DOE UltraScience Net

Jefferson Lab JET Workshop

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OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

Outline:

- **What are we doing?**
- **Why do it?**
- **How will we do it?**
- **Details**

UltraNet Research Testbed: The Mgmt View

- **Build a sparse, lambda-switching, dedicated channel-provisioning testbed**
- **Connect hubs close to DOE's largest Science users (but let the user labs pay last-mile costs)**
- **Provide an evolving matrix of switching capabilities**
- **Separately fund research projects (e.g., high-performance protocols, control, visualization) that will exercise the network and directly support applications at the host institutions**

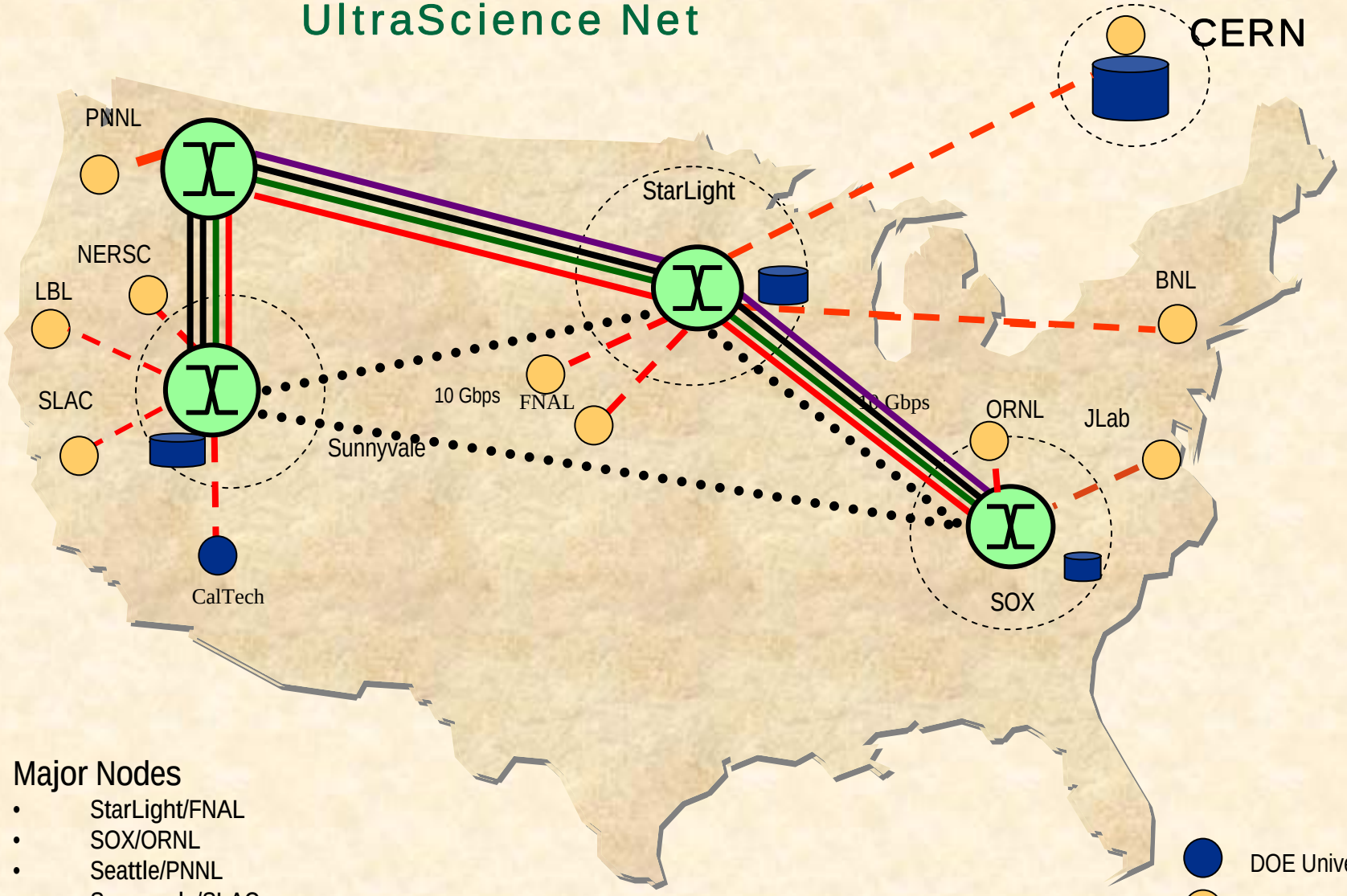
The Resources:

- **Off hours capacity from ESnet**
  - **Probably 2 x OC48 between Sunnyvale and Chicago in the northern route (MPLS)**
- **Dedicated Lambdas on NLR**
  - **Two 10G lambdas between Chicago and Sunnyvale**
  - **Possibly more in year two or three**
- **Two dedicated lambdas on the ORNL Chicago-Atlanta connector**

Resources Cont.

- **A progression of switching technologies**
  - **Start with Ciena, Cisco, or Sycamore (SONET)**
  - **Migrate to Calient, Glimmerglass all-optical or a hybrid**
- **Some Local Storage**
  - **Logistical Storage Depot (prior to local application development)**
- **Progression of experimental point-to-point transport technologies (plus legacy)**
  - **Fiber channel**
  - **Infiniband**
- **Migrate to the Production ESnet environment**

UltraScience Net



Major Nodes

- StarLight/FNAL
- SOX/ORNL
- Seattle/PNNL
- Sunnyvale/SLAC
- Sunnyvale/Caltech

10 Gbps ESnet Links

10 Gbps UltraScience Net Link

under discussion

DOE University Partners

DOE National Lab

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The Research Network: The Engineer's View

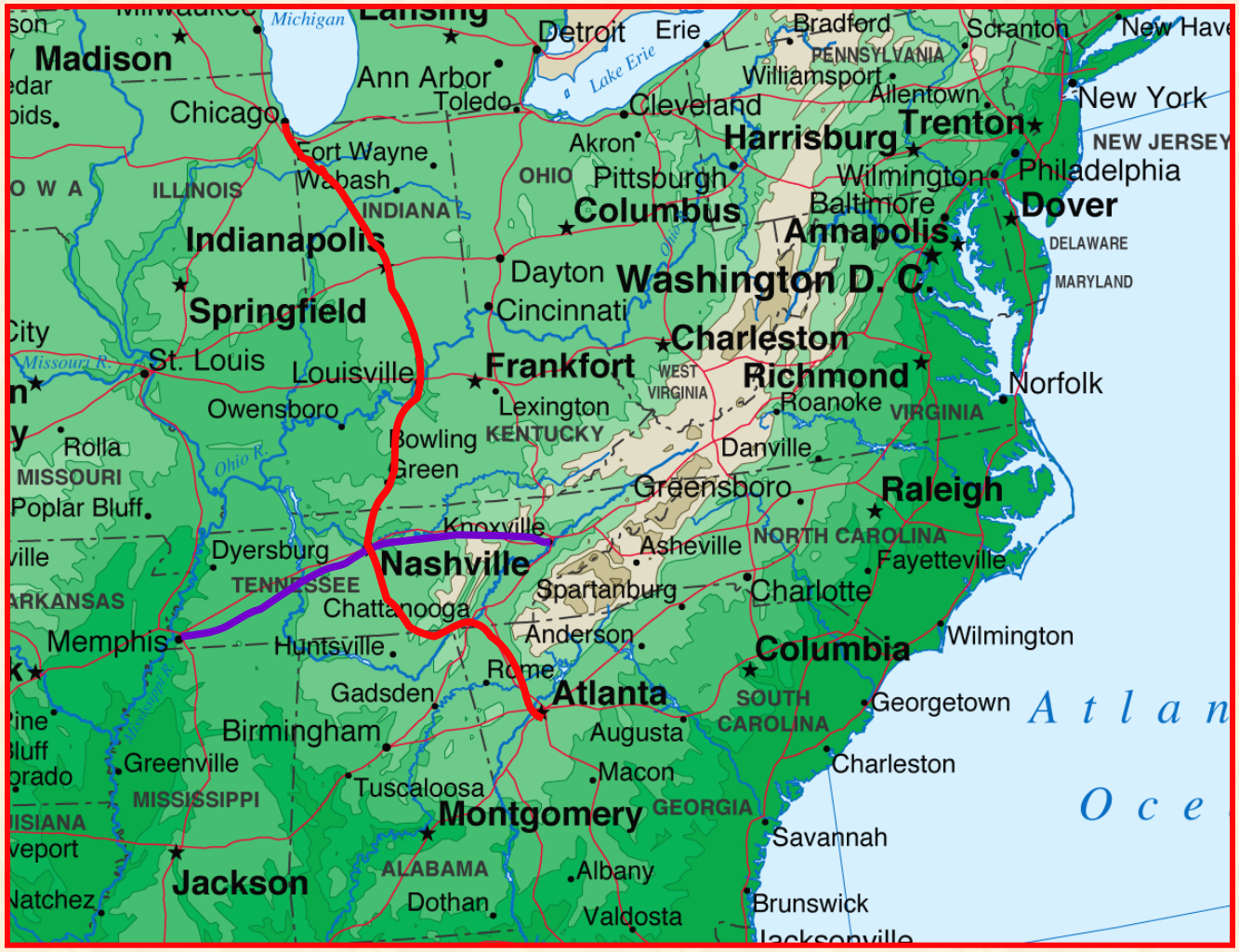
- **Build and light the first Third-Gen R&E network in the country**
  - **Connect Atlanta-Chicago via ORNL**
  - **16 point-to-point circuits (OC192 or 10Gig-E)**
  - **9 circuits to ORNL**
  - **Close the NLR (National Lambda Rail) unprotected ring**

