



# Louisiana Optical Network Initiative

## “LONI”

## Background and Overview

October 8, 2013

# Major Points

- Consistent investment over time in a focus area that provides critical opportunities for the educational and research enterprise, and for the State, can result in meaningful value and return on investment
- LONI's major elements
  - Statewide Network Capability
  - High Performance Computing Resources
  - National Connectivity
- LONI's focus
  - Research
  - Service to Campuses
  - Public Service
- Value Today
- New Opportunities and Directions

# State of Louisiana Investment in Information Technology Initiatives

- In FY2001-02, Governor Mike Foster initiated significant investments in human capital and infrastructure for higher education information technology. This began a seven year span of commitment by two State administrations in an unprecedented higher education research investment for Louisiana.
- The State made tremendous strides in the development of its information technology infrastructure over the past several years and has distinguished itself within the national science and technology research community.

# Initial State of Louisiana Investment in Information Technology Initiatives

- Initial Investment in the Governor's Information Technology Initiative in FY2001-02 provided:
  - \$18 to \$20 million annually, along with some capital outlay funding, provided research faculty, equipment and facilities
  - Funding also provided for:
    - ❖ Internet2 Connectivity for most of the public higher education institutions
    - ❖ Upgrade of the Library Network central operating system
    - ❖ Workforce Development within the Information Technology fields by LCTCS



# Governor's Information Technology Initiative

FY2001-02

## TARGETED AREAS OF INSTITUTIONAL RESEARCH

### LSU

- Biological Computing
- Materials Science
- Wireless Technologies
- Virtual Organization and Commerce
- Geoinformatics

### Southern

- E-Business: Focus on Small and Emerging Enterprises
- High Performance Networking
- Materials Science: Emphasis on Development of New Materials and Advanced Media for Information Storage and Transmission

### LA Tech

- Novel Technologies for Advanced Computing and Sensing
- Applications in Networking, Modeling, Simulation, and Design
- Technology Entrepreneurship

### UNO

- Nanomaterials
- Large-scale Software Design
- Simulation-based design
- Bioinformatics
- Environmental Simulations
- Advanced Applications of Image and Signal Processing
- Composite Materials/Ceramics/Advanced Alloys

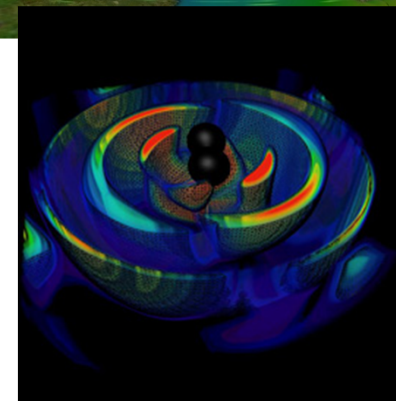
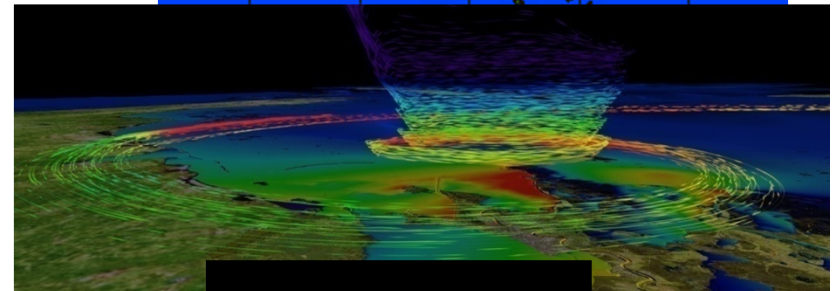
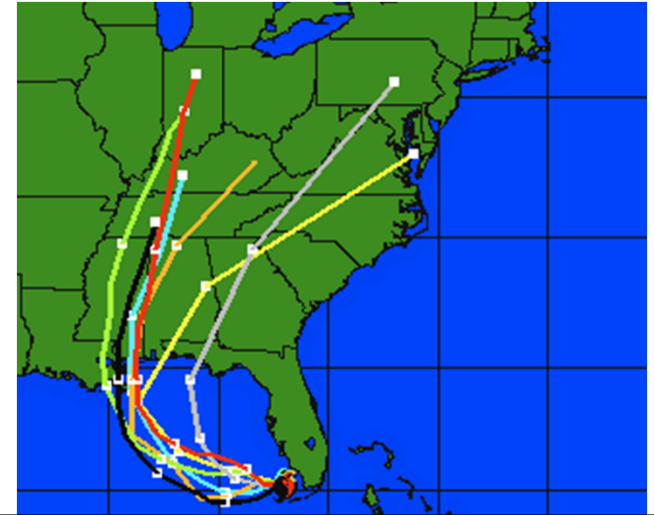
### UL at Lafayette

- Wireless Optical and Broadband Networks
- High Performance Computing
- Encryption and Data Security
- Integration of Digital Resources for the Web
- Computer Vision and Visualization
- Business and Health Informatics

# Initial State of Louisiana Investment in Information Technology Initiatives

- The investments in high-caliber research faculty, in turn, resulted in the establishment of some significant secondary assets:
  - ❖ **The Center for Computation & Technology (CCT) at LSU**

- Multidisciplinary, \$9M annual budget
  - Joint faculty across 13 departments in 4 Focus Areas: Core Computational Sciences, Coast to Cosmos, Material World, Human & Social World. About 40 faculty involved.
- HPC, Visualization, Data, Network investments:
  - procure and operate for Campus and State
- Cyberinfrastructure development group
  - Staff of Computational Scientists to help research groups take advantage of modern cyberinfrastructure

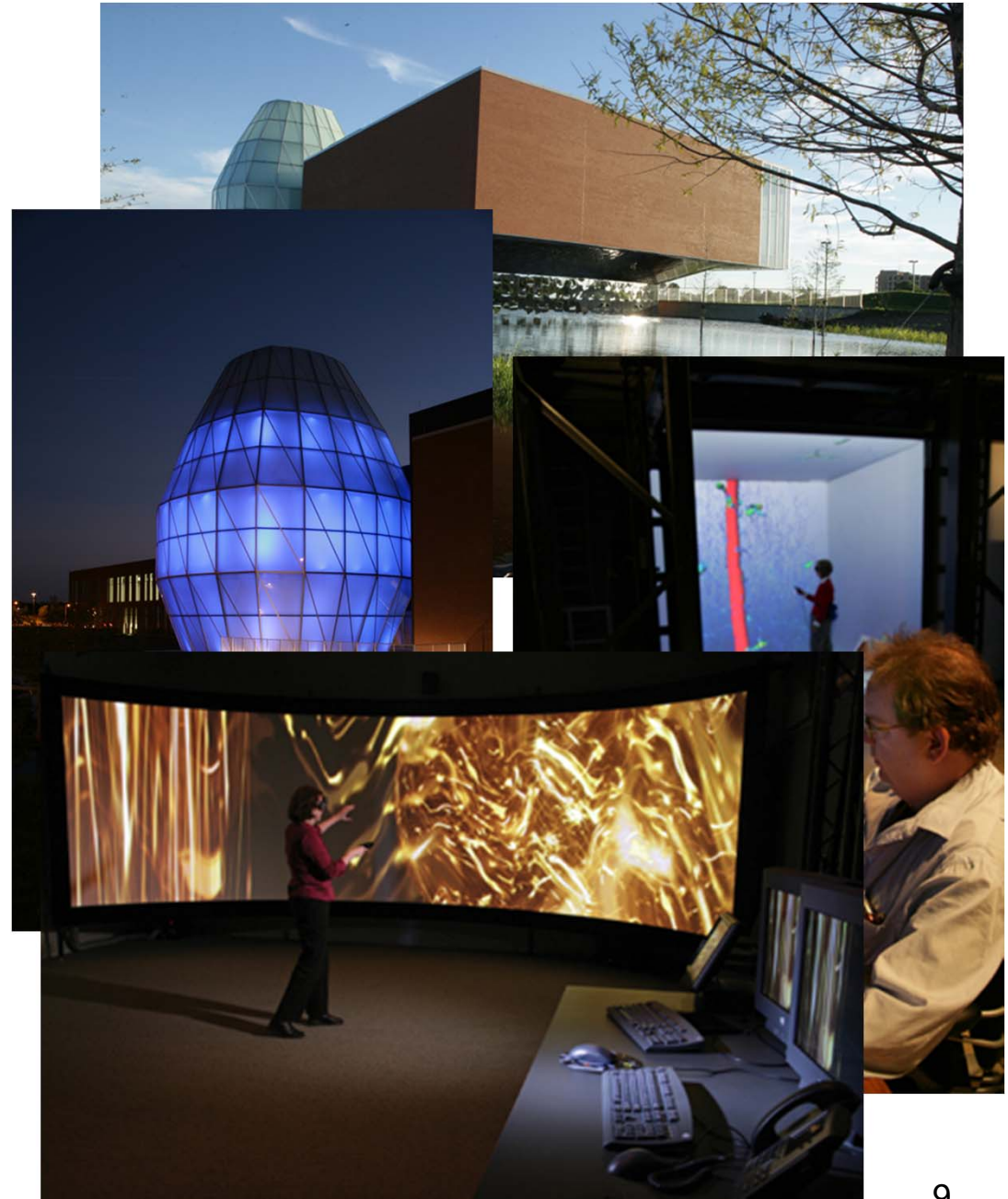


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- State of the art visualization environments driven by HPC
- A six-sided totally immersive space for visualization.
- 37 foot curved immersive screen in a 175 seat auditorium
- **Available to academia as well as industry**

