SDX Services and Technology At StarLight

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International Center for Advanced Internet Research (www.icair.org)

Northwestern University

GENI Engineering Conference (GEC 23)

UIUC, Champaign, IL

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StarLight International/National Communications Exchange Facility – “By Researchers For Researchers”

StarLight Is an Innovation Platform For Advanced Communications Services Architecture and Technologies, Including Experimental Testbeds Optimized For High-Performance Data Intensive Applications Multiple 10GE+100 Gbps Over Optics – World’s “Largest” 10G/100G Exchange First of a Kind Enabling Interoperability At L1, L2, L3,
Also, StarWave Multi-100 Gbps Exchange

View from StarLight

Abbott Hall, Northwestern University’s Chicago Campus

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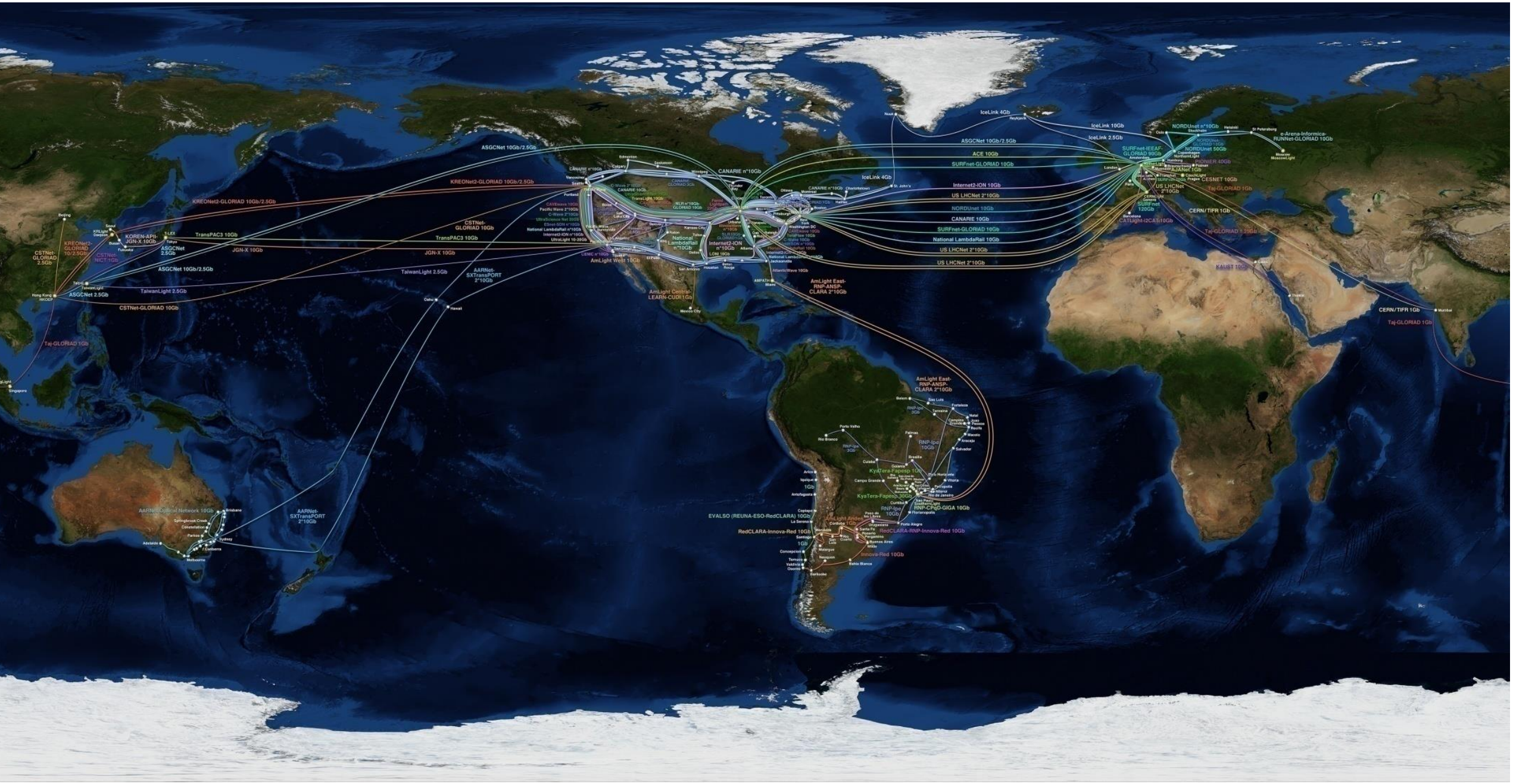
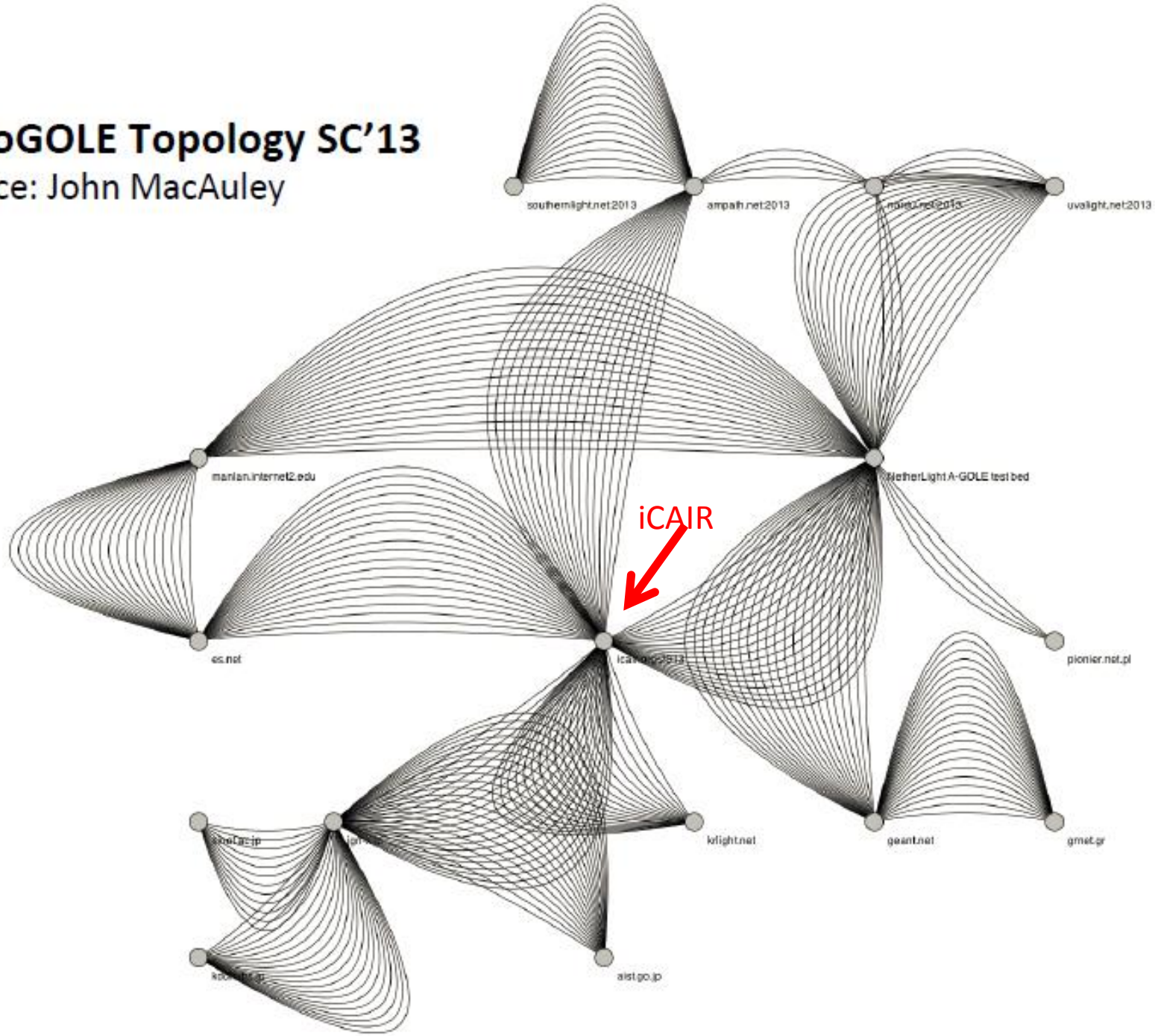
The Global Lambda Integrated Facility: a Global Programmable Resource



Automated GOLE Fabric

AutoGOLE Topology SC'13

Source: John MacAuley



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Software Defined Networking Exchanges (SDXs)

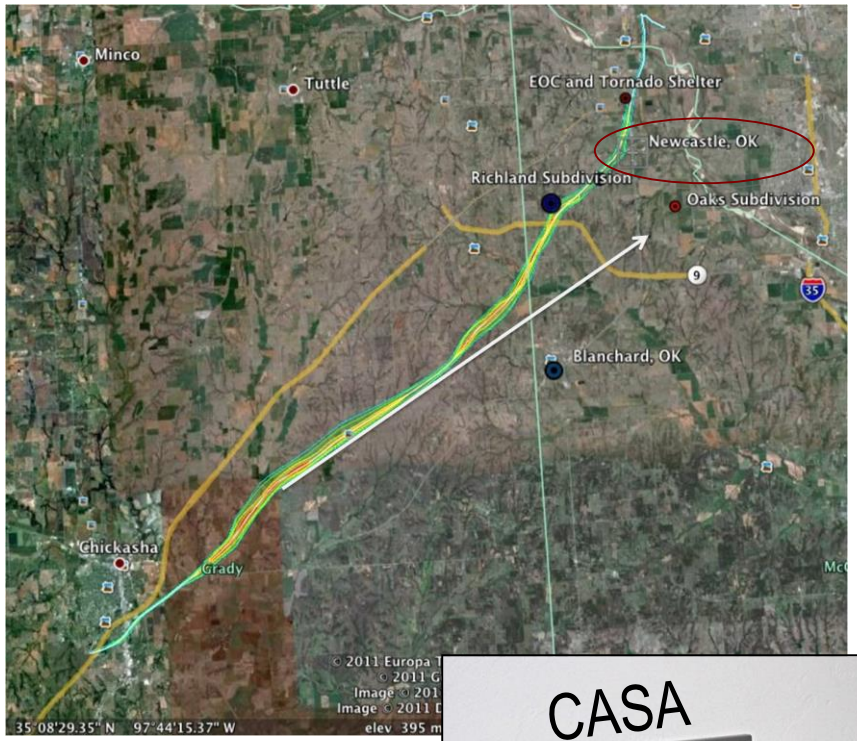
- With the Increasing Deployment of SDN In Production Networks, the Need for an SDN Exchange (SDX) Has Been Recognized.
- Many Motivations Exist for SDXs
  - Bridging SDN Islands (Which Are Single Domain & Centralized Operation Oriented)
  - Granulated Engineering Over Flows
  - High Degrees Of Exchange Customization
- Required: Capabilities for Multi-Domain Multi-Service Distributed SDN Resource Discovery, Signaling, Provisioning, Federation, Operational Functions, Fault Detection and Recovery, Monitoring, Measurement
- These Are Fairly Challenging Issues

