

Software-Defined Network Exchanges (SDXs) and Software-Defined Infrastructure (SDI)

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Northwestern University

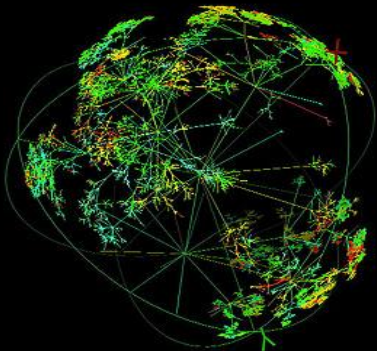
Director, Metropolitan Research and Education Network (www.mren.org)

Co-Director, StarLight, PI-iGENI, PI-OMNINet (www.startap.net/starlight)

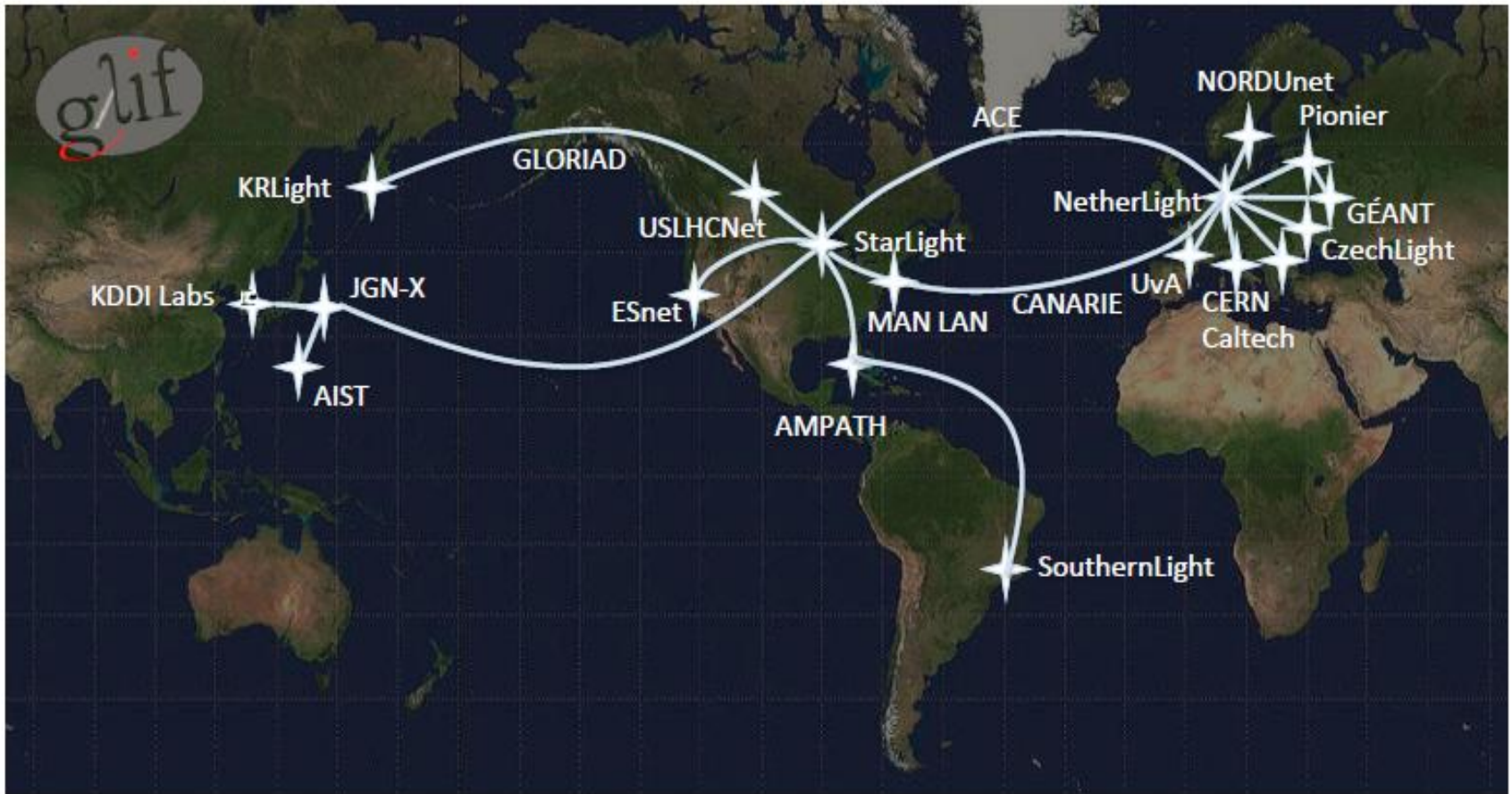
**Workshop on Prototyping and Deploying
Experimental Software Defined Exchanges (SDXs)**

