DOE UltraScienceNet - Update

Experimental Network Testbed for High-Performance Network technologies and Applications

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Contents

DOE UltraScience Net: Need, Concept and Challenges

The Need

- DOE large-scale science applications on supercomputers and experimental facilities require high-performance networking
  - Moving petabyte data sets, collaborative visualization and computational steering (all in an environment requiring improved security)
- Application areas span the disciplinary spectrum: high energy physics, climate, astrophysics, fusion energy, genomics, and others

Promising Solution

- High bandwidth and agile network capable of providing on-demand dedicated channels: multiple 10s Gbps to 150 Mbps
- Protocols are simpler for high throughput and control channels

Challenges: Several technologies need to be (fully) developed

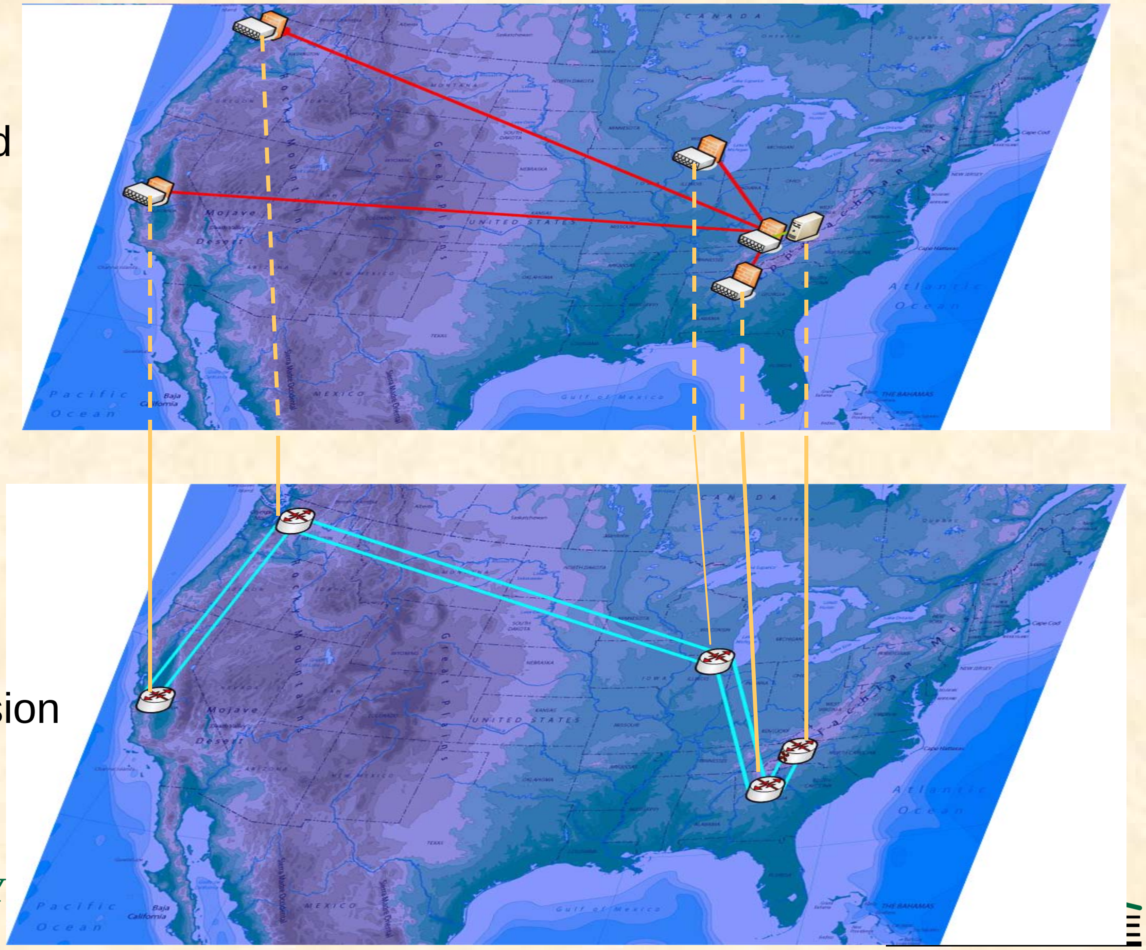
- User-/application-driven agile control plane:
  - Dynamic scheduling and provisioning
  - Security – encryption, authentication, authorization
- Protocols, middleware, and applications optimized for dedicated channels

DOE-Funded Support Application Projects

- **Lambda-Station**
  - **FNAL-developed analysis "station" for high-energy physics**
- **Peering and Terascale Supernova Initiative**
  - **Collaborative visualization**
  - **Interdomain peering with NSF CHEETAH**
- **ESnet MPLS Tunnels**
  - **MPLS signaling to setup on-demand and in-advance circuits**
- **Remote Microscopy and Genomics Applications**
  - **PNNL developed remote-user control of confocal microscopy**