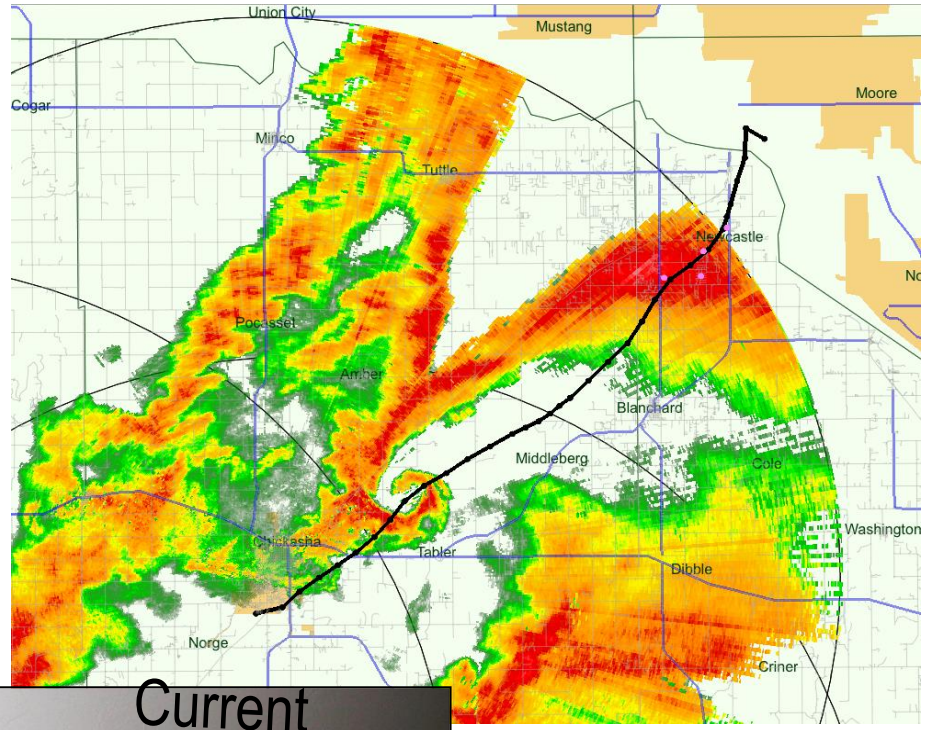
Selected SDX Architectural Attributes

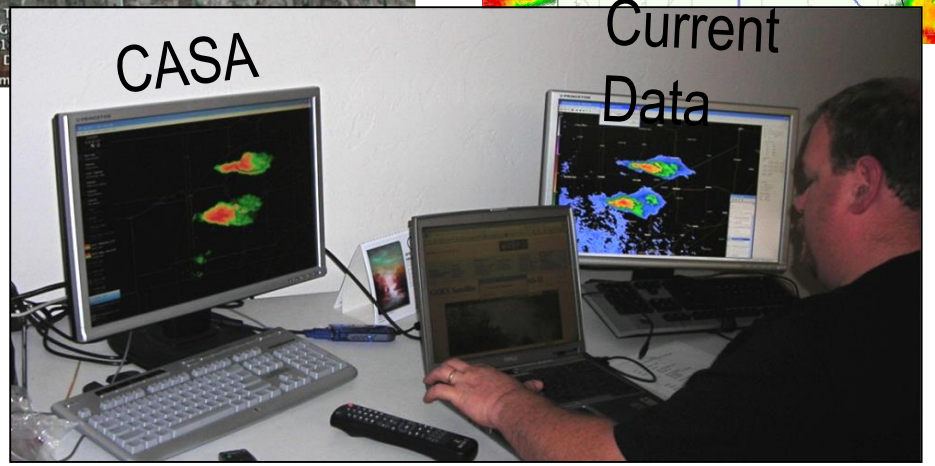
- Control and Network Resource APIs
- Multi Domain enabled Path/Link Controllers (With Federation)
- Controller Signaling, Including Edge/Application Signaling
- SDN/OF Multi Layer Traffic Exchange Services
- Multi Domain Resource Advertisement/Discovery
- Topology Exchange Services
- Multiple Highly Customized Services At All Layers
- Granulated Resource Access (Policy Based), Including Through Edge Processes, Including To individual Streams
- Foundation Resource Programmability
- Gateways Between Different Network/Cloud Environments
- Integration of OF and Non-OF Paths, Including 3rd Party Integration
- Programmability for Large Scale Large Capacity Streams