    …and give DOE an automatic seat at the table
- **Buy IRU's from Qwest and TVA**
- **Light with Equipment from Ciena**

Why Now?

- **Confluence of Circumstances**
  - **DOE UltraScience Research Net**
  - **NLR coming to Atlanta (but unprotected and with DOE not represented at the table)**
  - **NSF TeraGrid Proposal Success**
- **Opportunity for DOE to take the lead**
- **Ciena and Qwest willing to deal**
- **TVA (Tennessee Valley Authority) willing to work with us**

Qwest and TVA Routes



Qwest

TVA

The Physical View From 50,000 feet

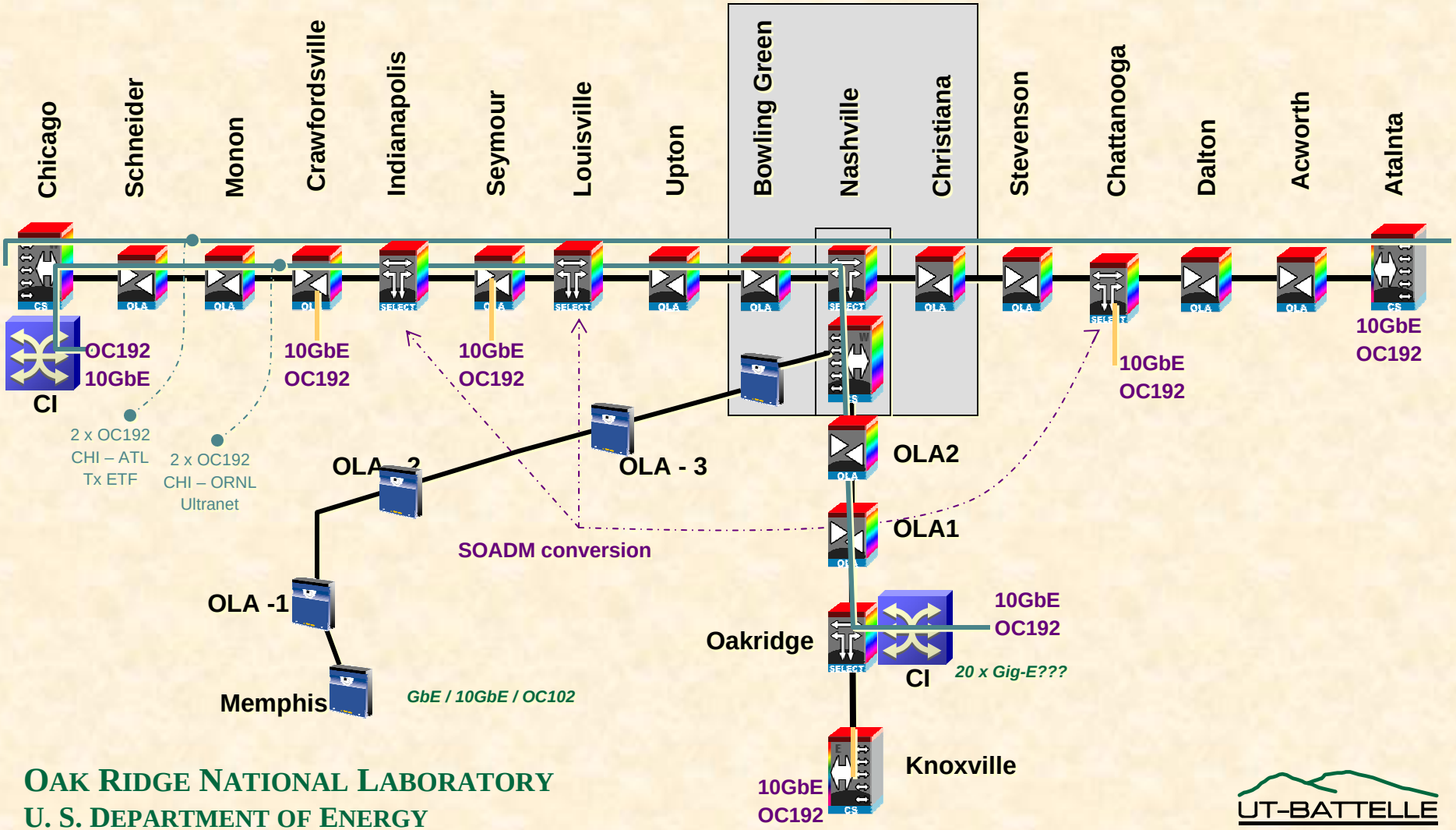
ESnet

CERN etc.

NLR

ORNL Connector

Network Overview



What Does Third-Gen Mean?

- **It means a fully transparent network**
  - **No OEO conversions**
  - **OADMs and Switches become clock-insensitive**
    - **NB: OC192 and 10Gig-E use different clocks**
- **It means network is intelligent:**
  - **Self-configuring, self-monitoring, self-grooming**
  - **New lambdas can be provisioned remotely (2-5 minutes)**
- **It means all-optical switching**
- **It means fully tunable lasers and components (color insensitive, and minimal spares)**

Third-Gen is a Requirement for Future DOE Science Networks

- **Transparency Required:**
  - **Flexible transport of both OC192 and 10Gig-E**
  - **40 Gig (OC768) available at any time**
- **All Optical Switching Required:**
  - **Instant provisioning (few seconds to a minute)**
  - **Lambda routing without interrupting service**
- **Intelligence Required:**
  - **“Lights Out” operation, no fleet of trucks**

Why Do it?

- **DOE Science needs it**
- **Puts DOE at the Center of Network R&D**
  - **There are no Third-Gen networks deployed today**
  - **First fully transparent Ultra-long haul backbone**
  - **Will support 10Gig-E in addition to OC192**
  - **Easy demo of OC768 (also a first)**
  - **First roll-out of application-driven lambda-switching**
- **Provide Core of State-Wide R&E Network**
  - **With easy extensions to Memphis and Bristol**
  - **Will provide fiber between ORNL and UT - first ever**
- **Provide Core of a Columbus-Springfield initiative**
  - **Help connect to "Hobson's initiative" in Ohio**