USN Architecture:
Separate Data-Plane and Control-Planes

Secure control-plane with:
- Encryption, authentication and authorization
- On-demand and advanced provisioning

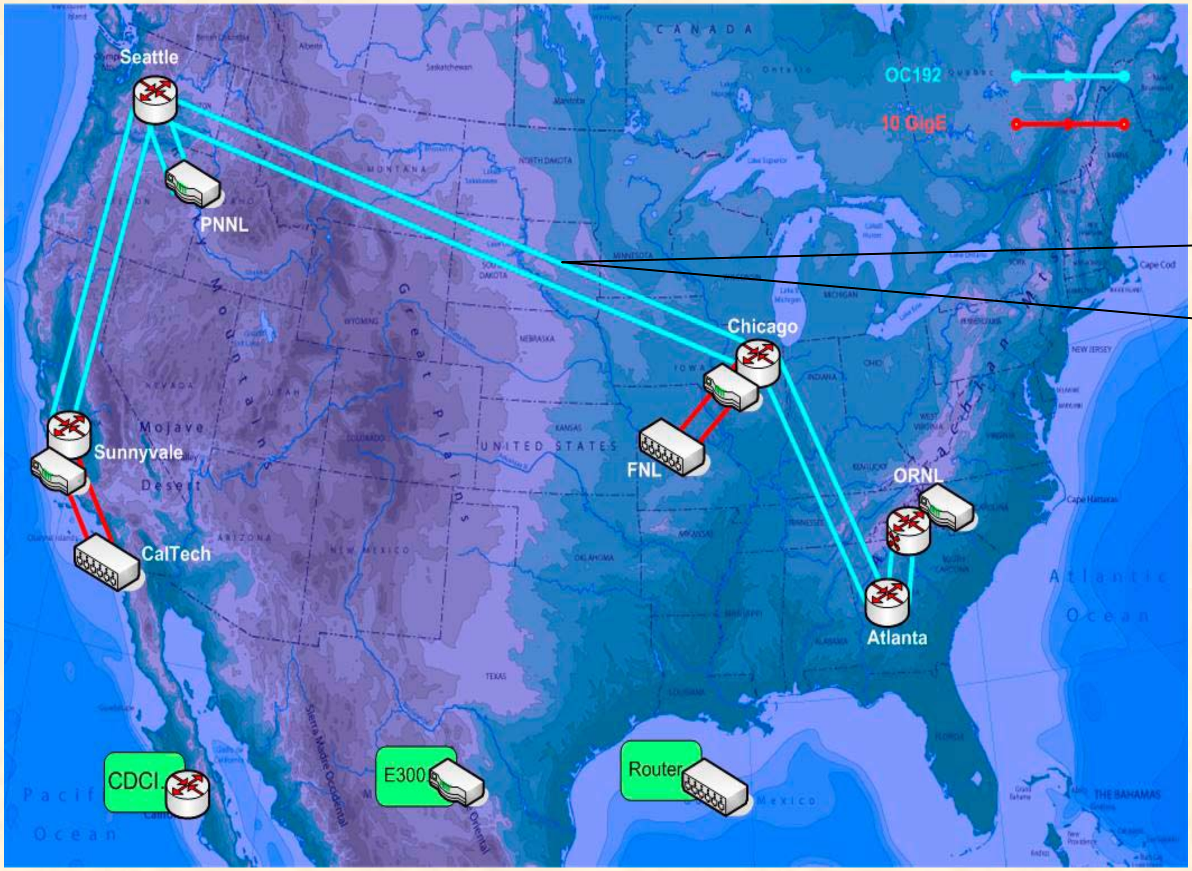


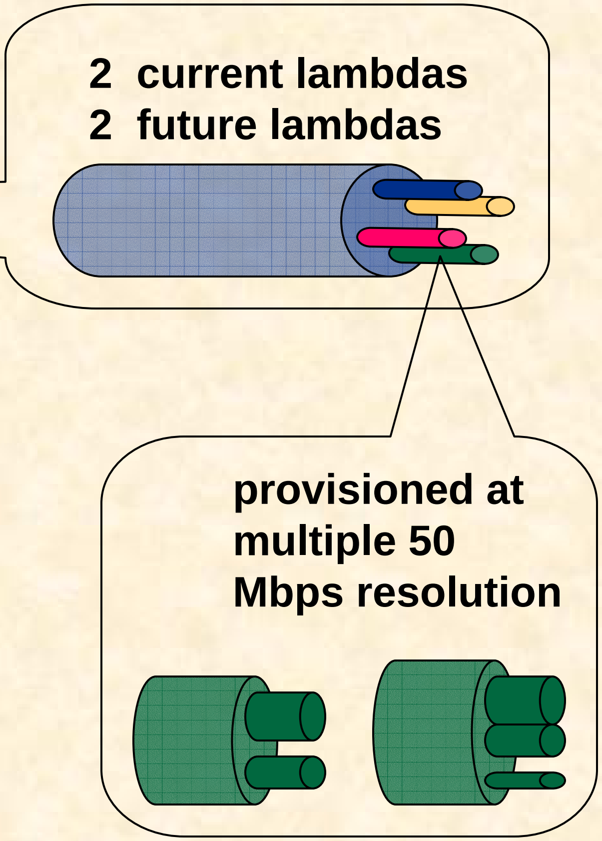
Dual OC192 backbone:
- SONET-switched in the backbone
- Ethernet-SONET conversion

