DevOps and Software Defined Networking (SDNs) and Software Defined Exchanges (SDXs)

Joe Mambretti, Director, (j-mambretti@northwestern.edu)
International Center for Advanced Internet Research (www.icair.org)
Northwestern University
Director, Metropolitan Research and Education Network (www.mren.org)
Director, StarLight, PI StarLight IRNC SDX, Co-PI Chameleon, PI-iGENI, PI-OMNINet (www.startap.net/starlight)

MAGIC Meeting
Washington DC
October 3, 2018
Introduction to iCAIR:

Accelerating Leading Edge Innovation and Enhanced Global Communications through Advanced Internet Technologies, in Partnership with the Global Community

- Creation and Early Implementation of Advanced Networking Technologies - The Next Generation Internet All Optical Networks, Terascale Networks, Networks for Petascale and Exascale Science
- Advanced Applications, Middleware, Large-Scale Infrastructure, NG Optical Networks and Testbeds, Public Policy Studies and Forums Related to Optical Fiber and Next Generation Networks
- Three Major Areas of Activity: a) Basic Research b) Design and Implementation of Prototypes and Research Testbeds, c) Operations of Specialized Communication Facilities (e.g., StarLight, Specialized Science Networks/Science Research Platforms)
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
Global Research Platform: Based On The Global Lambda Integrated Facility

Visualization courtesy of Bob Patterson, NCSA; data compilation by Maxine Brown, UIC.

www.glif.is
IRNC: RXP: StarLight SDX A Software Defined Networking Exchange for Global Science Research and Education

Joe Mambretti, Director, (j-mambretti@northwestern.edu)
International Center for Advanced Internet Research (www.icair.org)
Northwestern University
Director, Metropolitan Research and Education Network (www.mren.org)
Co-Director, StarLight (www.startap.net/starlight)
PI IRNC: RXP: StarLight SDX

Co-PI Tom DeFanti, Research Scientist, (tdefanti@soe.ucsd.edu)
California Institute for Telecommunications and Information Technology (Calit2),
University of California, San Diego
Co-Director, StarLight

Co-PI Maxine Brown, Director, (maxine@uic.edu)
Electronic Visualization Laboratory, University of Illinois at Chicago
Co-Director, StarLight

Jim Chen, Associate Director, International Center for Advanced Internet Research, Northwestern University

National Science Foundation
International Research Network Connections Program
Emerging US SDX Interoperable Fabric
PetaTrans: Petascale Sciences Data Transfer

Singapore
- DTN @100G
  - SingAREN @100G
  - aarnet @100G

Sydney/Brisbane
- DTN @100G
  - NCI aarnet
  - KiSTI

Daejeon
- DTN @100G

CERN
- DTN @100G

Seattle/L.A./SunnyVille
- PacificWave & PRP DTNs @40G/100G
  - PRP Sites

Washington D.C.
- NRL 200G Node
- GSFC 200G Node

Denver
- SCinet & Booth DTNs @10X100G
- Persistence 100G DTN Services Beyond SC17

Sydney/Brigade
- SL-PetaTrans @4X100G
- SDXs 100G Switches

Daejeon
- NORDUnet @100G

CERN
- KRN Unet @100G

Warsaw
- ExoGENI @100G

Amsterdam
- ExoGENI @40G

Montreal
- ETS

Chicago
- STARLIGHT
  - The Optical STAR TAP

Ottawa
- Canane NLight

Denver
- CENI/MAX @2X100G

Sydney/Brigade
- GSFC & NRL @4X100G
Emerging Topics In Advanced Networking

- Transition From Legacy Networks To Networks That Take Full Advantage of IT Architecture and Technology
- Extremely Large Capacity (Multi-Tbps Streams)
- Specialized Network Services, Architecture and Technologies for Data Intensive Science
- High Degrees of Communication Services Customization
- Highly Programmable Networks
- Network Facilities As Enabling Platforms for Any Type of Service
- Network Virtualization
- Tenet Networks
- Network Virtualization
- Network Programming Languages (e.g., P4) API (e.g., Jupyter)
- Disaggregation
- Orchestrators
- Highly Distributed Signaling Processes
- Network Operations Automation (Including Through AI/Machine Learning)
- SDN/SDX/SDI/OCX/SDC/SDE
CHAMELEON: A LARGE SCALE, RECONFIGURABLE EXPERIMENTAL INSTRUMENT FOR COMPUTER SCIENCE

Kate Keahey

Joe Mambretti, Pierre Riteau, Paul Ruth, Dan Stanzione
A Disaggregated SCinet Optical Layer

**Reconfiguration options**
A. Booth to booth connections
B. Booth to WAN connections
C. Booth to switch or router connections
D. WAN to switch or router connections

