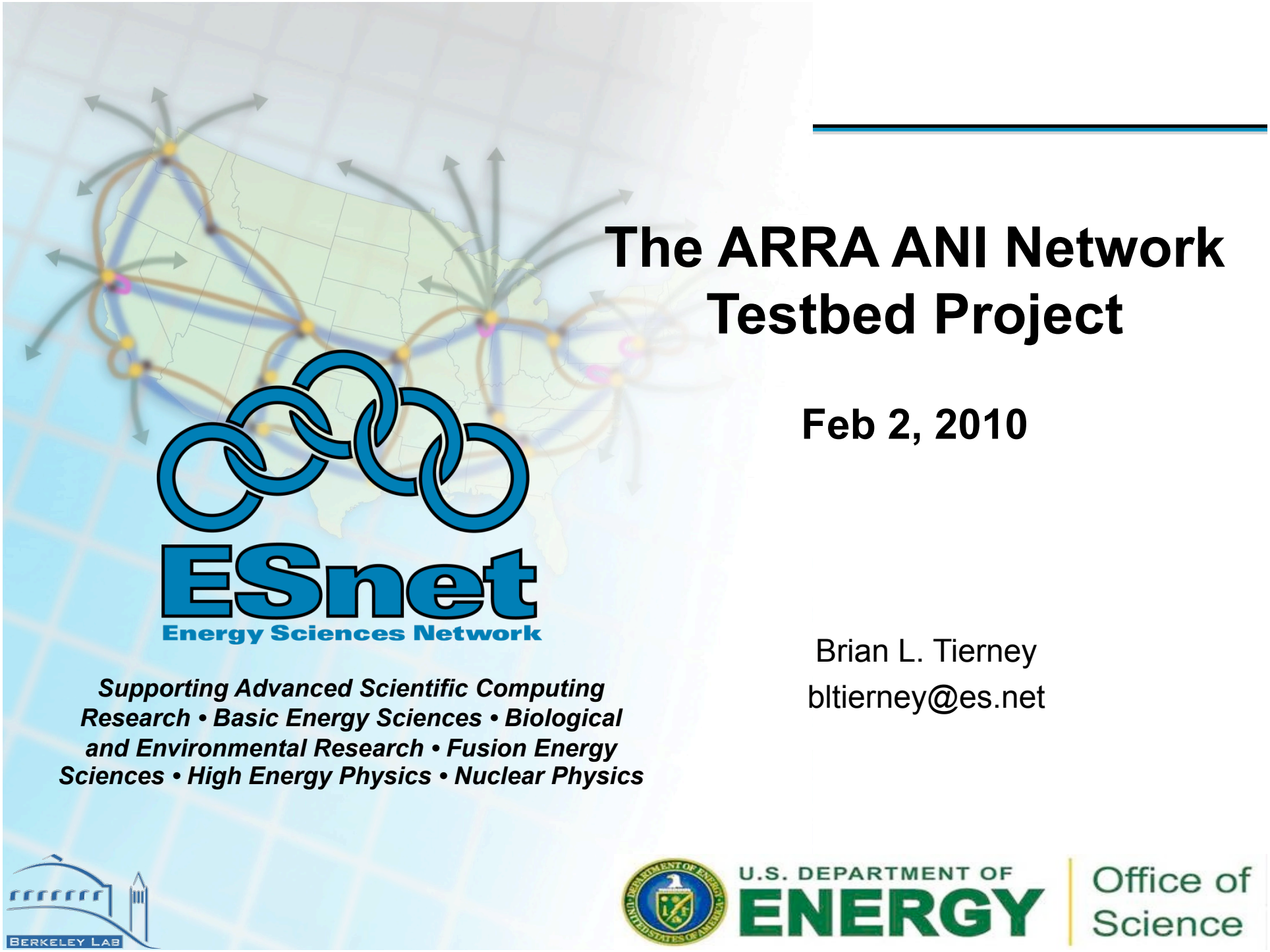

# The ARRA ANI Network Testbed Project

**Feb 2, 2010**

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ESnet
Energy Sciences Network

***Supporting Advanced Scientific Computing Research • Basic Energy Sciences • Biological and Environmental Research • Fusion Energy Sciences • High Energy Physics • Nuclear Physics***

BERKELEY LAB

U.S. DEPARTMENT OF ENERGY | Office of Science

# Overview

- Project Start Date: September, 2009
- Funded by ARRA for 3 years
  - Hopefully will continue beyond ARRA
- Designed, built, and operated by ESnet staff
- 1 of 3 ARRA "Advanced Network Initiative" (ANI) projects in the DOE
  - ANI 100G Prototype
  - ANI Network Testbeds
  - 4 ANI research projects

# ANI 100G Prototype Network

- The “100G Prototype” network will connect DOE Supercomputer Centers at NERSC, Argonne, Oak Ridge, and MANLAN at 100Gbps
  - Not for production ESnet traffic
- Testbed will use 100G waves from the prototype network
- Testbed will use 100G routers from the prototype network