DOE UltraScience Net: Data Plane

Connects Atlanta, Chicago, Seattle and Sunnyvale:

- **Dynamic and in-advance provisioned dedicated dual 10Gbps links at 50 Mbps resolution – SONET or Ethernet**





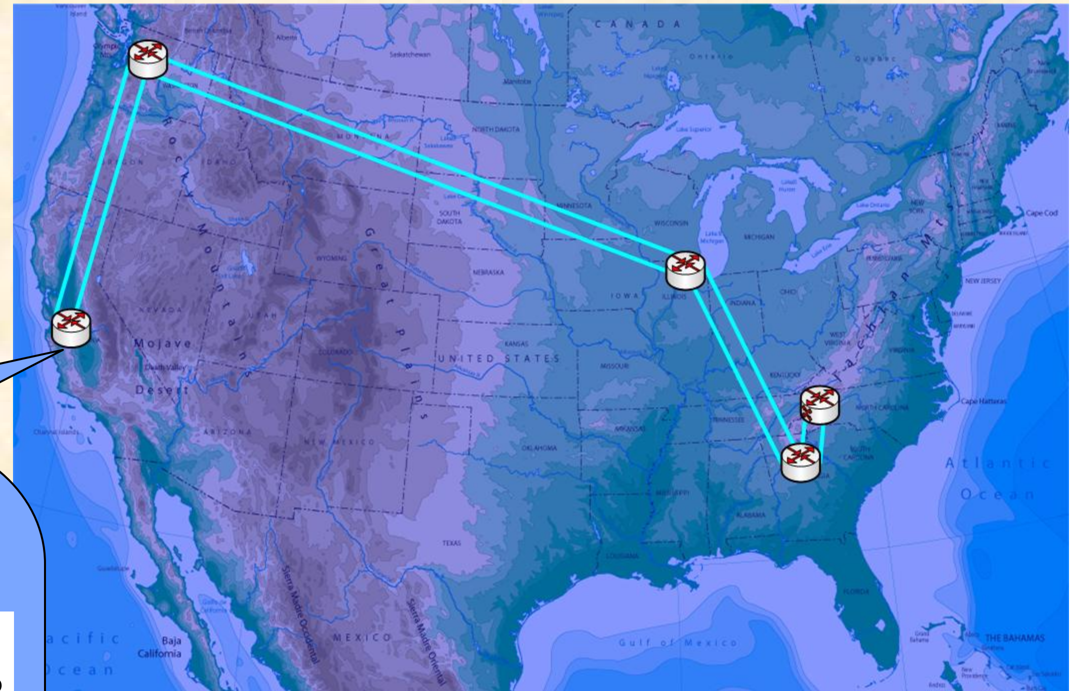
USN Data-Plane: Node Configuration

In the Core:

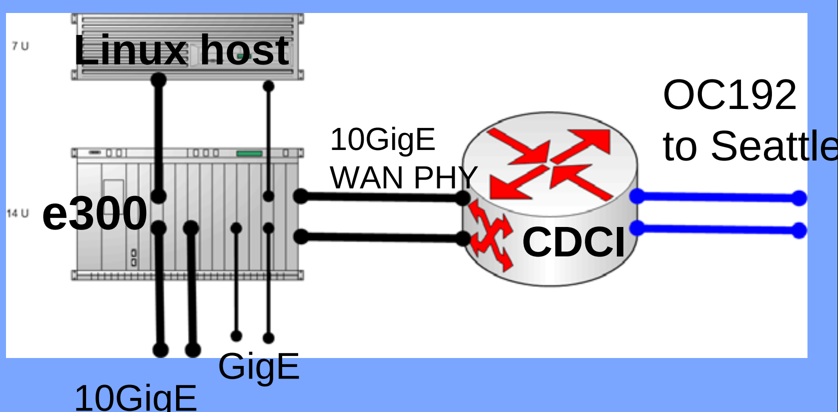
- **Two OC192 switched by Ciena CDCIs**

At the Edge

- **10/1 GigE provisioning using Force10 E300s**



Node Configuration



Connections to
CalTech and ESnet

Data Plane User Connections:

