Internet2 DCN and Dynamic Circuit GOLEs

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Internet2 Strategic Plan

Operate a National R&E Network

Build Advanced Tools and Services Above the Network

Develop and Deploy Middleware

Enable Network Research

Become “Community Commons” for Cyberinfrastructure

Advocacy and Outreach to Advance National CI

Technology Transfer

Work as a Community and with Partners

http://www.internet2.edu/strategicplanning/

Cyberinfrastructure and the Internet2 Community

- Operating advance services by and for the community
  - e.g. Networks, Observatories, Federations
- Experimenting with developmental services
  - e.g. Dynamic Circuits, Distributed Monitoring, Hybrid Networking
- Adopting new technologies
  - e.g. Workshops, Targeted Communities
- Partnering with like-minded organizations

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Integrated Systems Approach

- What does “Integrated” mean?
  - Interoperable
  - Widely Deployed
  - Community Best Practices
  - Extensible
- Observation: Building distributed systems that operate as a larger distributed system

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Distributed System Design Goals

- Take existing scientific applications, without recompilation or awareness of circuits, e.g.
  - Bulk File Transfer
  - Real Time
  - Video
- Exploit performance possibilities of new networking technologies
- Preserve “current politics of business,” (don’t upset the apple cart)
- Improve efficiency of problem diagnosis (eliminate reliance on “old boy network”)

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Distributed System Requirements

- These distributed systems share common requirements:
  - Heterogeneous network architecture
  - Multiple administrative entities; no central authority
  - Local customization of operational environment
  - Applications driven by orthogonal virtual organizations
- Suggests parallel design approach
  - Toolkit approach
  - Web services / defined APIs

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Distributed Systems for Networks

- To build next generation networks, we need distributed software systems on top of the network hardware
  - Session-Application (Session-Layer tools [e.g. Phoebus], Community-specific abstraction applications [e.g. Lambda Station, Terapaths], true applications)
  - Dynamic Circuit Networks (DCN, e.g. Internet2 DCN, ESnet SDN, GÉANT2 Autobahn)
  - Performance Measurement Framework (e.g. perfSONAR)
  - Information Services (IS)
    - Discovery
    - Topology
  - Authentication, Authorization, and Accounting (AAA, e.g. Shibboleth, etc.)

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perfSONAR

- A collaboration
  - Production network operators focused on designing and building tools that they will deploy and use on their networks to provide monitoring and diagnostic capabilities to themselves and their user communities.
- An architecture & a set of protocols
  - Web Services Architecture
  - Protocols based on the Open Grid Forum Network Measurement Working Group Schemas
- Several interoperable software implementations
  - Java, Perl, Python…
- A Deployed Measurement infrastructure

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Dynamic Circuit Networking

- Provides short-term dedicated bandwidth
- Similar and complementary to IP (Internet Protocol) networking:
  - Protocol-based connections
  - Connect to anyone else on the network
- Supports high-bandwidth and real-time applications being developed and deployed by a number of R&E networks
- More flexible (and potentially more cost-effective) than long-term dedicated circuits

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DCN Software Suite Status

- Open Source
- Version 0.4 released December 2008
- Introduced many new features:
  - Protocol enhancements
  - Notification interface
  - VLAN Translation
  - Information Service Integration
- Currently deployed at 12 sites

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Next DCN Software Suite Release

- Open Source
- Version 0.5 will be released in March
- Focus on internal architecture changes and pilot service preparation
  - Modularization of interfaces and components
  - Pluggable policy engine
  - Automatic topology generation
  - Simplified inter-domain configuration

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Internet2 DCN Status

- Internet2 operates the Internet2 Dynamic Circuit Network (DCN)
  - Used for “proto-duction” services for about 2 years
    - 5243 circuit creations since 1/1/08, of which 573 to Europe
  - Working on a pilot service to be deployed this summer
- Worked with DICE group to define IDC protocol
  - Protocol implemented by ESnet OSCARS, GÉANT2 Autobahn, Internet2 DCN SS
- IDC protocol has been used for demos by UvA, NorduNet, JGN
- Internet2 is interested in demonstrating interoperability with other non-IDC systems

Use of the DCN Software Suite 0.4

Connectors	Running IDC	Using DCN SS
CENIC	No	No
CIC OmniPoP	No	No
GPN	Planned	Planned
LEARN	Yes	Yes
LONI	Yes	Yes
MAX	Yes	Yes
Merit	Planned	Planned
NOX	No	No
NYSERNet	Yes	Yes
PNWGP	No	No

Use of the DCN Software Suite 0.4 (cont.)