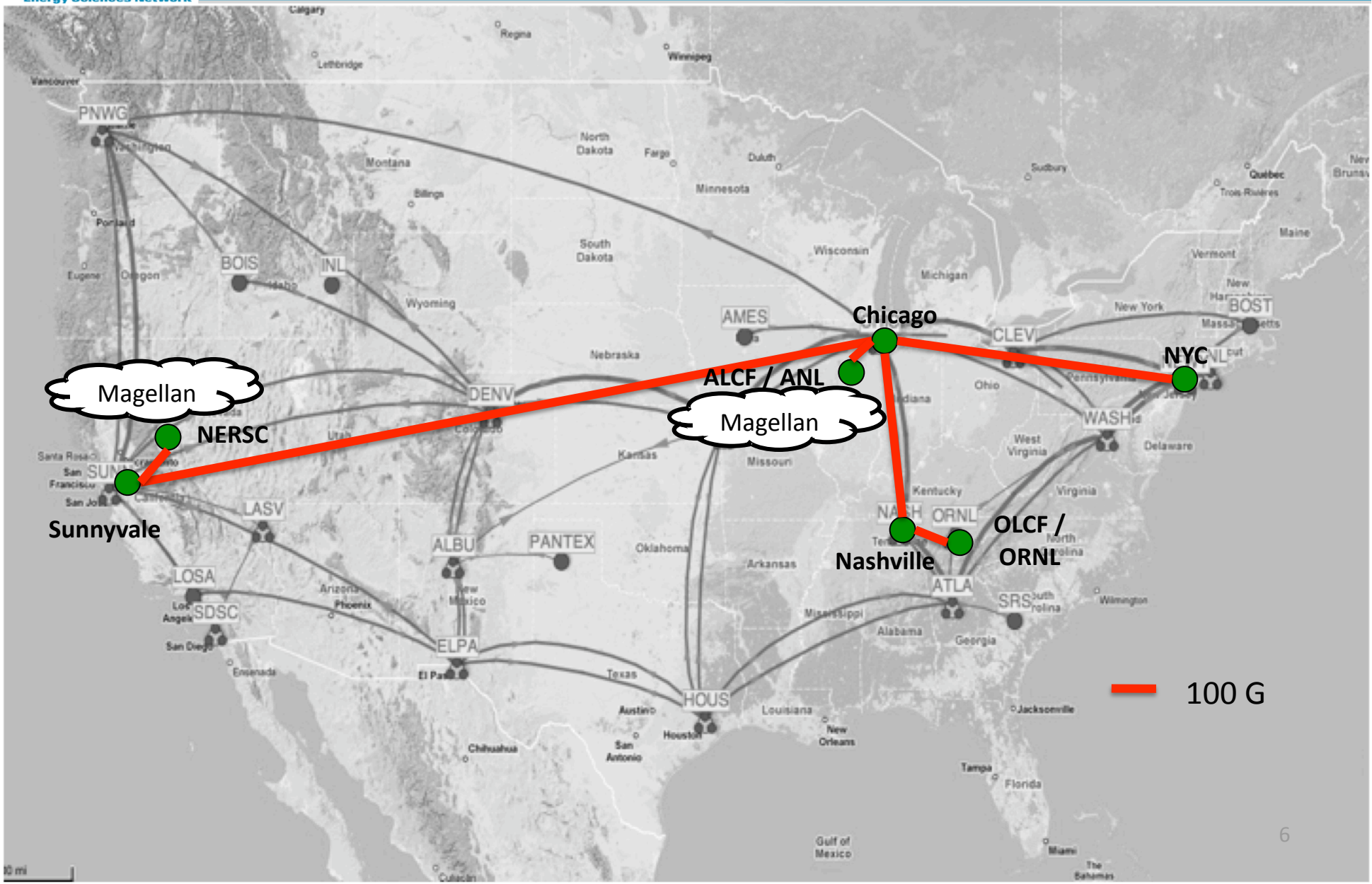
# 2 Testbeds Components

- Network Research Testbed
  - Phase 1: “tabletop” testbed at LBNL
  - Phase 2: Deployed on ESnet dark fiber in Long Island
- Application / Middleware Testbed
  - ANI 100G network connecting Magellan resources

# Relation to the Magellan Project

- High-speed storage resources for the ANI Application Testbed will be provided by the ARRA-funded Magellan Project
  - DOE computing project funded at $33M
- Magellan is:
  - a research and development effort to establish a nationwide scientific mid-range distributed computing and data analysis testbed.
  - Consists of two sites
    - NERSC / LBNL
    - ALCF / ANL
  - Will provide multiple 10's of teraflops and multiple petabytes of storage, as well as appropriate cloud software tuned for moderate concurrency.

# Nationwide 100G Prototype Network



# ARRA/ANI Testbed Goals

- Enable network, middleware and application end-to-end R&D at 100G
- Configurable
- Breakable
  - Isolated from the production network
- Reservable
- Easy to reset to known state
- A community network R&D resource
  - open to researchers and industry to conduct experiments

# Testbed Requirement: Support Network Research

- Support research on:
  - Data Plane
  - Control Plane
  - Management Plane
  - AA Plane
  - Service Plane
- Ability to do multi-domain hybrid networking
  - Support R&D on multi-layer and multi-domain control and signaling at layers 1-3
- Ability to reserve and manage each components
- Support protection and recovery research
- Support interoperability testing of multi-vendor 100G network components
- Provide access to all available monitoring data

# Testbed Requirement: Support Middleware/Application Research

- Ability to support end-to end experiments at 100 Gbps
  - Connect to Magellan systems at NERSC (Oakland, CA) and ALCF (Argonne, IL)