Science Use Case: Nowcasting With SDXs

Source: Mike Zink, UMass Amherst

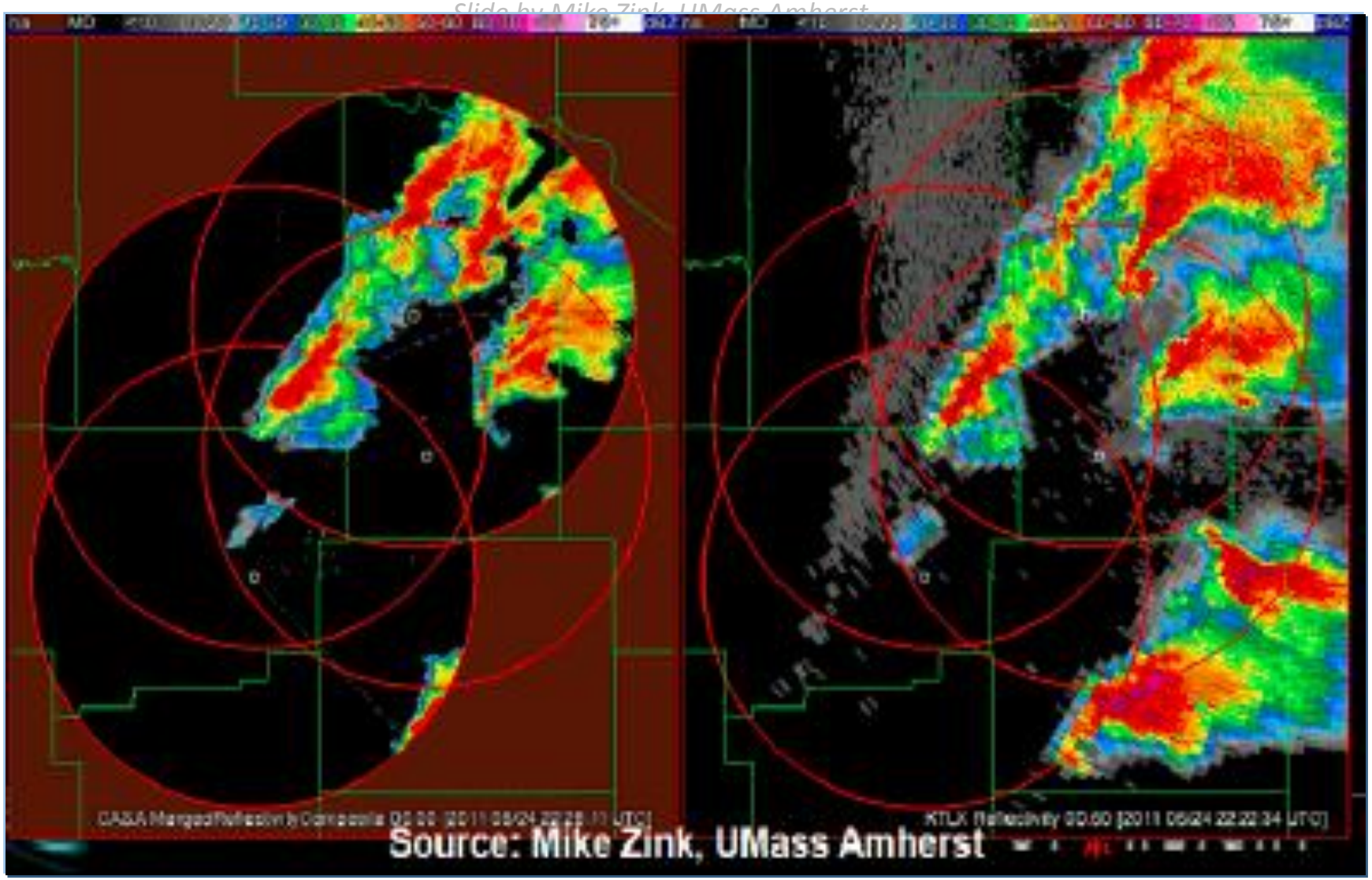






CASA Data, EM Decision-Making Protects First Responders and Public

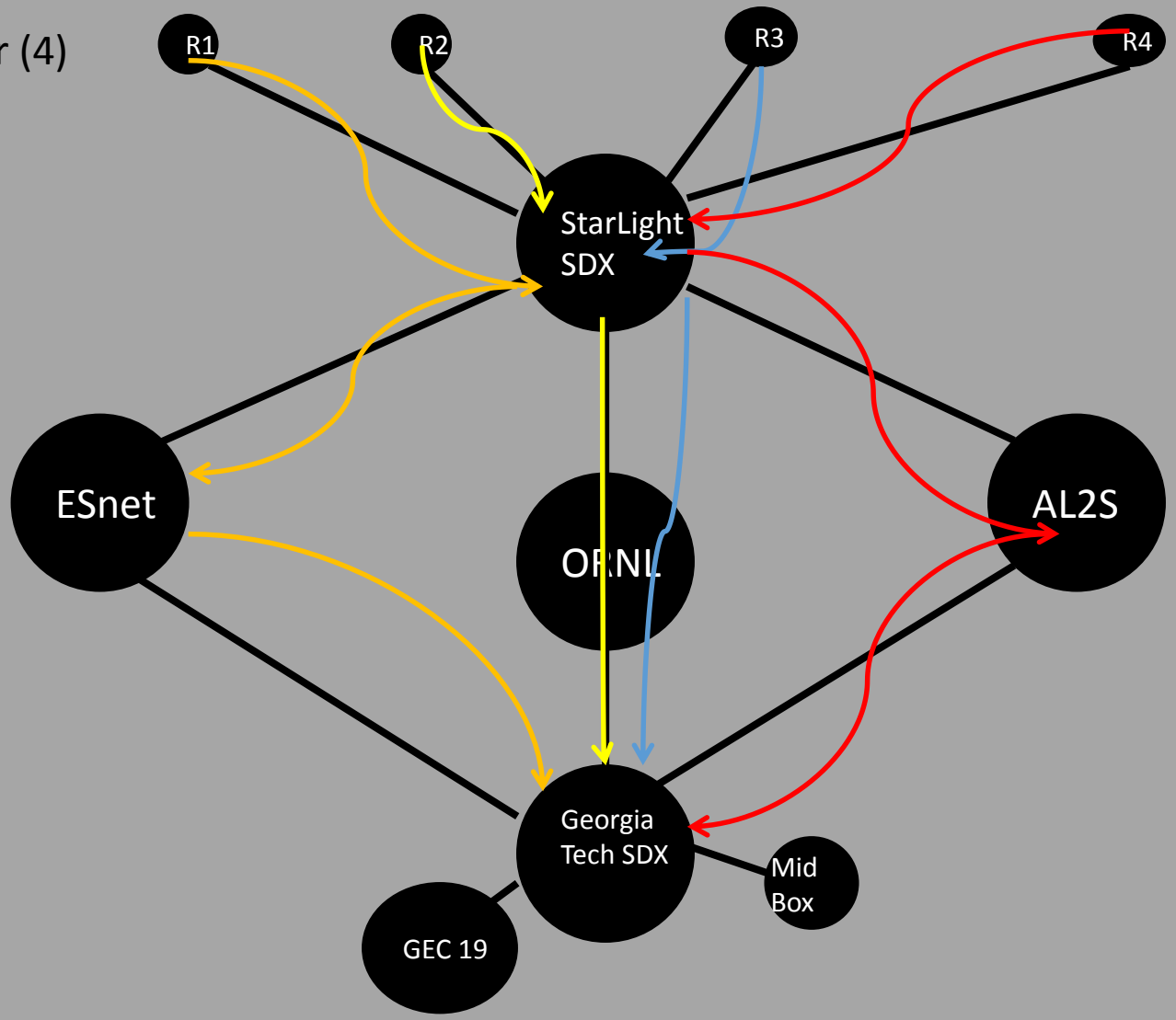
Comparison With Existing System



Source: Mike Zink, UMass Amherst

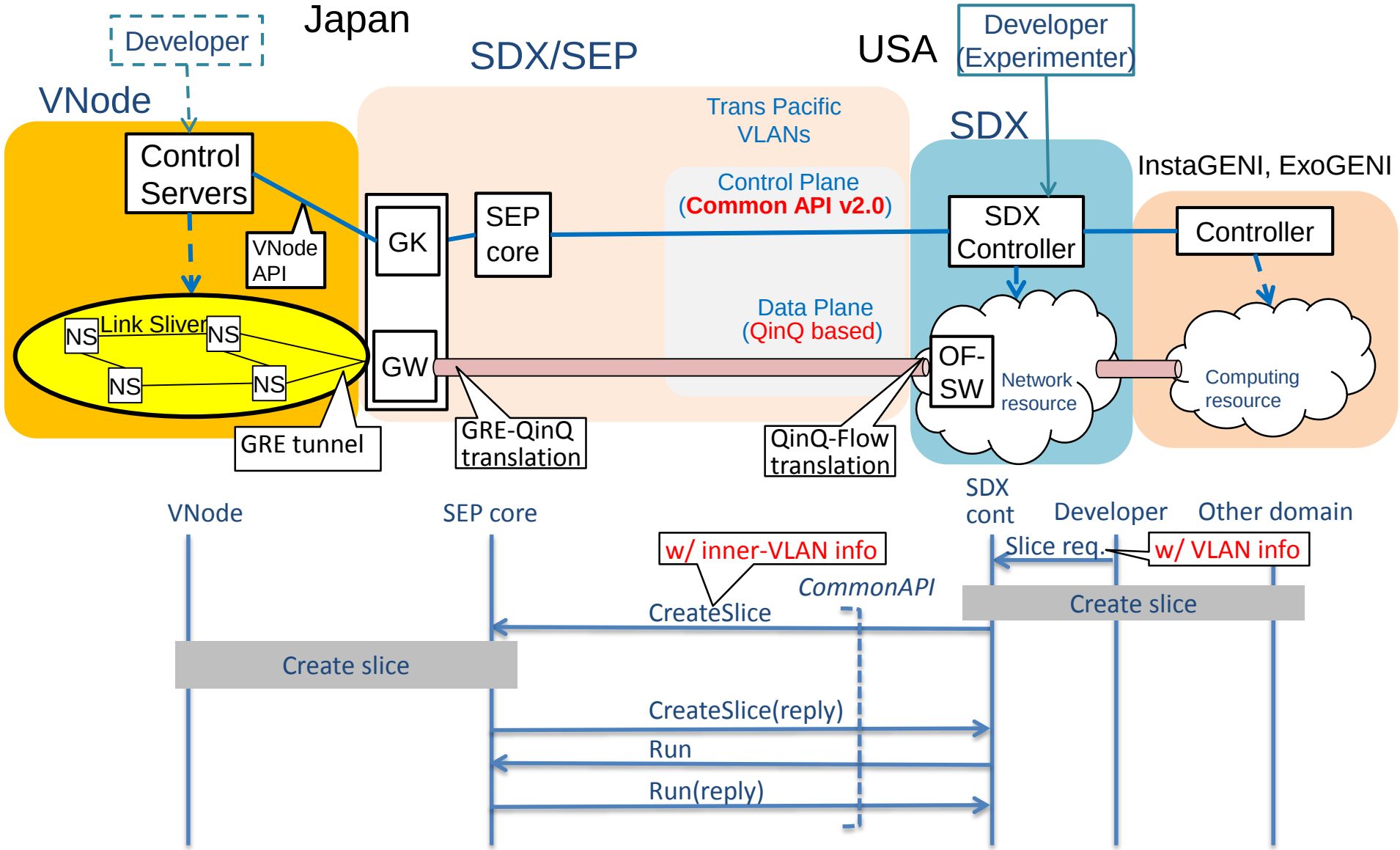
GENI SDX Demo Scenario

Simulated Radar (4)