Direct connections to:

core switches –SONET &1GigE

MSPP – Ethernet channels

Utilize UltraScience Net hosts

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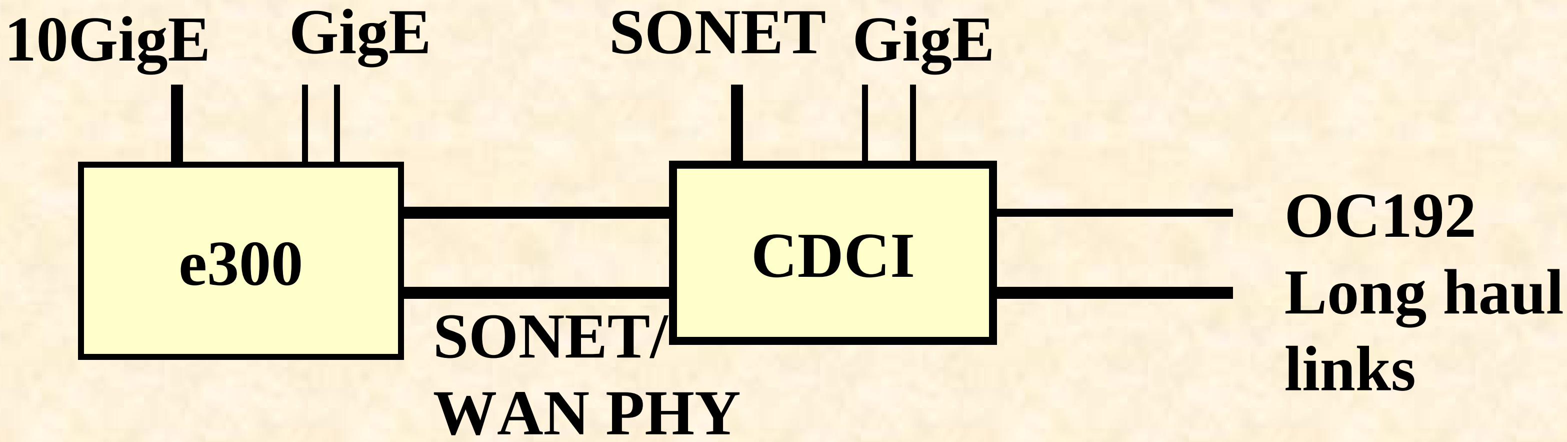
USN Data-Plane: User Ports

- **User connections**
  - **Ciena CDCI**
    - **SONET ports on CDCI**
    - **GigE ports on CDCI**
  - **Force10 E300**
    - **10GigE ports on E300**
    - **GigE ports on E300**

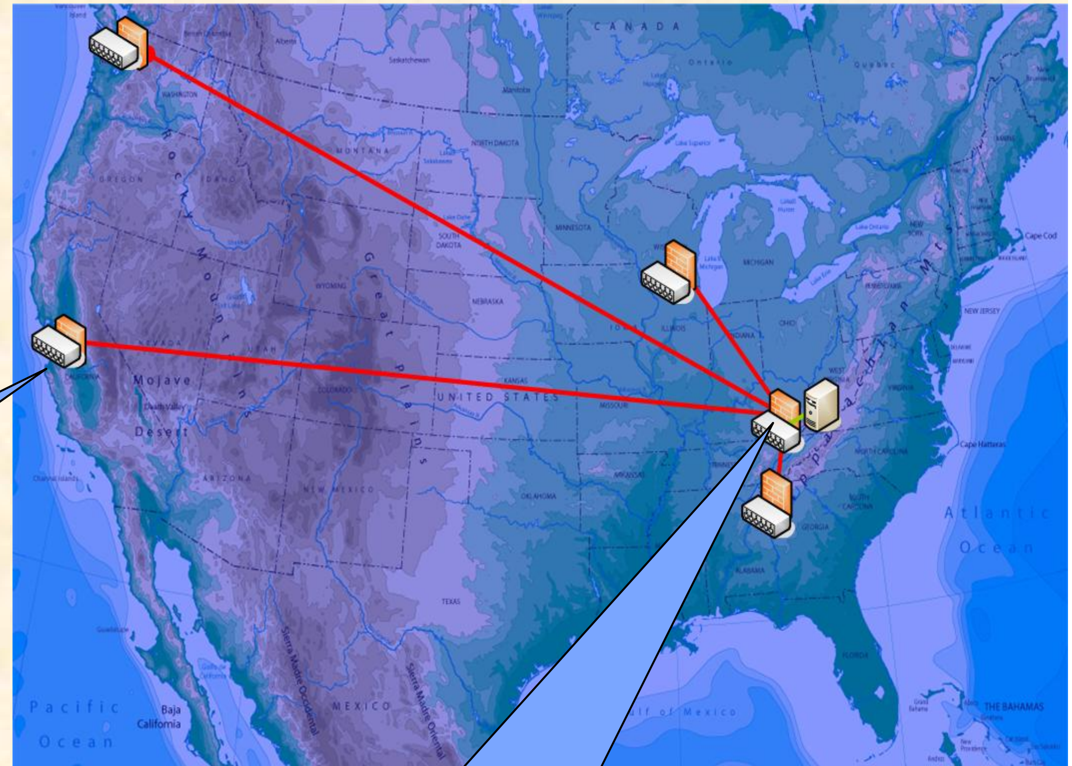
GigE ports must match at the connection end points