Washington DC

June 5-6, 2014



Automated GOLE Fabric



Source: GLIF Auto GOLE Group

GLIF AutoGOLE Initiative Oct 2013

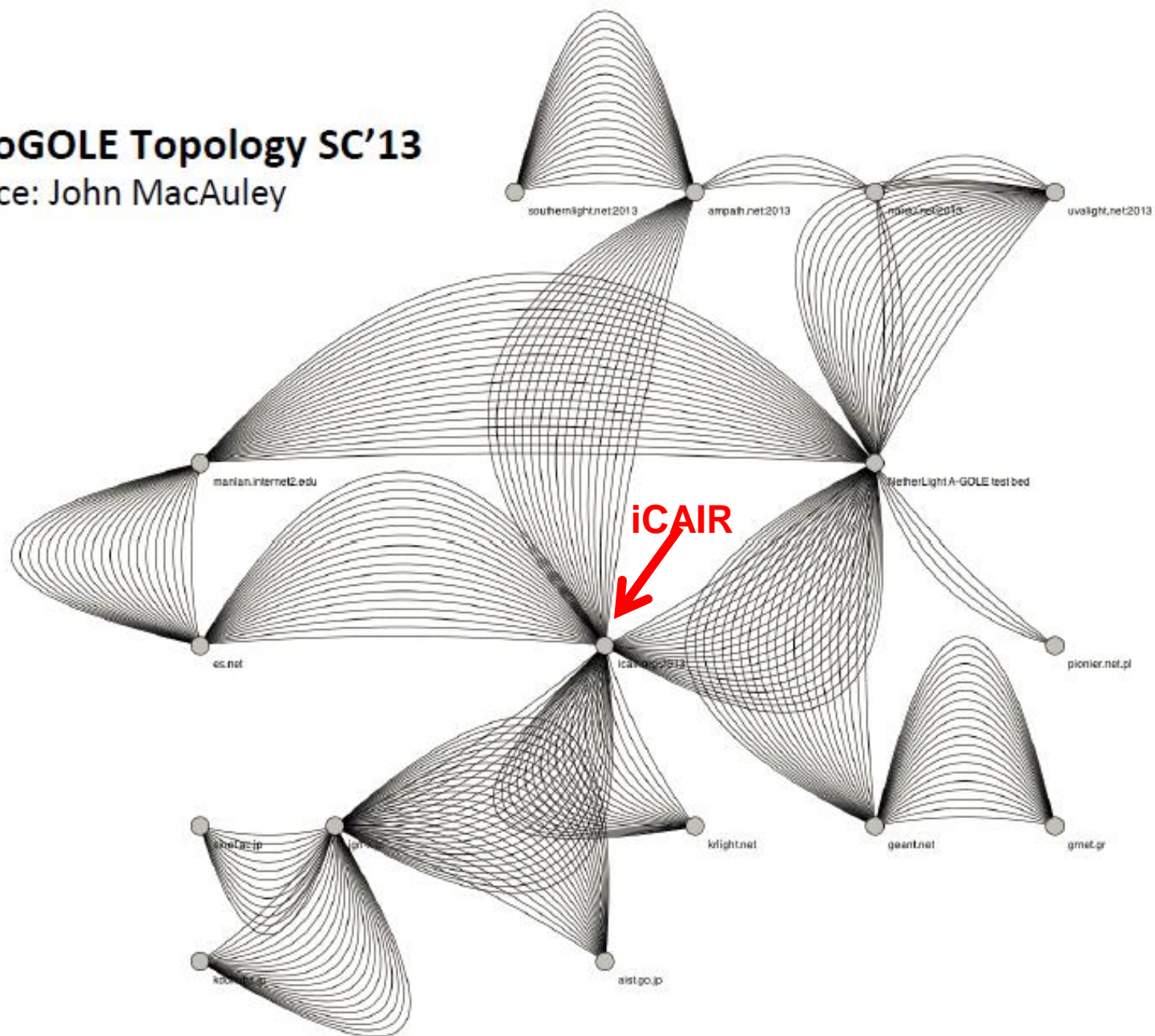


Source: GLIF Auto GOLE Group



AutoGOLE Topology SC'13

Source: John MacAuley



Tasks/Goals For 2014

Work items 2014

Item	Description	Due	Leading organization
Authentication / Authorization	Creating a AAI framework that allows secure setup of services	TNC2014	SURFnet (Hans Trompert)
Topology Exchange	Creating a mechanism that exchanges topology descriptions of GOLEs automatically	SC'14	ESnet, UvA (Chin Guok, Miroslav Zivkovic)
Retagging capabilities	Describing what's necessary to implement retagging capabilities inside the AutoGOLE fabric - also creating a plan for implementing	SC'14	Group effort
SDN/OpenFlow inside the AutoGOLE	It's foreseen that AutoGOLE NRMs could be talking OpenFlow to actual hardware. This item results in deployment of an OpenFlow controller speaking NSIv2 inside the AutoGOLE	Q4	iCAIR (Jim Chen, Joe Mambretti)
Operational items	Creating concepts on strengthening operations, implementing these	Q4	Tangur Courouarn to look for someone to lead (uniform) perational issues