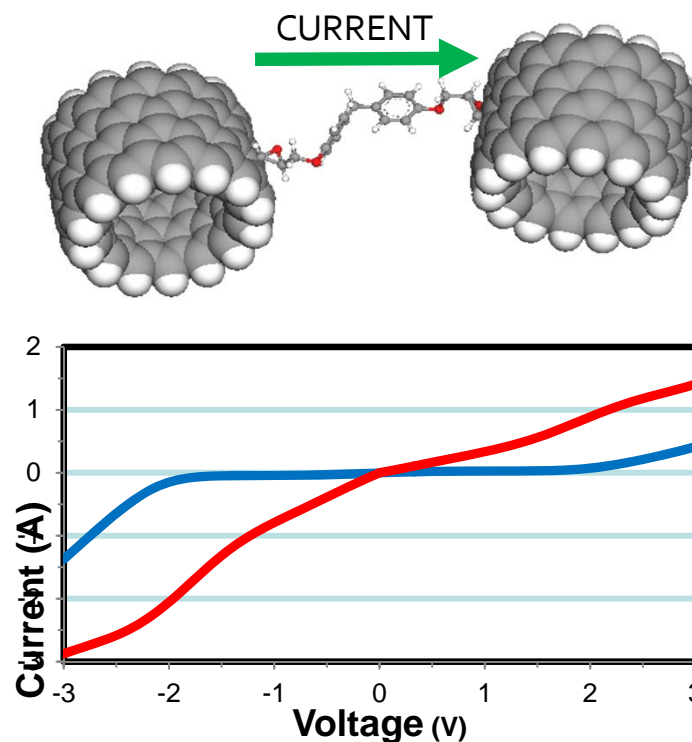
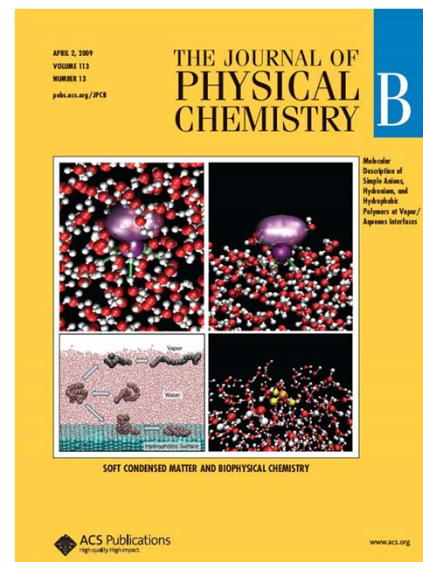
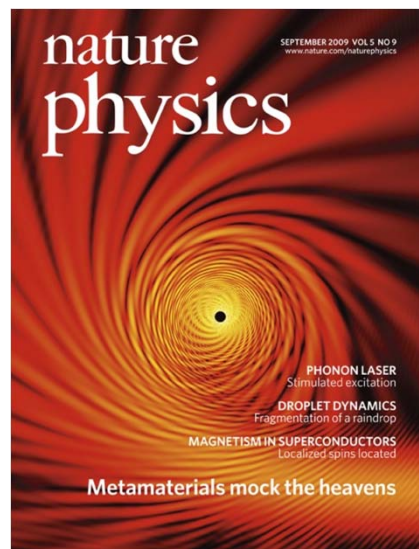


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  - ❖ **The Center for Entrepreneurship and Information Technology (CEnIT) at Louisiana Tech**



- Technology Entrepreneurship
- Novel Technologies for Advanced Computing and Sensing
- Applications in Networking, Simulation, Modeling and Design
- Undergraduate and graduate courses in Entrepreneurship
- Student-owned start-up companies





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  - ❖ The Louisiana Optical Network Initiative (LONI) and its connected High Performing Computer resources, all under the authority of the Board of Regents
  - ❖ **The LONI Institute, a collaboration of researchers among the six LONI sites that creates a multi-disciplinary environment**

# LONI: Louisiana Optical Network Initiative

Respectfully submitted by Louisiana's Research Universities  
January 12, 2004

## Abstract

The goal of the Louisiana Optical Network Initiative (LONI) is to create a statewide environment that can integrate and aggregate Louisiana's many strengths, currently geographically distributed across its universities and industries. This proposal presents the design for the state's high-speed advanced data network, Louisiana Advanced Regional Network (LARN), that connects the major research centers at LA Tech, ULL, SU-Baton Rouge, LSU-Baton Rouge, UNO, LSUHSC-Shreveport, LSUHSC-NO and Tulane University. LARN will be capable of supporting technological and scientific research, while stimulating economic development across the state. This proposal also recommends new grid technologies connecting LARN sites that will form the LAGrid, enable new collaborations, and provide necessary shared computational resources. LONI, the complete system incorporating both the network (LARN) and grid (LAGrid), is a direct investment in Louisiana Vision 2020's major goals to foster learning enterprises and cultural innovation, and to become a top 10 state. The estimated cost of this initiative is \$27.3M, with a yearly running cost of \$2.5M.

## Introduction

High-speed advanced data networks are revolutionizing not only the way educators, researchers, and businesses work, but they are also changing dramatically the scale and character of the problems they can attack. Computer installations, sensor networks, digital television, animation companies, experimental facilities and many others are increasingly generating unfathomably large amounts of data that must be moved, stored, accessed and processed by people and machines in virtually every walk of life, especially in research and high-tech areas. High-speed networks must be deployed to keep up with the exponentially increasing demands of a data driven society.

*The Louisiana Optical Network Initiative (LONI) proposes the deployment of both the Louisiana Advanced Regional Network (LARN) and the LAGrid. High-speed networks, coupled with new application technologies, become "grids", the fundamental conduit for new models of computation and collaboration across large distances. Grids provide distributed computational facilities, greatly exceeding the capabilities of any one site, while providing tools that can, for example, enable data mining for researchers and businesses to extract information from warehouses full of data.*

Regions across the Nation and throughout the world are scrambling to deploy high-speed networks capable of carrying 10's of Gbits /sec to closely link universities, high-tech industries, research centers and experimental facilities. These networks are typically hundreds to thousands of times faster than the previous generation currently deployed in Louisiana. This capacity, along with the advanced capabilities new networks provide, is required for present and future applications being used and developed today. *As detailed below, we propose to deploy a high-speed advanced data network, entitled Louisiana Area Research Network, or LARN, as soon as possible.*

This LONI proposal comes at a unique time because optical switching network technology has matured considerably in recent years. LARN will carry the state forward into the next decade, using "lambda" technology (each lambda is capable of carrying 10 Gbits/sec). LARN is easily upgradeable, additional lambdas can be added at relatively little cost. The initial deployment of LARN, is estimated to cost \$27.3M.

One might question why a "multi-lambda" network across the state is necessary, when presently the much lower bandwidth available (typically below 10 Mbits/sec) is not fully saturated. But many problems of importance to industry and academia alike simply cannot be attempted without a very significant upgrade to the existing infrastructure. For example, a single channel of full quality high definition television (HDTV) or video conferencing requires 50Mbits/sec (10x the bandwidth between most campuses). A single interactive remote visualization of a large dataset, needed for medical imaging, requires a network of at least 150Mbits/sec. Such applications are simply not possible on the state's existing network. Several of Louisiana's major research centers are already active in developing advanced grid applications, and LSU has recently recruited a team from Europe with unique and world renowned, expertise in grid applications and collaborative technology.

# LONI: Louisiana Optical Network Initiative

## Louisiana Research Universities Proposal Highlights

January 12, 2004

- Goal of LONI: create a statewide environment that can integrate and aggregate Louisiana's many strengths, currently geographically distributed across its universities and industries.
- Design and establish: state high-speed advanced data network, (Louisiana Advanced Regional Network - LARN) with multi-lambda fiber-optic capacity, that connects the major research centers at LA Tech, ULL, SU-Baton Rouge, LSU-Baton Rouge, UNO, LSUHSC-Shreveport, LSUHSC-NO and Tulane University and capable of supporting technological and scientific research, while stimulating economic development across the state.
- Proposal also recommends: new grid technologies connecting LARN sites that will form the LAGrid, enable new collaborations, and provide necessary shared computational resources.
- LONI: complete system incorporating both the network (LARN) and grid (LAGrid), a direct investment in Louisiana Vision 2020's major goals to foster learning enterprises and cultural innovation, and to become a top 10 state.