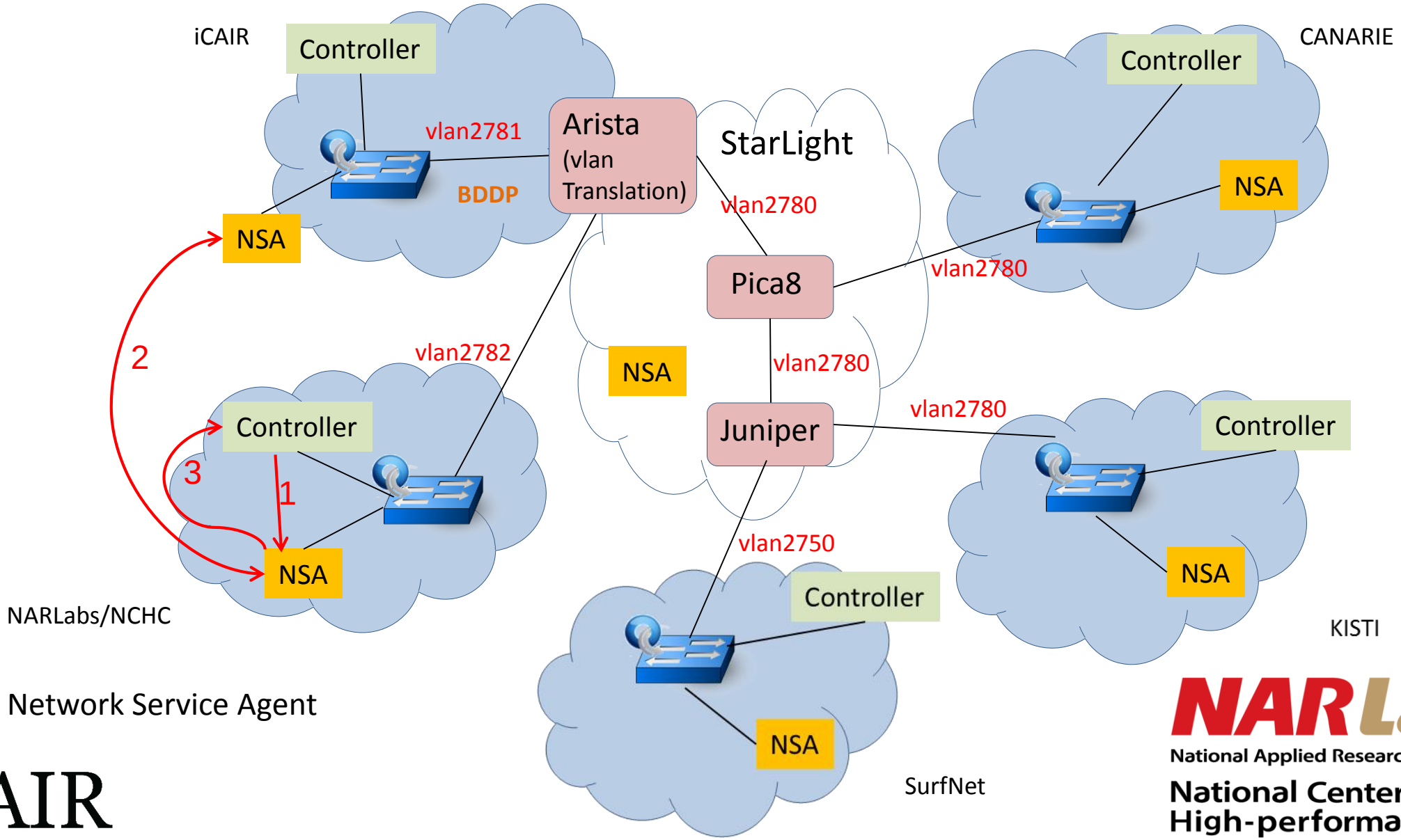


vNode/SEP & StarLight Inter-SDX federation 2014

Multi-architecture Federation



NSI-OpenFlow Hybird Topology Exchange



NSA : Network Service Agent

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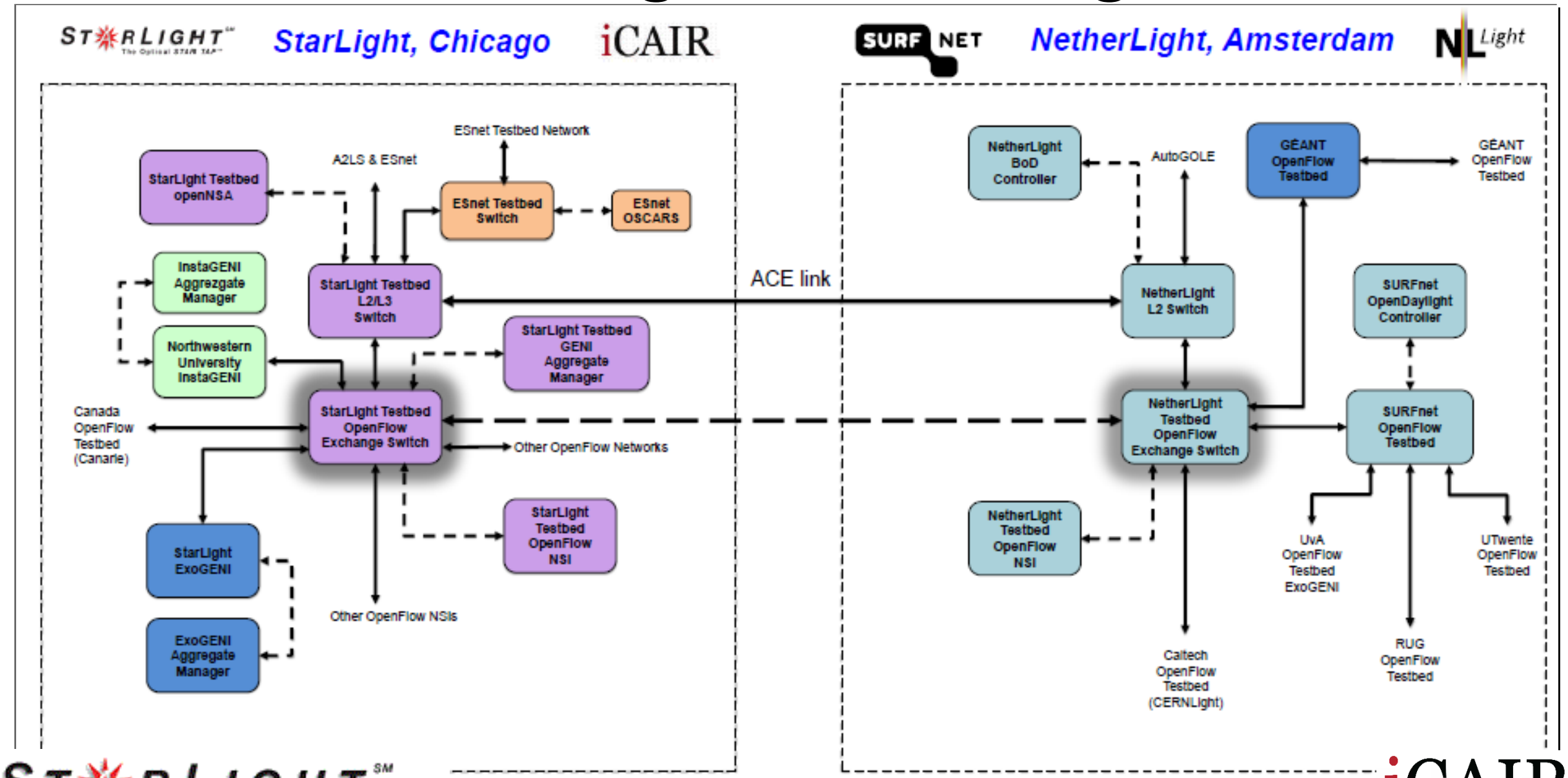
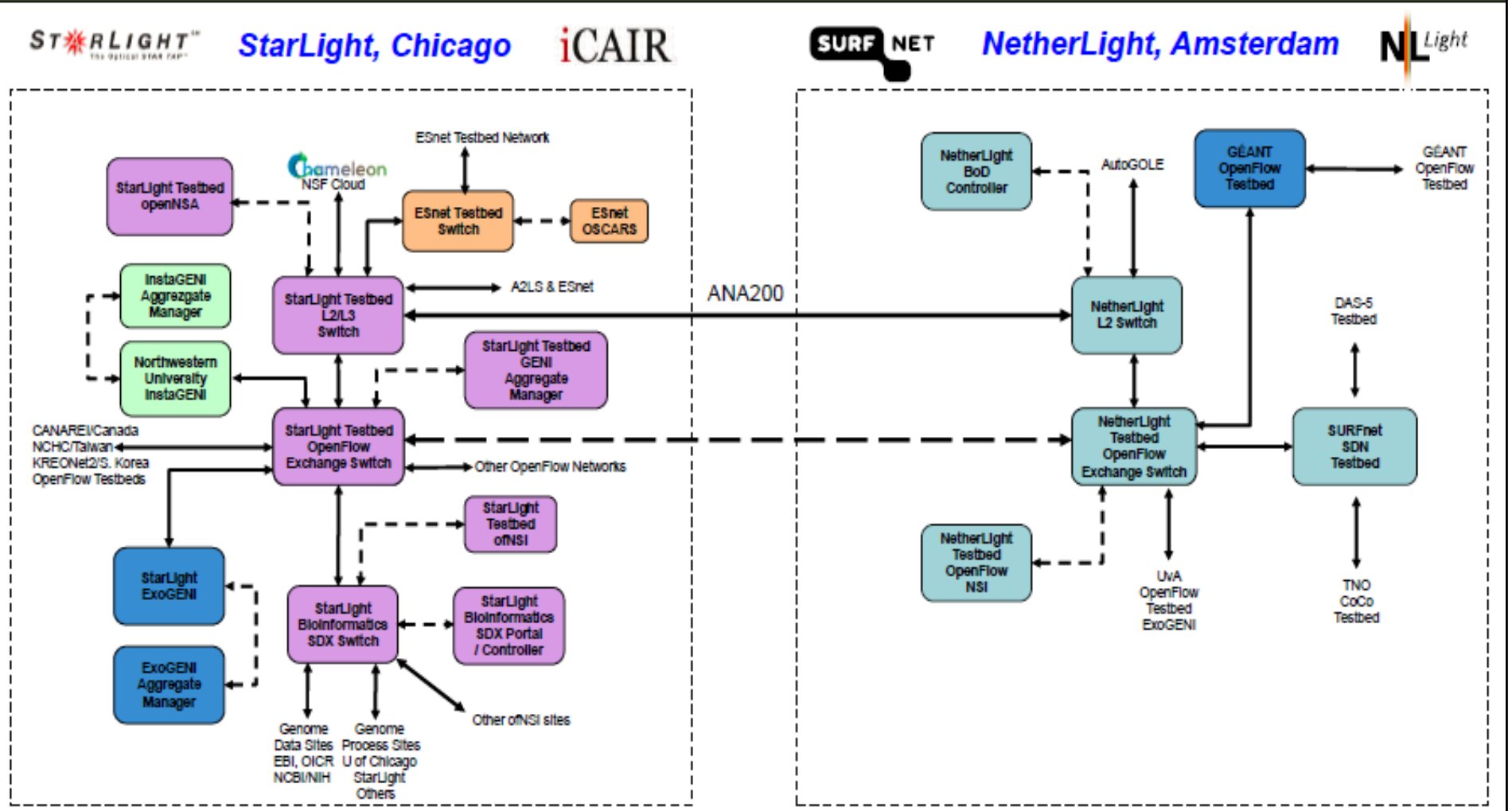
NARLabs
National Applied Research Laboratories
National Center for
High-performance Computing