Networks	Running IDC	Using DCN SS
ESnet	Yes	Yes
AutoBAHN/GEANT	Yes	No
NetherLight	Planned	No
JGN	Yes	Yes
USLHCnet	Yes	Yes
Local/ Campus	**Running IDC**	**Using DCN SS**
Northrop Grumman	Yes	Yes
University of Amsterdam	Yes	Yes
CalTech	Yes	Yes
University of Houston	Yes	Yes
Texas A&M University	Yes	Yes

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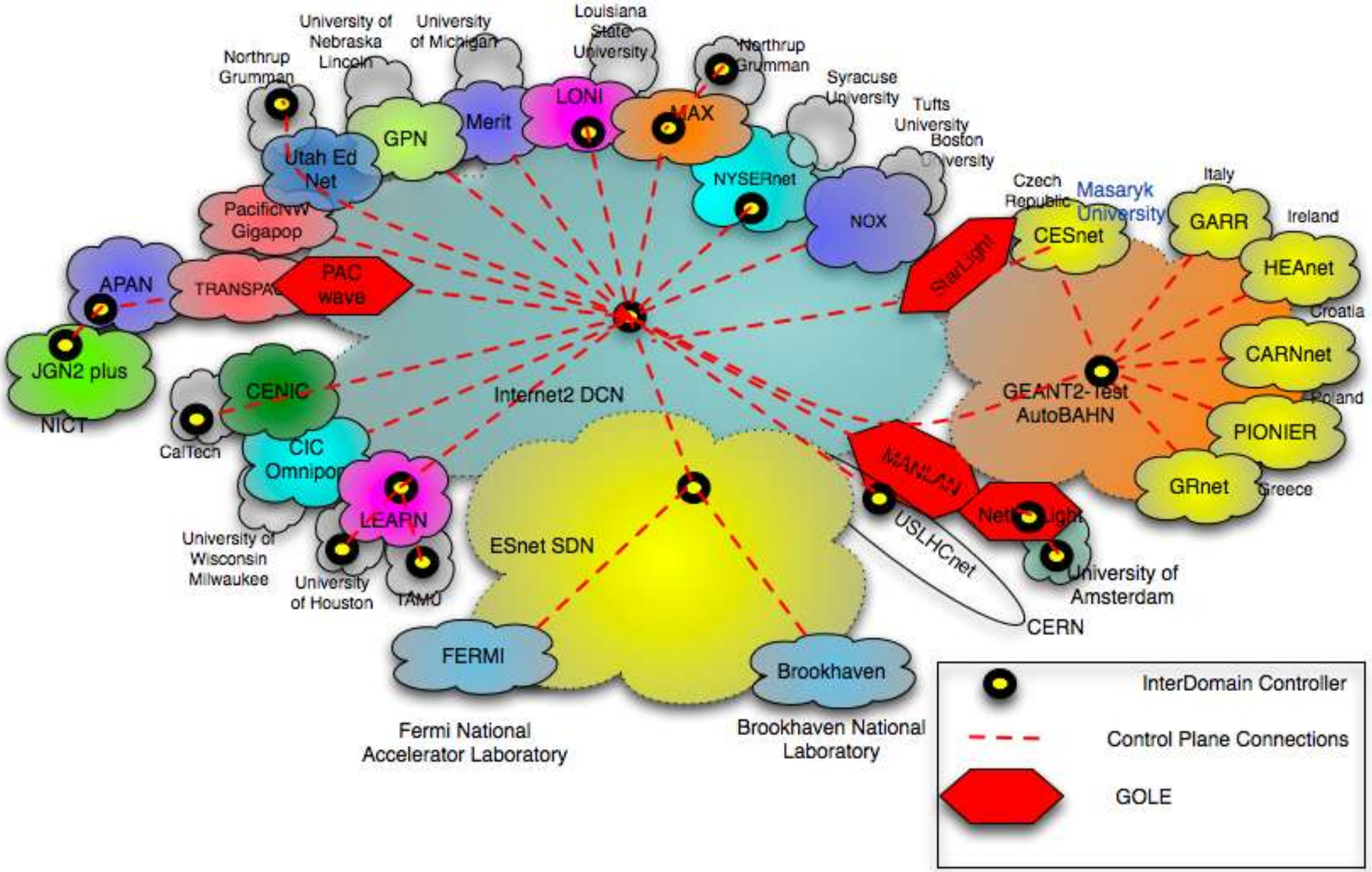
Global Dynamic Circuit Network



Behind the Scenes: LHC / iHDTV Demo

FMM08 iHDTV Demo

New Orleans – CERN

v9

End System Addressing:
10.32.17.x/24 : NIC 1 on iHDTV machines
10.32.22.x/24 : NIC 2 on iHDTV machines

Data Flows
CERN Sender to NO Receiver:
17 .1 ---->17 .2 (vlan 3217)
22 .1 ---->22 .2 (vlan 3222)