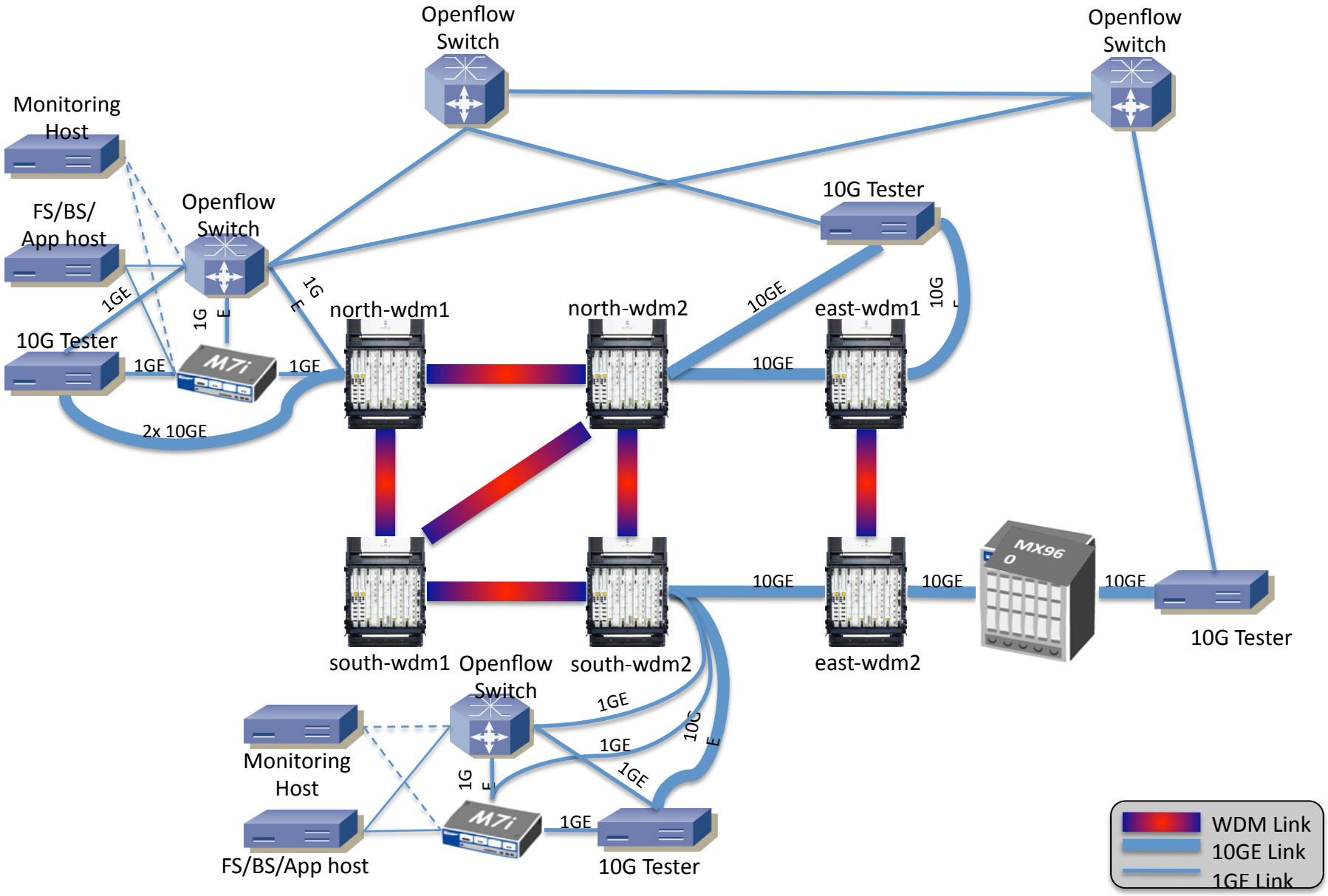
# Network Testbed Components

- Network Testbed will consist of:
  - DWDM devices (Layer 0-1)
    - GMPLS-enabled
  - Layer 2 switches supporting Openflow
  - Layer 3 Routers
    - Juniper M7i
    - OSCARS compatible, MPLS-enabled
  - Test and measurement hosts
    - Virtual Machine based test environment
    - 2x10G test hosts initially
      - Eventually 100G from Acadia 100G NIC project