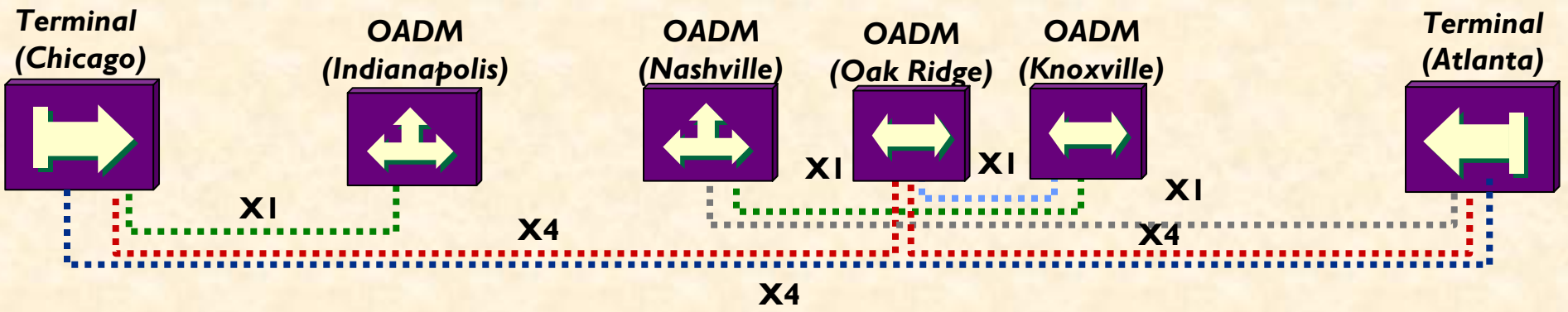
How Will We Do It?

- **Dark Fiber IRUs from Qwest and TVA**
  - **Qwest fiber at SOX (56 Marietta St.)**
  - **Starlight arranging fiber X-connect to Qwest POP in Chicago**
  - **TVA has the Only E-W Fiber in Tennessee that crosses DOE Reservation**
- **Light it with latest round of Ciena gear coming out of the lab (research partnership)**

