Washington University in St. Louis

Engineering

NDN Managed Gateways and The NDN Testbed

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NDN Nodes

- **Types of NDN Nodes**
  - » **Gateway Routers**
  - » **End User**
  - » **Application Nodes**
- **Gateway Router Nodes**
  - » **Managed**
    - **Managed by Washington U. team so you don't have to…**
    - **ONLY used for:**
      - – **Gateway routing function (ndnd, OSPFN)**
      - – **Running a repository (ndnr)**
      - – **Operator management of site keys and certificates**
    - **Each member site will provide at least one managed gateway node**
      - – **More may be provided if desired.**
    - **Non-member sites may provide managed node(s) also**
  - » **Unmanaged . . .**

NDN Nodes

- **Gateway Router Nodes (continued)**
  - » **Unmanaged**
    - **Member sites may run additional unmanaged router nodes**
      - **Behind the site's managed gateway router**
    - **Non-member sites with a managed gateway router**
      - **May have additional unmanaged router nodes behind the site's managed gateway router**
    - **Non-member sites without a managed gateway router**
      - **May have unmanaged node(s) connected through a member site**
        - » **That member site takes on some responsibility for non-member site**
    - **Before any unmanaged node is added to the Testbed WU team needs to be notified**
- **To contact WU Testbed Management Team:**
  - » **Send email to: ndntestbed@arl.wustl.edu**

Managed Gateway Router Nodes

- **Installation (Done by local Site personnel)**
  - **OS: Ubuntu 12.04 LTS Server (Not Desktop)**
    - **http://www.ubuntu.com/download/server**
    - **Add ssh server during installation**
    - **Two accounts:**
      - **operator: For local site operator**
      - **ndnops: For WU team (provide us with the password so we can use sudo)**
        - **We will provide a public key for ssh access**
      - **NO OTHER USER ACCOUNTS.**
  - **Firewall Issues**
    - **GRE tunnel access to/from other gateway nodes**
    - **ndnx access to/from clients of a gateway node**
      - **Port 6363**
      - **Broadcast/Multicast group on UDP 224.0.23.170 port 56363**
    - **ssh access for WU team**
    - **Probably some others that we'll learn about as we bring it all up…**
  - **Certificates and keys**
    - **UCLA team is working on a new set of tools.**
    - **Local operator will be responsible for signing keys for local users**

Managed Gateway Router Nodes

- **Configuration and Maintenance (Done by WU team)**
  - » **git vs. apt-get**
    - **Tagged versions of packages from git repos and build on each node**
    - **In the future we may build Ubuntu pkgs for installation from a PPA**
      - **> sudo apt-get install ndn**
  - » **What NDN related packages?**
    - **ndnx: (ndnd, ndnr, …)**
    - **OSPFN3.0**
    - **ndnxml client: generates data for ndnmap**
    - **NDN packages to support certificates and keys**
    - **Perhaps a few others…**
  - » **Configuration of a Node**
    - **GRE Tunnels**
    - **OSPFN Configuration**
    - **Configuration files installed from git repo**
      - **Separate set of files for each Testbed node**
        - » **WU team will define and maintain configuration files**
      - **May use a private git repo to protect configuration files**
      - **In the future configuration files may be installed as part of 'apt-get'**

Managed Gateway Router Nodes

- Plan for releases
  - » 3 month cycle (11/2013, 2/2014, …)
  - » Testing of new releases
    - Unit testing of each individual package is done by owner of package
    - Integration testing to be done by WU
      - – WU's Open Network Lab (ONL) Testbed (http://onl.wustl.edu/)
        - » More about this later…
- Research Testbed vs. Reliable Managed Testbed
  - » What are we allowed to experiment with?
    - Strategy layer experimentation?
    - Caching and forwarding strategy experimentation?
    - Routing protocol experimentation?
  - » ndnd development responsibilities
    - Strategy layer
    - Caching and Forwarding
    - Bug Fixes
    - Testing and Release

