# Control Planes and Control Frameworks: Issues, Evolution, and Future Directions

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**Legacy Architecture: Carrier Cloud/Managed Service – Assumption End Point Should Not Know Or Care About Paths**

Cloud of Unknowing

A

B

**Emerging Architecture: MyNet**

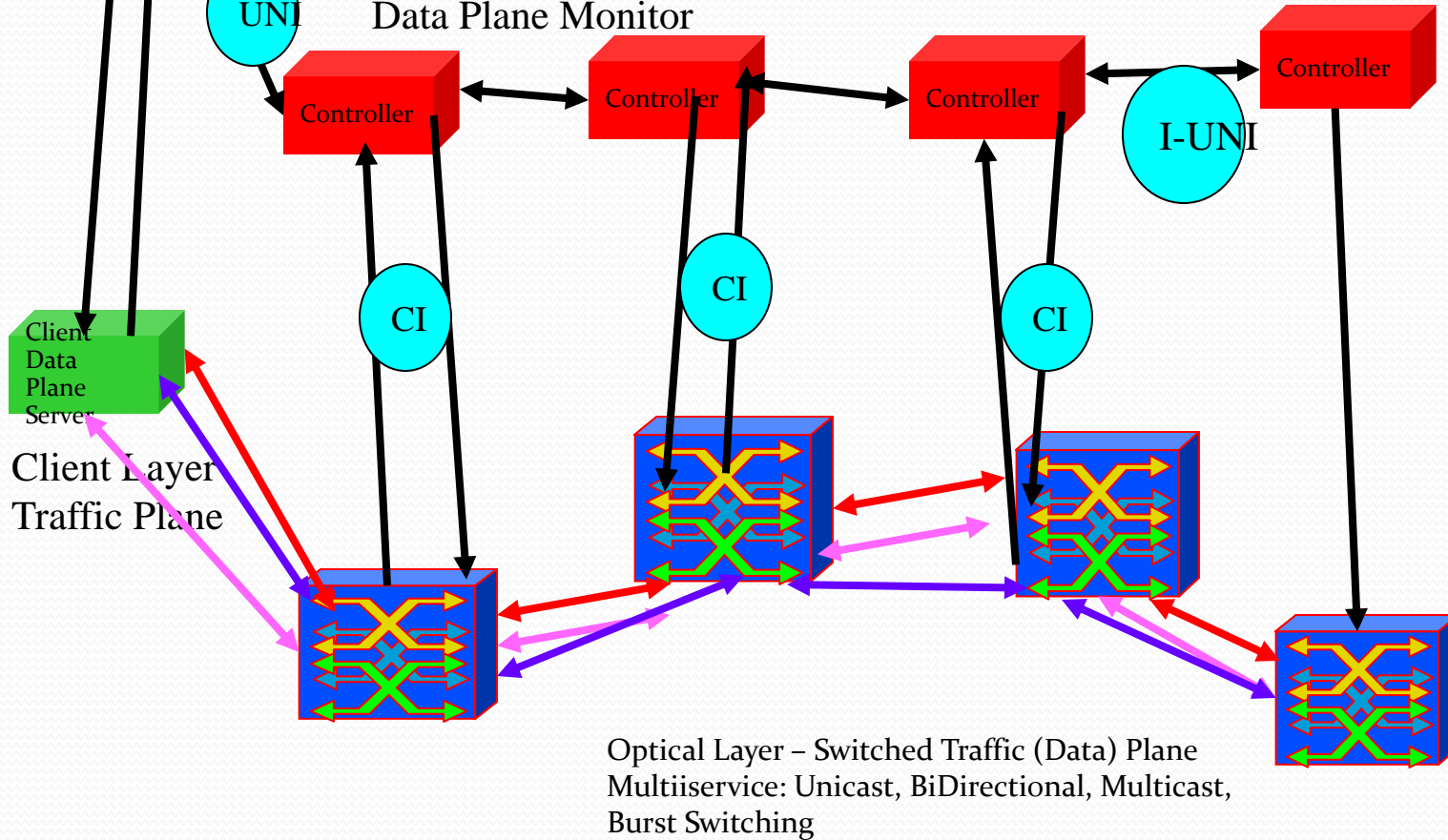Complete Understanding And Control

A

B

**Q: Why Are Control Planes An Important Topic? A: MyNet**
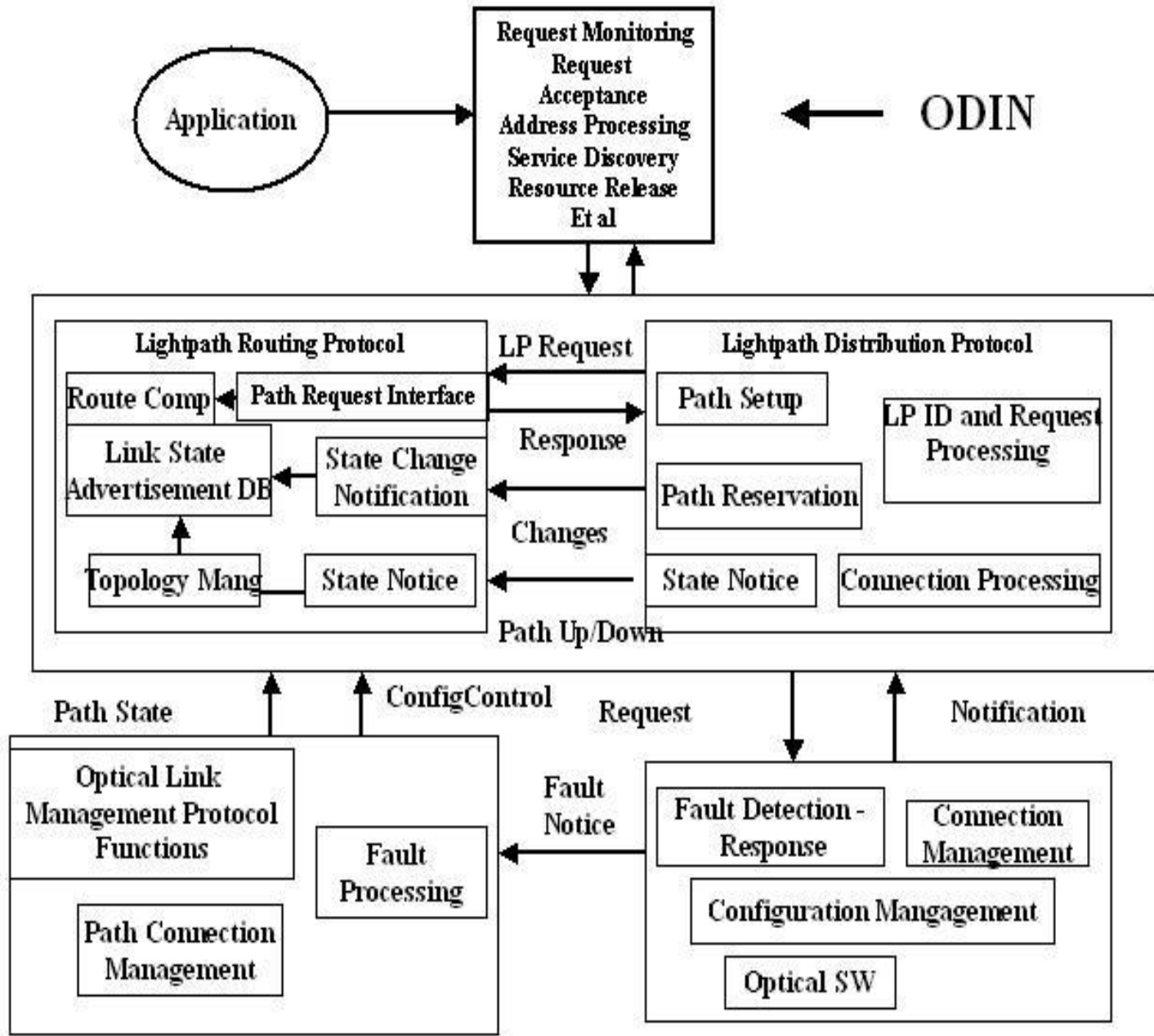
# Context: Control "System"

- Management Plane
- Control Plane
- Data Plane
- L3 vs L2, vs L1: Traditionally Each Have Had Different Attributes
- Innovations (Late 1990s, Early 2000s)
  - Architecture: Separation of Control Plane From Data Plane
  - Base Control Plane On IP Signaling (Traditionally Proprietary Systems)
  - Dynamic Configuration of L1, L2 Paths (Traditionally Static)
  - Edge Process Signaling (Traditionally Centralized Only)

# New: Intelligent Application Signaling *

Client Layer Control Plane: Communications Service Layer
Service Layer, Policy Based Access Control, Client Message
Receiver, Signal Transmission, Data Plane Controller,
Data Plane Monitor

