OSCER: State of the Center

Henry Neeman, OSCER Director

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OU Supercomputing Center for Education & Research

A Division of OU Information Technology

Wednesday October 7 2009

University of Oklahoma

This Happened Monday

Preregistration Profile

- Organizations
  - **Academic**: preregistered 43 institutions in 15 states (AR,CA,IL,IN,KS,LA,MD,MS,ND,NM,OK,TX,UT,VT,WV)
    - Includes 30 institutions in 9 EPSCoR states (AR,KS,LA,MS,ND,NM,OK,UT,WV)
  - **Industry**: preregistered 16 firms
  - **Government**: preregistered 16 agencies (federal, state, local)
  - **Non-governmental**: preregistered 4 organizations
- Demographics (preregistrations)
  - 36% OU, 64% non-OU
  - 73% Oklahoma, 27% non-Oklahoma
  - 87% from EPSCoR states, 13% non-EPSCoR
  - 81% academic, 19% non-academic

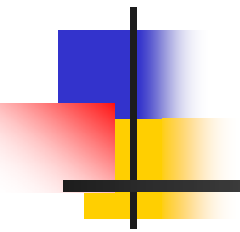
This Year's Big Accomplishments

- Many new grants, especially NSF EPSCoR Track 1, Track 2
- Over 1.6 million batch jobs run already on Sooner, the cluster that we deployed a year ago – more than all of the jobs on the previous cluster, Topdawg, over its entire lifetime!
- MATLAB (OU Norman campuswide license)

Outline

- Who, What, Where, When, Why, How
- What Does OSCER Do?
  - Resources
  - Education
  - Research
  - Dissemination
- OSCER's Future

OSCER:
Who, What, Where, When, Why, How



What is OSCER?

- Division of OU Information Technology
- Multidisciplinary center
- Provides:
  - Supercomputing **education**
  - Supercomputing **expertise**
  - Supercomputing **resources**: hardware, storage, software
- For:
  - Undergrad students
  - Grad students
  - Staff
  - Faculty
  - Their collaborators (including **off campus**)

Who is OSCER? Academic Depts

1. Aerospace & Mechanical Engr
2. Anthropology
3. Biochemistry & Molecular Biology
4. Biological Survey
5. Botany & Microbiology
6. Chemical, Biological & Materials Engr
7. Chemistry & Biochemistry
8. Civil Engr & Environmental Science
9. Computer Science
10. Economics
11. Electrical & Computer Engr
12. Finance
13. Health & Sport Sciences
14. History of Science
15. Industrial Engr
16. Geography
17. Geology & Geophysics
18. Library & Information Studies
19. Mathematics
20. Meteorology
21. Microbiology & Immunology
22. Petroleum & Geological Engr
23. Physics & Astronomy
24. Psychology
25. Radiological Sciences
26. Surgery
27. Zoology

More than 150 faculty & staff in **27 depts** in Colleges of Arts & Sciences, Atmospheric & Geographic Sciences, Business, Earth & Energy, Engineering, and Medicine – with **more to come**!

Who is OSCER? OU Groups

1. Advanced Center for Genome Technology
2. Center for Analysis & Prediction of Storms
3. Center for Aircraft & Systems/Support Infrastructure
4. Cooperative Institute for Mesoscale Meteorological Studies
5. Center for Engineering Optimization
6. Fears Structural Engineering Laboratory
7. Human Technology Interaction Center
8. Institute of Exploration & Development Geosciences
9. Instructional Development Program
10. Interaction, Discovery, Exploration, Adaptation Laboratory
11. Microarray Core Facility
12. OU Information Technology
13. OU Office of the VP for Research
14. Oklahoma Center for High Energy Physics
15. Robotics, Evolution, Adaptation, and Learning Laboratory
16. Sasaki Applied Meteorology Research Institute
17. Symbiotic Computing Laboratory

Oklahoma Collaborators

1. Cameron University (**masters)**
2. East Central University (**masters**)
3. Langston University (**minority-serving**, **masters**)
4. NOAA National Severe Storms Laboratory
5. NOAA Storm Prediction Center
6. **NEW! Northeastern State University (masters)**
7. Oklahoma Baptist University (**bachelors**)
8. Oklahoma City University (**masters**)
9. Oklahoma Climatological Survey
10. Oklahoma Medical Research Foundation
11. Oklahoma School of Science & Mathematics (**high school**)
12. Oklahoma State University
13. **NEW! Rogers State University** (**masters**)
14. St. Gregory's University (**bachelors**)
15. **NEW! Samuel Roberts Noble Foundation**
16. Southeastern Oklahoma State University (**masters**)
17. Southwestern Oklahoma State University (**tribal**, **masters**)
18. University of Central Oklahoma (**masters**)
19. **NEW! University of Tulsa**