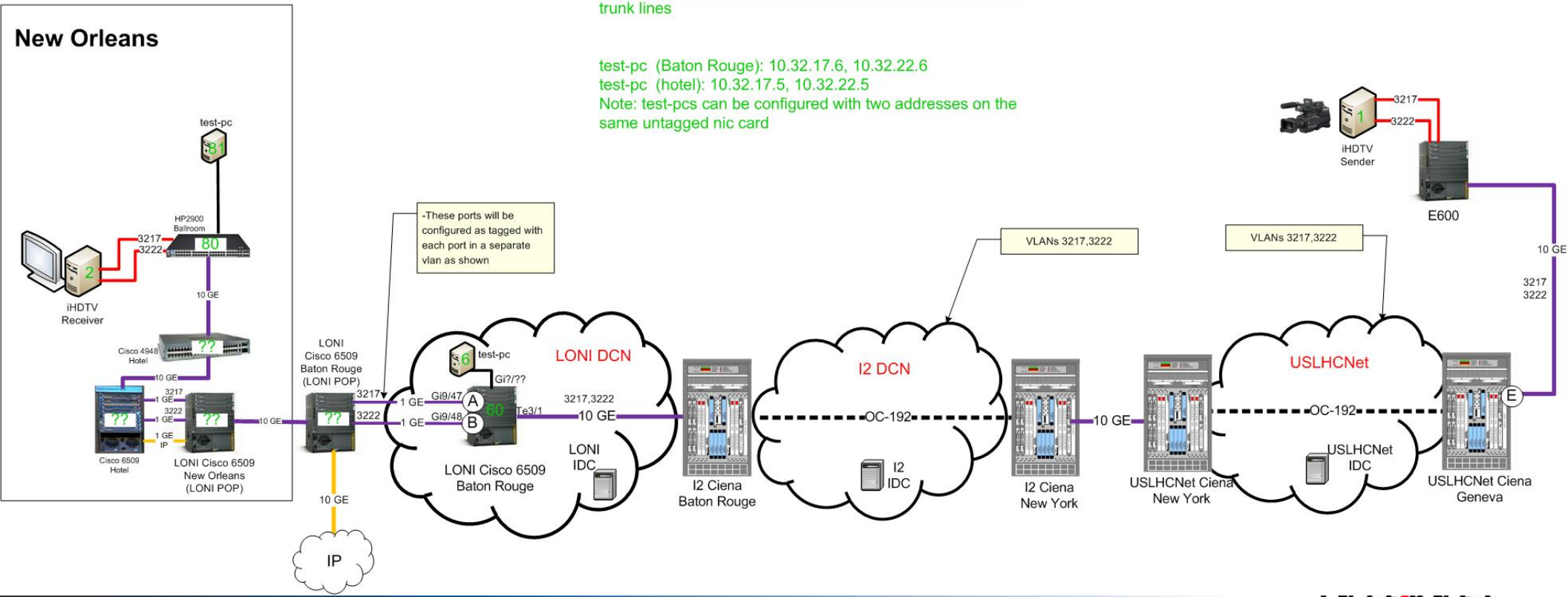
Note: all the end systems can be configured as untagged, the vlan#s are shown just to show how flows are mapped on trunk lines

test-pc (Baton Rouge): 10.32.17.6, 10.32.22.6
test-pc (hotel): 10.32.17.5, 10.32.22.5
Note: test-pcs can be configured with two addresses on the same untagged nic card

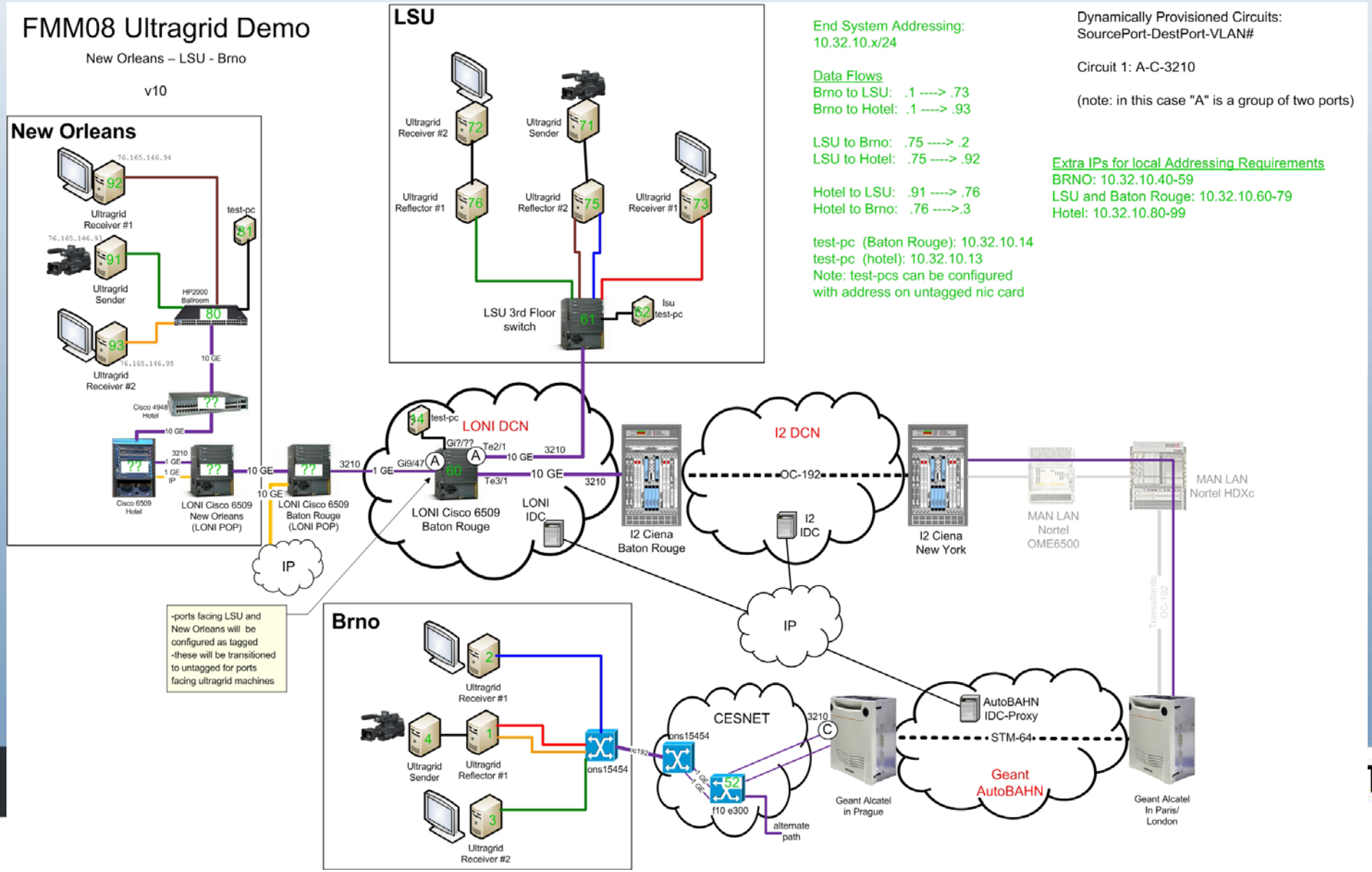
Dynamically Provisioned Circuits:
SourcePort-DestPort-VLAN#