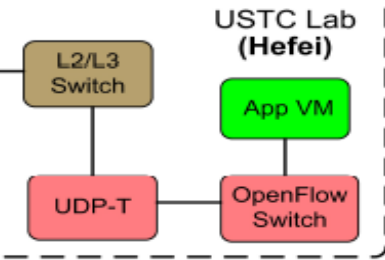
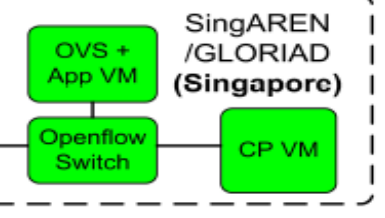
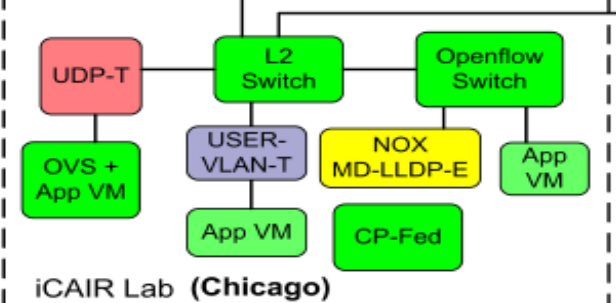
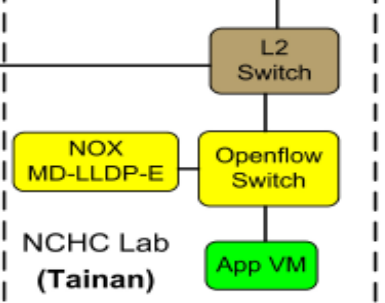
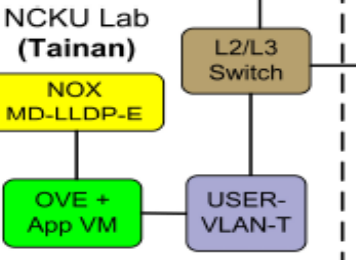
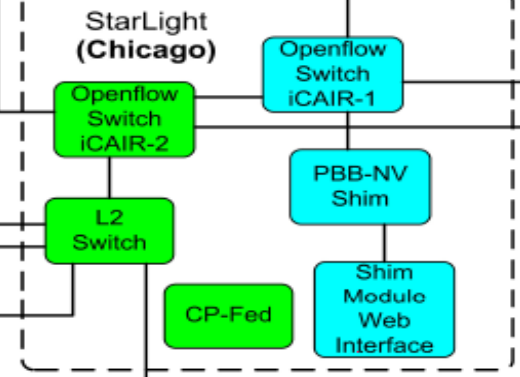
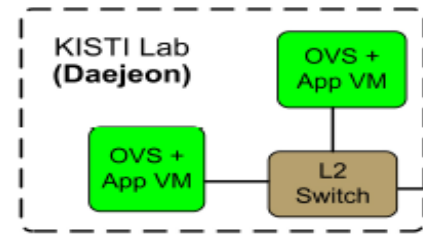
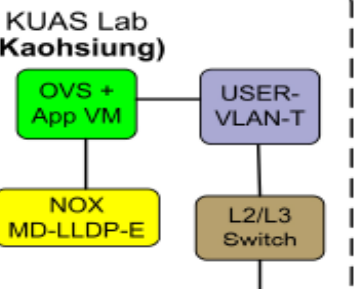
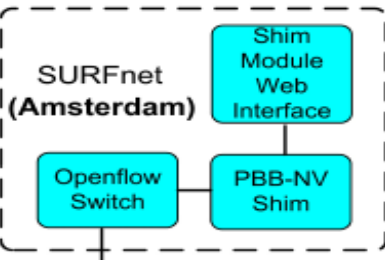
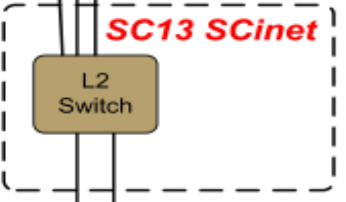
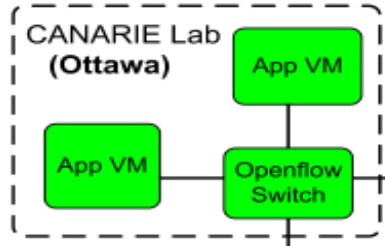
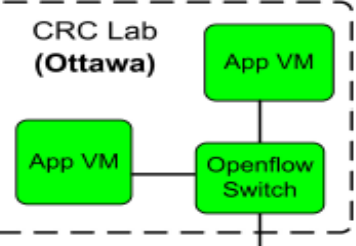
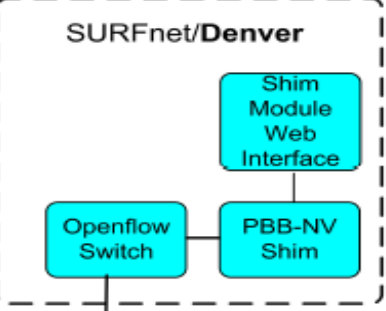
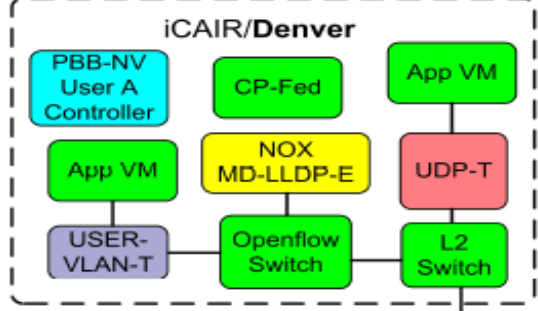
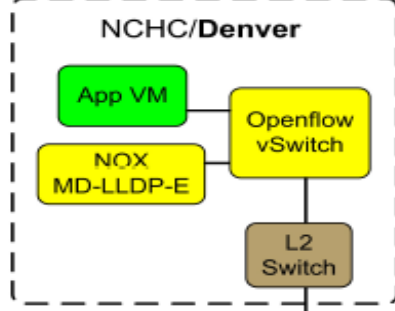