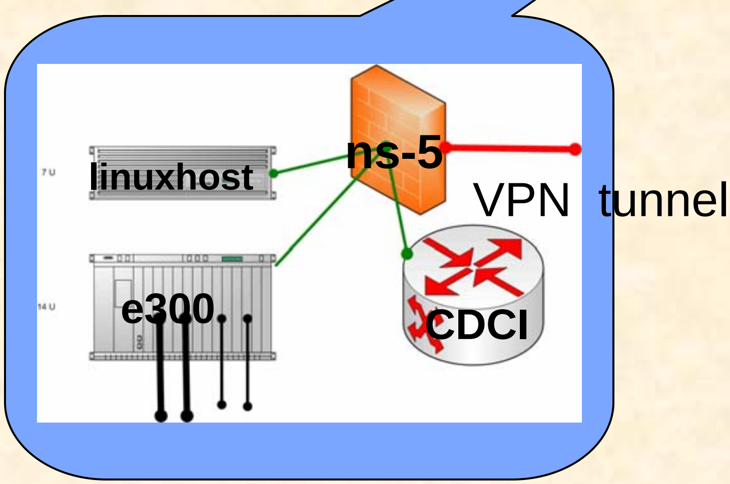


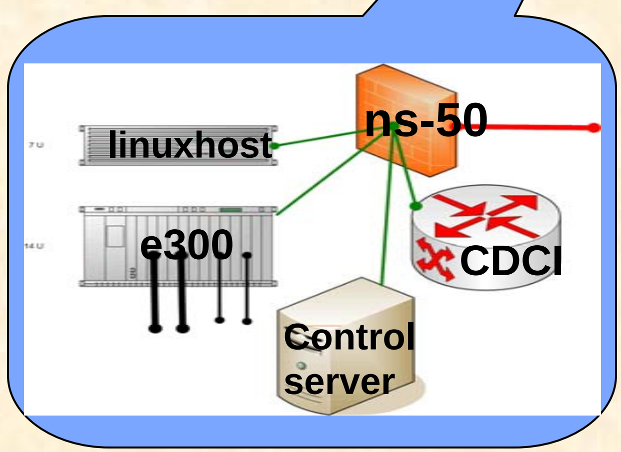
Secure Control-Plane

VPN-based authentication, encryption and firewall

- Netscreen ns-50 at ORNL
  NS-5 at each node
- Centralized server at ORNL
  - bandwidth scheduling
  - singnalling







Need for Secure Control Plane

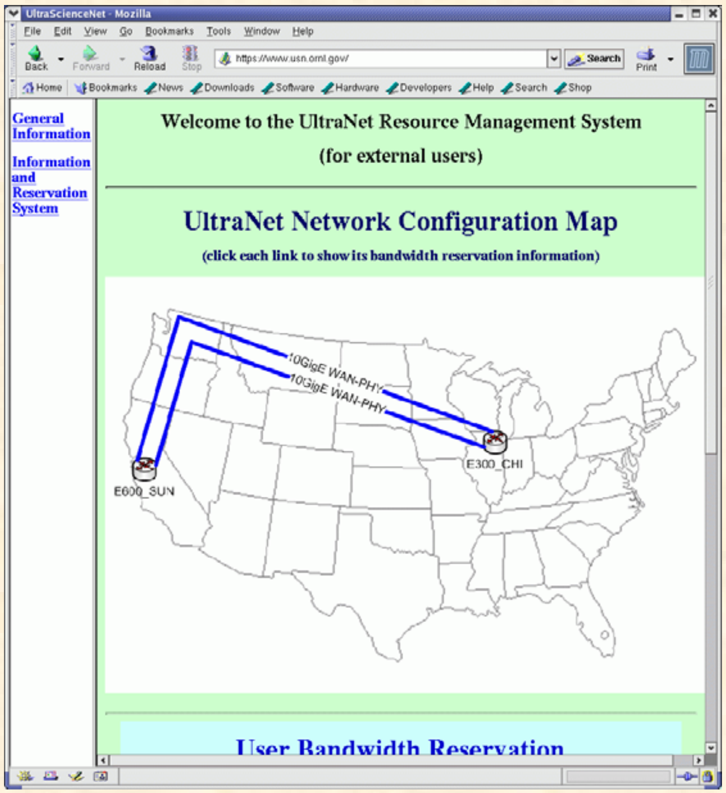
- **Security of control plane is extremely important**
  - **USN switches (Ciena, Force10, Turin, Sycamore, Whiterock) do not support IPSec – do not know of any that do**
  - **TL1/CLI and GMPLS commands sent in the "clear"**
    - **Can be sniffed to profile the network**
    - **Can be injected to "take over" the control**
  - **Following cyber attacks could be easily launched**
    - **Hijack the dedicated circuits; sustain a DOS flood to prevent recovery**
    - **Takeover/flood UltraScienceNet end hosts and switching gear**
- **USN control-plane is out-of-band and secure**
  - **Uses VPN-based control channels and firewalled enclaves**