# LONI: Louisiana Optical Network Initiative

## Louisiana Research Universities Proposal Highlights

January 12, 2004

*Louisiana has an opportunity not only to be competitive with other states in attracting and retaining high-tech research and industry activity, but to surpass them due to its exceptionally strong application base and grid computing expertise.*

*LONI will create an environment that makes it possible for companies to flourish in the modern, data driven age, as well as for university researchers to develop applications on national grids on a multi-institutional basis.*

*The objective is to position Louisiana as a leader in facilitating collaborations between universities, industries, and government, focused on creating and deploying new technologies, new jobs and new companies.*



# LONI: Louisiana Optical Network Initiative

## Louisiana Research Universities Proposal Highlights

January 12, 2004

**Types of Applications:** *Applications drive the need for such a network. This is the area where the state has a unique opportunity to leapfrog other efforts, becoming a world leader in short period of time. Louisiana has the applications that can use grids, and the research expertise to truly enable scenarios such as the following:*

- Astrophysics
- Bioinformatics, Biomedical, Biotechnology and Life Sciences
- Coastal Ocean Observing
- Microsystems, Nanosystems and Advanced Materials
- Mississippi River Basin
- Petroleum Engineering





# LONI: Louisiana Optical Network Initiative

## Louisiana Research Universities Proposal Highlights

January 12, 2004

### Applications Development Focus: *Applications*

*development can be focused on the state's industry clusters and serve high technology companies already in place, as well as leverage relationships at the national and international levels.*

*Opportunities to enhance Louisiana's competitiveness exist in all of the targeted clusters:*

- Oil & Gas and Energy
- Information Technology
- Transportation/Logistics
- Durable Goods
- Entertainment
- Advanced Materials
- Biotech
- Agriculture/Food Technology
- Petroleum and Environmental



# State of Louisiana Investment in LONI

- In FY04-05, with guidance from the research community spurred by prior IT investments, the State embarked on an investment in high-speed fiber-optic networking and high performance computing.
- Higher education and the State proceeded to:
  - Develop a state-wide fiber optic network connecting, at a minimum, its major research institutions
  - Provide for significant computing enhancements at 5 different institutions establishing a networked computing infrastructure/grid
  - Provide for Louisiana to become a member of the National LambdaRail organization, a national high-speed fiber optic network for major research institutions across the nation.

# State of Louisiana Investment in LONI and National Computing Networks

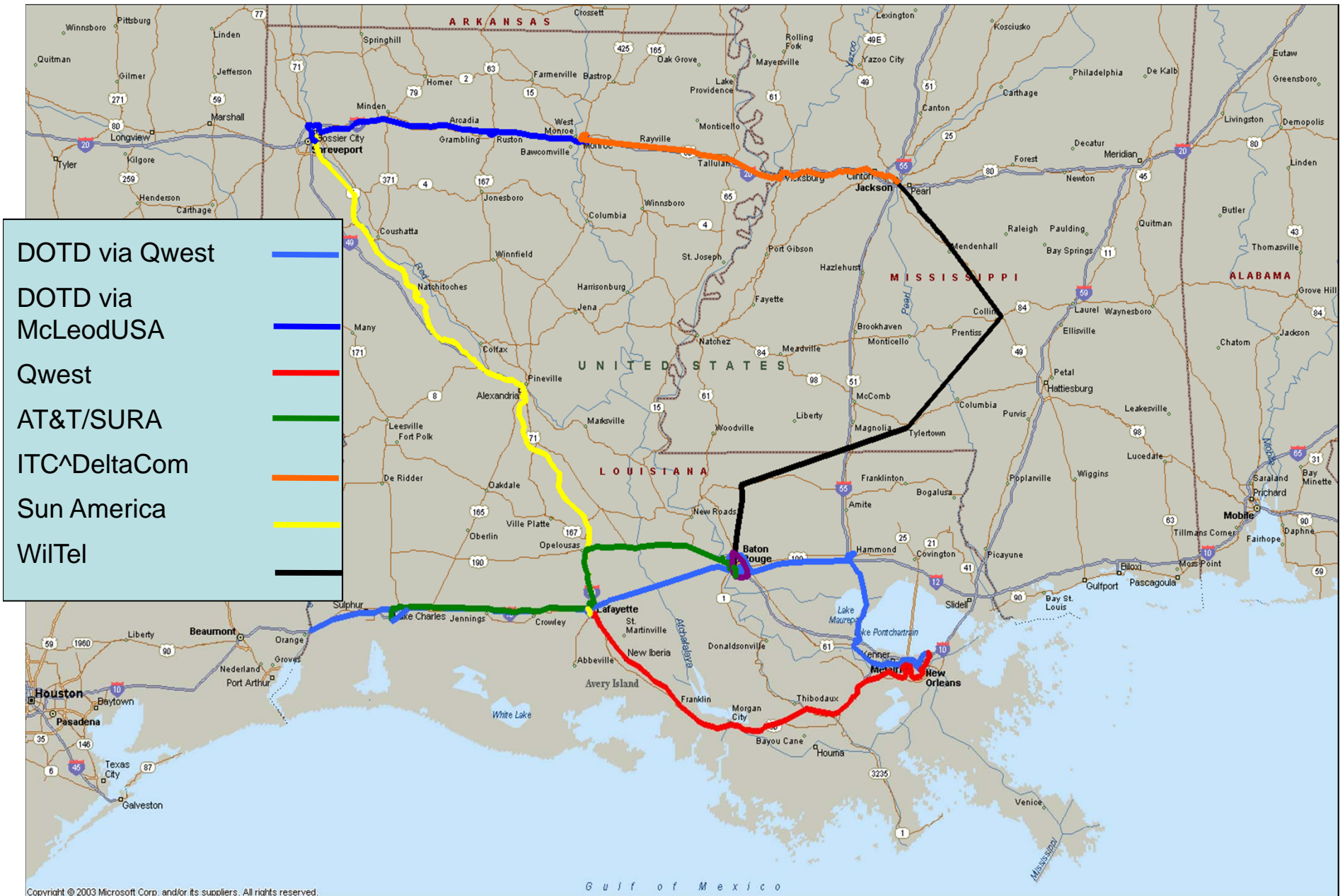
- The costs for this initiative was provided in the following ways:
  - Funding for initial development of the high-speed and computing network was provided to the Board of Regents in an amount of \$3.2 million in the FY04-05 budget. Thereafter, \$4 million annually was committed for LONI's on-going development and operation.
  - The Board of Regents, LSU-BR and Tulane University made a joint commitment to provide \$1 million annually for a five year term of membership in the National Lambda Rail. Regents committed \$700,000 annually from the La Education Quality Support Fund and LSU and Tulane each pledged \$150,000 annually.
  - Board of Regents funding originally provided through an earlier Governor's Information Technology Initiative in the amount of approximately \$1 million was committed to LONI.