- **YOU COULD BE HERE!**

National Collaborators (22 states)

1. California State Polytechnic University Pomona (**minority-serving**, **masters**)
2. Colorado State University
3. Contra Costa College (CA, **minority-serving**, **2-year**)
4. Delaware State University (**EPSCoR**, **masters**)
5. Earlham College (IN, **bachelors**)
6. Emporia State University (KS, **EPSCoR**, **masters**)
7. Florida State University
8. Georgia Institute of Technology
9. Great Plains Network
10. Harvard University (MA)
11. Indiana University
12. Kansas State University (**EPSCoR**)
13. Kean University (NJ)
14. Longwood University (VA, **masters**)
15. Marshall University (WV, **EPSCoR**, **masters**)
16. Navajo Technical College (NM, **tribal**, **EPSCoR**, **2-year**)
17. Purdue University (IN)
18. Riverside Community College (CA, **2-year**)
19. St. Cloud State University (MN, **masters**)
20. Syracuse University (NY)
21. Texas A&M University
22. Texas A&M University-Corpus Christi (**masters**)
23. University of Arkansas (**EPSCoR**)
24. University of Arkansas Little Rock (**EPSCoR**)
25. University of California Santa Barbara
26. University of Illinois at Urbana-Champaign
27. University of Kansas (**EPSCoR**)
28. University of Nebraska-Lincoln (**EPSCoR**)
29. University of North Dakota (**EPSCoR**)
30. University of Northern Iowa (**masters**)
31. University of Utah (**EPSCoR**)
32. Widener University (**masters**)
33. Worcester Polytechnic Institute (MA)

- **YOU COULD BE HERE!**

Who? OSCER Personnel

- Director: Henry Neeman
- Associate Director for Remote & Heterogeneous Computing: Horst Severini
- Manager of Operations: Brandon George
- System Administrator: David Akin
- System Administrator: Brett Zimmerman
- HPC Application Software Specialist: Josh Alexander
- A little bit of OU IT sysadmin Chris Franklin to run the Condor pool.

Who Are the Users?

Approximately 580 users so far, including:

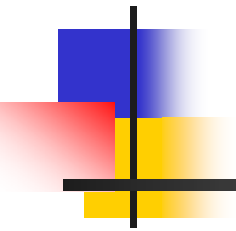
- Roughly equal split between students vs faculty/staff;
- many off campus users;
- … more being added **every month**.

Comparison: The TeraGrid, a national supercomputing metacenter consisting of 11 resource provide sites across the US, has about 5000 unique users.

Biggest Consumers

- **Center for Analysis & Prediction of Storms**: daily real time weather forecasting
- **Oklahoma Center for High Energy Physics**: simulation and data analysis of banging tiny particles together at unbelievably high speeds
- Chemistry & Chemical Engineering (molecular dynamics)
- **NEW! Computer Science (!)**

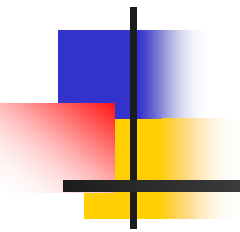
What Does OSCER Do?



What Does OSCER Do?

- Resources
- Teaching
- Research
- Dissemination

OSCER Resources
(and a little history)



2002 OSCER Hardware

- **TOTAL: 1220.8 GFLOPs*, 302 CPU cores, 302 GB RAM**
- Aspen Systems Pentium4 Xeon 32-bit Linux Cluster (Boomer)
  - 270 Pentium4 Xeon CPUs, 270 GB RAM, 1080 GFLOPs
- IBM Regatta p690 Symmetric Multiprocessor (Sooner)
  - 32 POWER4 CPUs, 32 GB RAM, 140.8 GFLOPs
- IBM FAStT500 FiberChannel-1 Disk Server
- Qualstar TLS-412300 Tape Library
- Internet2