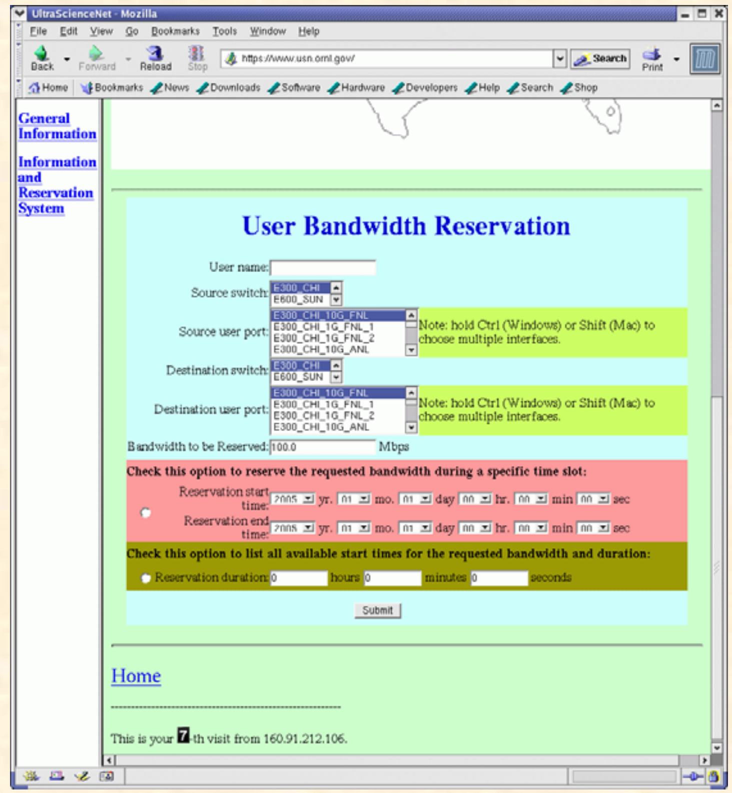
Control Plane

- **Phase I**
  - **Centralized VPN connectivity**
  - **TL1/CLI-based communication with CoreDirectors and E300s**
  - **User access via centralized web-based scheduler**
- **Phase II**
  - **GMPLS direct enhancements and wrappers for TL1/CLI**
  - **Inter-domain “secured” GMPLS-based interface**
  - **Webservices interface for OSCARS**

Web Interface

- **Allows users to logon to website**
- **Request dedicated circuits**
- **Based on cgi scripts written in c and c++**