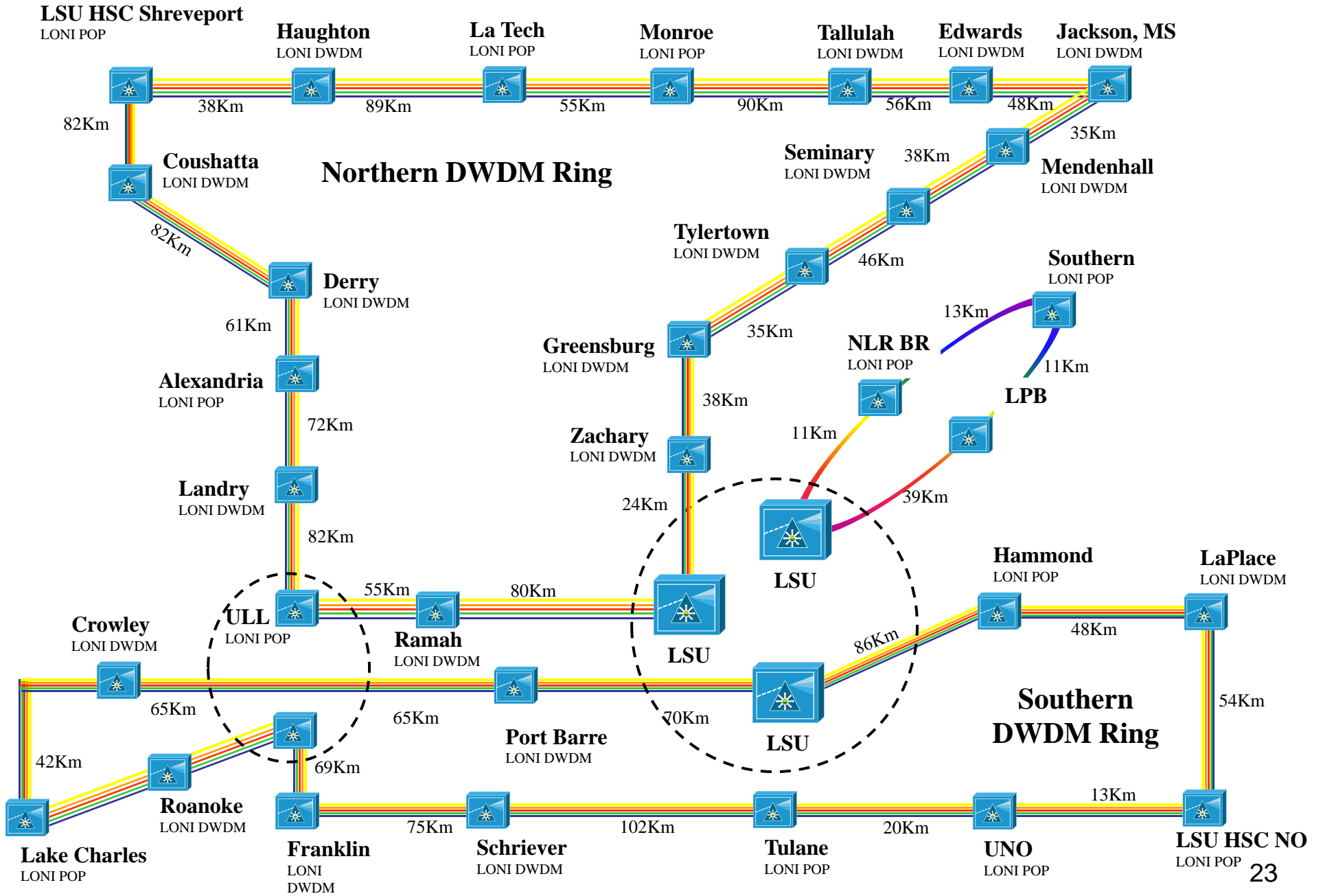
# State of Louisiana Investment in LONI

Beginning in FY05-06, the \$5 million recurring funding commitment allowed the Regents to:

- Incur approximately \$1.9 million annually in financing costs (for a term up to 10 years) for:
  - \$11-\$12 million of network equipment for the build-out of the fiber optic network
  - \$2.5 million for five IBM P-5 computers to establish a networked computing infrastructure/grid
- Provide approximately \$900,000 on a one-time basis and \$1.4 million annually for fiber lease and maintenance costs
- Approximately \$1.4 million annually for operation and maintenance of the network
- Continue to provide for statewide participation in Internet2



# LONI Network Design





## Original Network Concept



## What the Network is Today

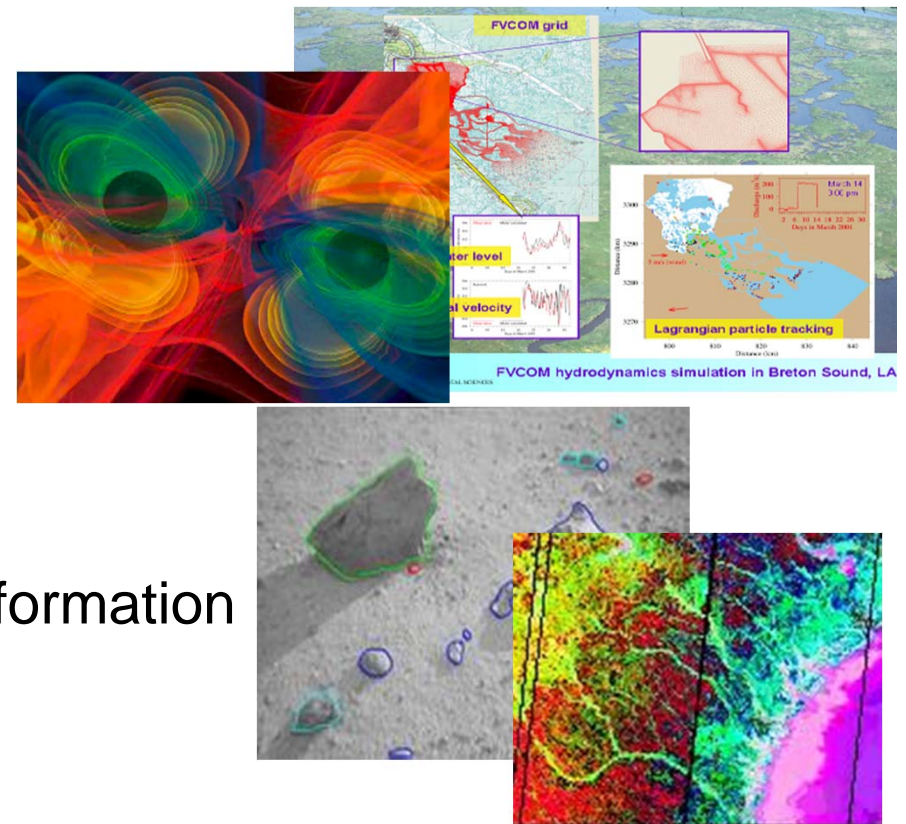


# State of Louisiana Investment in High Performance Computing



# What can HPC do?

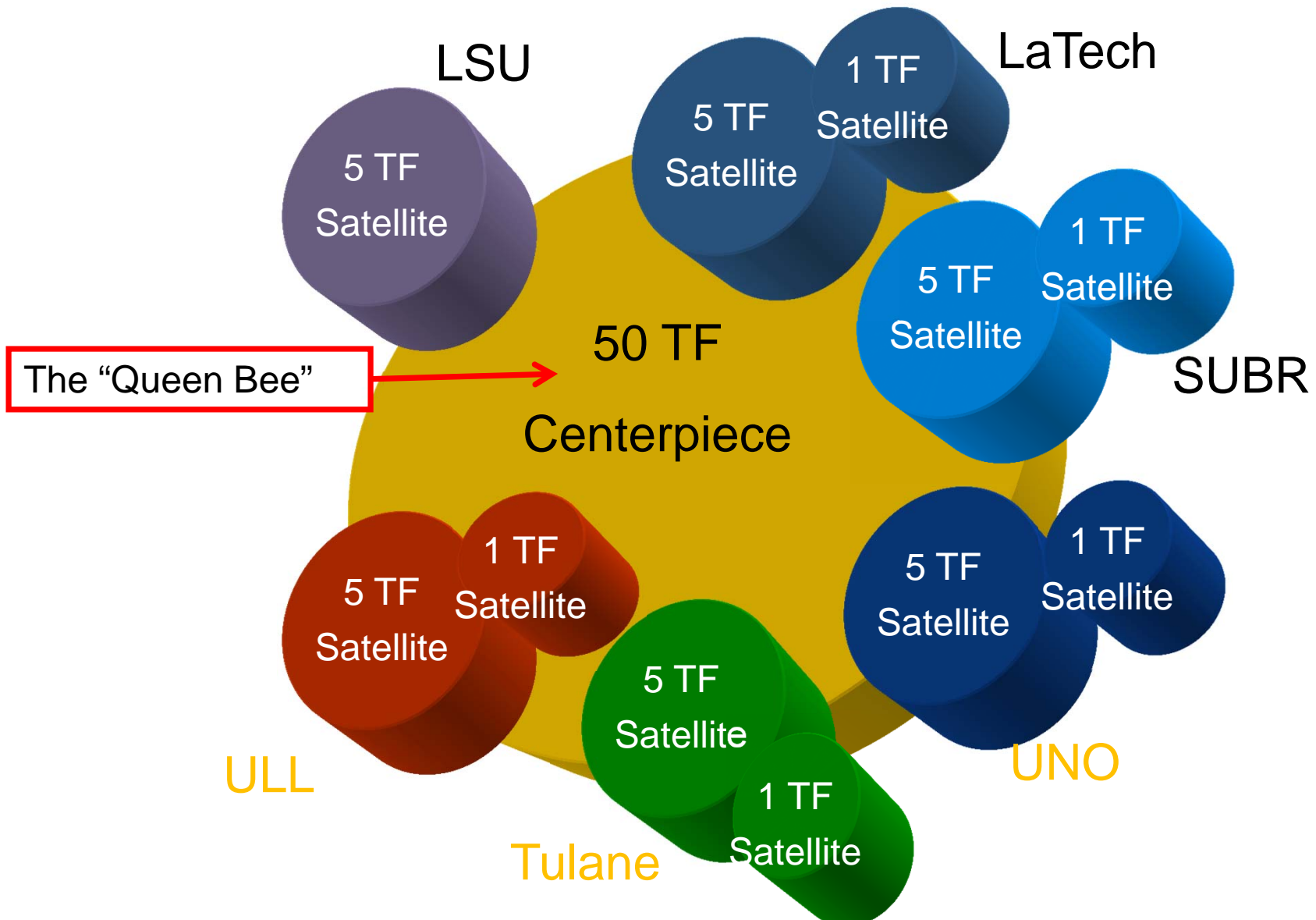
- **Simulation of physical phenomena**, such as
  - Bioinformatics/Biocomputing
  - Materials
  - Weather forecasting
  - Storm damage prediction
  - Black holes colliding
  - Oil reservoir management
- **Data mining**: finding needles of information in a haystack of data, such as
  - Gene sequencing
  - Signal processing
  - Threat assessment from intelligence data
- **Visualization**: turning lots of data into pictures that a scientist can understand



# State of Louisiana Investment in High Performance Computing

- In FY06-07, the State provided \$7.5 million to acquire and set-up within the State's Information Services Building the "Queen Bee" super-computer, related LONI connections, and a set of Dell HPC Clusters at LONI anchor institutions.
- At the time of its purchase and installation (June, 2007) Queen Bee was ranked 23<sup>rd</sup> in the world and 7<sup>th</sup> in the academic environment.