NCHC: Booth 3137

iCAIR: Booth 828

DRC: Booth 3322

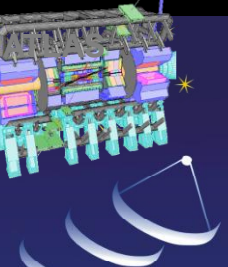
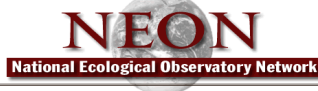
SC13 SCinet
Network
Research
Exhibition
 PBB-NV
 UDP-T
 MD-LLDP-E
 U-VLAN-T
 CP-Fed



Software Defined Networking Exchanges (SDXs)

- **With the Increasing Deployment of SDN In Production Networks, the Need for an SDN Exchange (SDX) Has Been Recognized.**
- **Current SDN Architecture Is Single Domain Centralized Controller Oriented**
- **Required Capabilities for Multi-Domain Distributed SDN Resource Discovery, Signaling Provisioning, Operations, and Fault Detection and Recovery Are Fairly Challenging.**
- **Nonetheless – Many Motivations Exist for SDXs**





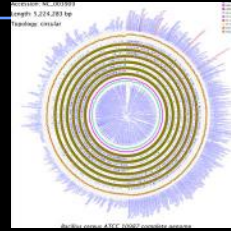
ALMA
ALMA: Atacama Large Millimeter Array



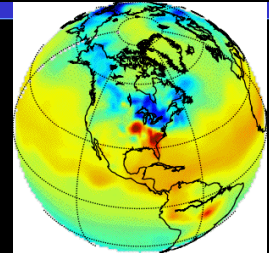
ANDRILL:
Antarctic Geological Drilling
www.andrill.org



BIRN: Biomedical Informatics Research Network
www.nbirn.net



CAMERA
metagenomics
camera.calit2.net



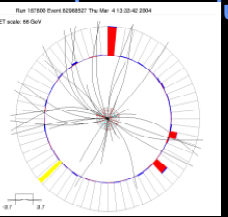
Carbon Tracker
www.esrl.noaa.gov/gmd/ccgg/carbontrack



CineGrid
www.cinegrid.org



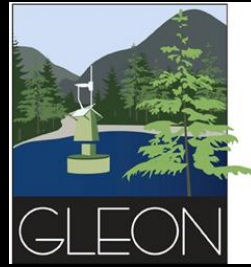
LHCONE
www.lhccone.net



DØ (DZero)
www-d0.fnal.gov



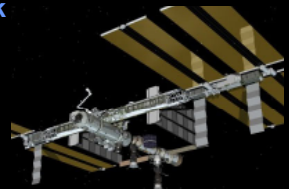
GEON: Geosciences Network
www.geongrid.org



GLEON: Global Lake Ecological Observatory Network



OOI-CI
ci.oceanobservatories.org



ISS: International Space Station
www.nasa.gov/station



CLASS
Comprehensive Large-Array Stewardship System
www.class.noaa.gov



IVOA: International Virtual Observatory
www.ivoa.net



LIGO
www.ligo.org



WLCG
lcg.web.cern.ch/LCG/public/



PRAGMA
Pacific Rim Applications and Grid Middleware Assembly
www.pragma-grid.net



TeraGrid
www.teragrid.org



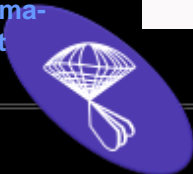
OSG
www.opensciencegrid.org



Globus Alliance
www.globus.org



SKA
www.skatelescope.org



Sloan Digital Sky Survey
www.sdss.org



XSEDE
www.xsede.org



Compilation By Maxine Brown



Software Defined Networking Exchanges (SDXs)

- **Today, No Production SDX Exists.**
- **However, Currently the International Center for Advanced Internet Research (iCAIR) and Its Research Partners Are Designing and Implementing a Prototype SDX at the StarLight International/National Communications Exchange Facility**
- **Georgia Tech and SOX Are Prototyping a SDX In Atlanta**
- **Progressing With Support from the National Science Foundation's Global Environment for Network Innovations (GENI) Program/GENI Program Office (GPO).**
- **The StarLight SDX Is a Multi-Domain Service Enabling Federated Controllers To Exchange Signaling and Provisioning Information.**