Qwest and TVA

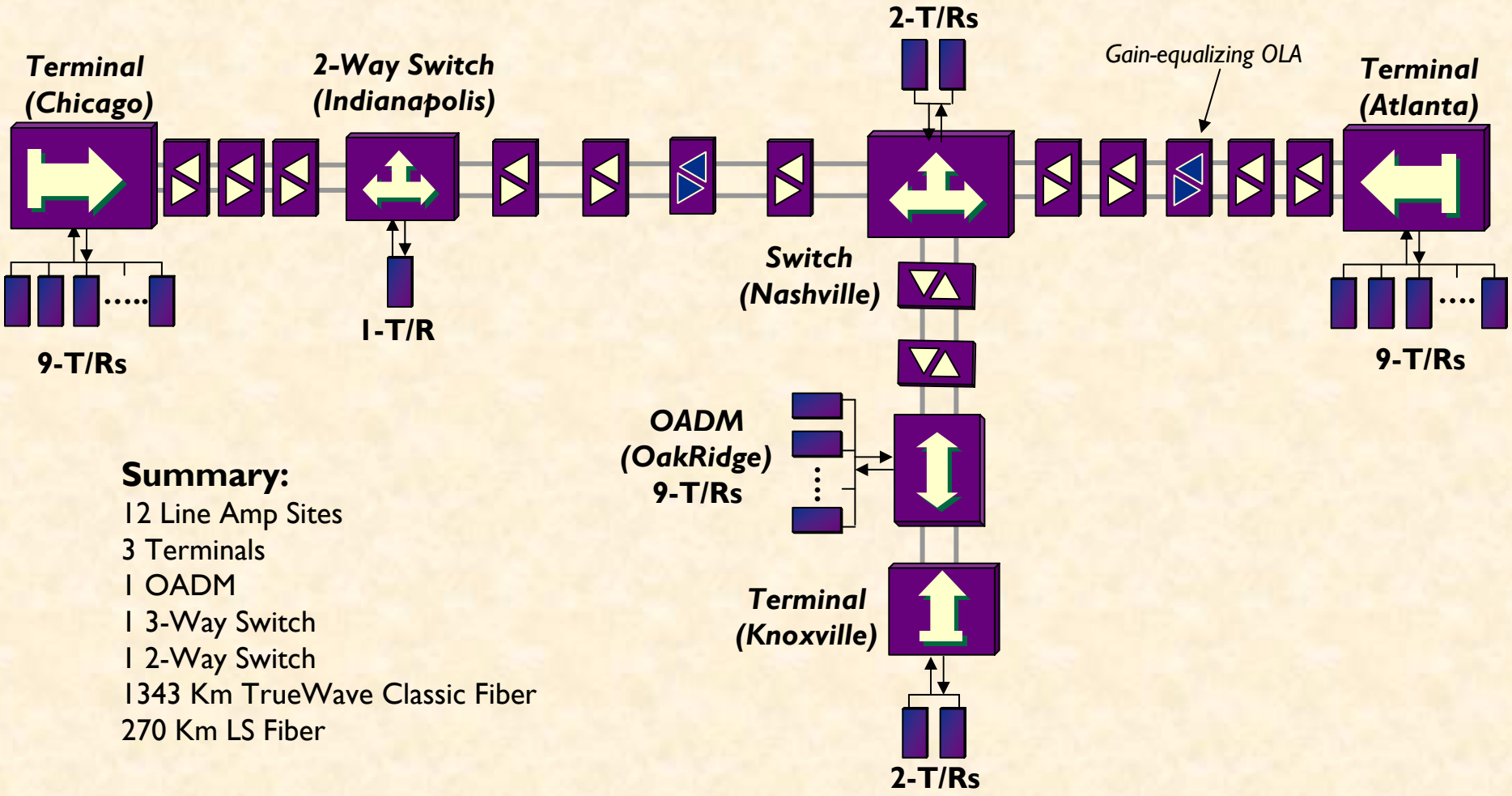
- **Qwest Route**
  - **Atlanta, Chattanooga, Nashville, Louisville, Indianapolis, Chicago**
- **TVA Route**
  - **Knoxville, ORNL, Nashville**
- **Possible Extensions**
  - **TVA fiber to Memphis (hits Memphis metro ring)**
  - **TVA fiber to Mississippi and Alabama**
  - **Qwest fiber to Cincinnati (/w OARnet to Columbus)**