# LONI Hardware





# The Queen Bee

## Dedicated facility - Baton Rouge

- 680 nodes  $\times$  8 cores  
= 5440 cores
- 4 Gb RAM per node  
= 2.88 Tb
- ~ 50 TFLOPS
- #23 in the world in  
June 2007
- #7 in an academic  
environment

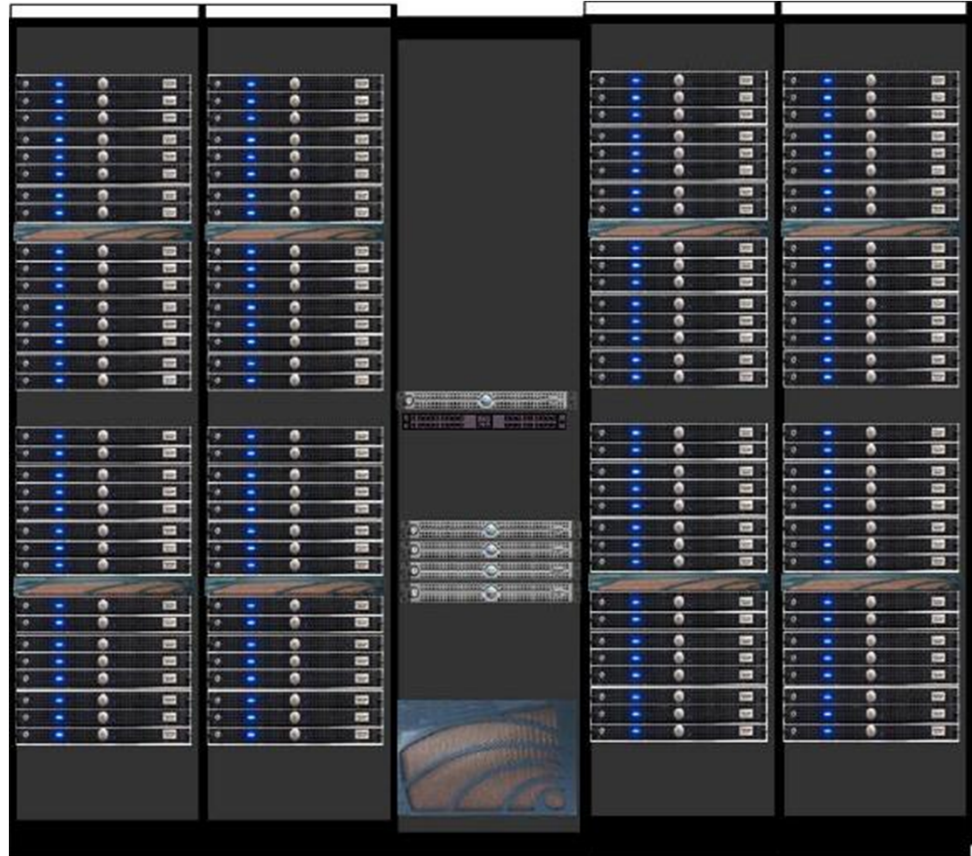


# The worker bees

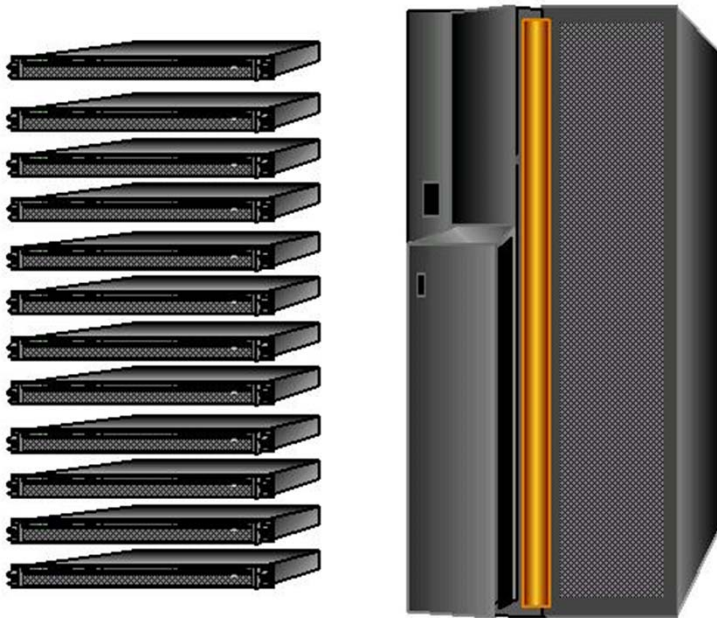
6 Dell Linux clusters

Located at member institutions

- 132 nodes  $\times$  4 cores  
= 528 cores
- 4 Gb memory per node
- ~ 300 Gb storage
- ~ 5 TFLOPS each

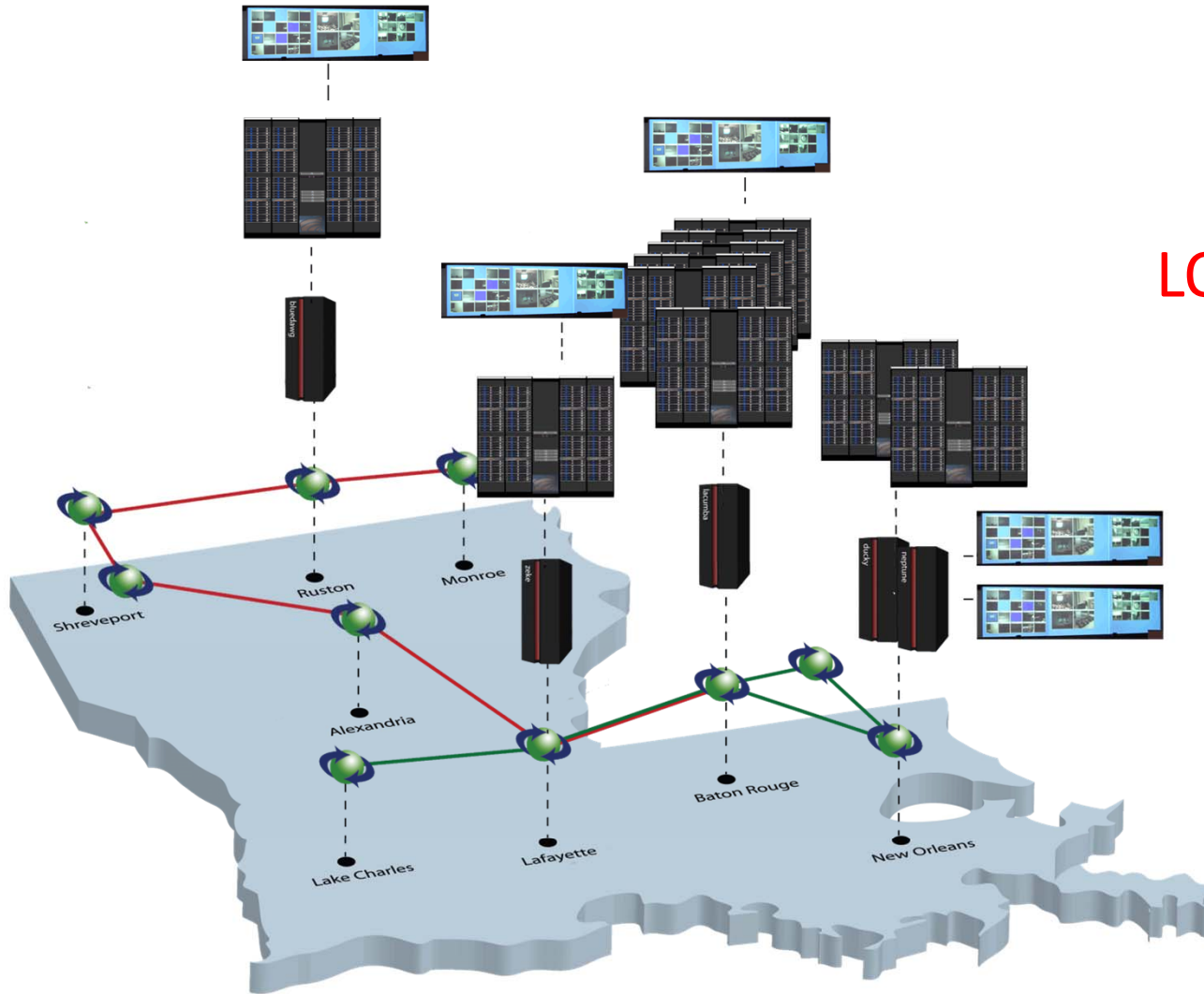


# The “retired” worker bees



5 IBM p5-575 computers  
at member institutions

- 14 nodes  $\times$  8 cores  
= 112 cores
- 16 Gb memory per node
- 70 Gb disk per node
- ~ 0.85 TFLOPS each