Optical Layer Control Plane

IAS Server

UNI

Controller

Controller

Controller

Controller

I-UNI

Client
Data
Plane
Server

CI

CI

CI

Client Layer
Traffic Plane

Optical Layer – Switched Traffic (Data) Plane
Multiiservice: Unicast, BiDirectional, Multicast,
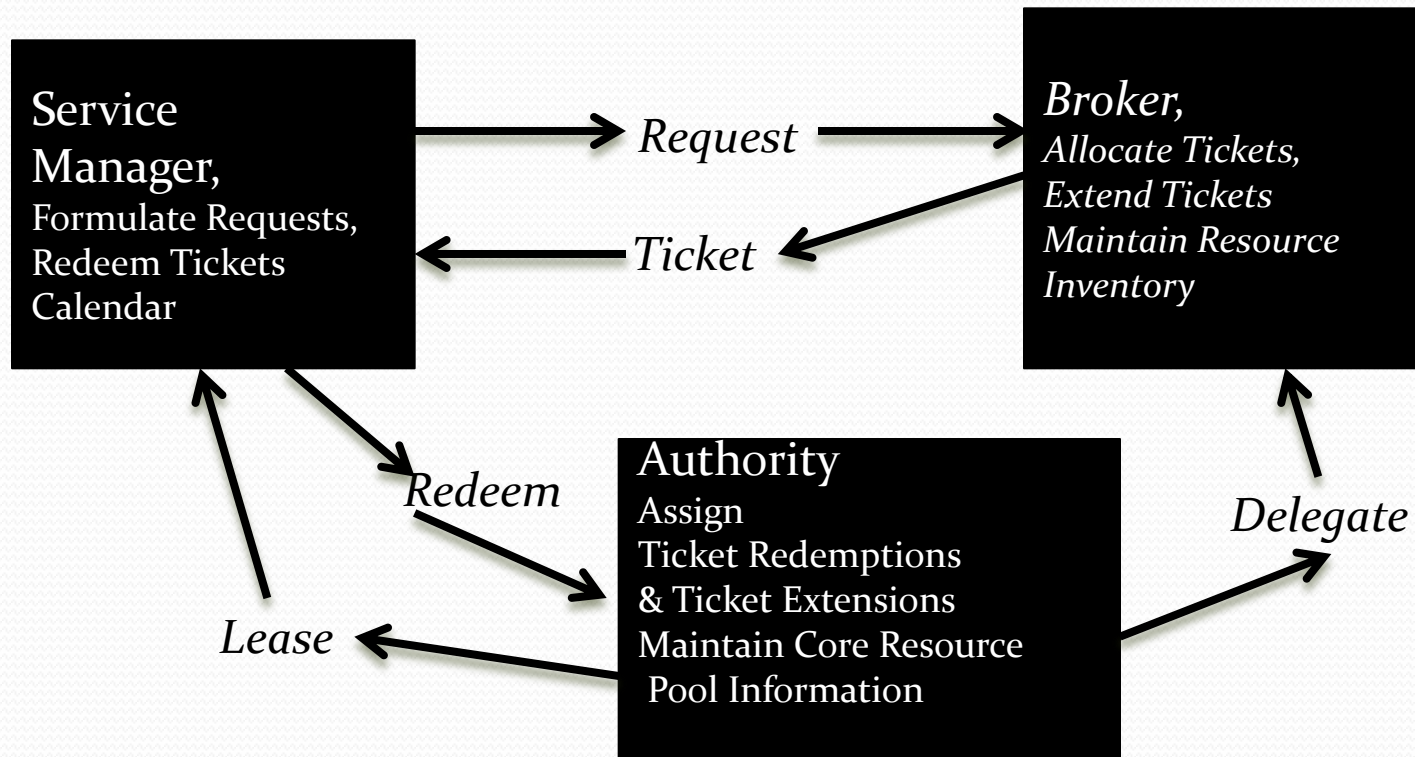Burst Switching

* Also Control Signaling, et al

# A Few Selected Experimental Architectures

- UCLP
- ODIN
- DRAC
- OSCARS
- DRAGON
- EnLIGHTened
- G-Lambda
- AutoBAHN
- CHEETAH
- OptIPuter
- Phosphorus
- OpenNSA
- DynamicKL
- Emulab
- And Many, Many More…
- Leading To GridNets, Programmable Networking, Software Defined Networking, RTMA, etc

