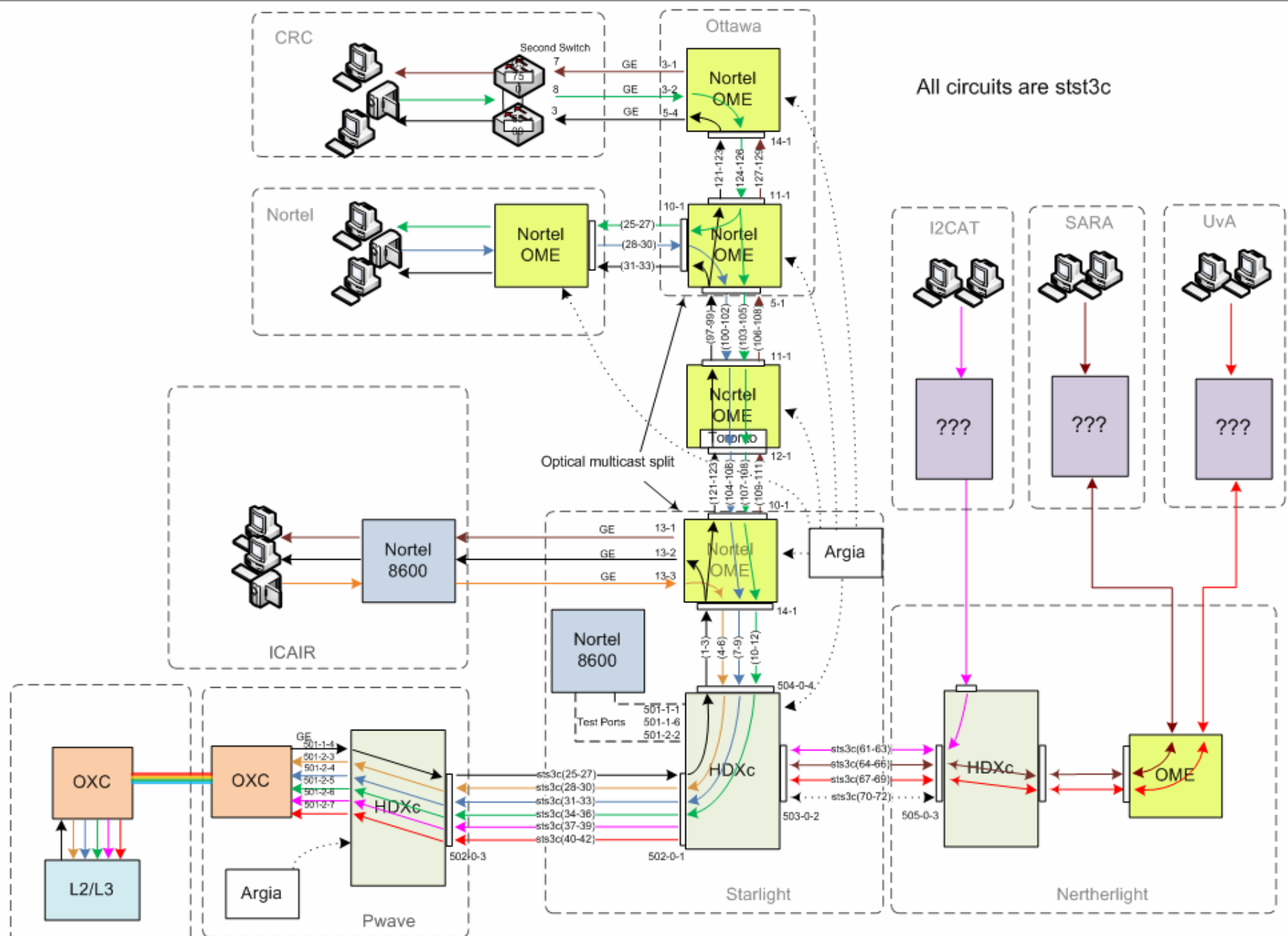
- Reload Network
- Is Available
- Create Reservation
- Delete Some Reservations
- Delete Completed Reservations
- Delete ALL Reservations

Below the tree view is an 'Information' section with the following details:

Service ID:	1	Type of reservation:	fixed
Status:	pending	Start Time:	30/09/2008 10:00:00
Automatic Activation:	true	End Time:	30/09/2008 11:01:00







All circuits are stst3c



CANARIE

CRC



NORTEL



STARLIGHT<sup>SM</sup>



UvA  UNIVERSITEIT VAN AMSTERDAM



GLIF R&D Projects

Standards Development

Projects, e.g, OGF, IETF,  
IEEE

US Based

EU Based

Asia Based

Etc

Example: MANTICORE:

Extension of IaaS Concepts

- Korea
- Czech Republic
- UCSD
- Dataville, Canada
- Etc.