* GFLOPs: billions of calculations per second

2005 OSCER Hardware

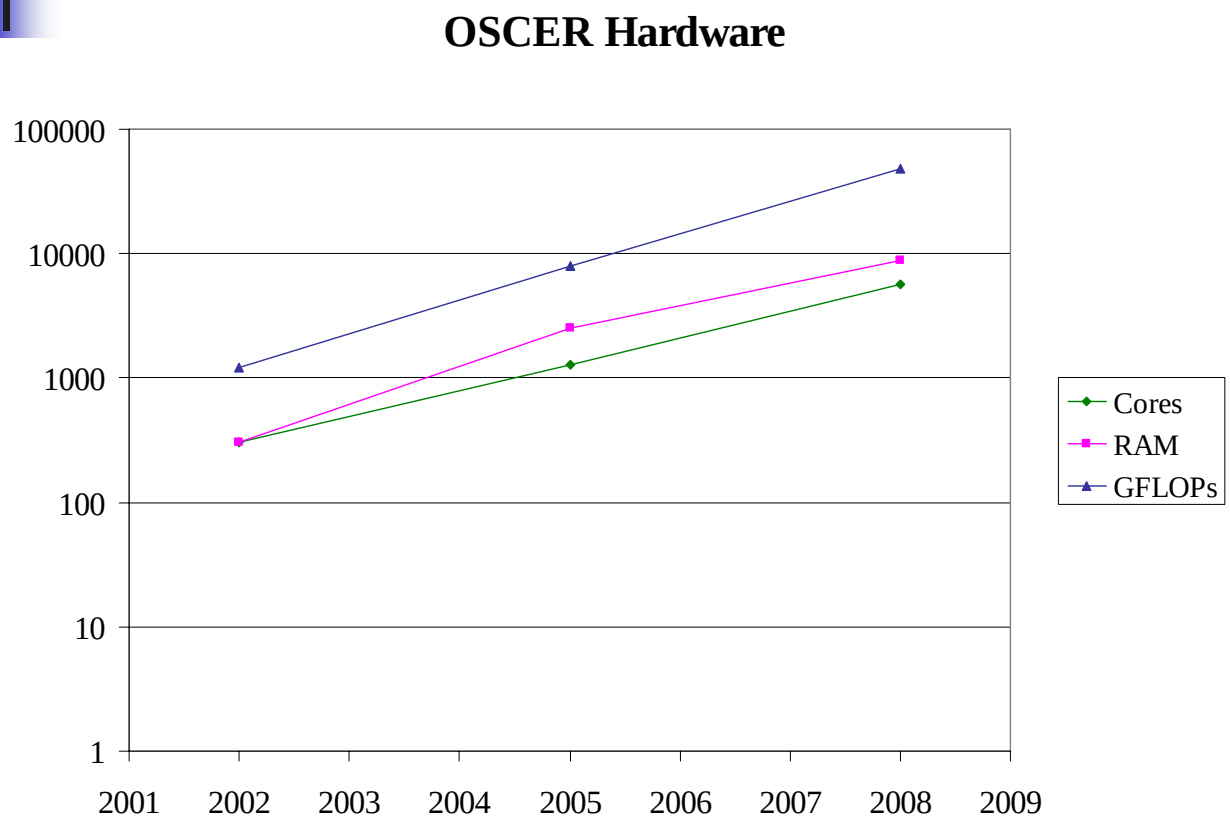
- **TOTAL: 8009 GFLOPs*, 1288 CPU cores, 2504 GB RAM**
- Dell Pentium4 Xeon 64-bit Linux Cluster (Topdawg)
  - 1024 Pentium4 Xeon CPUs, 2176 GB RAM, 6553.6 GFLOPs
- Aspen Systems Itanium2 cluster (Schooner)
  - 64 Itanium2 CPUs, 128 GB RAM, 256 GFLOPs
- Condor Pool: 200 student lab PCs, 1200 GFLOPs
- National Lambda Rail (10 Gbps network), Internet2
- Storage library: Qualstar (10 TB, AIT-3)

* GFLOPs: billions of calculations per second

Current OSCER Hardware

- **TOTAL: 54,626.88 GFLOPs; 6304 cores; 12,390 GB RAM**
- Dell Xeon Quad Core Linux Cluster (Sooner)
  - 531 Xeon 2.0 GHz Harpertown dual socket quad core, 16 GB RAM
  - 3 Xeon 2.33 GHz Clovertown dual socket quad core, 16 GB RAM
  - 2 Xeon 2.4 GHz quad socket quad core nodes, 128 GB RAM each
  - 34,514.88 GFLOPs
  - **NEW! 22 NVIDIA Tesla C1060 cards (933/78 GFLOPs each)**
- Condor Pool: 795 lab PCs, 20,112 GFLOPs, 3590 GB RAM
  - **NEW! 205 x Intel Core i7 quad 2.4 GHz with 6 GB RAM each**
  - 400 x Intel Core2 Duo 2.4 GHz with 4 GB RAM each
  - 190 x Intel Core2 Duo 3.0 GHz with 4 GB RAM each
- National Lambda Rail, Internet2 (10 Gbps networks)

Improvement in OSCER Hardware



GFLOPs:
2008 = 39 x 2002

RAM:
2008 = 29 x 2002

CPU cores:
2008 = 19 x 2002

Moore's Law:
2008 = 16 x 2002

OSCER: Dell Intel Xeon Cluster

1,076 Intel Xeon CPU chips/4304 cores

- 528 dual socket/quad core Harpertown 2.0 GHz, 16 GB each
- 3 dual socket/quad core Harpertown 2.66 GHz, 16 GB each
- 3 dual socket/quad core Clovertown 2.33 GHz, 16 GB each
- 2 x quad socket/quad core Tigerton, 2.4 GHz, 128 GB each