Selected SDX Architectural Attributes

- **Control and Network Resource APIs**
- **Multi Domain Integrated Path Controller**
- **Controller Signaling, Including Edge Signaling**
- **SDN/OF Multi Layer Traffic Exchange**
- **Multi Domain Resource Advertisement/Discovery**
- **Topology Exchange**
- **Multiple Service Levels At All Layers**
- **Granulated Resource Access (Policy Based), Including Through Edge Processes**
- **Foundation Resource Programmability**
- **Various Types of Gateways To Other Network Environments**
- **Integration of OF and Non-OF Paths, Including 3rd Party Integration**
- **Programmability for Large Scale Large Capacity Streams**



StarLight – “By Researchers For Researchers”

StarLight is an experimental optical infrastructure and **proving ground for network services** optimized for high-performance applications

Multiple
10GE+100 Gbps
StarWave
Multiple 10GEs
Over Optics –
World’s “Largest”
10G/100G Exchange
First of a Kind
Enabling Interoperability
At L1, L2, L3



View from StarLight

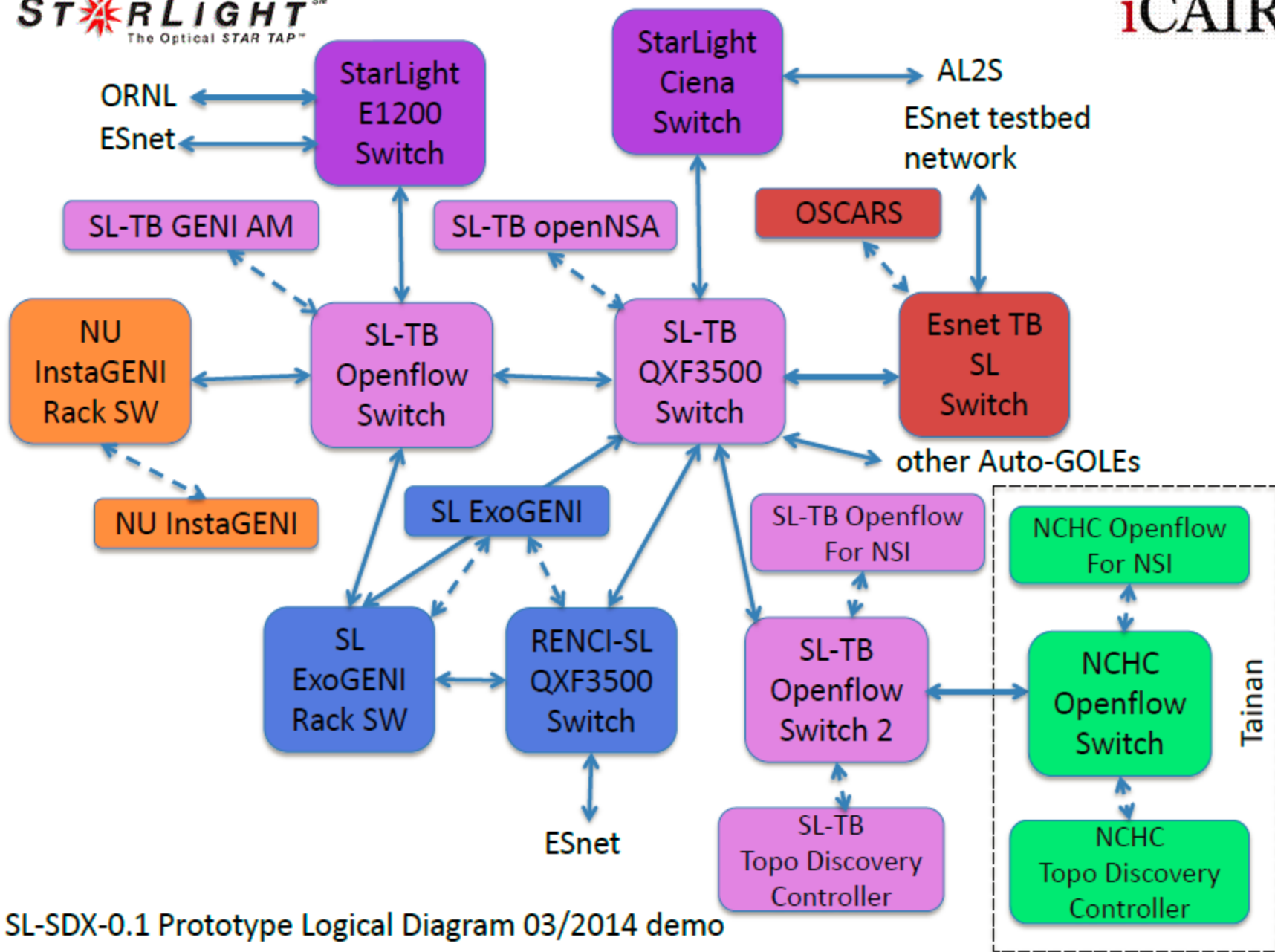


Abbott Hall, Northwestern University's Chicago Campus

SDX As A Large Scale Virtual Switch

- **Ultra Large Scale Virtual Switch Comprised of Resources That Can Be Partitioned For Use by External Controllers Within Other Domains**
- **Foundation = Actual SDN/OpenFlow Switches**
- **Resources Appear As Components That Are Extensions Of Those External Domains**
- **Architectural Design Intended To Remove Middle Processes Between Domains**
- **Federation Policies and Processes Are Key**