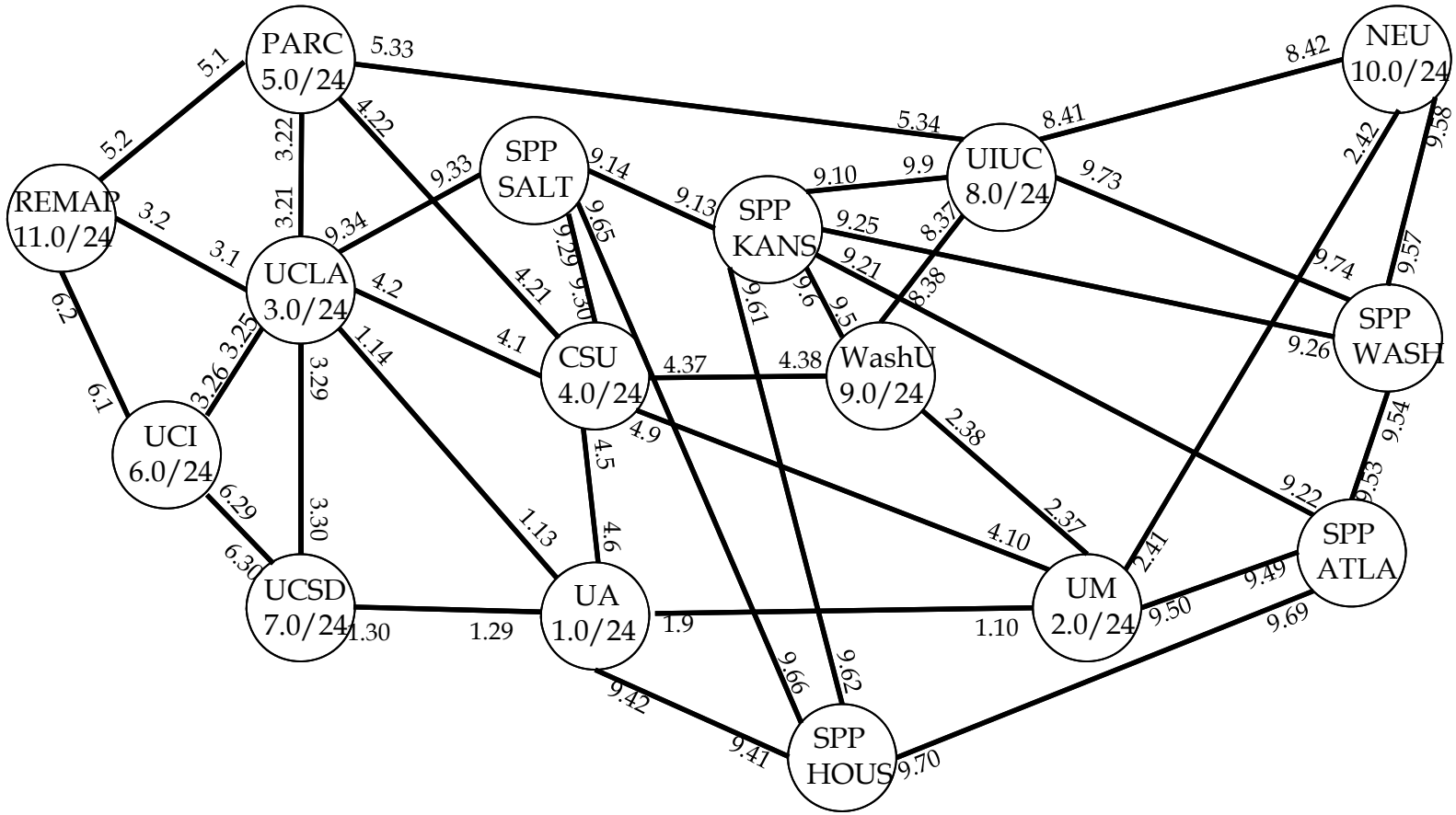
NDN Testbed Operations

- **Responsible Parties**
  - » **Washington U. Team will manage**
    - **Remote restarts**
    - **Remote updates**
    - **Remote configuration**
  - » **Operator(s) at each site will be responsible for:**
    - **Physical Installation**
    - **Initial OS Installation**
    - **Manual interventions (power cycle, crash recovery, etc.)**
    - **Local user key signing**
  - » **Testbed Root key management**

NDN Testbed Operations (continued)

- **Status Monitoring**
  - » We plan to consolidate and augment current status monitoring tools
    - Memphis: http://netlab.cs.memphis.edu/script/htm/status.htm
    - Arizona: http://www.cs.arizona.edu/people/yifengl/tbs.html
  - » Node status
  - » Link status
  - » ndnd status
    - Memory size?
    - etc…
  - » Routing/Prefix/FIB status
  - » etc…
- **Usage Monitoring**
  - » Bandwidth
    - Washington U: http://ndnmap.arl.wustl.edu/
  - » Investigate what ndnd internals can be monitored effectively
    - PIT entries?
    - Content store?
  - » Application specific monitoring?
  - » etc…