8,800 GB RAM

~105 TB globally accessible disk

QLogic Infiniband

Force10 Networks Gigabit Ethernet

Red Hat Enterprise Linux 5

Peak speed: 34.5 TFLOPs*

*TFLOPs: trillion calculations per second

sooner.oscer.ou.edu

OSCER: Dell Intel Xeon Cluster

DEBUTED NOVEMBER 2008 AT:

- **#90 worldwide (currently #183)**
- **#47 in the US**
- **#14 among US academic**
- **#10 among US academic excluding TeraGrid**
- **#6 among EPSCoR states**
- **#4 among EPSCoR states excluding TeraGrid**
- **#2 in the Big 12**
- **#1 in the Big 12 excluding TeraGrid**

sooner.oscer.ou.edu

OSCER: Dell Intel Xeon Cluster

- First friendly user: Aug 15 2008
- HPL benchmarked Sep 30-Oct 1: 28 TFLOPs (81% of peak)
- In production: Thu Oct 2 2008
- Thu Oct 1 2009: 1.65M jobs, more than the previous cluster's entire lifetime.
- Sep 2009 average utilization: 70% of nodes @ 7 cores per node

sooner.oscer.ou.edu

Condor Pool

Condor is a software package that allows number crunching jobs to run on idle desktop PCs.

OU IT has deployed a large Condor pool (795 desktop PCs in IT student labs all over campus).

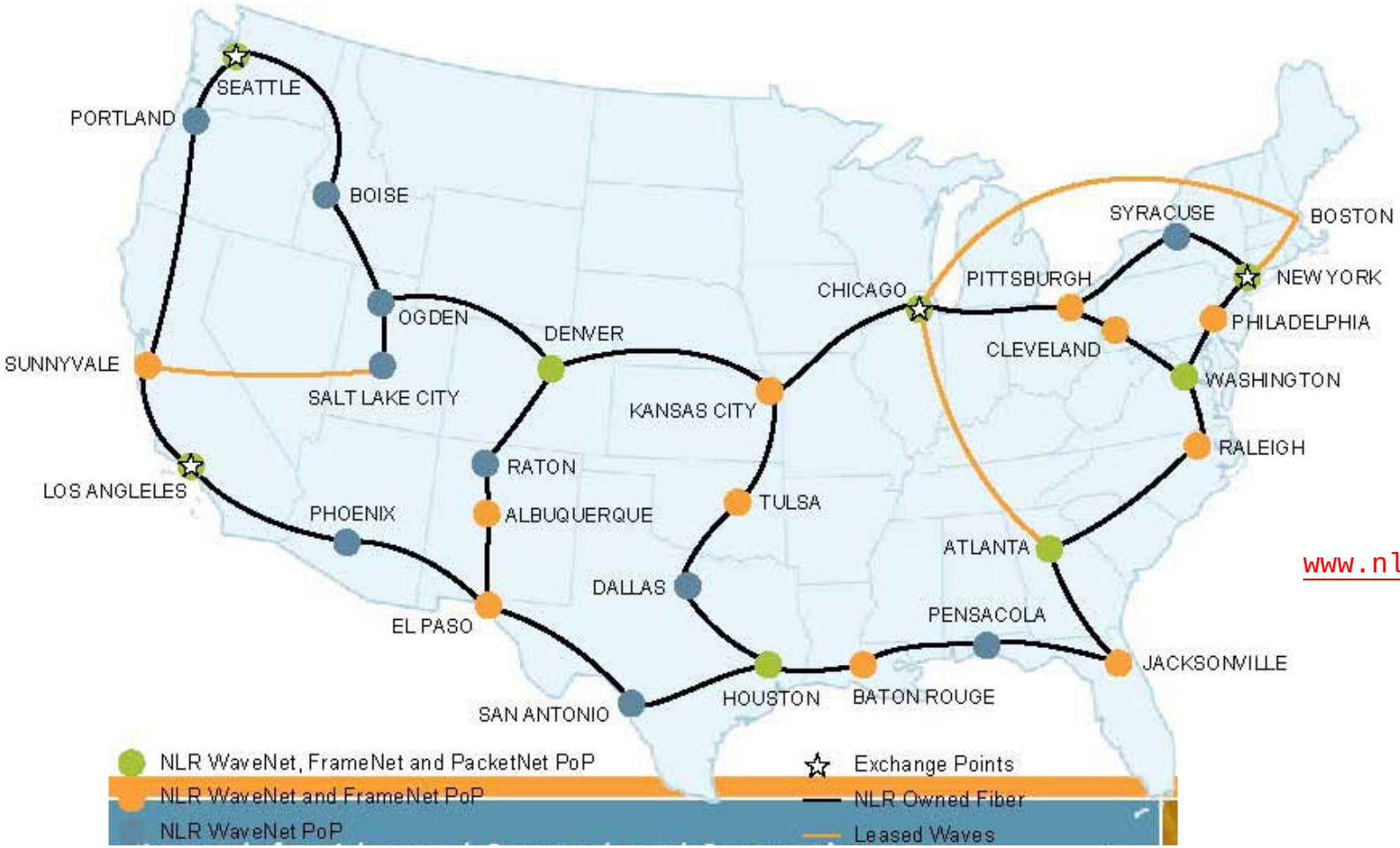
It provides a huge amount of additional computing power – more than was available in all of OSCER in 2005.