Circuit 1: A-E-3217

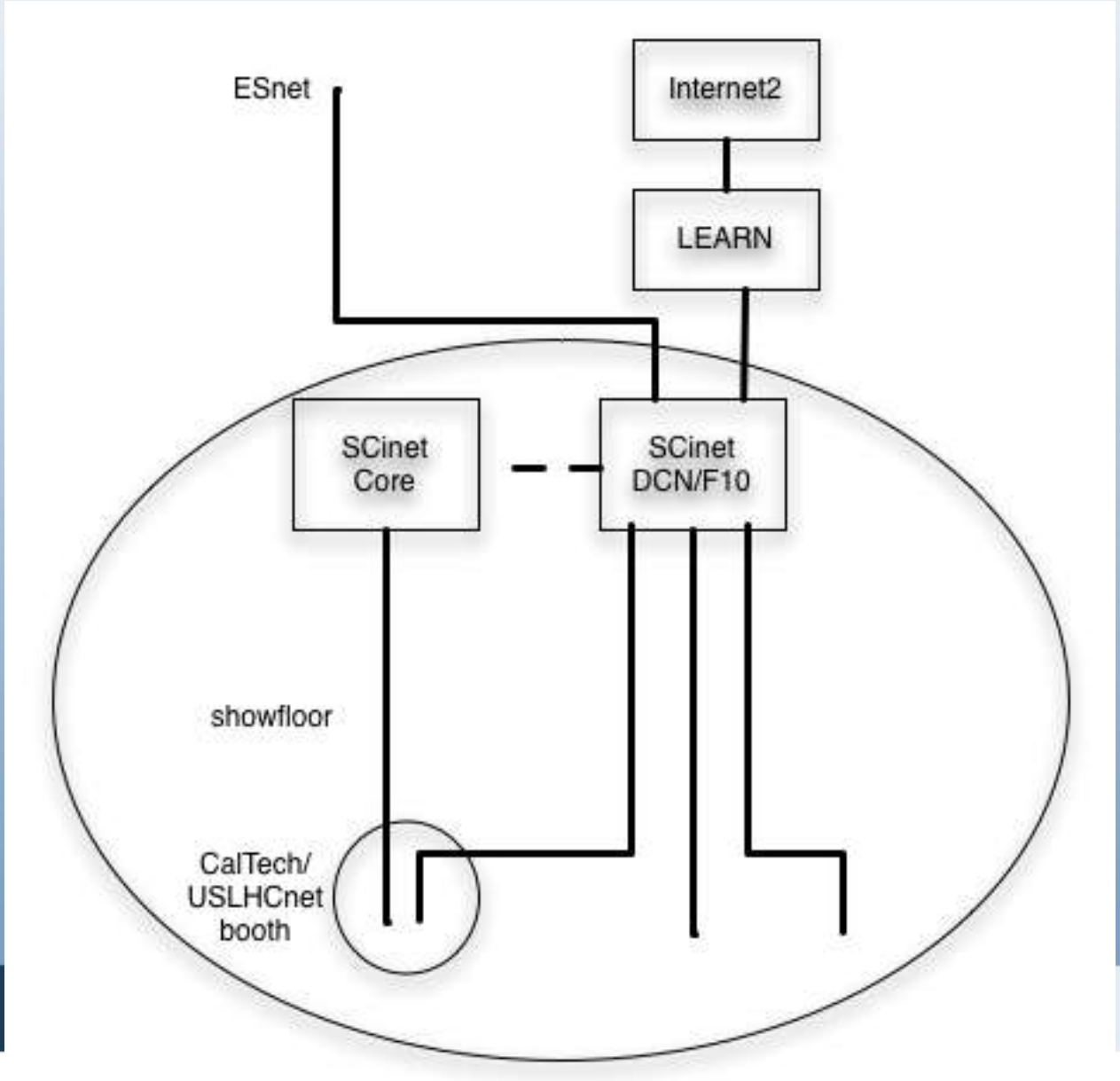
Circuit 2: B-E-3222



Behind the Scenes: Distance Learning / Ultragrid Demo

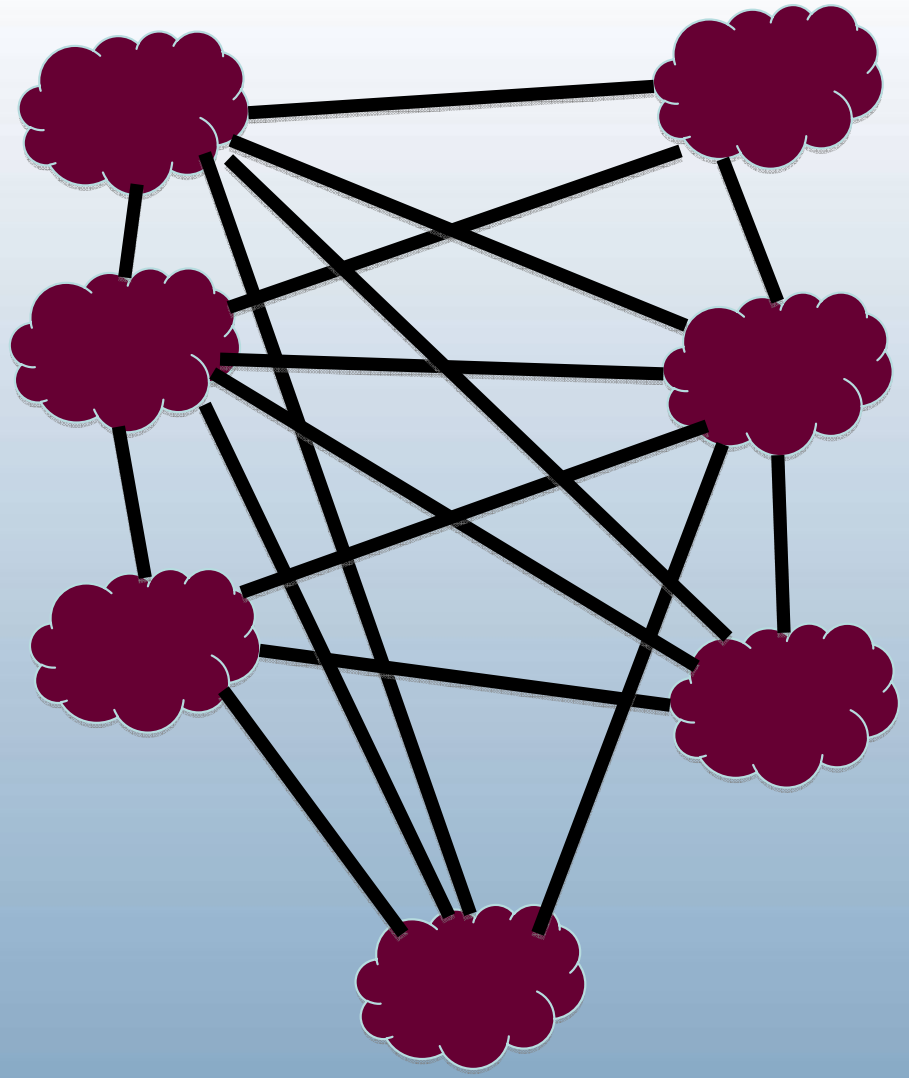


Behind the Scenes: SC08 Configuration

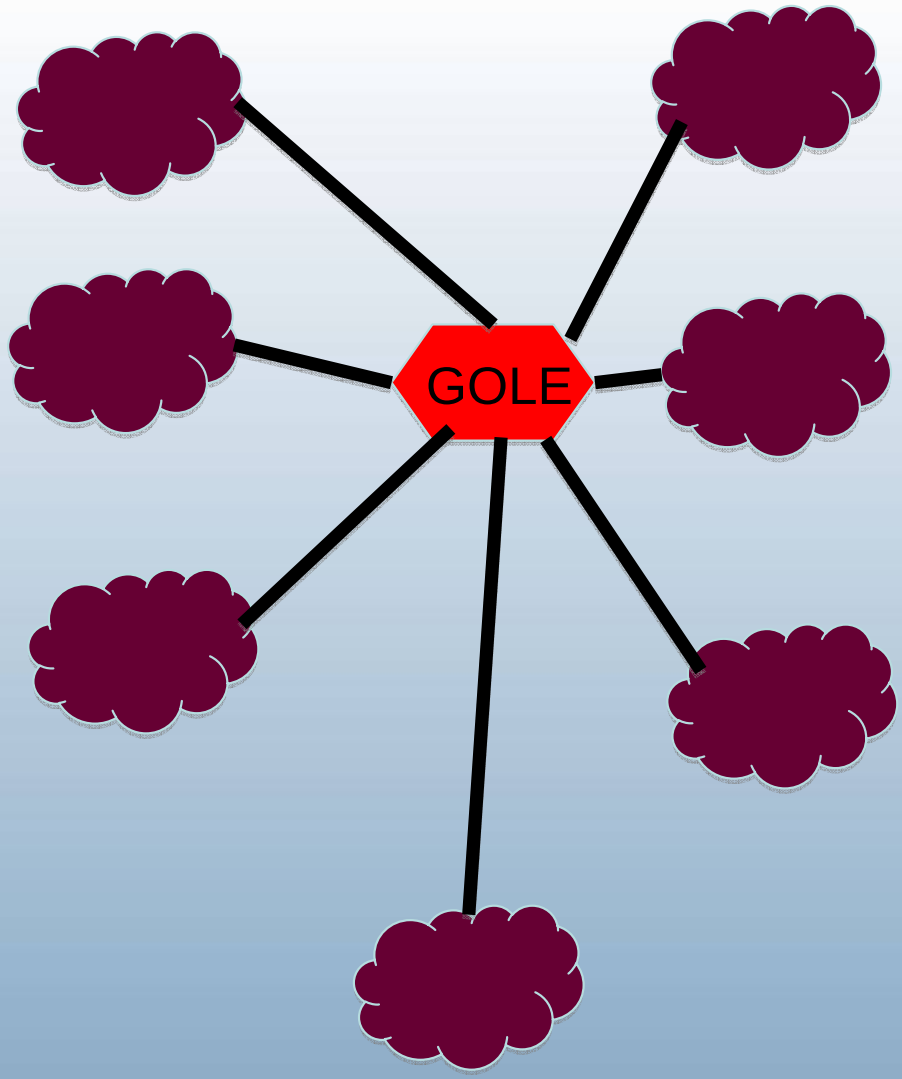


GOLEs and Internet2

- Internet2 is both a user and operator of Exchange Point(s)
- Operates MANLAN in cooperation with NYSERNET and IU GRNOC
- Current DCN connects to 3 GOLEs
  - MANLAN, StarLight and PacWave