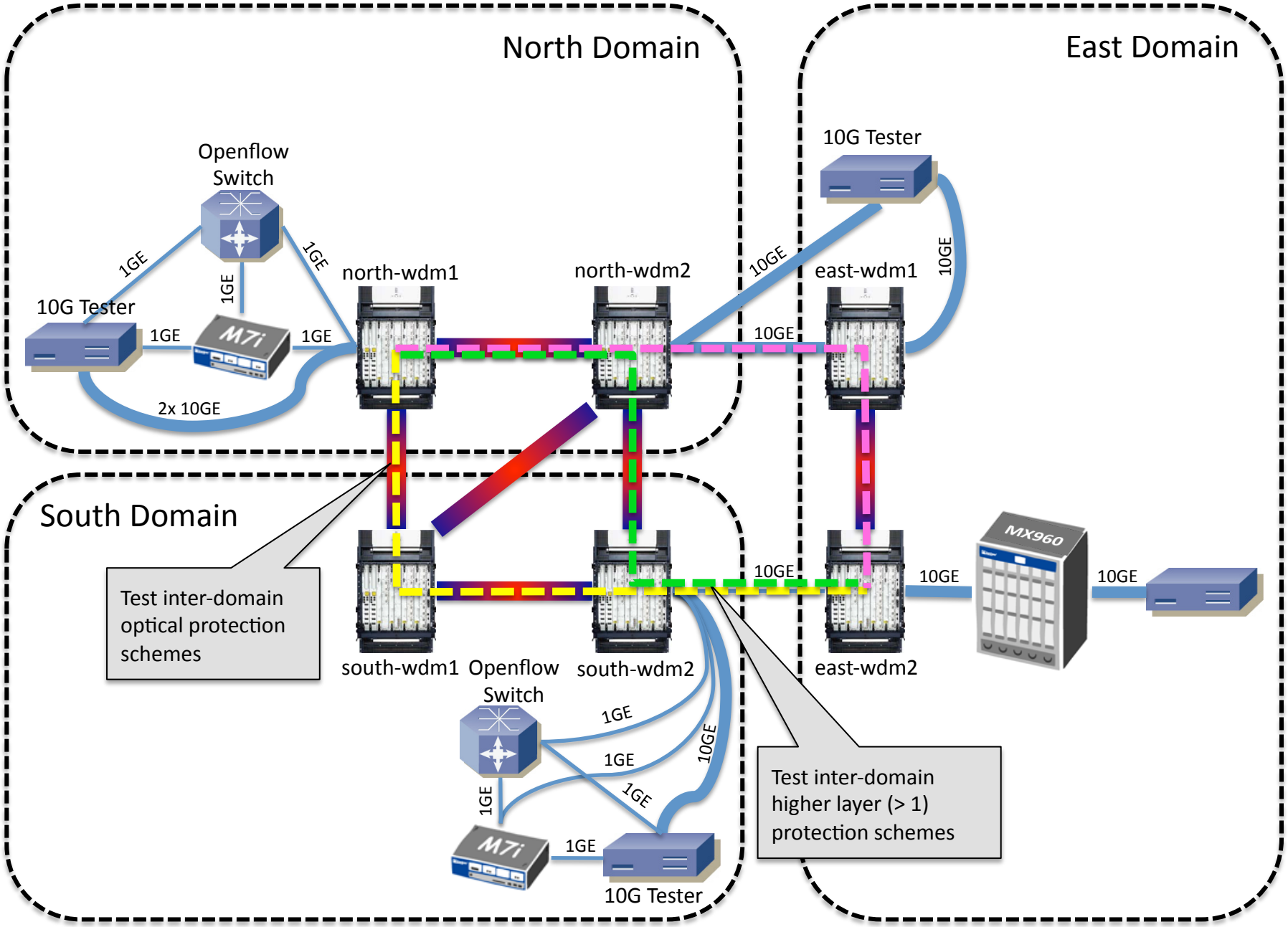
# Phased Approach

- Phase 1:
  - "Tabletop Testbed" at LBL
  - Ability to simulate multiple domains
  - MPLS enabled routers
  - Secure access via a gateway node from anywhere
  - Scheduled via simple calendar
  - Available to researchers this summer

# Tabletop Testbed Configuration



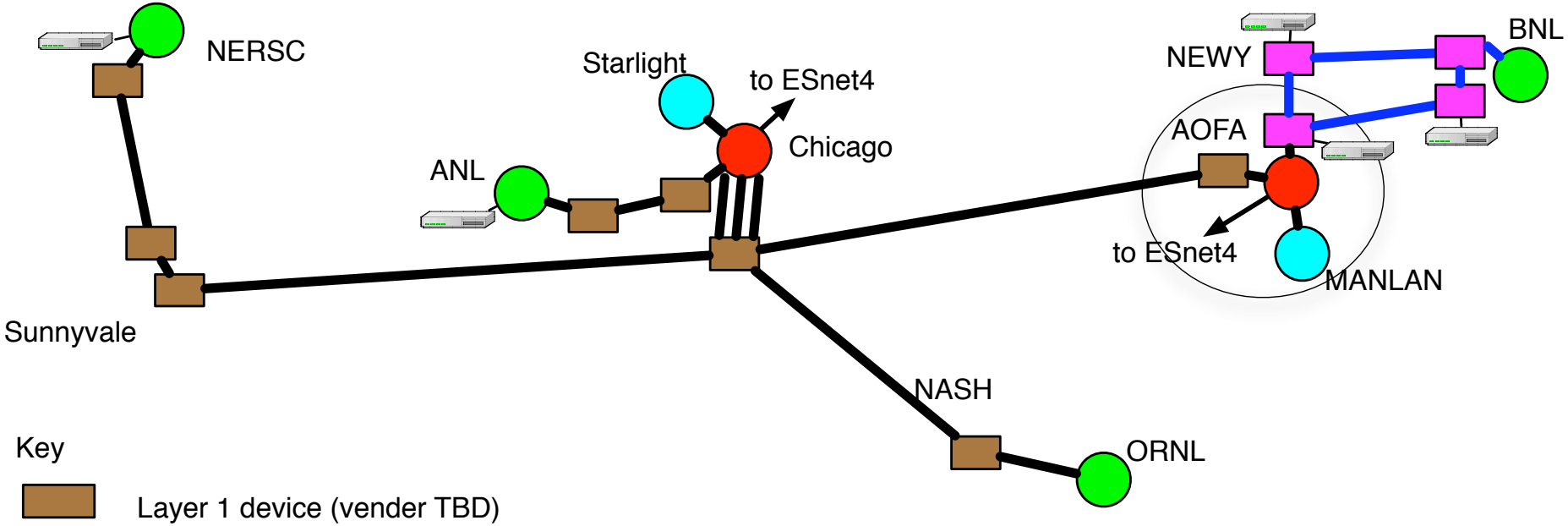
# Sample Configuration: Multi-Domain Multi-Layer Protection Testing