## LONI Components

Optical Network

Access Grid

LONI Sites

IBM P5 Supercomputers

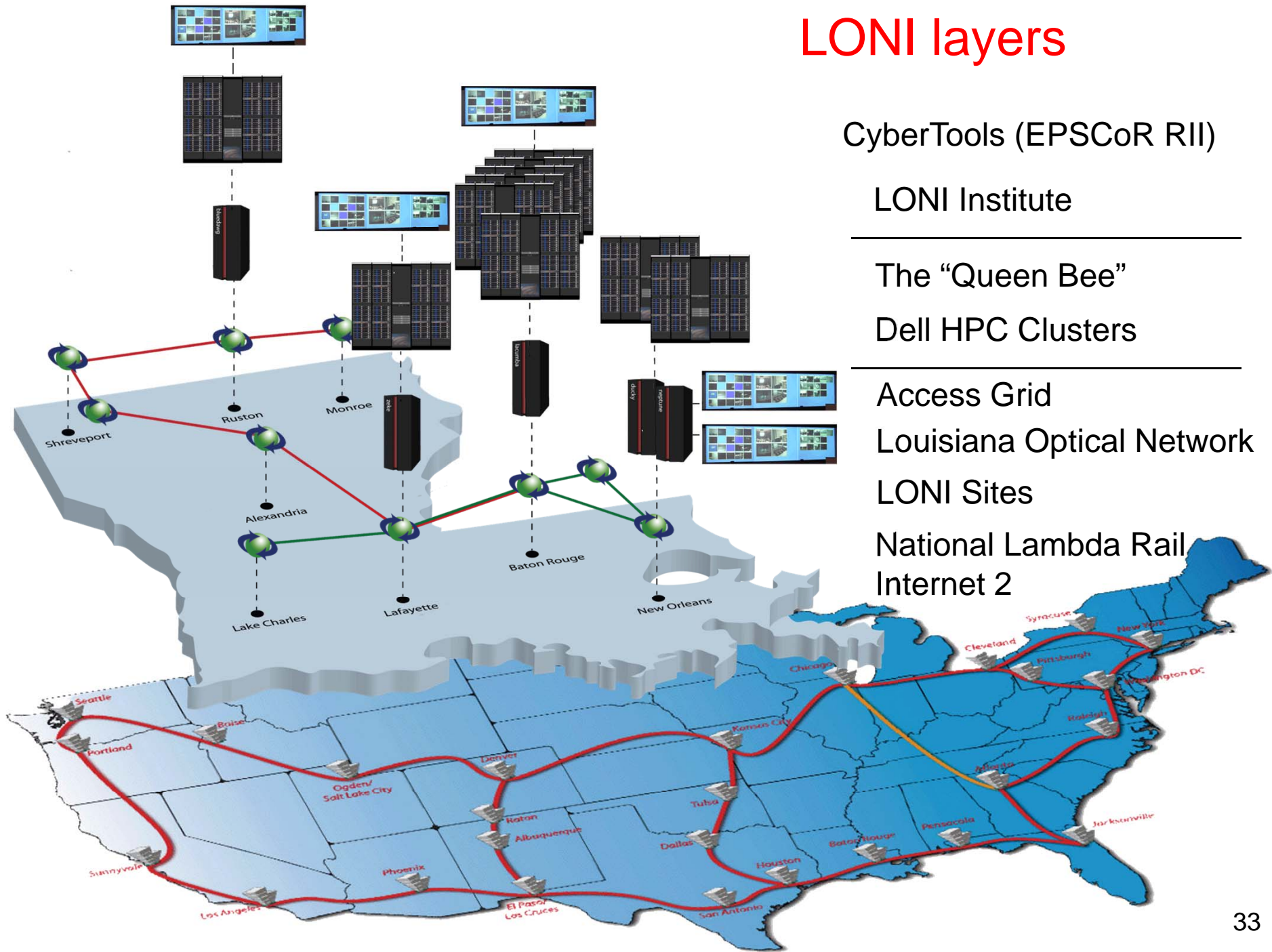
The "Queen Bee"

Dell HPC Clusters

LONI Institute



# LONI layers



CyberTools (EPSCoR RII)

LONI Institute

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The "Queen Bee"