- Connection in all current cases is Ethernet with VLANs
- Current GOLEs provide “static” trunks to other networks connected to GOLE
- Actively investigating Dynamic Circuit GOLE as both user and provider



Without GOLE



With GOLE

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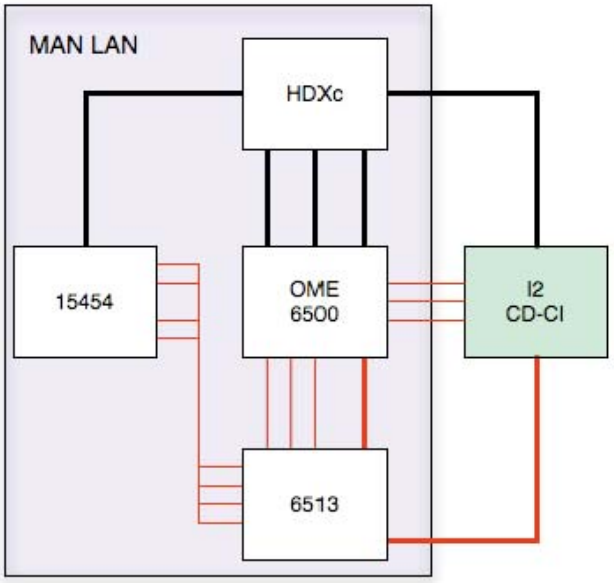
Internet2 DCN Connectivity to MAN LAN

MAN LAN DCN Connectivity

Nortel HDXc	
Geant2 London	Geant2 Paris
MAN LAN 15454	MAN LAN OME
MAN LAN OME	MAN LAN OME
GEANT M160	Internet2 Ciena
CA*Net4 (NYC) via OME	Netherlight (Qwest)
CA*Net Toronto via OME	Netherlight (Qwest)
	Netherlight (GLBX)

Nortel OME6500	
MAN LAN 6513 10 GE (Geant2 Peering	MANLAN HDXc OC-192
MAN LAN 6513 1GE	MAN LAN HDXc OC-192
MAN LAN 6513 1GE	MAN LAN OME OC-192
MAN LAN 6513 1GE	MAN LAN OME OC-192
MAN LAN 6513 1GE (SURFNET)	Internet2 Ciena 1GE (Geant2)
Internet2 Ciena 1GE (UvA)	Internet2 Ciena 1GE (Geant2)