# Phased Approach

- Phase 2:
  - Nodes are deployed on Long Island MAN
    - This is where ESnet will have dark fiber
  - 1 or more 10G Ethernet circuits between each node
    - Hope to upgrade segments to 100G as hardware becomes available
  - Ability to simulate multiple domains
  - MPLS enabled routers
  - Scheduled using OSCARS-like system
  - Available Early 2011

# ANI Prototype Network Architecture – current plan




Key

- Layer 1 device (vender TBD)
- Testbed Layer 1 device (Infinera DTN)
- Site Router
- ESnet Router
- Exchange Point Router
- 100GE
- ESnet managed fiber
- Testbed Node (test and measurement hosts)

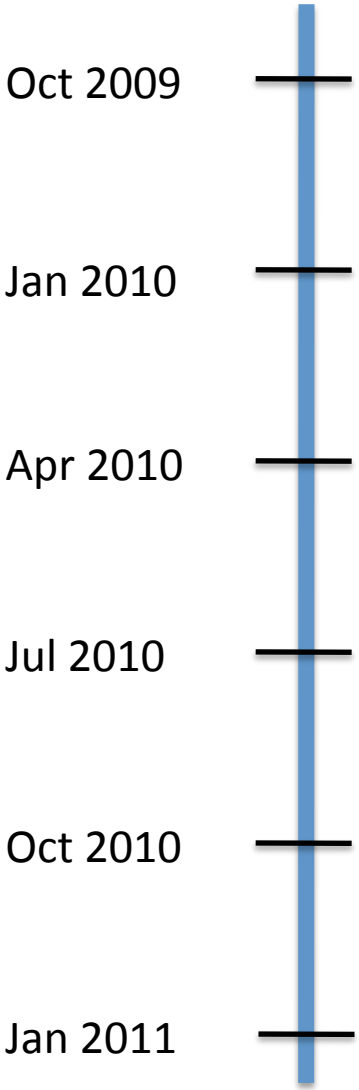
# Prototype or Testbed?

- Some confusion on these terms:
  - Prototype: 100G network connecting 3 Supercomputer Centers and MANLAN
  - Network Testbed: Network devices and hosts that researchers can configure
    - 1st in Tabletop, later in LIMAN (Long Island MAN)
  - Application/Middleware Testbed: Magellan connected by prototype network

# Testbed Access

- Currently there are 9 DOE-funded projects that will be the first to get access
- Testbed will be accessible to anyone:
  - DOE researchers
  - Other government agencies
  - Industry
- Must submit a short proposal to the testbed review committee
  - Committee will be made up of members from the R&E community and industry

# Timeline: Phase 1 (Tabletop Testbed)



| | Milestone |
|---|---|
| Oct 2009 | • Project start<br>• Network device selection |
| Jan 2010 | • Hardware arrives; begin install and config |
| Apr 2010 | • Application testbed (Magellan) available,10G<br>• Simple management software developed |
| Jul 2010 | • Tabletop Testbed available to DOE-funded researchers |
| Oct 2010 | • Start accepting Testbed proposals |
| Jan 2011 | • Hold Testbed Workshop |

# Timeline: Phase 2

**Milestone**

- **Oct 2010**
  - Final WAN deployment planning based on ANI Prototype awards
- **Jan 2011**
  - Magellan-based Application Testbed available at 100G
  - Long Island dark-fiber based network testbed available to researchers
- **Apr 2011**
  - Testbed available to 1st group of non-DOE researchers
- **Jul 2011**
  - Accept 2nd round of Testbed Proposals
- **Oct 2011**
  - Deploy v2 of Testbed Management Software
- **Jan 2012**
  - 2nd round Testbed users get access

# For More Information

- Contact: bltierney@es.net
- https://sites.google.com:443/a/lbl.gov/ani-100g-network/
  - (temporary location)
- http://twitter.com/100Gnetwork

# EXTRA SLIDES

# Testbed to support DOE ARRA-funded Research Projects

- Climate 100 (LLNL, LBL, ANL)
  - Project Goal: Scaling the ESG to 100G
  - Testbed role: provide interconnect between “Magellan project” resources at ANL and NERSC
- Advanced Network and Distributed Storage Laboratory (OSG: U Wisc, FNAL, etc)
  - Project Goal: enhance Virtual Data Toolkit (VDT) data management tools to effectively utilize 100G networks
  - Testbed role: provide interconnect between “Magellan project” resources at ANL and NERSC
- 100G NIC (Acadia and Univ New Mexico)
  - Project Goal: produce a host NIC capable of 100 Gbps
  - Testbed role: Provide test environment for this device
- 100G FTP (BNL/Stony Brook University)
  - Project Goal: design 100G transport protocols and tools to enable 100G FTP server to client data transfer
  - Testbed role: Provide a 100G test environment