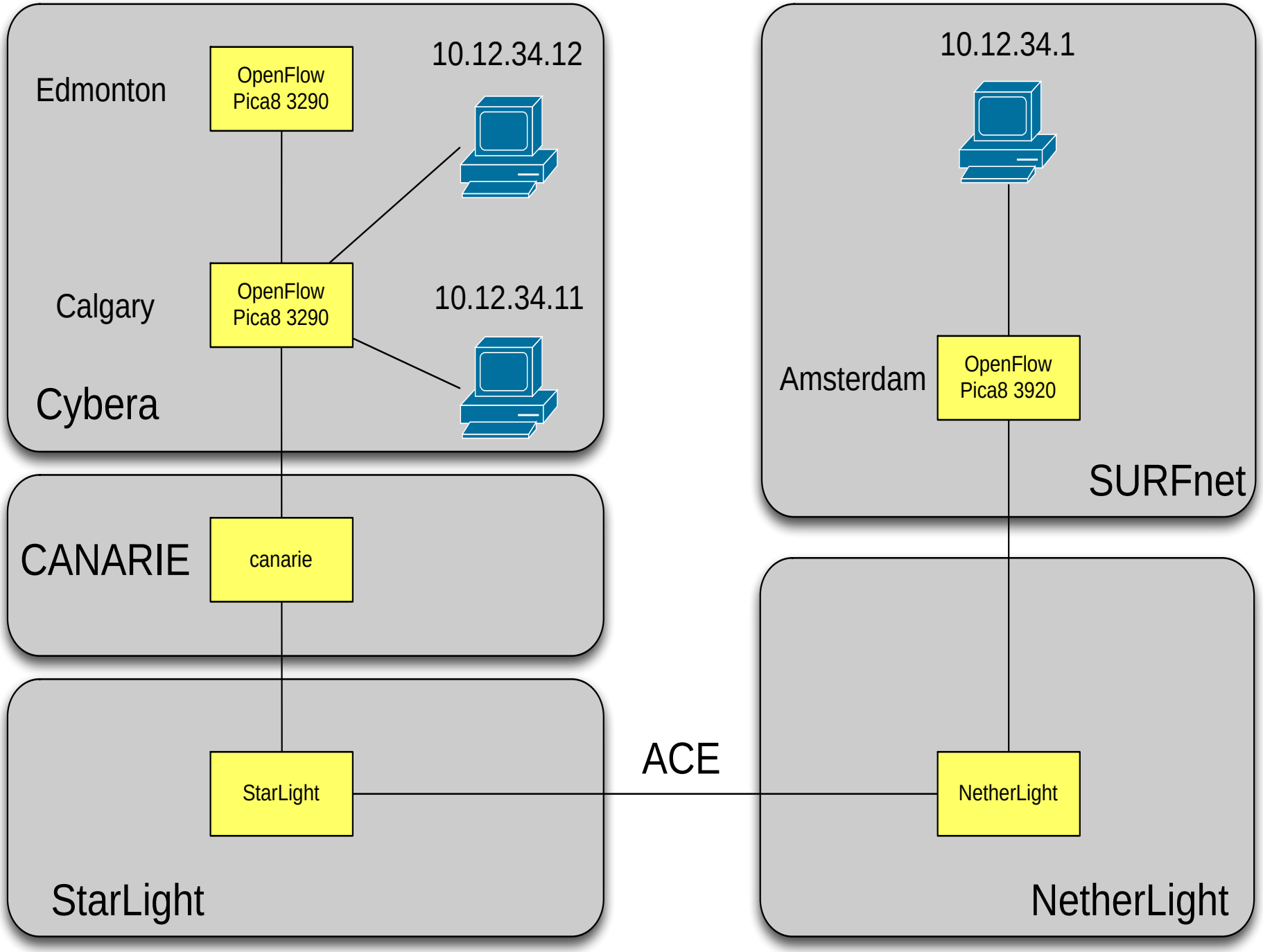
SDX StarLight⇔NetherLight



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

Netherlands-US Software Defined Networking Exchanges(SDXs)




Edmonton
OpenFlow
Pica8 3290
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Calgary
OpenFlow
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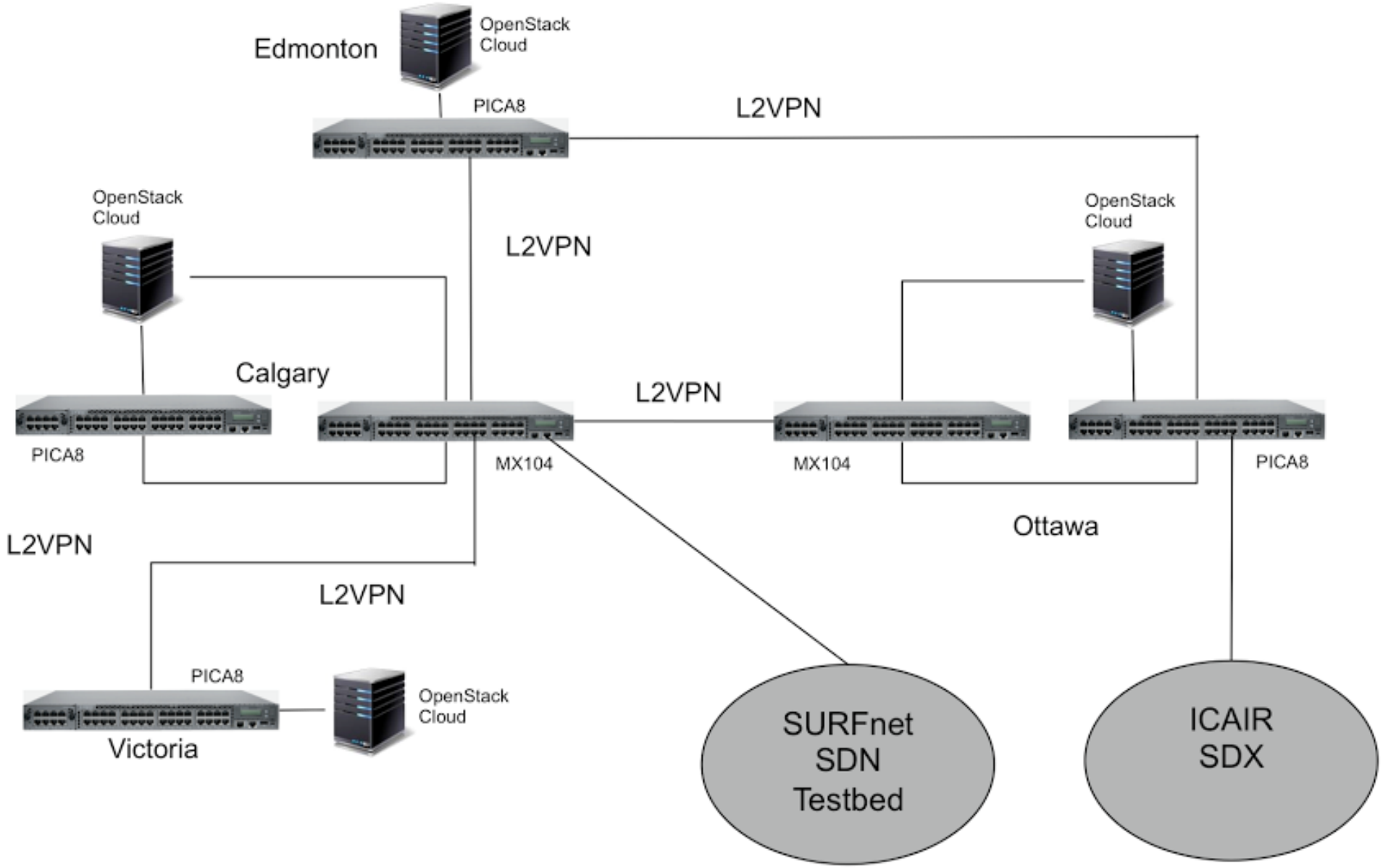
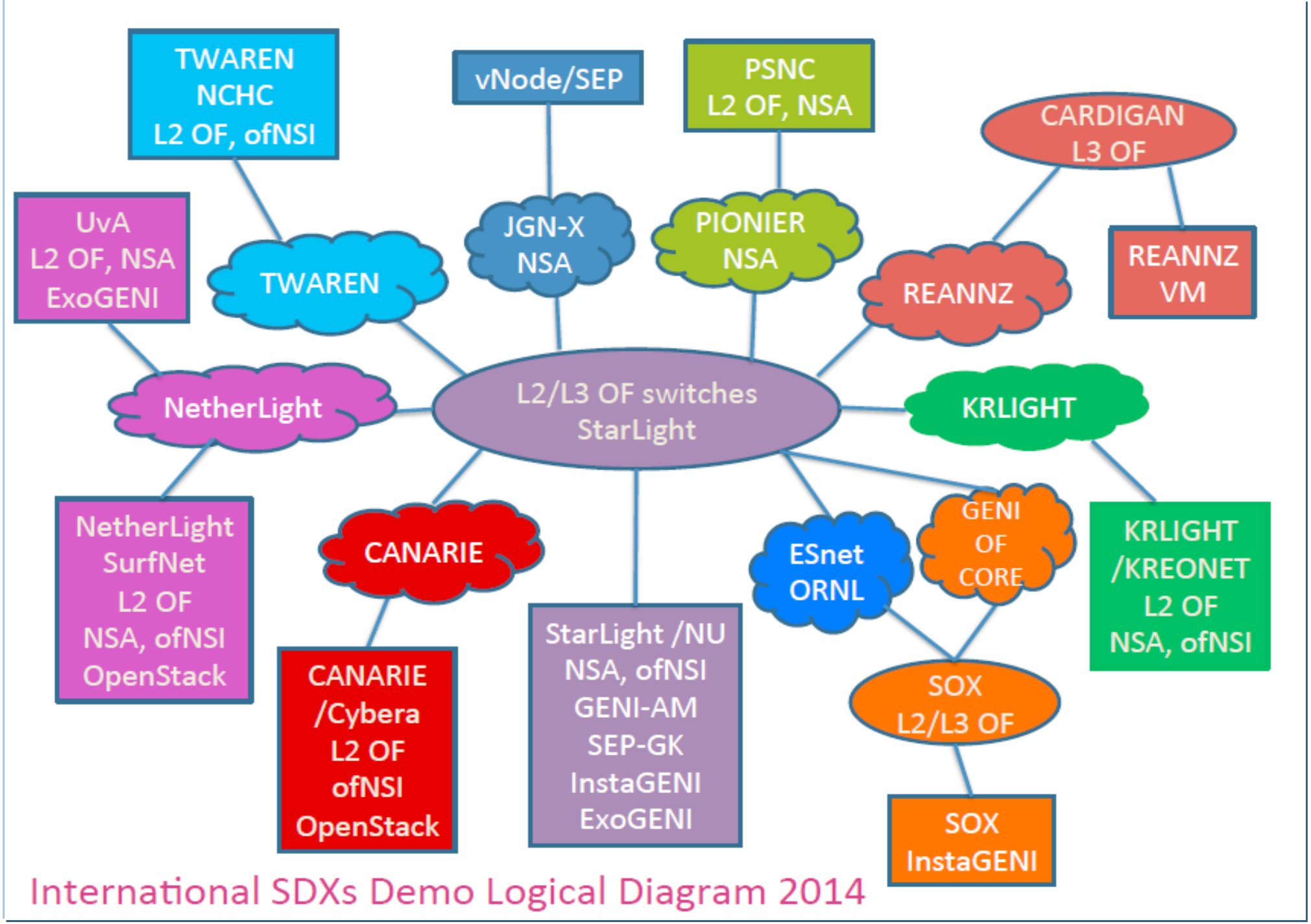
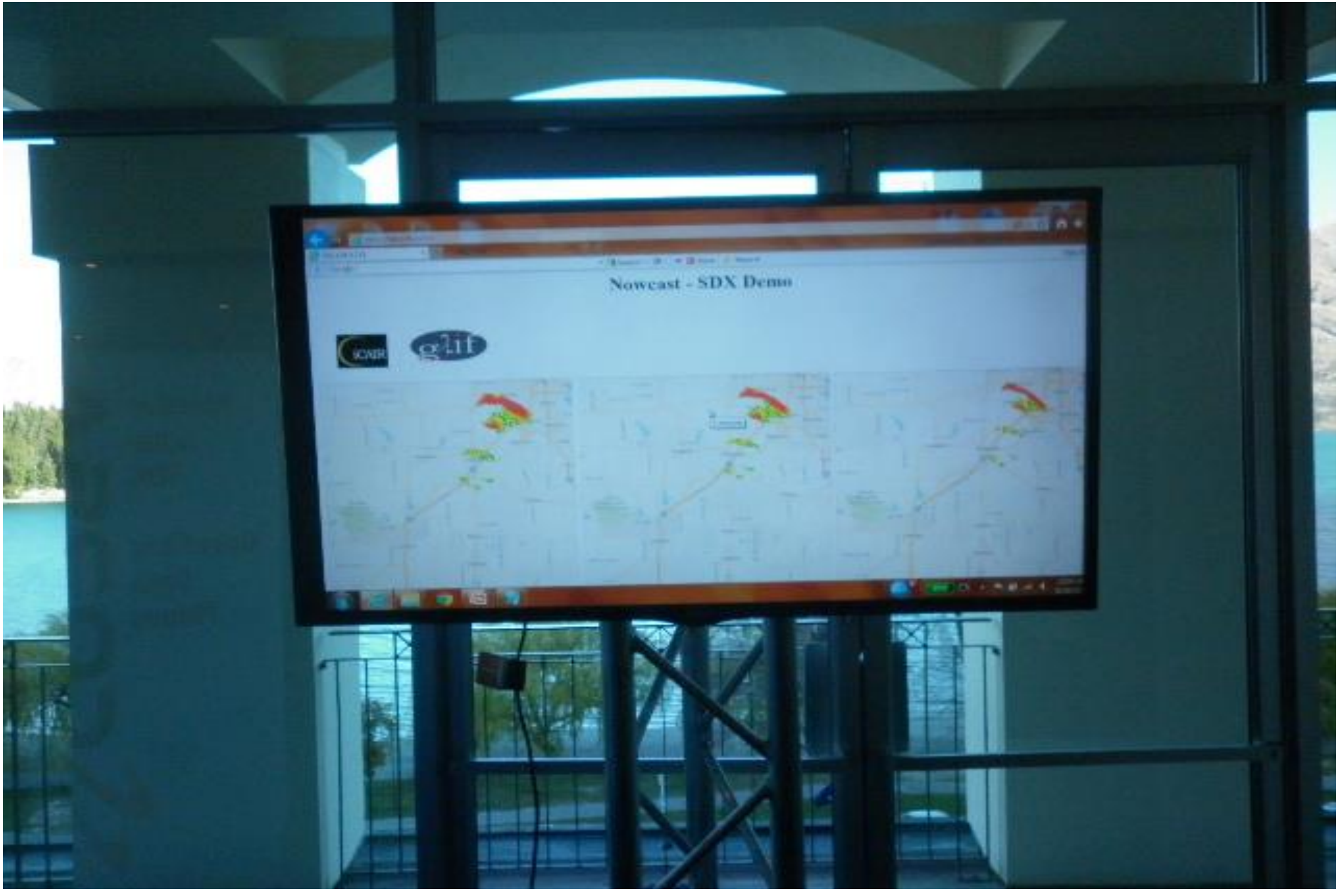
Cybera
CANARIE
canarie
StarLight
StarLight
ACE
10.12.34.1
Amsterdam
OpenFlow
Pica8 3920
SURFnet
NetherLight
NetherLight