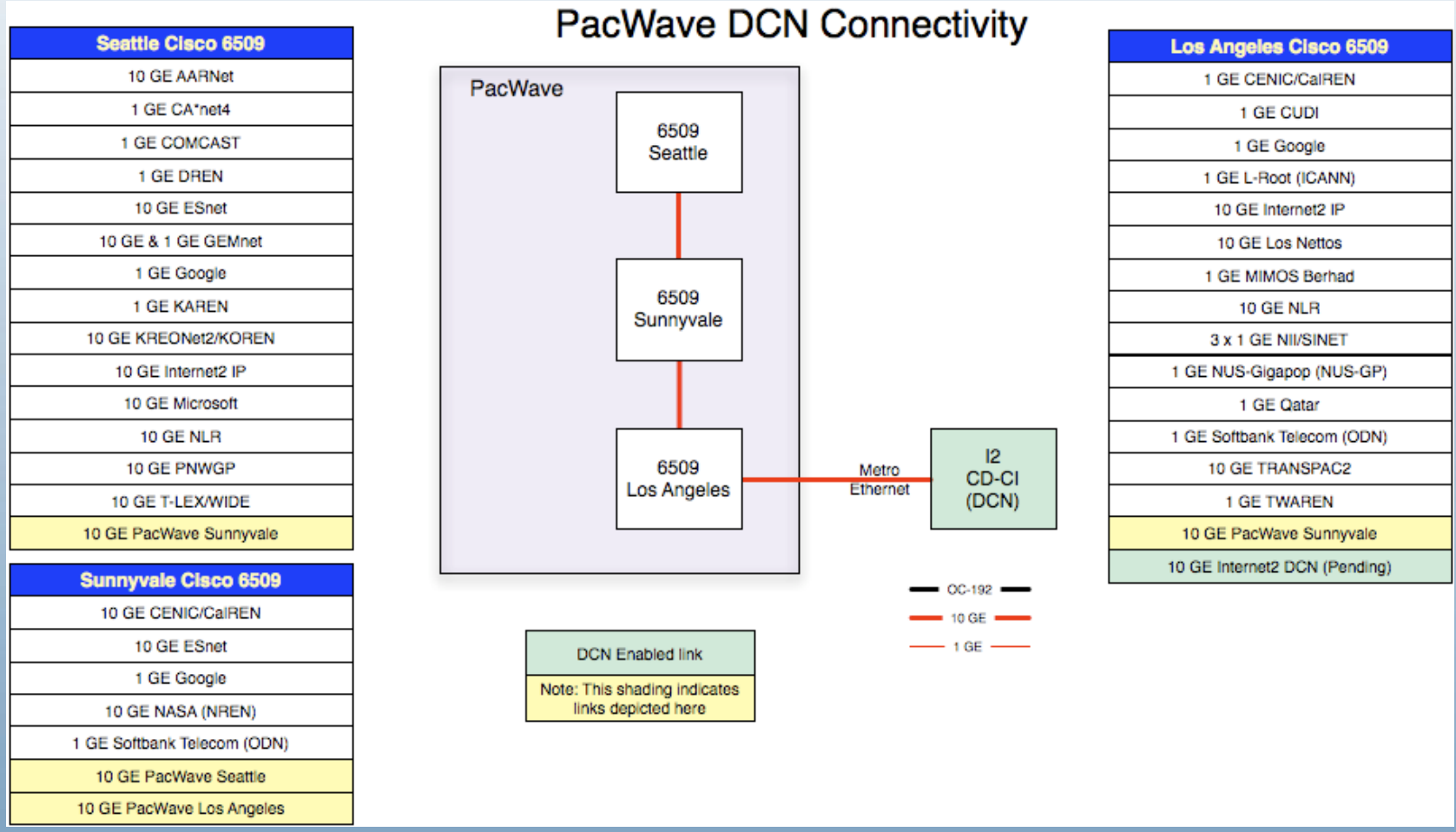
DCN Enabled link
Note: This shading indicates links depicted here

Cisco 6513	
1GE	10 GE
CA*Net4 Montreal	USLHCNet Ciena
CA*Net4 Toronto	USLHCNet IP Peering
SURFNET (via OME)	ESNET SDN
QATAR	ESNET IP Peering
MCIT/ENERGI	SINET
NYSERNet	Internet2 NEWY router
TWAREN	Internet2 Ciena
ANKABUT	GEANT2 via OME
DRAC PC	Atlantic Wave
MAN LAN 15454	NLR Layer 2
MAN LAN 15454	NLR Layer 3
MAN LAN 15454	MAN LAN OME
MAN LAN 15454	
MAN LAN OME	
MAN LAN OME	
MAN LAN OME	