And, the cost is very very low – almost literally free.

Also, we've been seeing empirically that Condor gets about 80% of each PC's time.

About ¼ to ½ of the PCs get replaced every year.

National Lambda Rail

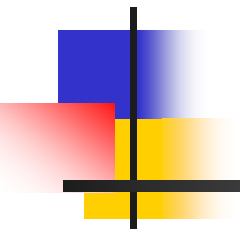


www.nlr.net

Internet2

www.internet2.edu

OSCER Teaching



What Does OSCER Do? Teaching

Science and engineering faculty from all over America learn supercomputing at OU by playing with a jigsaw puzzle (NCSI @ OU 2004).

What Does OSCER Do? Rounds

OU undergrads, grad students, staff and faculty learn how to use supercomputing in their specific research.

OSCER's Education Strategy

- "Supercomputing in Plain English" workshops
- Supercomputing tours (like last night)
- Q&A
- Rounds

Supercomputing in Plain English

Supercomputing in Plain English workshops target not only people who are sophisticated about computing, but especially students and researchers with strong science or engineering backgrounds but modest computing experience.

Prerequisite: 1 semester of Fortran, C, C++ or Java

Taught by analogy, storytelling and play, with minimal use of jargon, and assuming very little computing background.

Streaming video: **http://www.oscer.ou.edu/education.php**

Registrations: over 800 from 2001 to 2009

Workshop Topics

- Overview
- The Storage Hierarchy
- Instruction Level Parallelism
- High Performance Compilers
- Shared Memory Parallelism
- Distributed Parallelism
- **NEW! Applications & Types of Parallelism**
- Multicore
- High Throughput Computing
- **NEW! GPGPU: Number Crunching in Your Graphics Card**
- Grab Bag: Scientific Libraries, I/O libraries, Visualization

Teaching: Workshops

- Supercomputing in Plain English
  - Fall 2001: 87 registered, 40 – 60 attended each time
  - Fall 2002: 66 registered, c. 30 – 60 attended each time
  - Fall 2004: 47 registered, c. 30-40 attend each time
  - Fall 2007: 41 @ OU, 80 at 28 other institutions
  - Spring 2009: 65 @ OU, 360 at over 70 other institutions
- NCSI Parallel & Cluster Computing workshop (summer 2004, summer 2005)
- Linux Clusters Institute workshop (June 2005, Feb 2007)
- Co-taught at NCSI Parallel & Cluster Computing workshop at Houston Community College (May 2006)
- SC08 Education Program Parallel Programming & Cluster Computing workshop Aug 2008, Aug 2009
- SC08 Education Program Parallel Programming & Cluster Computing daylong workshop at OK Supercomputing Symposium 2007, 2008, 2009

… and more to come.

OU is the only institution in the world to host and co-instruct multiple workshops sponsored by each of NCSI, LCI and the SC education program.

Teaching: Academic Coursework

- CS: Scientific Computing (S. Lakshmivarahan)
- CS: Computer Networks & Distributed Processing (S. Lakshmivarahan)
- Meteorology: Computational Fluid Dynamics (M. Xue)
- Chemistry: Molecular Modeling (R. Wheeler)
- Electrical Engr: Computational Bioengineering (T. Ibrahim)
- Chem Engr: Nanotechnology & HPC (L. Lee, G. Newman, H. Neeman)
- **NEW! Parallel Computing course at Cameron University (OK)**
- **NEW! Software Engineering course at Oklahoma City University**

Teaching: Presentations & Tours

- Courses at OU
  - Chem Engr: Industrial & Environmental Transport Processes (D. Papavassiliou)
  - Engineering Numerical Methods (U. Nollert)
  - Math: Advanced Numerical Methods (R. Landes)
  - Electrical Engr: Computational Bioengineering (T. Ibrahim)
- Research Experience for Undergraduates at OU
  - Ind Engr: Metrology REU (T. Reed Rhoads)
  - Ind Engr: Human Technology Interaction Center REU (R. Shehab)
  - Meteorology REU (D. Zaras)
- External
  - American Society of Mechanical Engineers, OKC Chapter
  - Oklahoma State Chamber of Commerce
  - National Educational Computing Conference 2006 (virtual tour via videoconference)
  - Norman (OK) Lions Club
  - Society for Information Technology & Teacher Education conference 2008
  - Acxiom Conference on Applied Research in Information Technology 2008
  - Shawnee (OK) Lions Club