Possible Wavelength Configuration



4 Atlanta – Chicago
3 Oak Ridge – Chicago
3 Oak Ridge – Atlanta
3 Atlanta – Nashville
1 Indianapolis – Chicago
2 Knoxville – Nashville
1 Oak Ridge – Knoxville
16 Channels Total

Component Layout



Summary:

12 Line Amp Sites
3 Terminals
1 OADM
1 3-Way Switch
1 2-Way Switch
1343 Km TrueWave Classic Fiber
270 Km LS Fiber

Research Topics (Switching):

- **Which switching works best when?**
  - **MPLS/GMPLS**
    - **Pros: bridge to TCP/IP networks**
    - **Cons: bridge to TCP**
  - **SONET**
    - **Pros: Good MTU, diagnostics, transport for Fiber Channel etc.,**
    - **Cons: Expensive**
  - **Pure Optical**
    - **Pros: Cheap**
    - **Cons: Granularity, peering,**

Research Topics (Measurement):

- **How (and what) do you monitor to document performance of an lambda-level network?**
  - **MPLS/GMPLS allows traditional techniques**
  - **SONET offers DCC and OAM bits**
  - **10Gig-E offers almost nothing**
  - **Raw Lambdas are just that**

Research Topics (Security):

- **Scalable Security…**
  - **These networks *will* bypass firewalls**
    - **Inter-domain trust relationships**
    - **Hard enough when the technology is understood**
  - **These networks *will* connect deeply inside systems**
    - **Direct connections to high-performance file systems**
    - **Direct connections to supercomputers**
    - **Direct connections to grid clusters**

In Summary - a Unique Opportunity

- **Opportunity to Develop Network Technology Required for DOE's Next-Gen Computing**
- **Opportunity to contribute to National Interagency Effort (TeraGrid and NLR)**
- **Opportunity to Contribute to Region**
- **Opportunity to Put DOE Back in Forefront of Agency Network R&D**

Thank you