Cisco 15454	
TWAREN OC-48	MAN LAN HDXc OC-192
SURFNET IEEAF OC-12	Gloriad (???) OC-12
MAN LAN 6513 1GE	MAN LAN 6513 1GE
MAN LAN 6513 1GE	MAN LAN 6513 1GE

OC-192
10 GE
1 GE

Internet2 DCN Connectivity to PacWave

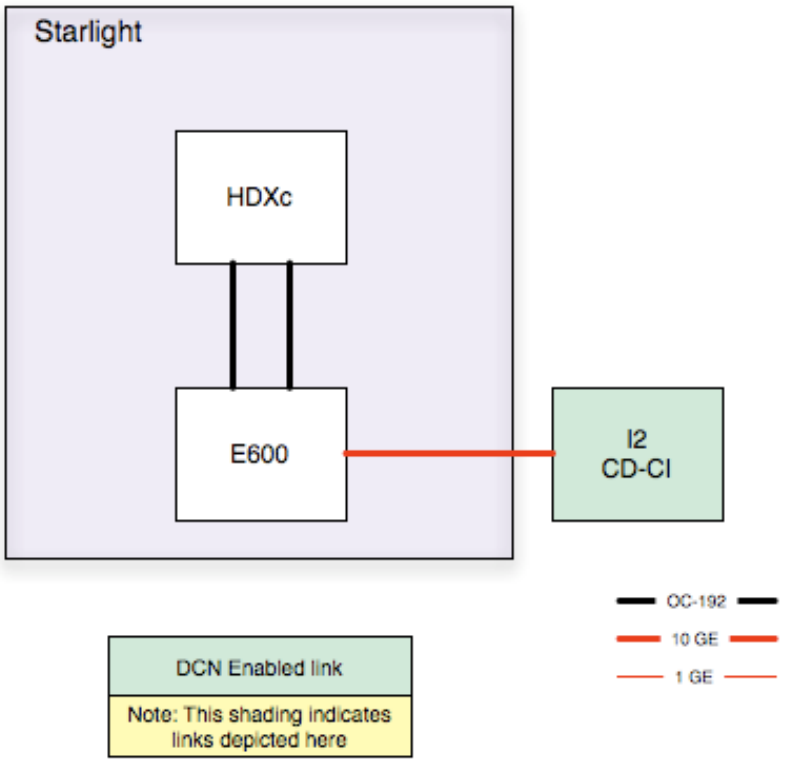


Internet2 DCN Connectivity to Starlight

Starlight DCN Connectivity

Nortel HDXc
2 x OC-192: Amsterdam IRNC and Surfnet
4 x OC-192: Canada, Seattle, Korea Taiwan, NYC, Amsterdam, GLORIAD
N x OC-192 via DXs: OMNInet2
2 x OC-192: Force10

Force10 E600	
6 x 1GE: UKLight (London)	10GE: JGN II (Tokyo)
1 GE: HARnet (Hong Kong) : CERnet (China)	2 x 1GE: ASNet (Taiwan)
1GE: SINET (Japan)	10 GE: MREN
10 GE: NLR	10 GE: Internet2 IP
2 x 10 GE: CAVEWave/NLR	10 GE: Internet2 Ciena
10 GE: Fermilab DWDM	Internet2 Ciena 1GE (Geant2)
N x OC-192: Calient	N x 10 GE: ESnet, NREN, NASA/GSFC, NISN, DREN...
10 GE: Fermilab DWDM	10 GE: TeraGrid
10 GE: Caltech	N x 10 GE: Clusters (Starlight, NU, NSCA, IU)



Thoughts about Dynamic Goles

- General Value of Dynamic GOLE
  - saves ports in certain situations
  - simplifies connections between many users
- Networks connect to Dynamic GOLE in their area or to the Dynamic GOLE with networks they want to reach
- Where would Dynamic GOLEs be useful?
- GOLEs may connect to other GOLEs
  - How would this happen?
  - What would it mean?
- Requests to GOLE should be automated
  - Allow connections to be created by users
    - From web page or by protocol
  - Work with OGF/NSI and GLIF GUSI to develop protocol
- Dynamic GOLE must be policy neutral

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Policy Neutral Dynamic GOLEs

- Dynamic GOLE facilitates decisions made by Link owners
  - Does not make policy decisions itself
  - Every Link is in a policy domain
- GOLE verifies that Link owners agree to request to connect segment from Links
- GOLE guarantees that connected segments are from requested Links
- Non-blocking GOLE does no advance reservation
  - If needed, advanced reservation is done by Link owners
  - If there is a resource limitation within the GOLE or between GOLES, you may also need to do advanced reservation

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Proposed Next Steps

- Create GLIF DC-GOLE TF
- Describe expectations for DC GOLE
  - Suggest initial case be switching VLANs
- Define alternative implementations
- Provide use cases
- Define security and trust requirements
- Define protocol requirements and evaluate protocol candidates
- Define monitoring requirements
- Incorporate DC GOLE into GOLE SLAs

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Questions?

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