# National Science Foundation's Global Environment for Network Innovations (GENI)

- GENI Is Funded By The  National Science Foundation's Directorate for Computer and Information Science  and Engineering (CISE)
- GENI Is a Virtual Laboratory For Exploring Future Internets At Scale.
- GENI Is Similar To Instruments Used By Other Science Disciplines, e.g., Astronomers – Telescopes, HEP - Synchrotrons
- GENI Has Supported 4 Control Frameworks and an Integration API (GENI Aggregation Manager)
  - ProtoGENI.
  - PlanetLab
  - ORCA
  - Orbits
- Note that GENI Uses OpenFlow – However, In Contrast To Common Misperceptions, OpenFlow Is Not a Control Framework
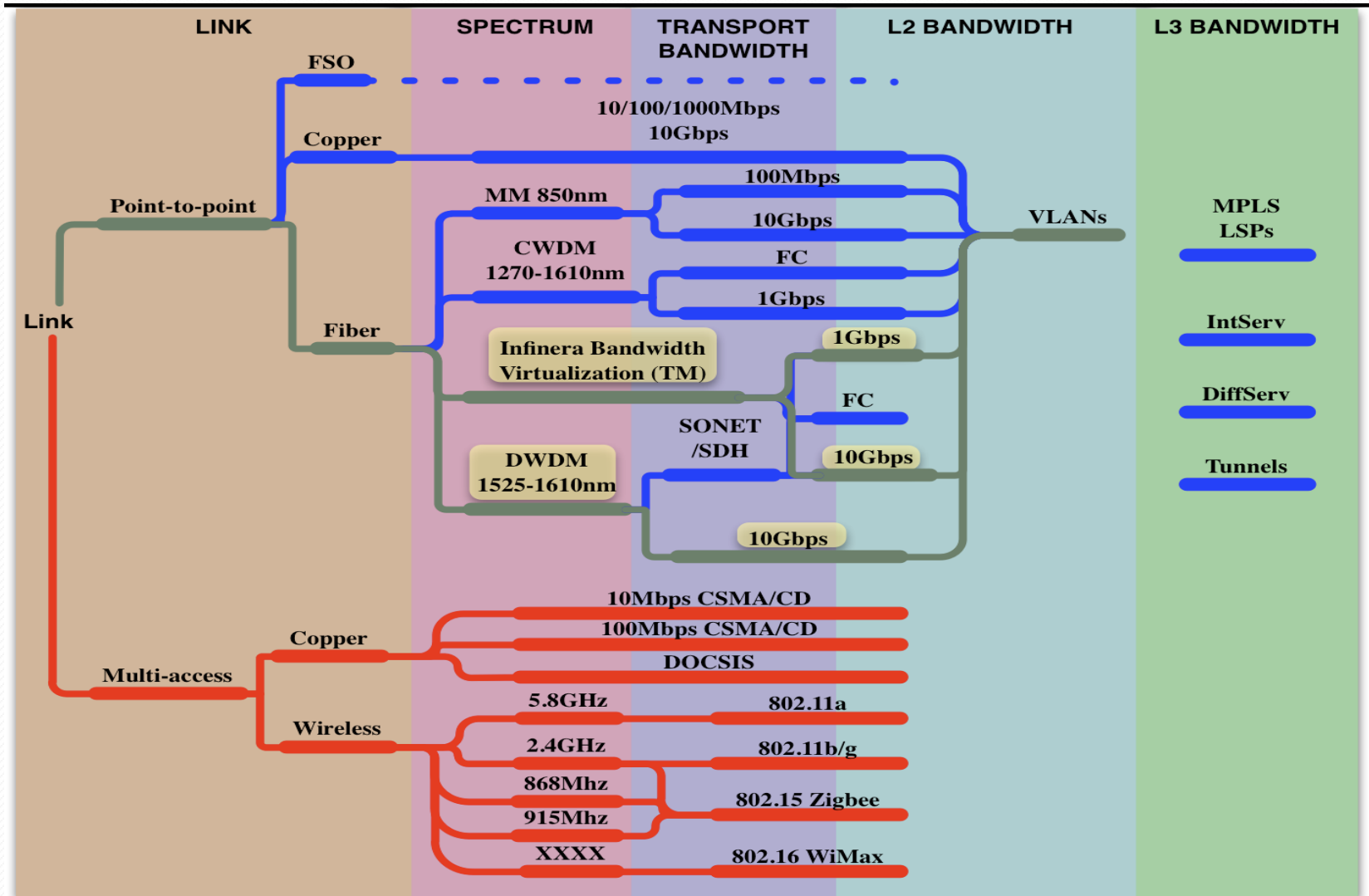
# Basic Open Resource Control Architecture (ORCA)