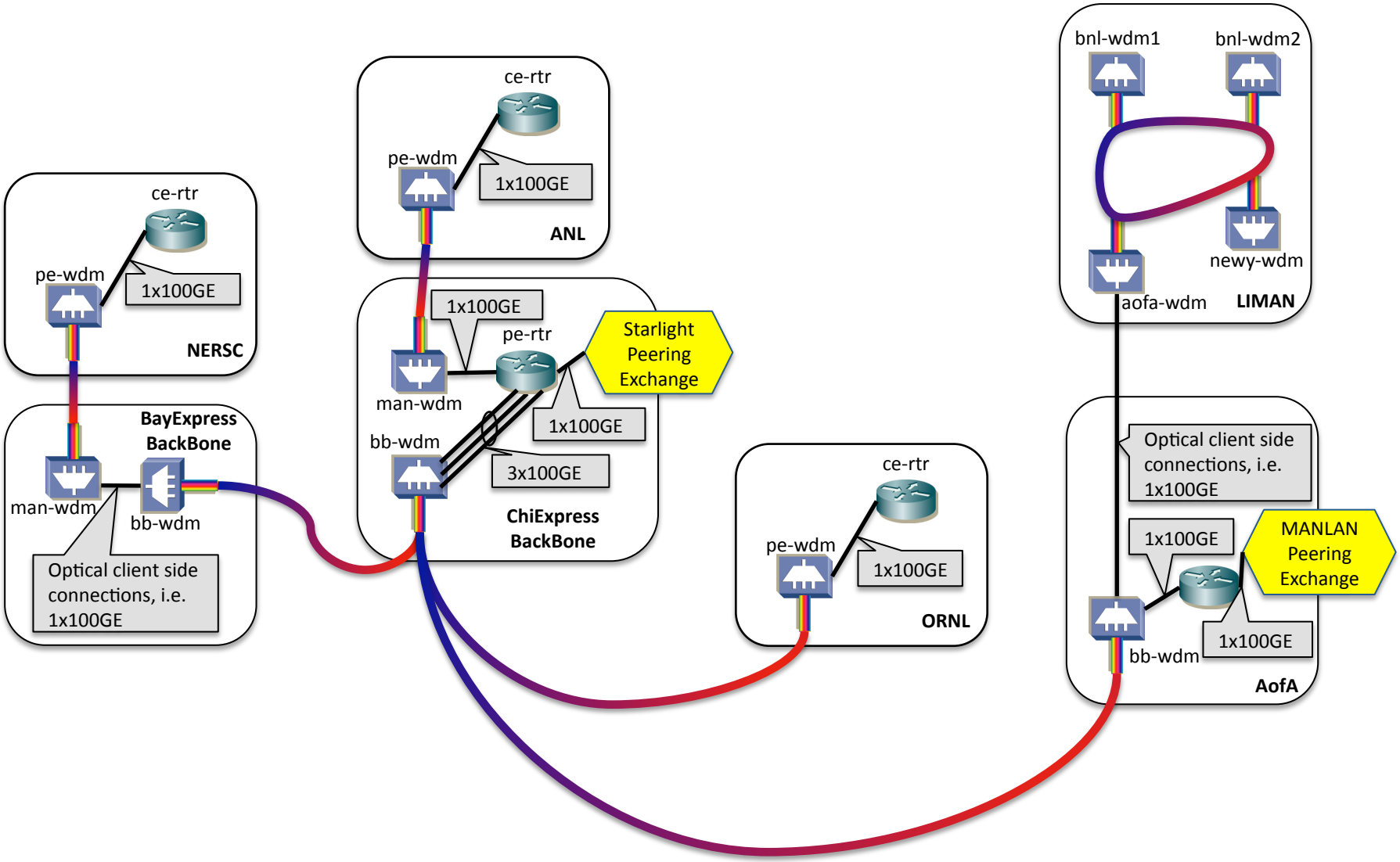
# Testbed to support DOE Network Research Projects

- "Resource optimization in hybrid core networks with 100G links" (Univ Virginia)
  - Project Goal: Design a hybrid network architecture that scales to multi-Tb/s and supports both IP-routed and dynamic-circuit services efficiently
  - Testbed role: Provide a test environment for validating these these methods
- "Integrating Storage Resource Management with Dynamic Network Provisioning for Automated Data Transfer" (BNL, LBL)
  - Project Goal: Integration of dynamic virtual circuits into BestMAN (Berkeley Storage Manager / SRM v2.2)
  - Testbed role: Provide a 100G test environment for verifying this work
- "Provisioning Terascale Science Apps using 100G Systems" (UC Davis)
  - Project Goal: Advanced path computation algorithms for efficiency and resiliency
  - Testbed role: Provide a control plane test environment for these algorithms using OSCARS