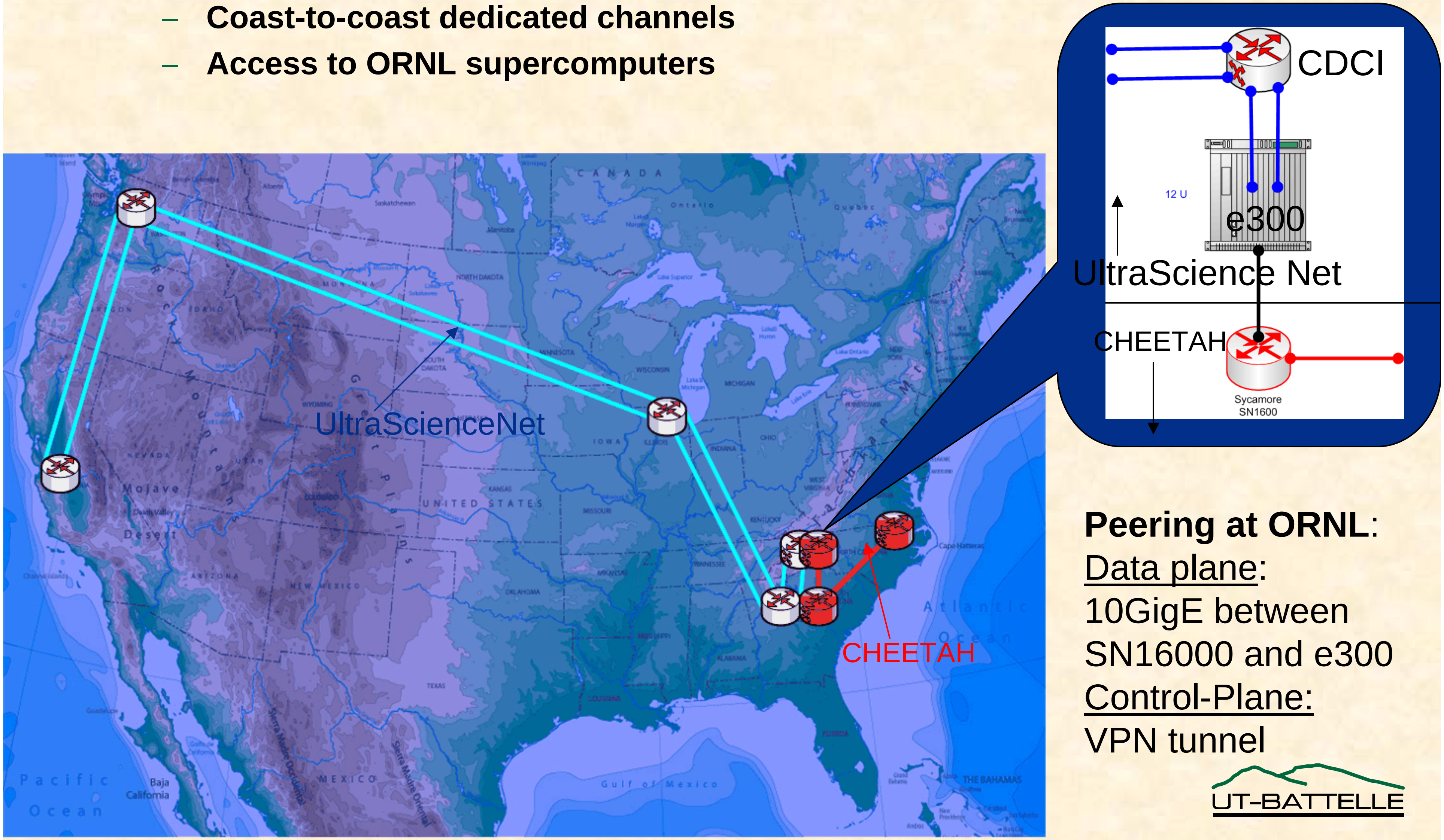


Bandwidth Scheduler

- **Computes path with target bandwidth**
  - **Is currently available?**
    - **Extension of Dijkstra's algorithm using interval sequences**
  - **Provide all available slots**
    - **Extension of closed semi group structure to sequences of reals**
  - **Both are solvable by polynomial-time algorithms**
  - **Implementation – first part almost complete; needs interface**
- **Notes:**
  - **GMPLS does not have this capability**
  - **Control-plane engineering taskforce interested in using it.**
  - **Not an NP-Complete problem**

Peering: UltraScience Net – NSF CHEETAH

- **Peering: data and control planes**
  - **Coast-to-coast dedicated channels**
  - **Access to ORNL supercomputers**



Peering at ORNL:
Data plane:
10GigE between SN16000 and e300
Control-Plane:
VPN tunnel

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Current Status: Data-Plane

- **Data-Plane Connections:**
  - **Chicago-Sunnyvale**
    - **May 2005: 10GigE WAN-PHY between E300**
    - **August 2005: 2 x OC192 links between CDCIs**
  - **ORNL-Chicago**
    - **August 2005: 2 x OX192 links between CDCIs**
  - **Atlanta will be connected after SC2005**
- **User-connections**
  - **August 2005**
    - **PNNL, FNL, CalTech, ESnet**
  - **November 2005**
    - **SLAC**
  - **February 2006**
    - **Atlanta node installation**