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- Other Universities
  1. SUNY Binghamton (NY)
  2. Bradley University (IL)
  3. Cameron University (OK)
  4. DeVry University (OK)
  5. East Central University (OK)
  6. El Bosque University (Colombia)
  7. Southwestern University (TX)
  8. **NEW! Langston University (OK)**
  9. Louisiana State University
  10. Midwestern State University (TX)
  11. **NEW! Northeastern Oklahoma State University**
  12. Northwestern Oklahoma State University
  13. Oklahoma Baptist University
  14. Oklahoma City University
  15. **NEW! Oklahoma State University**
  16. Oklahoma State University – OKC
  17. **REPEAT! Oral Roberts University (OK)**
  18. **REPEAT! St. Gregory's University (OK)**
  19. **REPEAT! Southeastern Oklahoma State University**
  20. **REPEAT! Southwestern Oklahoma State University**
  21. Texas A&M-Commerce
  22. University of Arkansas Fayetteville
  23. University of Arkansas at Little Rock
  24. University of Central Oklahoma
- High Schools and High School Programs
  1. Oklahoma School of Science & Mathematics
  2. Oklahoma Christian University's Opportunity Bytes Summer Academy
  3. Dept of Energy National Scholarship Finalists
  4. Ardmore High School (OK)

Teaching: Q & A

OSCER has added a new element to our education program:

When students take the Supercomputing in Plain English workshops, they then are required to ask 3 questions per person per video.

Dr. Neeman meets with them in groups to discuss these questions.

Result: A much better understanding of supercomputing.

What Does OSCER Do? Rounds

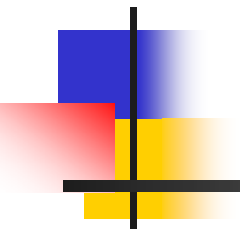
OU undergrads, grad students, staff and faculty learn how to use supercomputing in their specific research.

Research & Teaching: Rounds

Rounds: interacting regularly with several research groups

- **Brainstorm** ideas for applying supercomputing to the group's research
- **Code**: design, develop, debug, test, benchmark
- **Learn** new computing environments
- **Write** papers and posters

Has now evolved into **supercomputing help sessions**, where many different groups work at the same time.



OSCER Research

OSCER Research

- OSCER's Approach
- Rounds
- Grants
- Upcoming Initiatives

What Does OSCER Do? Rounds

OU undergrads, grad students, staff and faculty learn how to use supercomputing in their specific research.

Research: OSCER's Approach

- **Typically**, supercomputing centers provide resources and have in-house application groups, but **most users are more or less on their own**.
- OSCER's approach is **unique**: we **partner directly** with research teams, providing supercomputing expertise to help their research move forward faster (**rounds**).
- This way, OSCER has a stake in each team's success, and each team has a stake in OSCER's success.

Research & Teaching: Rounds

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- **Brainstorm** ideas for applying supercomputing to the group's research
- **Code**: design, develop, debug, test, benchmark
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Has now evolved into **supercomputing help sessions**, where many different groups work at the same time.

Research: Grant Proposals

- OSCER provides text not only about resources but especially about education and research efforts (workshops, rounds, etc).
- Faculty write in small amount of money for:
  - funding of small pieces of OSCER personnel;
  - storage (disk, tape);
  - special purpose software.
- In many cases, OSCER works with faculty on developing and preparing proposals.
- OSCER has a **line item** in the OU proposal web form that all new proposals have to fill out.

Spring Storm Experiment 2009

As usual, OSCER played a major role in the Spring Storm Experiment, which involved the Center for Analysis & Prediction of Storms, the NOAA Storm Prediction Center, the Pittsburgh Supercomputing Center, Oak Ridge National Laboratory, and others.

We were the primary HPC provider for the part of the project run by the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA).

This project consumed about 40% of Sooner for 3 months.