Dell HPC Clusters

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Access Grid

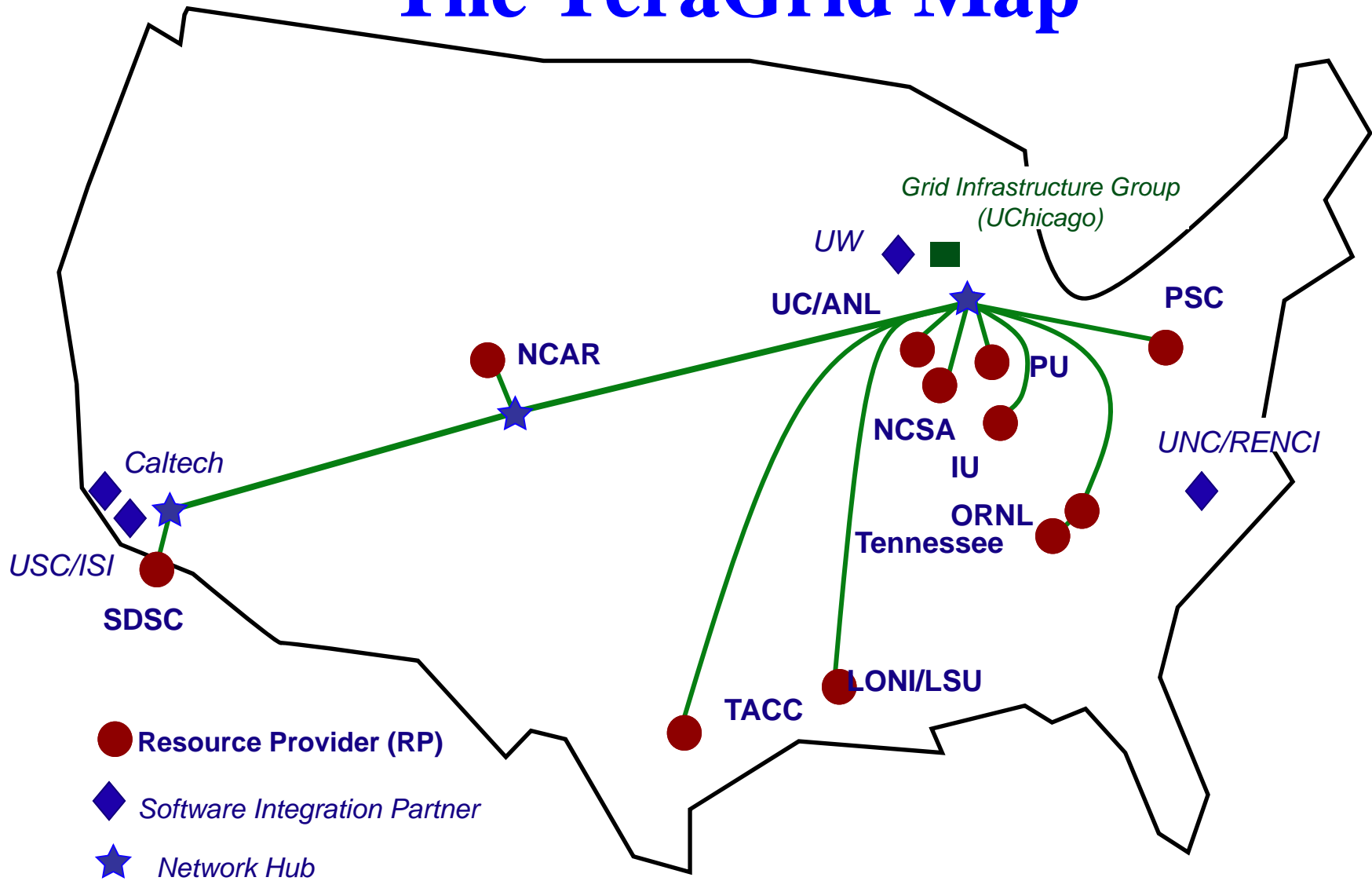
Louisiana Optical Network

LONI Sites

National Lambda Rail

Internet 2

# The TeraGrid Map



National Research Network Connectivity  
and  
Research and Education Networks

# National Research Connectivity

Links the State to the National LambdaRail and Internet2

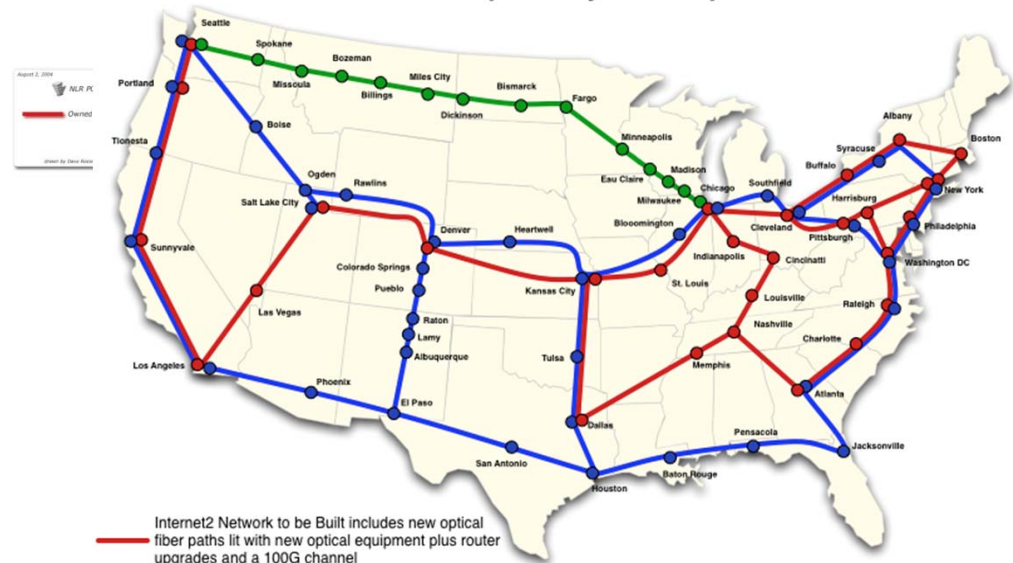


*National LambdaRail Architecture*



*Internet2 Architecture*

As Submitted:  
Combined Optical System Capabilities



- Internet2 Network to be Built includes new optical fiber paths lit with new optical equipment plus router upgrades and a 100G channel
- Contributed NLR Optical Network to remain primarily unchanged except for one new channel added at 100 Gbps. Routers and switches to be upgraded.
- Contributed NTNC Network to be upgraded from 100 Gbps to 500 Gbps with optical transport upgrade