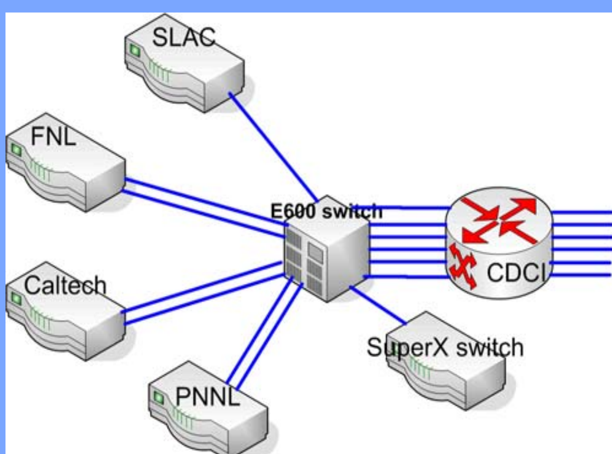
Current Status: Control-Plane

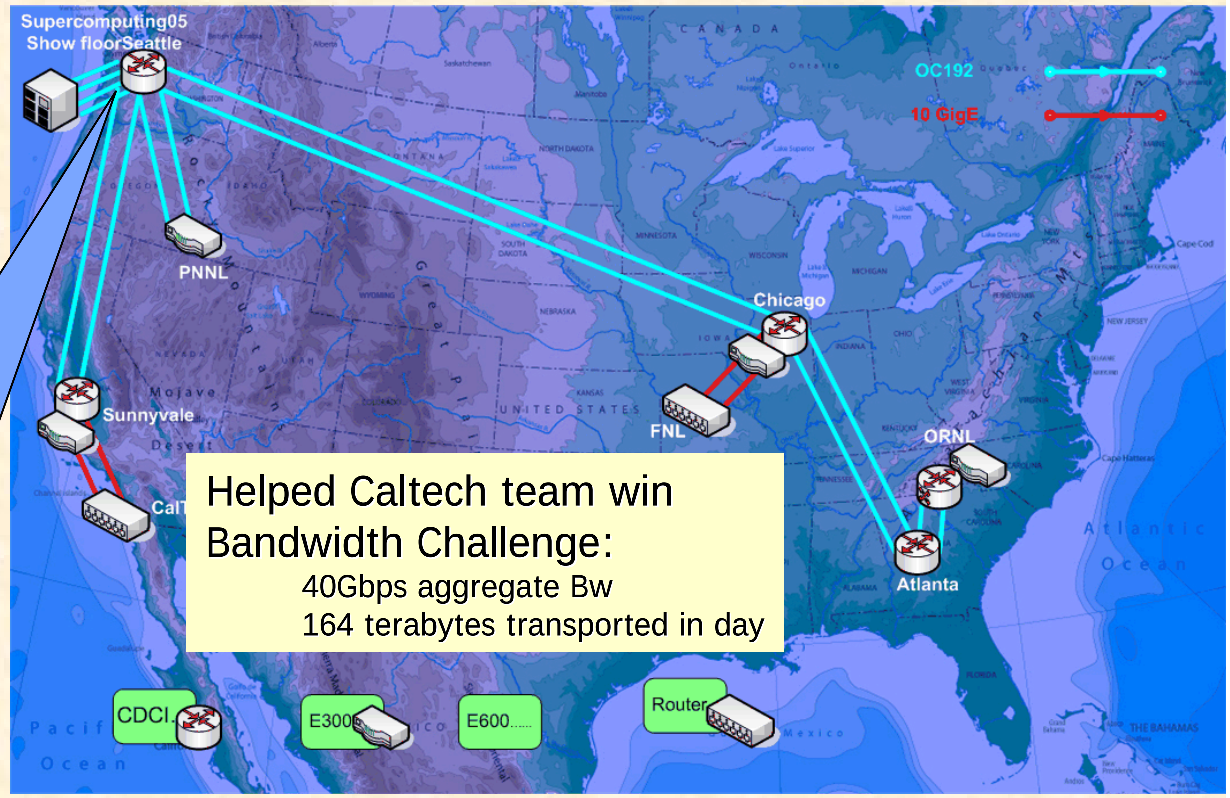
- **ORNL, Chicago, Seattle, Sunnyvale nodes are setup**
  - **VPN, console servers are setup**
  - **signaling modules – being integrated**
  - **Bandwidth/channel reservation system – being integrated with signaling system**
- **SC2005 node will be moved to Atlanta**

USN at Supercomputing2005

- Extended USN to exhibit floor: eight dynamic 10Gbps long-haul connections over time
- Moved and re-created USN-Seattle node on
- PNNL, FNL, ORNL, Caltech, SLAC at various booths to support:
  - applications and bandwidth challenge

Supercomputing05 exhibit floor





ESnet Related Issues

- **Port Assignments:**
  - **10GigE port each on E300 in Sunnyvale and Chicago**
  - **multiple 1GigE ports assigned on E300 in Sunnyvale and Chicago**
- **Cross-connects**
  - **1 SM and 4 MM cross-connects in Level(3) POP in Sunnyvale and in Starlight in Chicago**
- **Control-Plane Issues are being addressed**

OSCARS and USN Control-Plane Integration I

- Composition Front End: User
  - Back-end interaction with OSCARS and USNCP
  - Website and webservice: authentication + encryption
  - User request:
    - Scheduling
      - decomposed into OSCARS and USNCP requests
      - combine the responses and compose the path
    - Signaling
      - Pieces of paths are signaled separately

Drawbacks: VLANs need to be supported separately

OSCARS and USN Control-Plane Integration II

- VLAN transitioning
  - Scheduler explicitly allows for VLAN setup requests
    - Front end sends separate requests and handles boundaries
  - Signaling
    - Wrappers to OSCARS and USNCP to accept VLAN signaling
    - Uniform wrapper formats needed – WDSL+SOAP(?)
    - Authentication and Encryption

MPLS-GMPLS Integration

- Advanced Reservation:
  - Open issue within MPLS and GMPLS
  - Reservation front-end:
    - Scheduling a priori
    - Send MPLS-GMPLS messages for immediate setup/tear down
- Signaling
  - GMPLS wrapper for USNCP
- Scheduling Extensions of GMPLS and MPLS
  - Need to work with standards

Conclusions

USN Deployment
- **Data-Plane – Complete**
- **Control-Plane – almost Complete**

Request for USN Collaborations
- **USN channels/circuits**
- **USN hosts – transport, middleware**
- **Locate your hardware at USN nodes**

Thank you

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