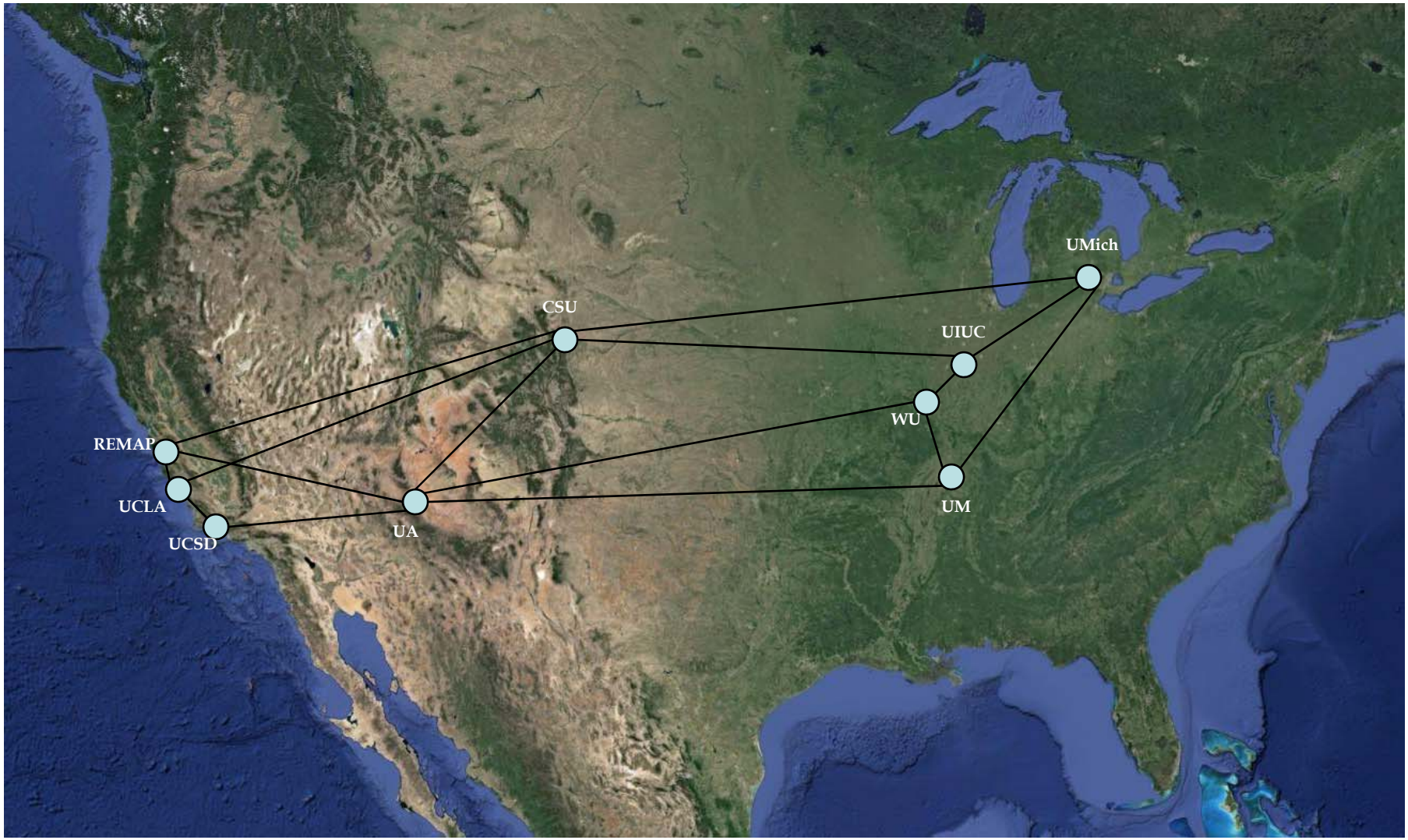
Current NDN Testbed



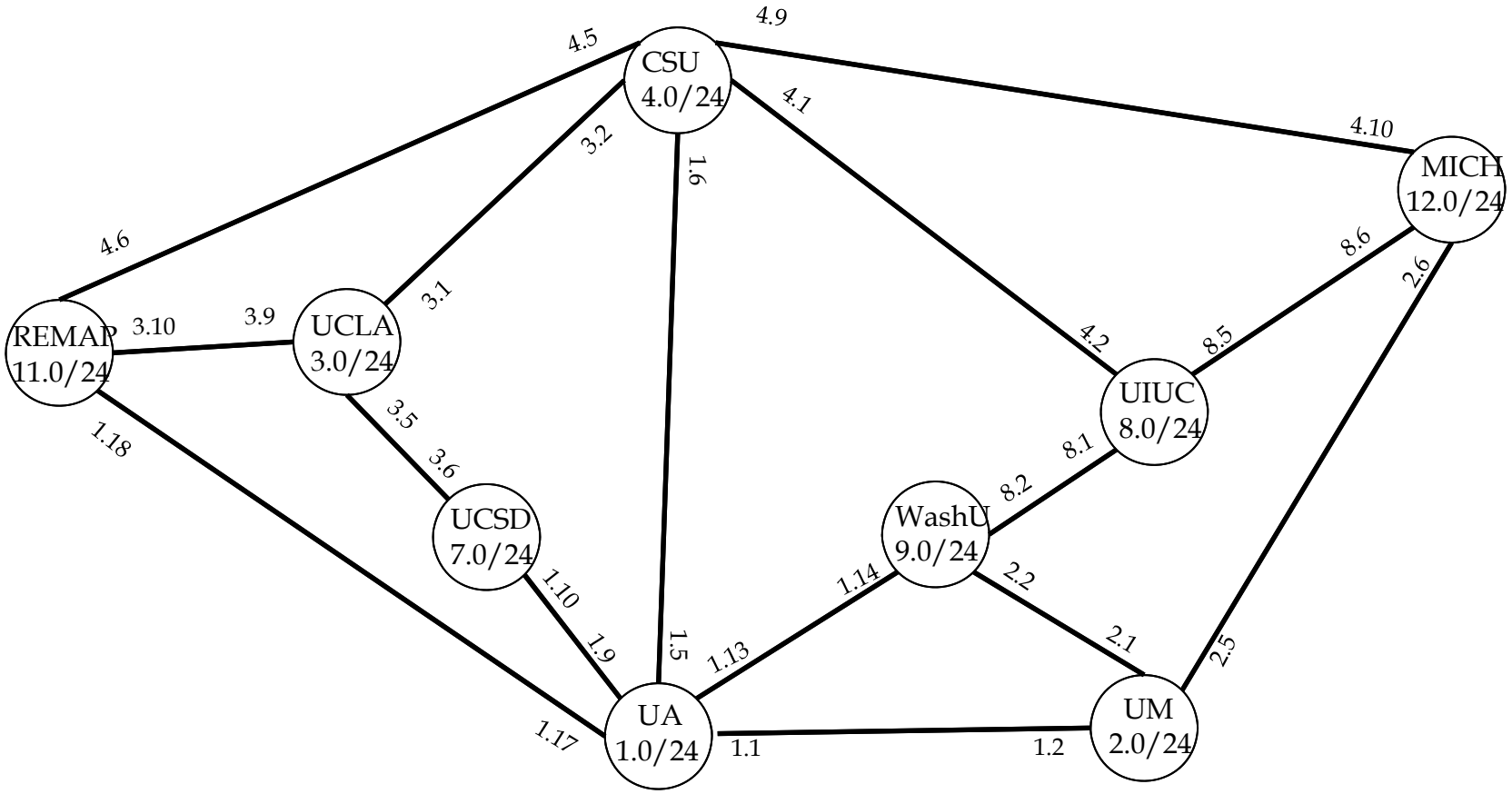
NDN Testbed Changes

- **Removal of WU SPP Nodes**
  - » Special purpose ATCA chassis that were part of the GENI project
  - » Located at Internet2 Sites
  - » No longer feasible time-wise to maintain
  - » Will not conform to new NDN-NP Testbed policy constraints
- **Change in participating sites**
- **Re-organization of inter-node links**
  - » Three general regions:
    - California (UCLA, UCLA Remap, UCSD)
    - Continental Divide (Arizona, CSU)
    - Midwest (Michigan, Memphis, UIUC, WashU)
- **We already have requests from non-members to join**
  - » Beijing and other sites in China
  - » Paris and other sites in Europe
  - » Others?

Proposed NDN-NP Testbed: Geographic View



Proposed NDN-NP Testbed



- **All IPs have the form 10.0.x.y. Last two bytes shown in above diagram.**
- **Each Site is assigned a /24 subnet**
- **Each link is in a /30 subnet**
  - **Link 10.0.x.y/10.0.x.y+1 is in a subnet of 10.0.x.y-1 – 10.0.x.y+2**