SL-SDX-0.1 Prototype Logical Diagram 03/2014 demo

Multi-Domain Provisioning Tool

URL:

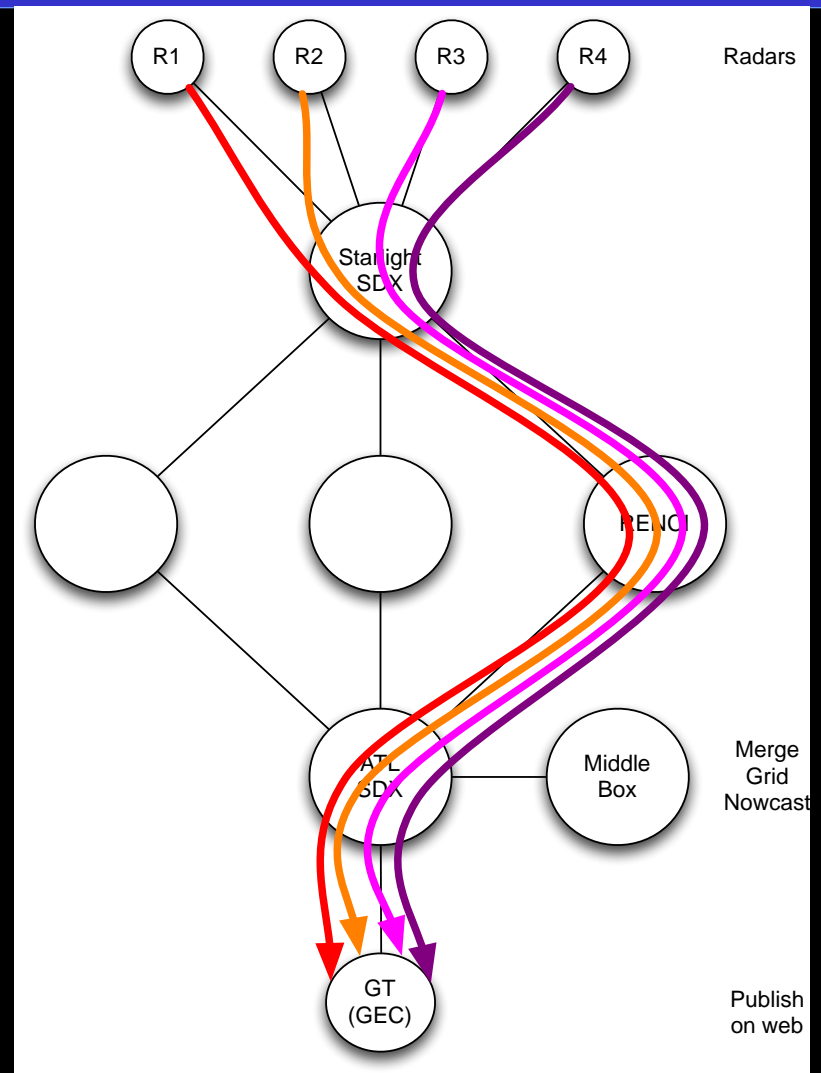
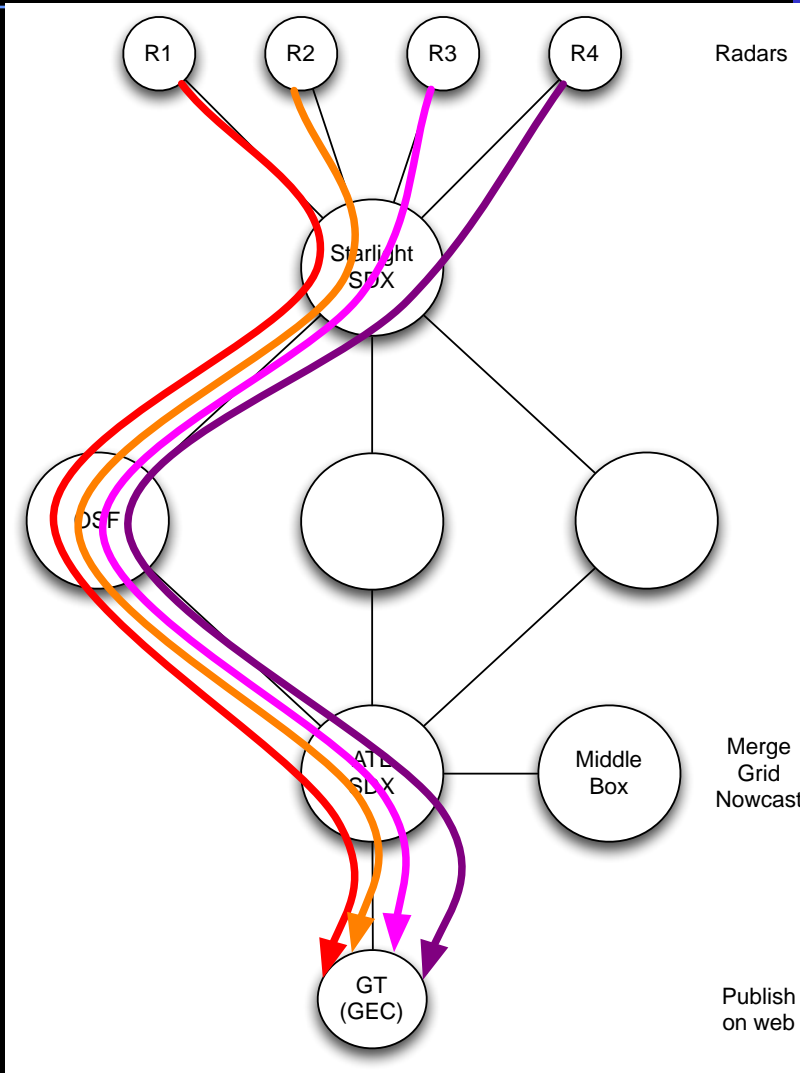
port:

server: 165.124.3.79:8080
client:Not known

- ▶ Create VLAN
- ▶ Add/delete port from VLAN
- ▶ Show port
- ▶ Show VLAN
- ▶ Show/Add/Delete Flow
- ▶ Connectivity Functions
 - Ping Trace
 - Interface:
 - MAC address:
 -

100%

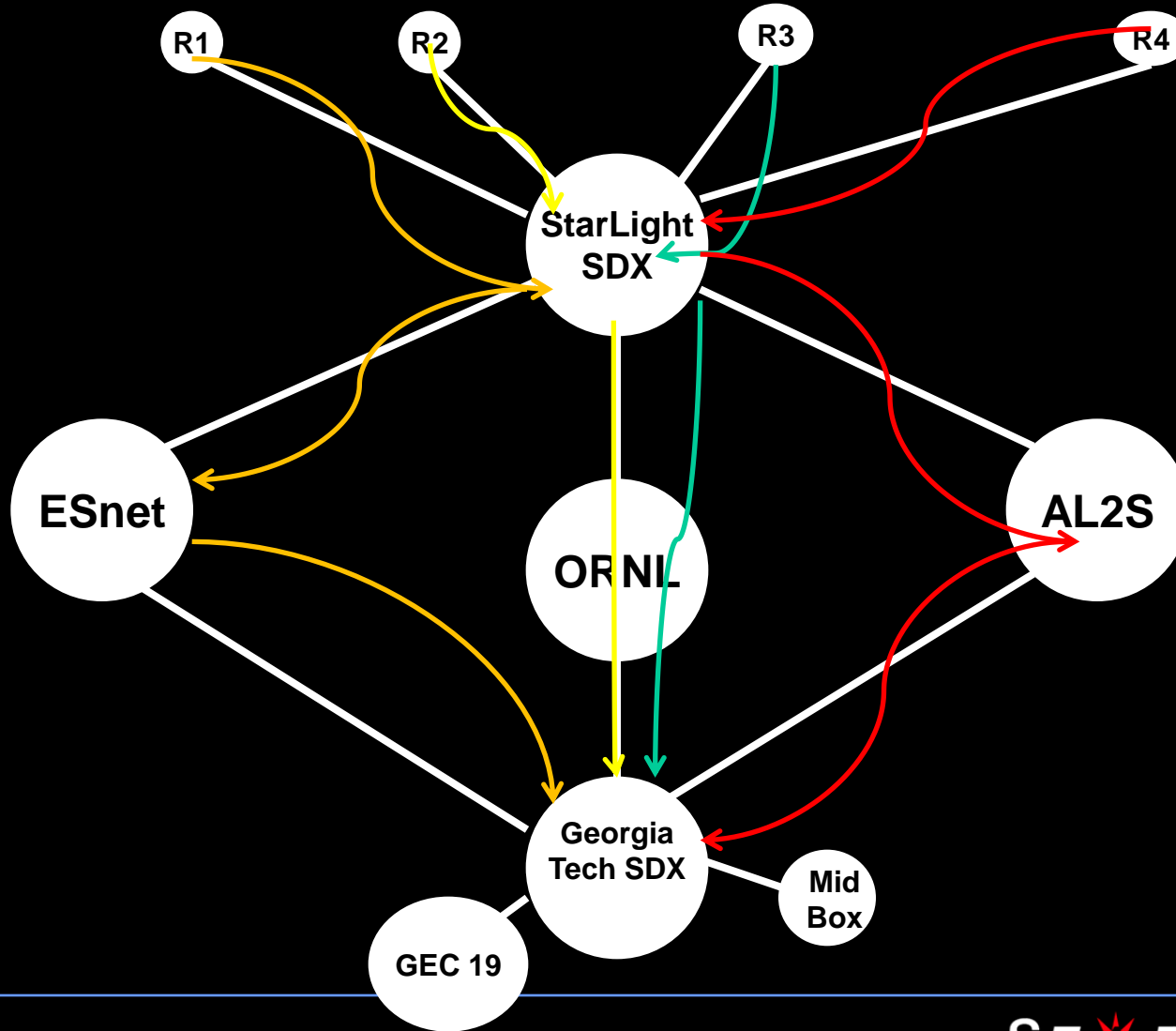
GENI SDX Demo Scenario 1: Mike Zink's Nowcast