# Research & Education Networking Today

- Regional/State Networks: 36+

3RoX

CT Education Network

CENIC

CIC-OmniPoP

Florida LambdaRail

Front Range Gigapop

Great Plains Network

Indiana Gigapop

IRON

KANREN

KyRON

LEARN

**LONI**

MAGPI

MAX

MCNC/NCREN

Merit

MOREnet

MREN

Network Virginia

NJEdge.Net

Northern Lights

NOX

NYSERNet

OARNet

OneNet

Oregon GigaPoP

OSHEAN

PeachNet

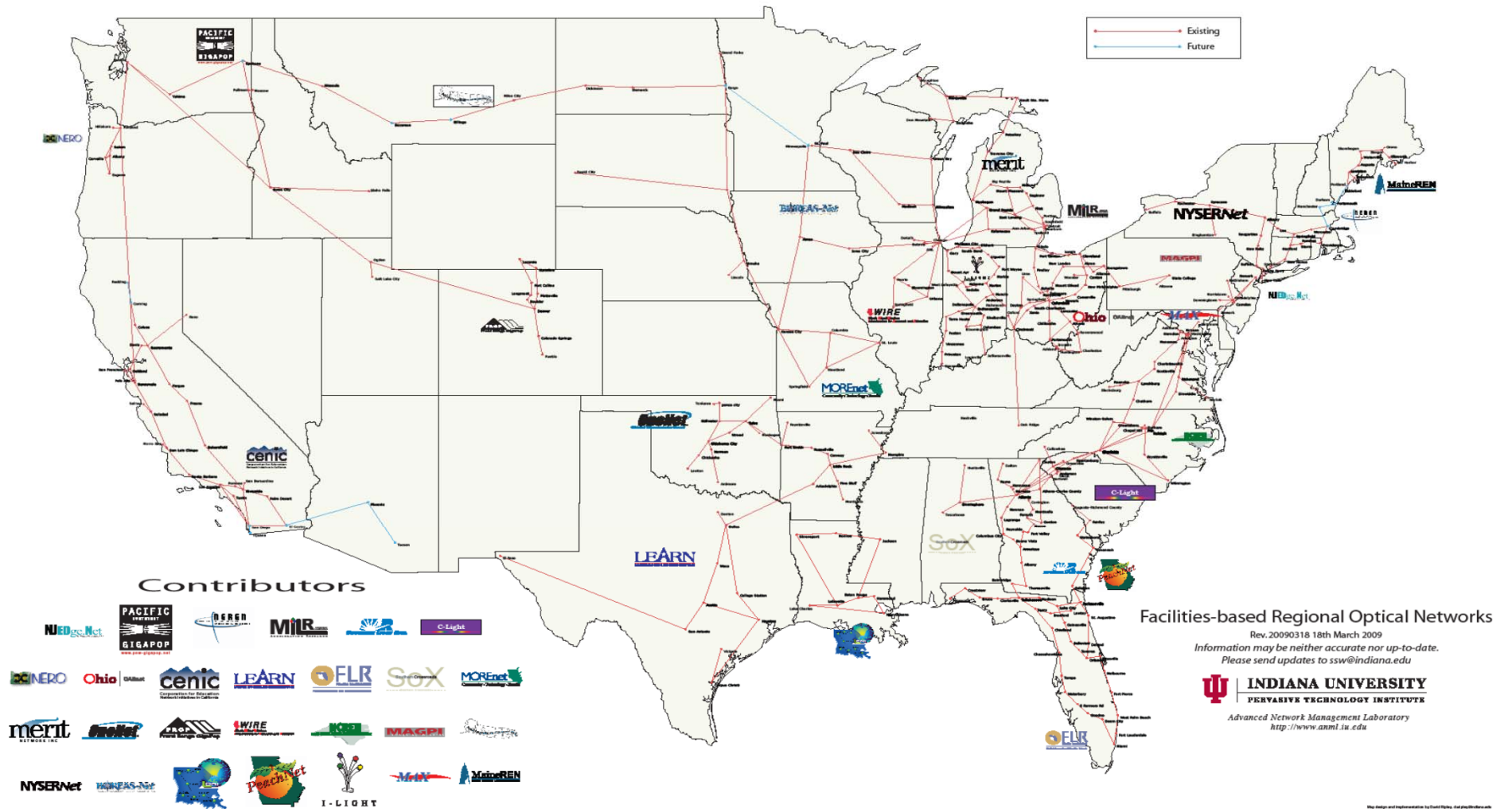
PNWGP

SoX

UEN

WiscNet

# Research and Education Networks

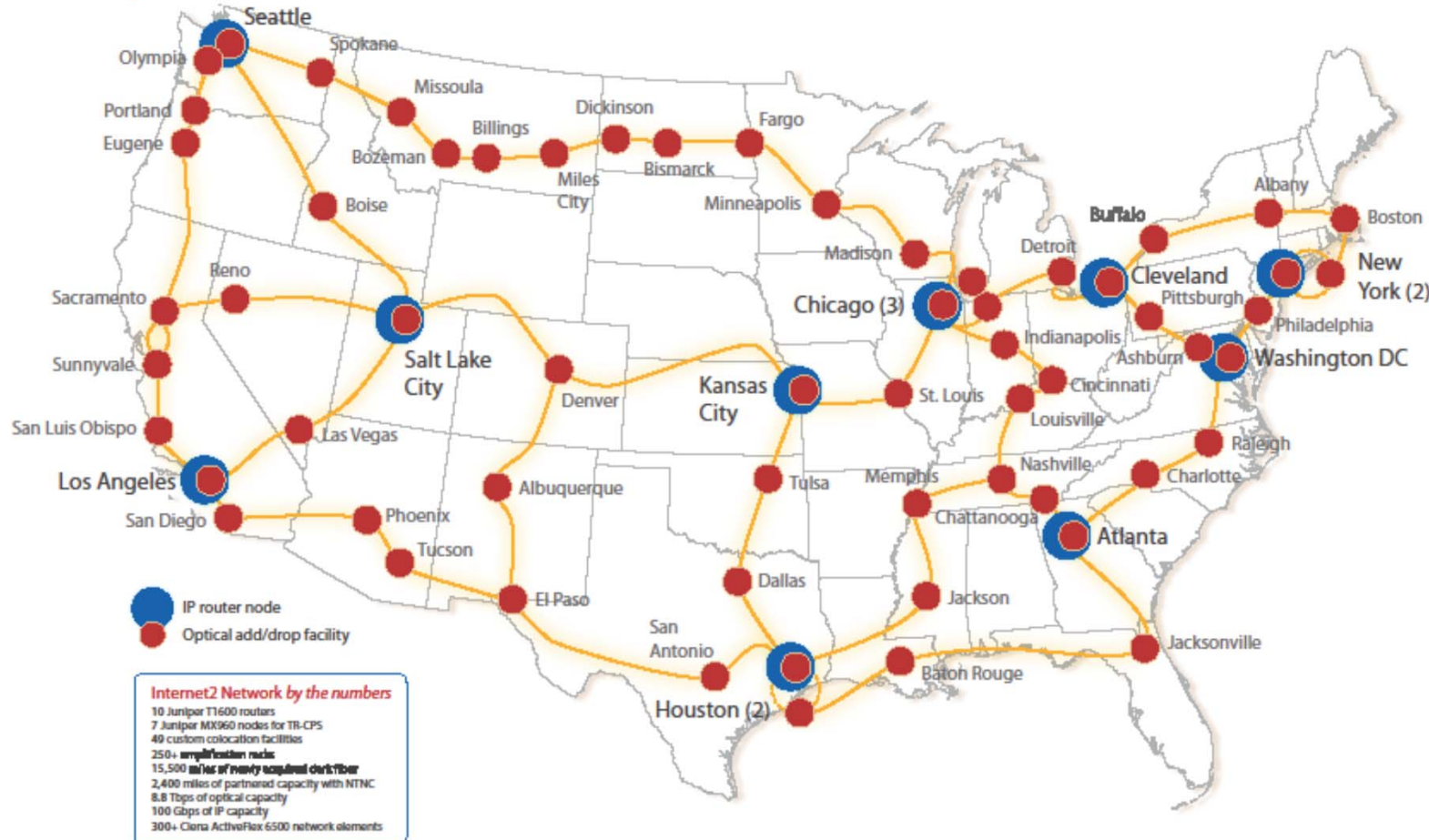


This design and implementation by David Forster, and project manager  
 completed in 2002-2003 by the Indiana University  
 Center for Network Management Laboratory



# Internet2 Planned 100 Gigabit Infrastructure Topology

Draft - Last updated 27 Mar 2012



IN SUPPORT OF  
**U.S. UCAN**

**NETWORK PARTNERS**



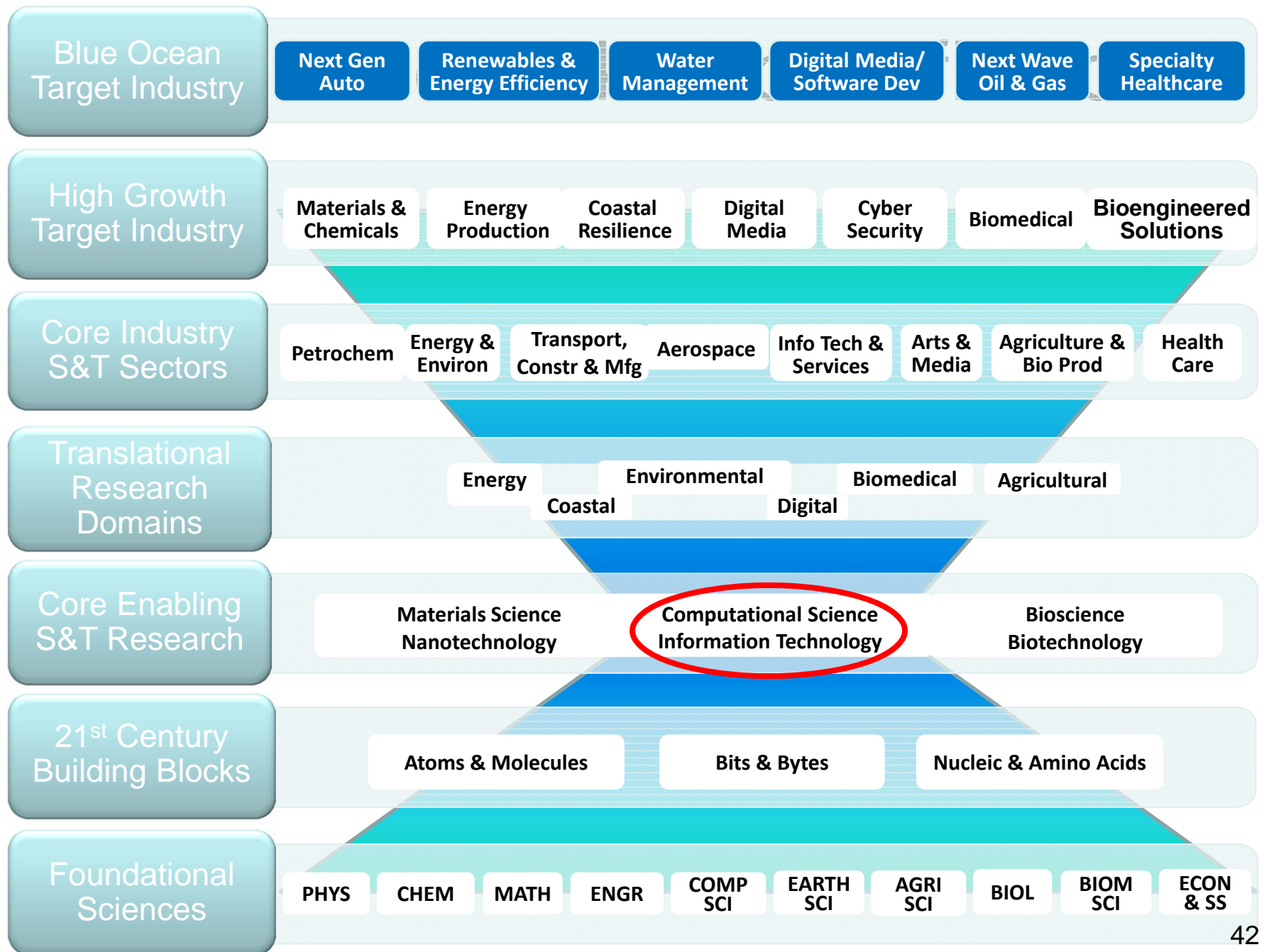
# FIRST Louisiana

Fostering Innovation through  
Research in **Science** and  
Technology in **Louisiana**

A Framework for a Science and Technology Plan for  
Louisiana

# Core Investments

- Louisiana's major research institutions have built very good R&D infrastructure in core enabling science and technology areas (materials, cyber, biotech)
- Louisiana researchers have over two decades of successful multi-institutional research collaborations
- Louisiana citizens have traditionally demonstrated an entrepreneurial culture





# Return on Investment



# LONI Investment and Return

- **Multiple Layers: Each reinforces the next**
  - **2001-3: Vision 2020**, Gov. Foster \$20+ million annually
  - **2004-5: LONI**, Gov. Blanco \$4 million annually + \$7.5 million for computer hardware acquisitions
  - **2005: Louisiana Biomedical Research Network (LBRN)**--\$16M NIH
  - **2007: CyberTools** -- \$12M Statewide NSF/EPSCoR CI project
  - **2007: LONI Institute** -- \$15M Statewide project to recruit people
  - **2007: NSF HPCOPS** -- \$3.8M TeraGrid project
  - **2010: \$20M Statewide NSF/EPSCoR RII in Materials Science**
  - **2010: \$6M tri-state NSF/EPSCoR RII Track 2 in Coastal Studies**
  - **2010: \$2M NSF ARI-R2** to advance LSU's Data Network Infrastructure
  - **2010: \$1.2M NSF/EPSCoR RII C2** connects Xavier to LONI
  - **2012: \$.5M NSF CC – NIE** award to LSU/CCT establishes Science DMZ
  - **2013: \$4M NSF MRI** grant funding for LSU's SuperMIC Supercomputer
  - **2005-13: Many federal grants and industry partnerships** across the state

# LONI Additional Benefits

- Louisiana Research Infrastructure
- Collaborative relationships and research output
- Centralized investment in critical research tools and capabilities
- Education, training and outreach across institutional boundaries
- Opportunities for centralized information and technology services and management
- State-focused efforts and emphasis:
  - Hurricane and storm surge modeling
  - Disaster response and recovery
  - Cyber security
  - Oil spill response and impact assessment/research
  - Economic development connections
  - Workforce development efforts
  - State image and recognition (NSF, Internet 2, NLR, SC'10)

# Support of System and Institution Needs

- Support and assistance of research grant activities
- Backup and Disaster Recovery
- LCTCS Enterprise System
- Electronic Health Records and LSU Hospitals
- Local WAN support
- Net+ Services

# National Cyberinfrastructure Landscape and Opportunities

- FCC's National Broadband Plan
- Changes in National Policy
- Regional Research and Education Networks
- National Networks
- Cyber Innovation and Security

# Challenges and Opportunities

- State Budget and Funding Uncertainty
- Technology is Dynamic and Reinvestment is Needed
- Competitive Environment
- Reluctance to Change Long-standing Approaches
  
- Research, Economic and Workforce Development
- New Education Delivery Methods
- Cost Savings Opportunities

# Discussion