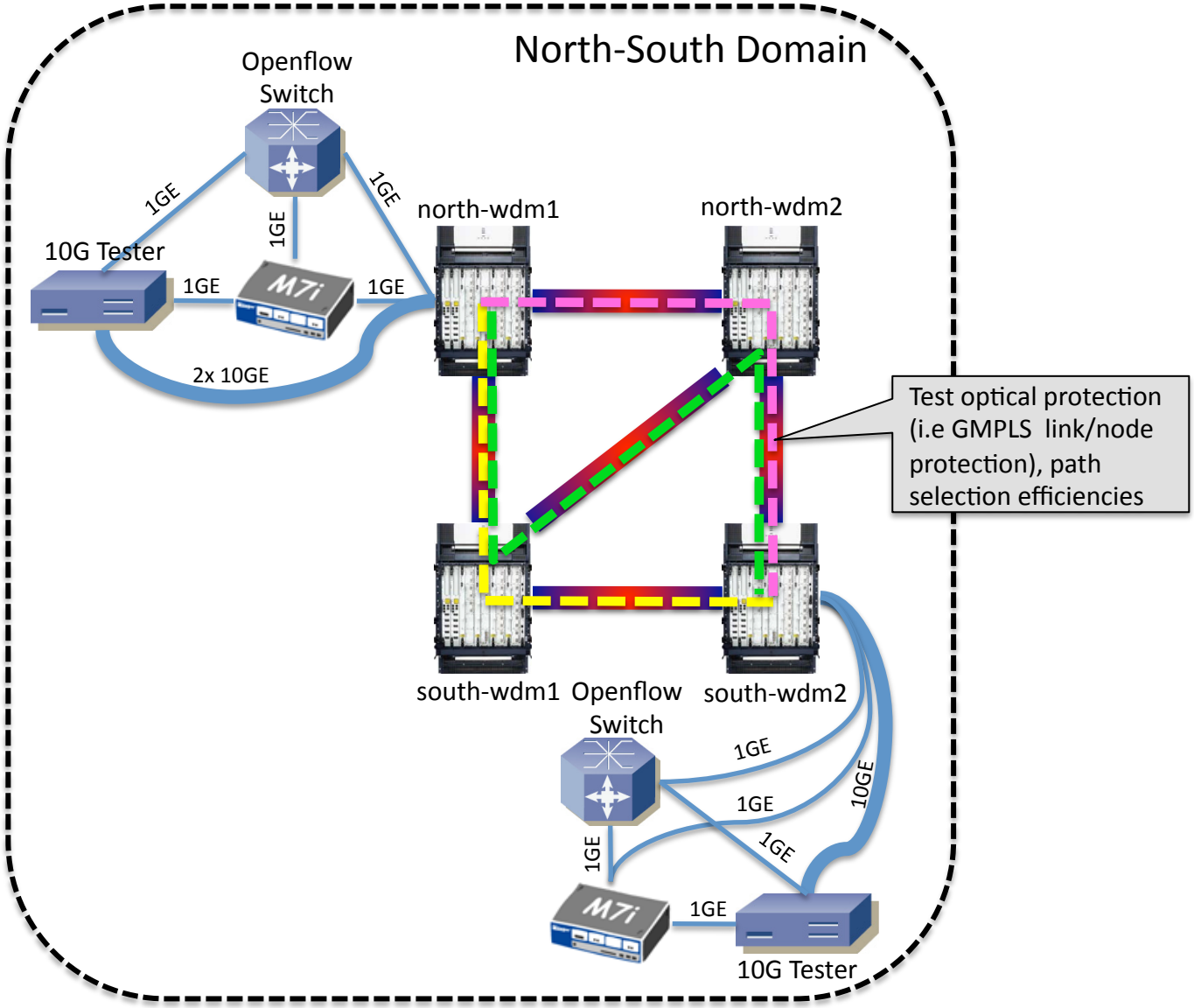
# Testbed to support DOE Network Research Projects (cont.)

- Virtualized Network Control (ISI, ESnet, Univ New Mexico)
  - Project Goal: multi-layer, multi-technology dynamic network virtualization
  - Testbed role: provide a control plane test environment for experiments using hybrid networking
- "Sampling Approaches for Multi-domain Internet Performance Measurement Infrastructures to Better Serve Network Control and Management" (Ohio State Univ)
  - Project Goal: Develop new network measurement sampling techniques and policies
  - Testbed role: Provide a network environment for initial deployment

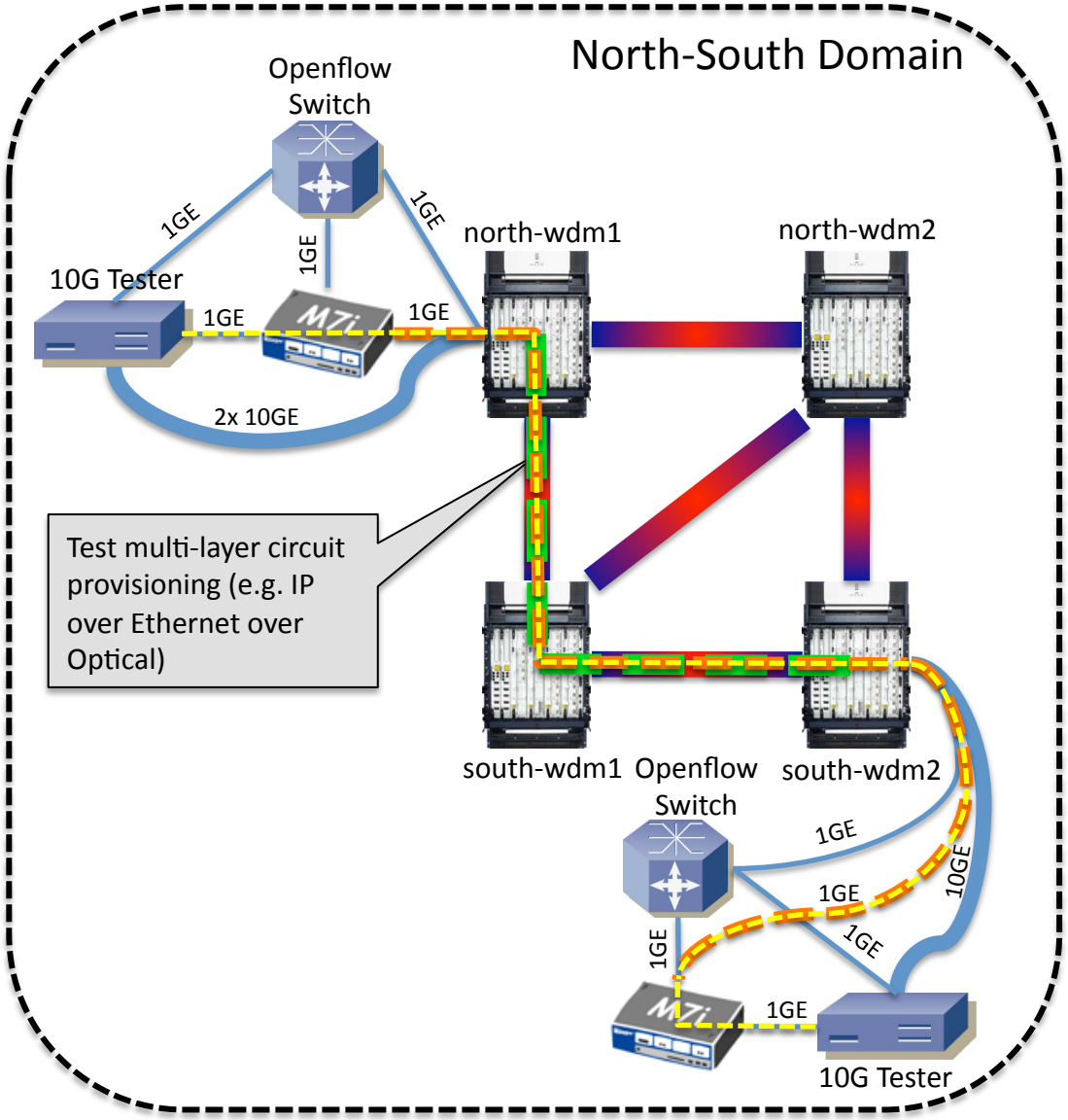
# 100G Prototype Network Design Final Baseline Design