**Examples**
A. B-B
a. Booth 1001-1 to 1002-1 via optical layer
b. Booth 1001-1 to 1004-3 via optical layer (assumes OLS2 to OLS4 path)
B. Booth to WAN
a. Booth 1001-2 to PoP1-1 via OLS2-2 and OLS1-1
b. Booth 1001-2 to PoP2-B1 via OLS2-2, OLS4, OLS6 and OLS5-1
C. Booth to switch/router
a. Booth 1001-3 to SW1-A1
b. Booth 1003-1 to RTR1-A5 (assumes OLS4 to OLS6 path)
D. WAN to switch/router
a. PoP2-A1 (WAN2) to SW1-3 via OLS3-1 and OLS4-3
b. PoP2-A2 (WAN2) to RTR1-3 via OLS3-2 and OLS4-7

**Notes**
1) Transponders could be from multiple vendors but for near term the links would need to be built with matching transponders.
2) Controllers and orchestration systems are **not shown** but all Tpndr/OLS systems must be connected
StarLight SDX Geoscience Research Workflow

Input parameter
1. Date
2. Time (00/06/12/18)

Download To SDX DTN → grib2 → Data convert1 → netCDF → Data convert2 → png → Convert to video → mp4 → Display → Select Data → Data Transfer To Other DTN
Source Corby Schmidt
DRAFT
Still Largely
Reflects SC17
Config in SL
booth.!!
tinyurl.com/SC18-JBDT
To request changes, please
leave a comment.
See also
http://tinyurl.com/SC18-NRE

09/02/2018
SC17

Demonstrations of 400 Gbps Disk-to-Disk WAN File Transfers using iWARP and NVMe Drives
An SC17 Collaborative Initiative Among NASA and Several Partners

SC17 @ Denver, CO
SCinet NOC Booth #1081

NASA demo @ StarLight/OCC/iCAIR Exhibit Booth #1653

Legend
100-GE NASA/GSFC-owned

SCinet

C14-C17

x10

CenturyLink

C21-C30

C14-C17

x10

CenturyLink

AOFA-CR5

ESnet

WASH-CR5

NASA/GSFC
Greenbelt, MD

Dell

HECN
X200NVME

24-NVME DISKS

NASA/GSFC HECN Team
Diagram by Bill Fink / Paul Lang - 8/14/2017
NRL will demonstrate:
- *Dynamic* distributed processing of large volumes of data
- Across geographically dispersed HPC and network resources
- Able to rapidly change resources to meet application demands.
- Software Defined Networking (SDN)
- Pipelined 12 Gbps real-time video processing workflows coexisting with bulk data transfers between processing nodes.
- 3 – 100 Gbps connections DC-to-SC17 floor plus 100 Gbps connections to Chicago and Oakland.

“Interconnected and interlocking problems” call for a high performance dynamic distributed data centric infrastructure.
A Cross-Pacific SDN Testbed
Transferring Large Scale Airline Data E2E Across WANs Using DTNs

v5, 21 SEP 2017

Ingredients
- Using Globus Toolkit (NOT Globus Online)
- Use GridFTP under the hood
- Under Globus license (must be evaluated)
- 400Gb/s data transfer expected
- VLAN 2098, multiprotocol tunneling
- Including authentication/authorization framework, e.g., SURFnet

Minimal setup
- Data transfer between DTN@Uva to DTN@Starlight at 40G
- Compare this to IPv4 performance Chicago-Amsterdam

Additional features
- Single Sign-On
- Comparison to IPv6
- Auto-deletion of file when transfer completed
- >40Gb/s data transfer
- Expanding sites for GLIF and/or 80

Ideas
- Dutch Research LAN Project
100 Gbps DTN Optical Testbed

Ciena's OPn research network testbed

StarLight

Chicago

Ciena

Ottawa

Montreal

New York

Hanover

Baltimore

Wash DC

In Service

Recently Deployed
In Partnership With The GENI Initiative, iCAIR Is Developing a P4 Testbed for Computer Science Research.

The Testbed Will Be Integrated With the GENI SDX At StarLight


An Emerging Networking Programming Language,

A Domain Specific Language for Network Protocols.

Highly Flexible In Contrast To OpenFlow

Testbed Based on Tofino (Barefoot Networks) Switches

Compiler (V16) Enables Rules To Be Dynamically Implemented In Chip
Other Notable iCAIR Supported Testbeds

- International AI Testbed (Currently Being Designed)
- International DTN Testbed
- LHC P2P Service
- High Performance Digital Media Network (HPDMnet)
- Geophysical Sciences Testbed
- Content Routing Network
- AutoGOLE
- MEICAN/Network Service Interface (NSI)
- AmoebaNet
- Cisco Information Centric Networking Testbed (ICN)
- SD-WAN Testbed
- ToMaTo
- Et Al
Building the Open Storage Network

Alex Szalay
The Johns Hopkins University

Institute for Data Intensive Engineering and Science
"Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Networking and Information Technology Research and Development Program."

The Networking and Information Technology Research and Development (NITRD) Program

Mailing Address: NCO/NITRD, 2415 Eisenhower Avenue, Alexandria, VA 22314

Physical Address: 490 L'Enfant Plaza SW, Suite 8001, Washington, DC 20024, USA Tel: 202-459-9674, Fax: 202-459-9673, Email: nco@nitrd.gov, Website: https://www.nitrd.gov