**Service Manager,**
Formulate Requests,
Redeem Tickets
Calendar

*Request* →

← *Ticket*

*Broker,*
*Allocate Tickets,*
*Extend Tickets*
*Maintain Resource*
*Inventory*

*Redeem*

**Authority**
Assign
Ticket Redemptions
& Ticket Extensions
Maintain Core Resource
 Pool Information

*Lease*

*Delegate*

Source: ORCA-BEN-RENCI

# ORCA "Link" Slivering



Source: ORCA-BEN-RENCI

# Network Services Interface (NSI)

- The Network Services Interface (NSI) Is
  - An Architecture For Multi-Domain Resource Discovery, Acquisition, Reservation, Provisioning, Releasing, Integration, Signalling, Messaging
  - A Standard Being Defined Through The Open Grid Forum
  - A Testbed Prototype (Quasi-Production?) Implementation
  - A Platform For Extension, e.g., the NSI Connection Service (NSI CS), a Protocol for Network Provisioning
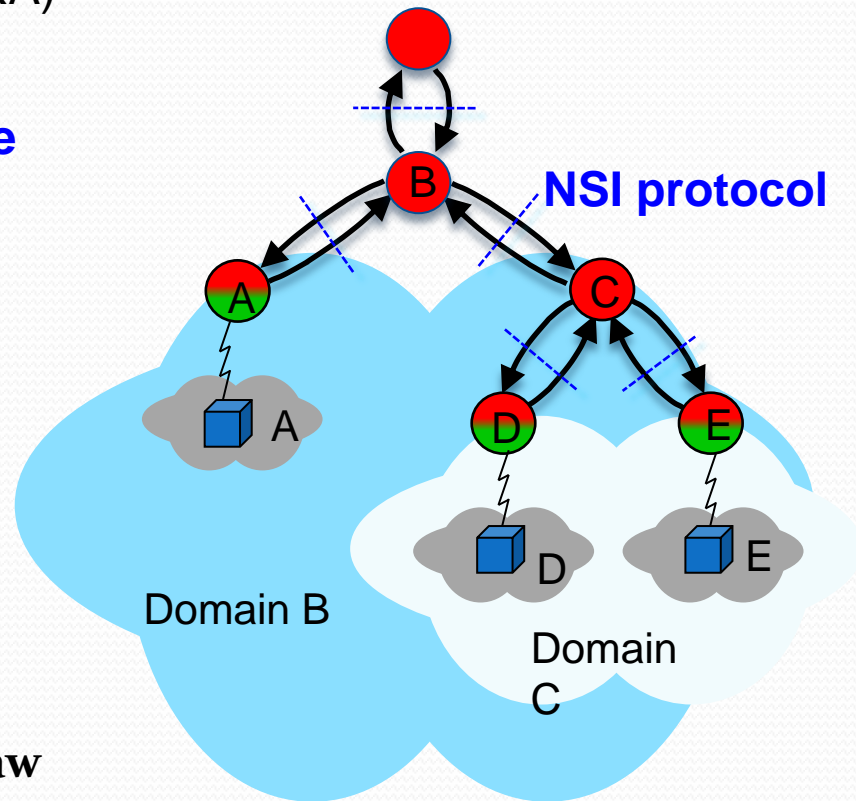
# NSI Architecture

Network Services Agents

Requesting
Agent (RA)