External Research Grants

1. A. Striolo, "Electrolytes at Solid-Water Interfaces: Theoretical Studies for Practical Applications," DOE EPSCoR, $450K
2. A. Striolo, Saha, "Experimental and Theoretical Studies of Carbon Nanotube Hierarchical Structures in Multifunctional Polymer Composites," DOD EPSCoR, $450K
3. D. Cole (ORNL), A. Striolo, "Structure and Dynamics of Earth Materials, Interfaces and Reactions," DOE, $1.5M ($75K OU)
4. D. Papavassiliou, A. Striolo, "Effects of Hydrophobicity-Induced Wall Slip on Turbulence Drag and Turbulence Structure," NSF, $230K
5. A. Striolo, D. Resasco, U. Nollert, "Understanding the Interactions between Carbon Nanotubes and Cellular Membranes," NSF, $380K
6. M. Xue, Y. Hong, X. Hu (GSU), "Integrated Weather and Wildfire Simulation and Optimization for Wildfire Management," NSF, $997K ($483K OU)
7. Y. Hong, "Next Generation QPE: Toward a Multi-Sensor Approach for Integration of Radar, Satellite, and Surface Observations to Produce Very High-resolution Precipitation Data," NOAA/OAR/NSSL via CIMMS, $83K
8. R. Palmer, Y. Hong, "Phased Array Technology for Weather Radar Applications," NOAA/OAR/NSSL via CIMMS, $426K
9. Y. Hong, Baski (OSU), "Proactive approach to transportation resource allocation under severe winter weather emergencies," OK-DOT/OTC, $261K ($101K OU)
10. R. Palmer, Y. Hong, "Atmospheric Observations using PhasedArray Technology," $340K
11. Y. Hong, "Toward Improved Flood Prediction and Risk Mitigation: Capacity Building for Africa," NASA, $87K
12. Y. Hong, "Improving NASA Global Hazard System and Implementing SERVIR-Africa," NASA, $272K
13. Y. Hong, "Link SERVIR-Africa Work to NASA Land Information System: Workshop Training and Data Assimilation of GRACE to NASA-OU Hydrologic Model," NASA, $10K
14. R. Adler (NASA), Y. Hong, "Global Hazard (Flood-Landslide) Decision-Support System," NASA, $900K
15. S. Schroeder, "CAREER: Advancing Viral RNA Structure Prediction," NSF, $750K

OSCER-RELATED FUNDING TO DATE:
$144M total, $76M to OU

External Research Grants (cont'd)

16. P. Attar, "High Fidelity Computational Aeroelastic Analysis of a Flexible Membrane Airfoil Undergoing Dynamic Motion," Ohio Aerospace Institute, $35K
17. P. Attar, "Computational Model Development and Experimental Validation Measurements for Membrane-Batten Wing" Flexible Membrane Airfoil Undergoing Dynamic Motion," Ohio Aerospace Institute, $43K
18. K. Droegemeier, F. Kong, P. Attar, "A Partnership to Develop, Conduct, and Evaluate Realtime High-Resolution Ensemble and Deterministic Forecasts for Convective-scale Hazardous Weather," NOAA, $375K
19. M. Xue, G. Zhang, K. Brewster, F. Kong, "Prediction and Predictability of Tropical Cyclones over Oceanic and Coastal Regions and Advanced Assimilation of Radar and Satellite Data for the Navy Coupled Ocean-Atmosphere Mesoscale Prediction System," ONR/DOD EPSCoR, $454K; OK Board of Regents $100K
20. S. Ahalt, A. Apon, D. Lifka, H. Neeman, "NSF Workshop High Performance Computing Center Sustainability," NSF, $49K ($0 OU)
21. Y. Luo, S. Lakshmivarahan, "Development of a Data Assimilation Capability towards Ecological Forecasting in a Data-Rich Era," NSF, $1.08M
22. Y. Luo, D. Schimmel (NEON), J. Clark (Duke U.), Kiona Ogle (U. Wyoming), S. LaDeau (Cary Institute of Ecosystem Study), "RCN: Forecasts Of Resource and Environmental Changes: Data Assimilation Science and Technology (FORECAST)," NSF, $500K
23. J. Straka, K. Kanak, Davies-Jones, H. Neeman, "Challenges in understanding tornadogenesis and associated phenomena," NSF, $854K
24. P. Risser et al, "A cyberCommons for Ecological Forecasting," NSF, $6M ($2.78M OU)
25. M. Xue, X. Wang, X. Li (OSU), R. Barnes, S. Sanielevici (PSC), H. Neeman, "Enabling Petascale Ensemble-Based Data Assimilation for the Numerical Analysis and Prediction of High-Impact Weather," NSF, $1.2M ($902K OU)
26. P. Skubic, B. Abbott, P. Gutierrez, M. Strauss, "ATLAS Southwest Tier 2 Computing Center," NSF, $600K/year ($60K/year OU)
27. Y. Hong, "Evaluation of NASA Global Hazard System," NASA, $45K

OSCER-RELATED FUNDING TO DATE:
$144M total, $76M to OU

External Research Grants (cont'd)