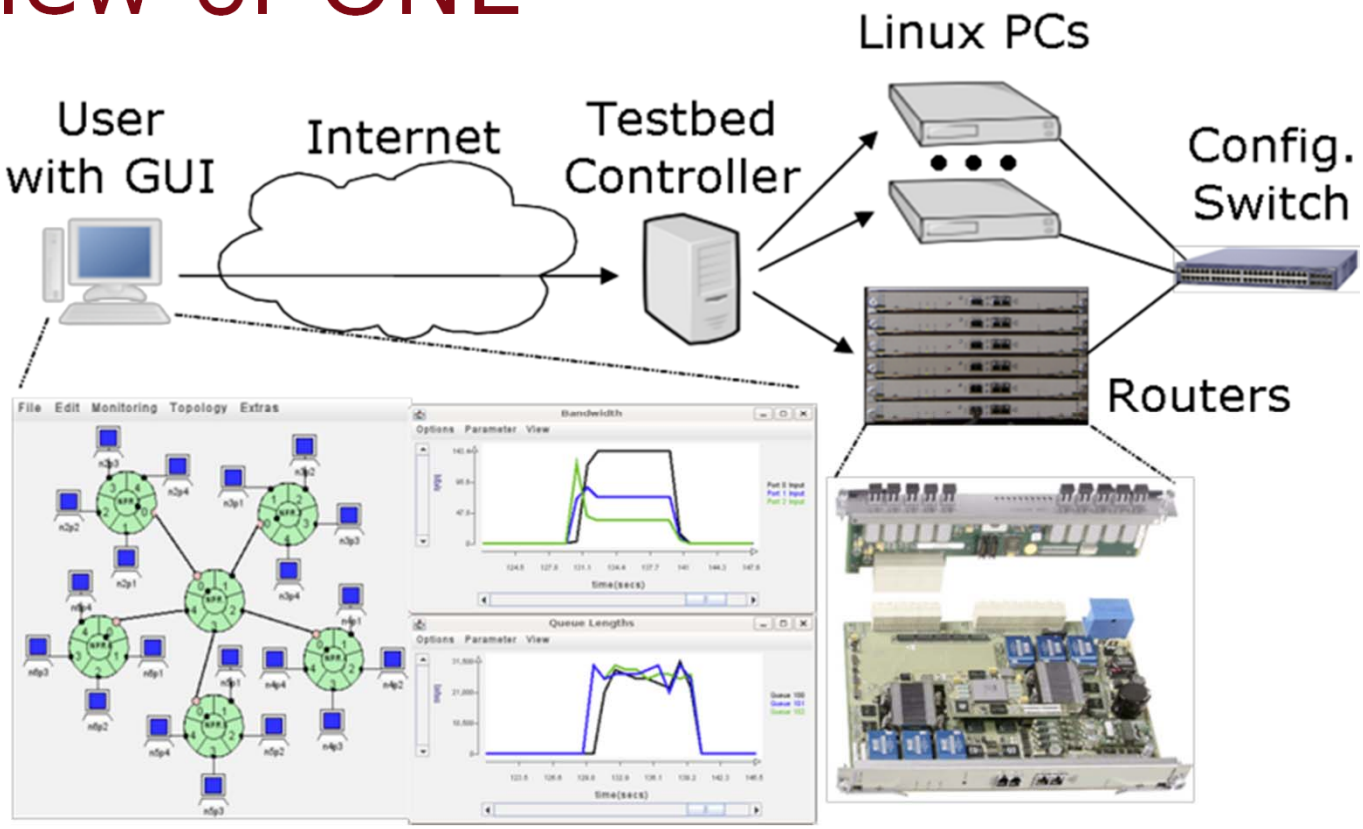
NDN Testbed Changes (continued)

- **Testbed size?**
  - » **Are there research goals that require a larger testbed?**
  - » **Are there any research goals that should influence link choices?**
    - **Rich vs. sparse interconnection**
- **Alternatives for adding more nodes**
  - » **Extra nodes at member sites**
  - » **Non-member sites**
  - » **EC2 Instances**

NDN Testbed Integration Testing using the Open Network Lab (ONL)

- ONL is an Internet-accessible networking lab (onl.wustl.edu)
  - » built around set of extensible gigabit routers
  - » intuitive Remote Lab Interface makes it easy to get started
  - » extensive facilities for performance monitoring
- Current Resources:
  - » 14 highly configurable five port Network Processor based Routers
  - » over 100 rack-mount computers that serve as end systems
    - including multicore servers with 8 cores and 48 cores
  - » Support for **ccnx**
- In the works:
  - » Support for **ndnx**
  - » Support for VMs
  - » 84 new machines (24 12 core, 60 2 core)
  - » 12 5-port software routers
  - » 8 2-port 10Gb/port (or 16-port 1Gb/port) software routers

Overview of ONL



- Remote access through the Internet using a graphical user interface (called the RLI)
- Provides access to variety of hardware resources
- Experimental networks built with configuration switches

NDN Testbed Topology in ONL for Testing