Canadian SDN Testbed 2015

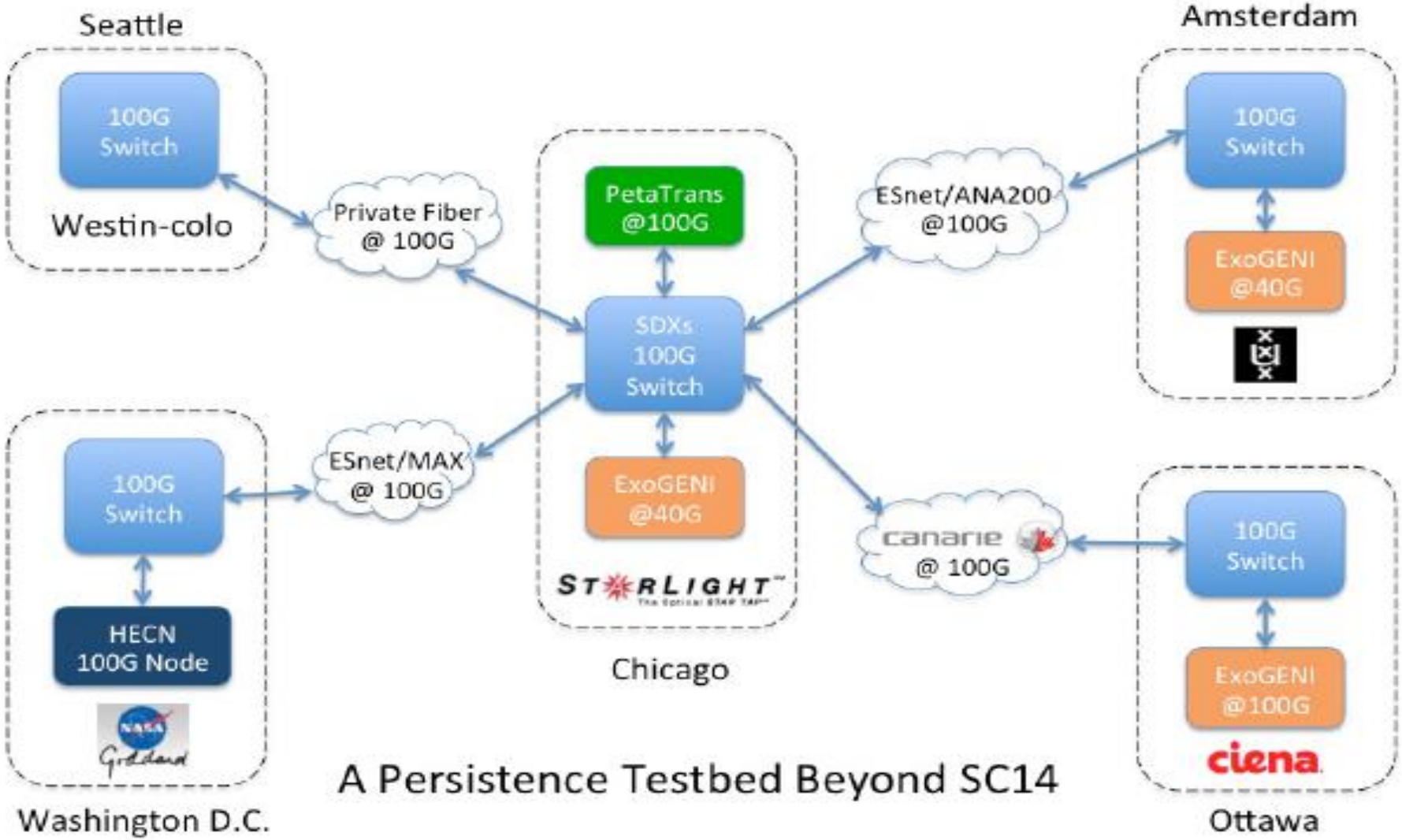




International SDXs Demo Logical Diagram 2014


Nowcast - SDX Demo
CNR
g.it

PetaTrans: Peta Byte Science Data Transfer



A Persistence Testbed Beyond SC14

Global Software-Defined Dynamic Circuits for Data Intensive Science
(PhEDEx – ANSE – PANDA - OpenDayLight)