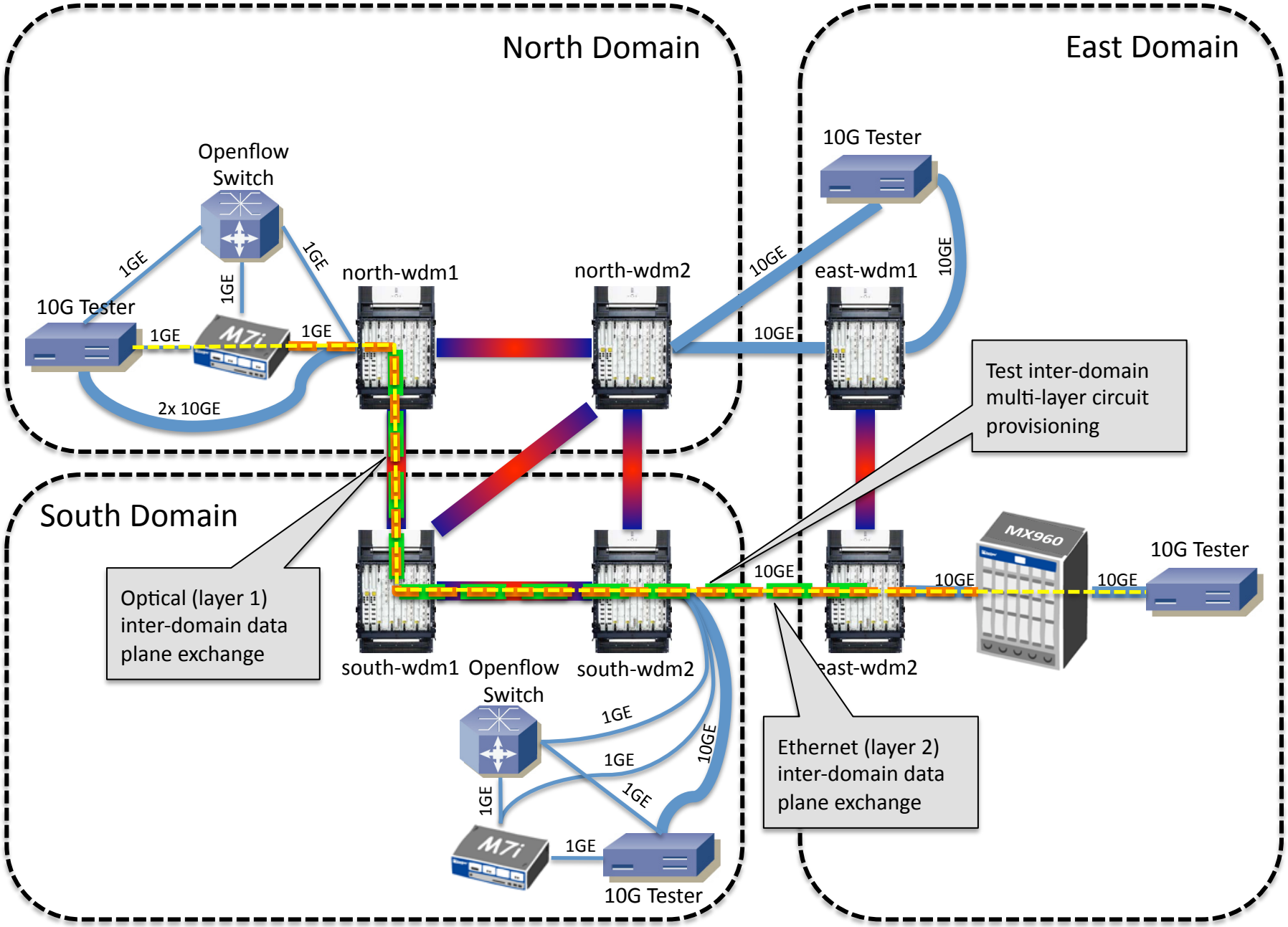
# Intra-Domain Protection Testing



# Intra-Domain Multi-Layer Circuit Provisioning



# Multi-Domain Multi-Layer Circuit Provisioning



# Intra-Domain Flow Selection Switching