**Network Services Interface**
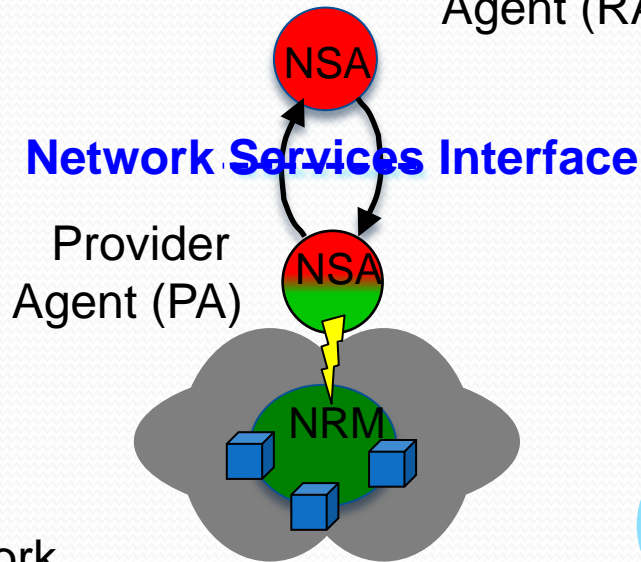
Provider
Agent (PA)

NSA

NSA

NRM

Network
Resource
Manager

**NSI protocol**

B

A

C

D

E

Domain B

Domain C

**Source: NSI Community Radosław Krzywania et al**
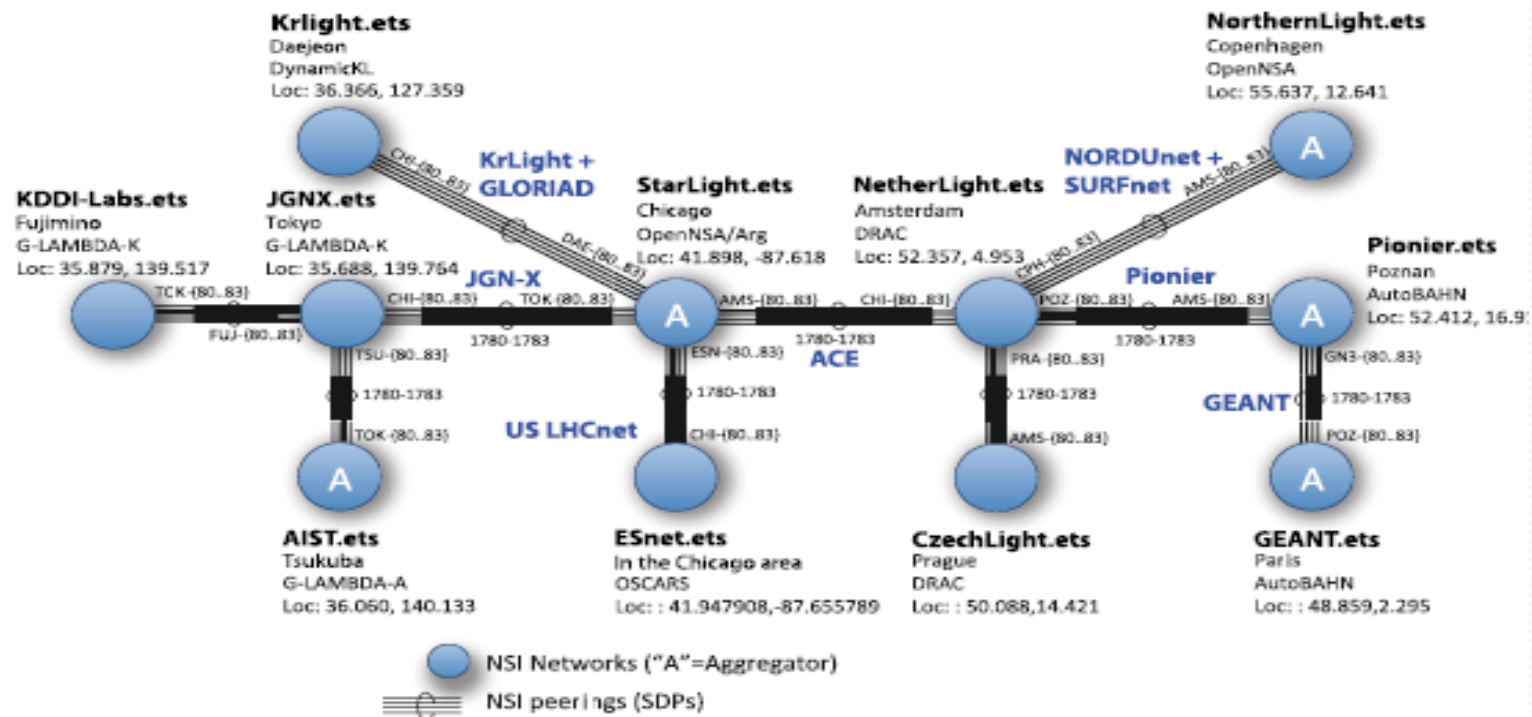
# Potential Option…

- LHCONE Prototype Based On NSI
- Initially an International Testbed
- Evaluation/Experimentation
- Quasi-Production
- Evaluation

# Discussion... Questions?