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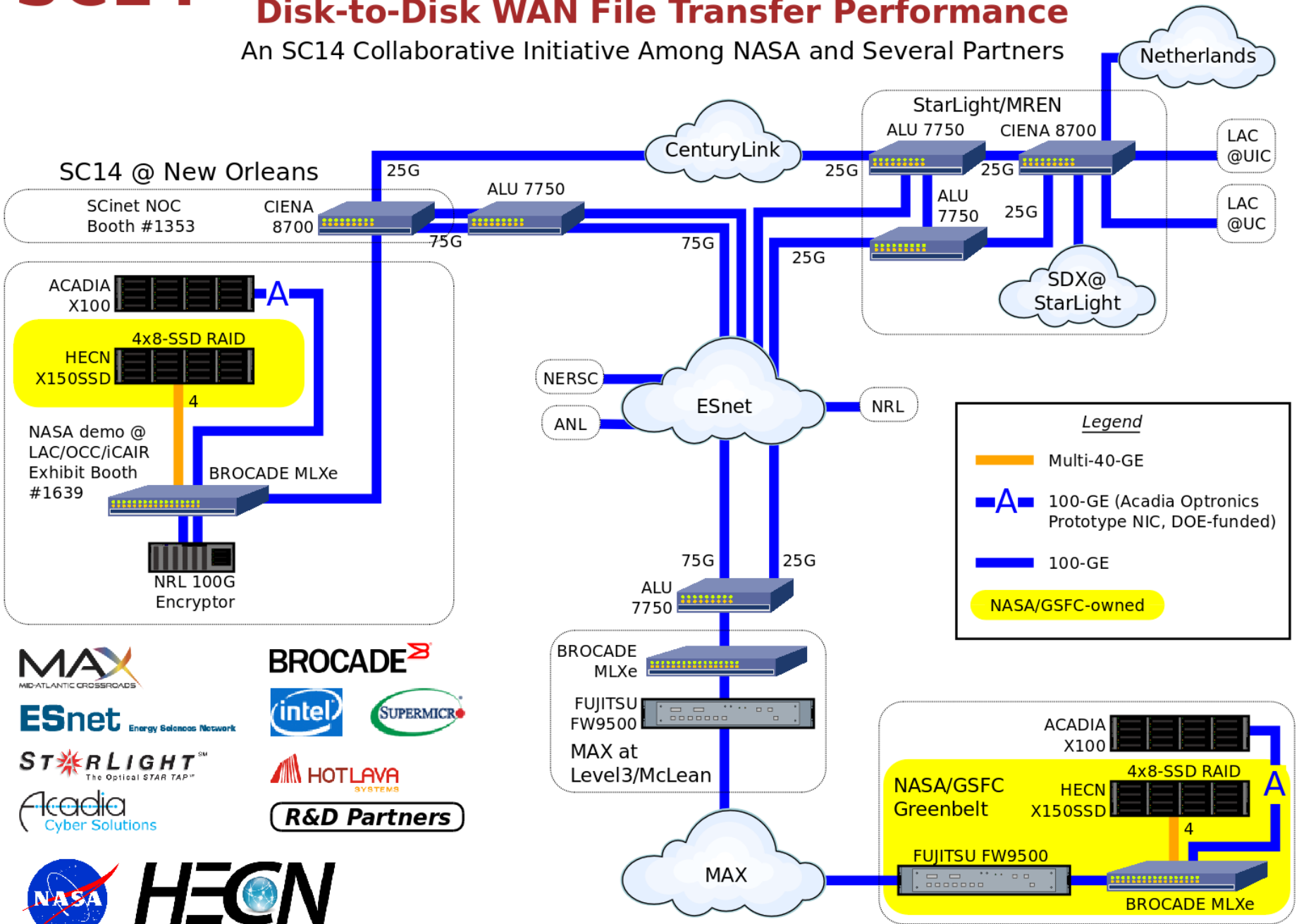
SC14

Evaluations/Demonstrations of 100 Gbps Disk-to-Disk WAN File Transfer Performance

An SC14 Collaborative Initiative Among NASA and Several Partners



NASA/GSFC High End Computer Networking (HECN) Team
Diagram by Bill Fink / Paul Lang - 11/1/2014

International Software-Defined Network Exchanges (iSDXs): A Demonstration of Global Capabilities

Joe Mambretti, Jim Chen, Fei Yeh/ International Center for Advanced Internet Research
Northwestern University, USA
Mike Zink, Divyashri Bhat/University of Massachusetts, Amherst, USA
Ronald Van der Pol / Surfnet, Netherlands
Grace Lee, WunYuan Huang, Te-Lung Liu / NARLabs, National Center for High Performance Computing,Taiwan
Thomas Tam, Herve Guy / CANARIE, Canada
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Buseung Cho / KISTI Republic of Korea
Michiaki Hayashi / KDDI Labs, Japan
Toshiaki Tarui / Hitachi, Japan
Aki Nakao / University of Tokyo, Japan
Steve Cotter, T. Charles Yun, Jamie Curtis, Andrej Ricnik / REANNZ, New Zealand
Josh Bailey, Google, New Zealand
Artur Binczewski Belter Bartosz Miłosz Przywecki Piotr Rydlichowski
Poznan Supercomputing and Networking Center, Poland
Russ Clark / Georgia Tech, USA

Global LambdaGrid Workshop, Queenstown, New Zealand September 30-October 1, 2014

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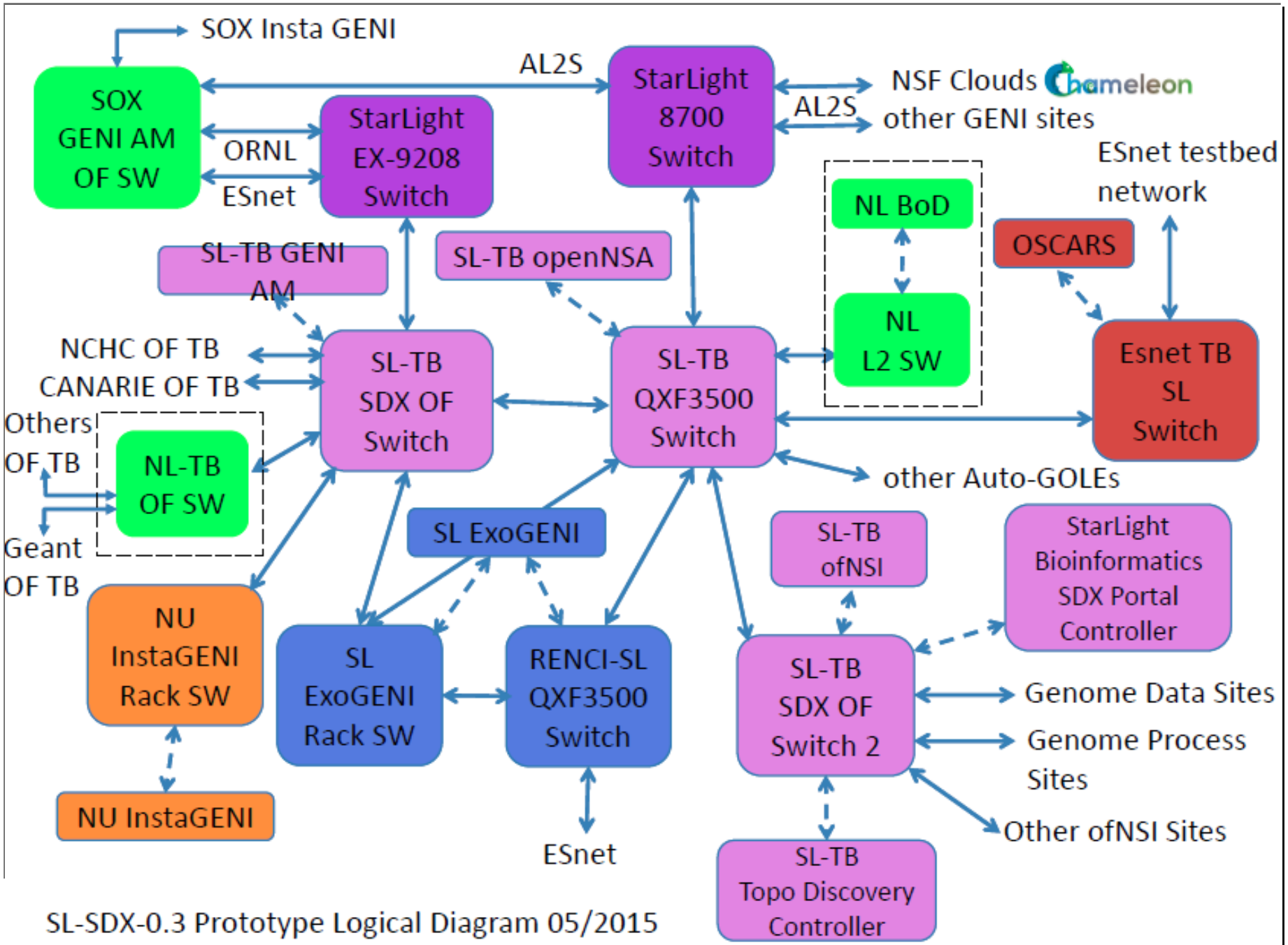