## Providing Users with a Logical IP Network Service

Victor Reijs, HEAnet

Eduard Grasa, Fundació i2cat

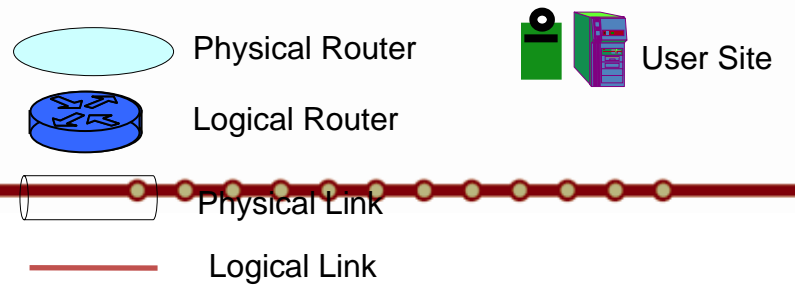
MANTICORE Partners (self funded project)



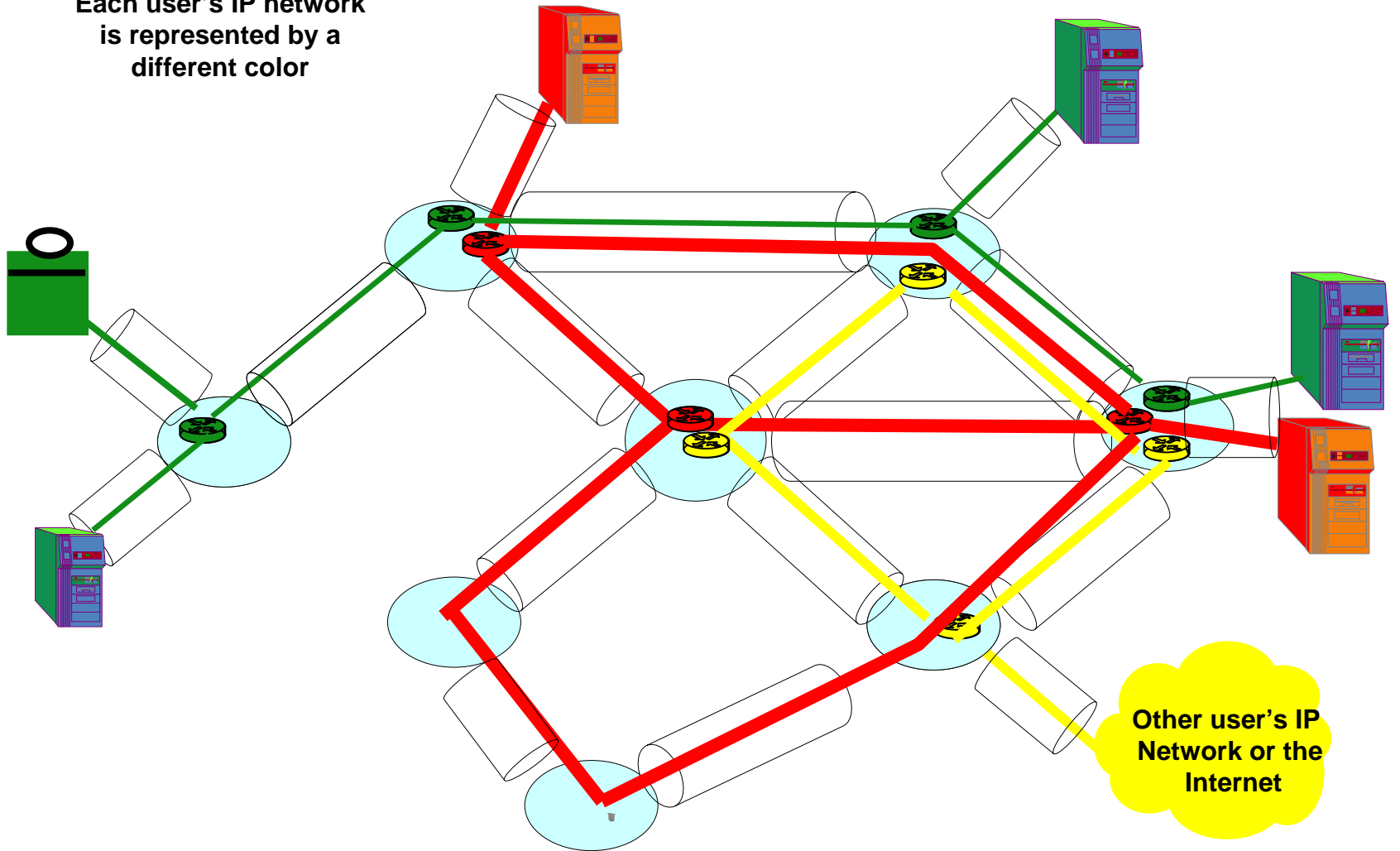
- A Web Service based system that provides the User (NOC and/or end user) with the ability to define and configure of its own physical and/or logical IP network
- Project partners:
  - HEAnet, i2CAT, Juniper, NORDUnet, RedIRIS

- Define the edge ports of the IP network
- Define the external Routing Service (policy)
- In case there are preferences on internal transport services, QoS: the internal Routing Service metric
- If available: IP address space

# MANTICORE Vision



Each user's IP network is represented by a different color



**Ref: [www.hpdmnet.org](http://www.hpdmnet.org)**