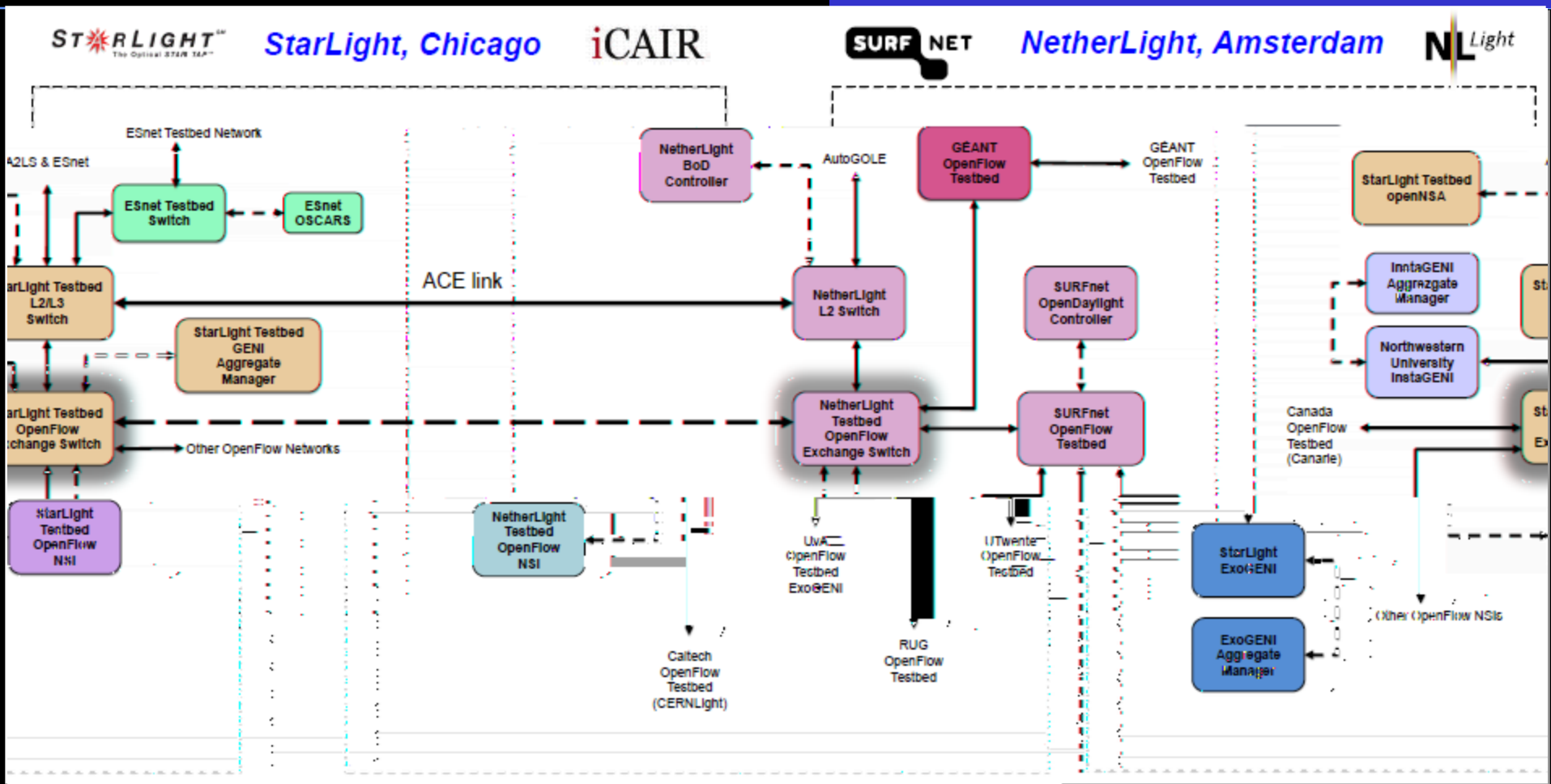
Slide by Mike Zink, UMass Amherst

GENI SDX Demo Scenario 2: Mike Zink's Nowcast

Simulated
Radar (4)



SDX StarLight ↔ NetherLight



Ronald van der Pol, Joe Mambretti, Jim Chen, John Shillington

Software Defined Infrastructure (SDI)

- Extensions of Architecture, Techniques Technologies To Other Resources
- Already Being Developed By Many Communities
- Computational Grids
- High Performance Computational Clouds
- Highly Virtualized Storage
- Distributed Sensor Networks
- Virtualized Large Scale Instruments
- Specialized Distributed Environments

Forthcoming StarLight SDX Demonstrations

- GEC 20, Davis California
- Global LambdaGrid Workshop (GLIF), Queenstown New Zealand (Joint Project With REANNZ, StarLight, CANARIE, SURFnet, Google, etc)
- GEC 21, Indianapolis Indiana
- SC14, New Orleans
- etc



www.startap.net/starlight

Thanks to the NSF, DOE, DARPA
Universities, National Labs,
International Partners,
and Other Supporters