SL-SDX-0.3 Prototype Logical Diagram 05/2015

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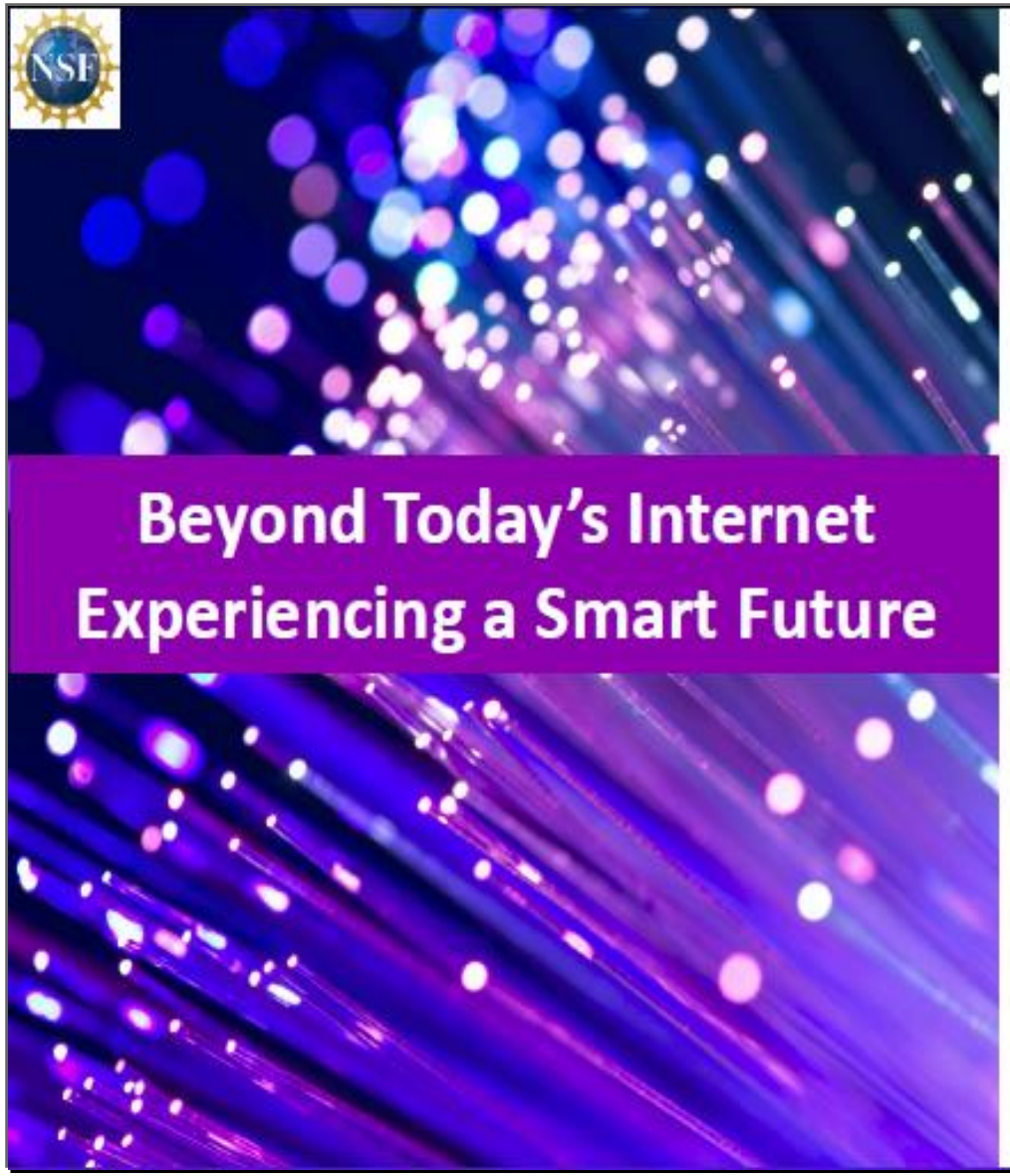

geni
Exploring Networks of the Future

usignite

Prototype SDX Bioinformatics Exchange: Demonstrating an Essential Use-Case for Personalized Medicine

Robert Grossman, Piers Nash, Allison Heath, Renuka Arya
University of Chicago

Joe Mambretti, Jim Chen
Northwestern University

THE UNIVERSITY OF CHICAGO MEDICINE

NORTHWESTERN UNIVERSITY

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Chameleon

www.chameleoncloud.org

CHAMELEON: A LARGE-SCALE, RECONFIGURABLE EXPERIMENTAL ENVIRONMENT FOR CLOUD RESEARCH

Principal Investigator: Kate Keahey

Co-PIs: J. Mambretti, D.K. Panda, P. Rad, W. Smith, D. Stanzione

Program: NSF IRNC

- National Science Foundation Program
- Directorate for Computer & Information Science & Engineering (CISE)
- Division of Advanced Cyberinfrastructure
- NSF 14-554 International Research Network Connections (IRNC)
- Infrastructure and Innovation of U.S. R&E Open Exchange Points (IRNC: RXP)

IRNC: RXP: StarLight SDX Key Participants

- **PI Joe Mambretti, Director, International Center for Advanced Internet Research**
- **Northwestern University, Director, Metropolitan Research and Education Network**
- **Co-Director, StarLight,**
- **Co-PI Tom DeFanti, Research Scientist, (tdefanti@soe.ucsd.edu)**
- **California Institute for Telecommunications and Information Technology (Calit2), University of California, San Diego**
- **Co-PI Maxine Brown, Director**
- **Electronic Visualization Laboratory, University of Illinois at Chicago**
- **Co-PI Jim Chen, Associate Director, International Center for Advanced Internet Research**
- **Northwestern University**
- **Senior Personnel**
- **Phil Papadopoulos, Program Director, UC Computing Systems, San Diego Supercomputer Center, UCSD, Associate Research Professor (Adjunct) Computer Science UCSD**
- **Tom Hutton, Network Architect, UC San Diego Supercomputing Center, SDSC/Calit2**
- **John Graham, Senior Development Engineer Calit2 UCSD**
- **Larry Smarr, founding Director of Calit2) a UC San Diego/UC Irvine partnership, Harry E. Gruber Professor in Computer Science and Engineering (CSE) at UCSD's Jacobs School.**
- **Linda Winkler, Senior Network Engineer, Math and Computer Science Division, Argonne National Laboratory, Senior Network Engineer, StarLight Facility, Technical Director, MREN**
- **Also, Other Members of the StarLight Consortium, Multi National and International Partner**

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StarLight Software Defined Networking Exchange (SDX)

- The StarLight SDX Will Provide The Services, Architecture, and Technologies Designed To Provide Scientists, Engineers, and Educators With Highly Advanced, Diverse, Reliable, Persistent, and Secure Networking Services, Enabling Them to Optimally Access Resources in North America, South America, Asia, South Asia (including India), Australia, New Zealand, Europe, the Middle East, North Africa, And Other Sites Around the World.
- The StarLight SDX Initiative Will Undertake Continued Innovation and Development of Advanced Networking Services and Technologies.

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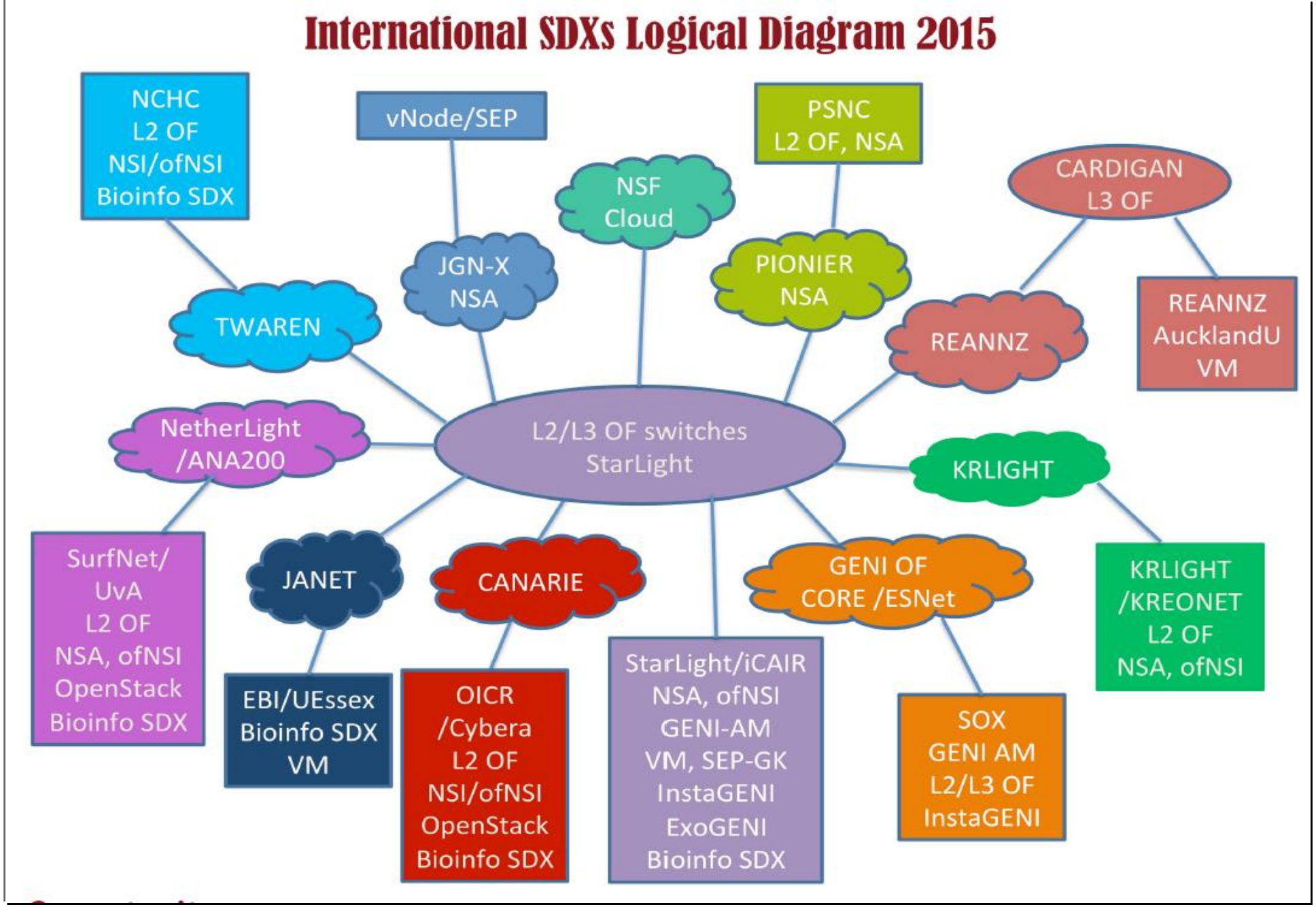
International SDXs Logical Diagram 2015



Question?

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