28. J Wicksted, F. Waxman et al, "Building Oklahoma's Leadership Role in Cellulosic Bioenergy," NSF EPSCoR, $15M ($5.7M OU)
29. D.S. Oliver, software, $16.7M
30. K.K. Muraleetharan, G. Miller, and A. Cerato, "Understanding and Improving the Seismic Behavior of Pile Foundations in Soft Clays," NSF, $1.15M ($500K OU)
31. K. Droegemeier, F. Kong, "Multisensor Studies of Precipitation for Model Verification and Data Assimilation," U Minn, ($7K OU)
32. K. Droegemeier, M. Xue, F. Kong, "Observing System Simulation Experiments for Airborne Weather Sensors," HRL, ($33K OU)
33. M. Nollert, Scholarship, FD-OMRF, $12K
34. R. Sigal, R. Philp, C. Rai,, S. Shah, R. Slatt, C. Sondergeld, D. Zhang, energy company, $1.9M
35. B. Grady, D. Schmidtke, A. Striolo, A. Cheville, D. Teeters, "Polymer Nanostructures on Solid Surfaces,"$208K ($125K OU)
36. T. Conway, "E. coli Model Organism Resource," UN-Purdue, ($685K OU)
37. R. Kolar, "Storm Surge Modeling in SE Liousiana - 2006," ARCADIS, ($37K OU)
38. D. Cole (ORNL), A. Striolo, "Rates and Mechanisms of Mineral-Fluid Interactions at the Nanoscale," DOE, $1.65M (total), ($55K OU)
39. R. Kolar, "A Prototype Operational Modeling System for Waves, Coastal Currents, Inundation and Hydrologic Flooding for Eastern North Carolina," UN-UNC-CH, ($209K OU)
40. R. Kolar, "A Coupled Regional-Coastal Ocean Model: HYCOM/CG-ADCIRC," DOD-NRL, ($333K OU)
41. M. Xue, "Contribution to WRF Model Development by the Center for Analysis and Prediction of Storms," DOC-NOAA, $821K
42. K. Marfurt, "Improving Geologic and Engineering Models of Midcontinent Fracture and Karst Modified Reservoirs Using 3-D Seismic Attributes," UKCRINC, ($61K OU)
43. P. Attar, P. Vedula, "Novel, Optimal, Physics-based Reduced Order Models for Nonlinear Aeroelasticity," Advanced Dynamics, $49K
44. S. Dhall, "Autonomous Data Partitioning using Data Mining for High Performance Computing," NSF, ($125K OU)

OSCER-RELATED FUNDING TO DATE:
$144M total, $76M to OU

External Research Grants (cont'd)

45. M. Xue, K. Brewster, J. Gao, "Ensemble-based Data Assimilation for Tropical Storms, and Realtime 3DVAR Analysis for Initial Proof of 'Warn-on-Forecast' Concept: Collaborative Research between CAPS and NSSL," DOC-NOAA, $100,000
46. M. Xue, "Contribution to Model Development and Enhancement Research Team by the Center for Analysis and Prediction of Storms," DOC-NOAA, $180,000
47. M. Xue, K. Brewster, "Ensemble-based Data Assimilation for Convective Storms and Hurricanes," DOC-NOAA, $100,000
48. S. Schroeder, "Discovering Satellite Tobacco Mosaic Virus Structure," OCAST, $85K
49. S. Schroeder, "Computational Advacnes Toward Predicting Encapsidated Viral RNA Structure," Pharmaceutical Research and Manufactuerer's Association of America, $60K
50. R. Kolar, "Outer Boundary Forcing for Texas Coastal Models," Texas Water Development Board, $20K
51. K. Milton, "Collaborative Research: Quantum Vacuum Energy", NSF, $250K
52. A. McGovern, "Developing Spatiotemporal Relational Models to Anticipate Tornado Formation," NSF, $500K
53. Y. Kogan, "Midlatitude Aerosol-Cloud-Radiation Feedbacks in Marine Boundary Layer Clouds", ONR, $638K
54. J. Straka, K. Kanak, Davies-Jones, "Challenges in understanding tornadogenesis and associated phenomena," NSF, $854K (total), $584K (OU)
55. Y. Hong, "Improvement of the NASA Global Hazard System and Implement Server-Africa," NASA, $272K
56. J. Antonio, S. Lakshmivarahan, H. Neeman, "Predictions of Atmospheric Dispersion of Chemical and Biological Contaminants in the Urban Canopy." Subcontract No. 1334/0974-01, Prime Agency DOD-ARO, Subcontract through Texas Tech University, Lubbock, TX, Sep. 29, 2000 to Nov. 3, 2001, $75K
57. A. Striolo, "Electrolytes at Solid-Water Interfaces: Theoretical Studies for Practical Applications," OSRHE Nanotechnology, $15K
58. D. Papavassiliou, "Turbulent transport in non-homogeneous turbulence, " NSF, $320K

OSCER-RELATED FUNDING TO DATE: $144M total, $76M to OU

External Research Grants (cont'd)

59. K. Droegemeier et al., "Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere," NSF, $17M (total), $5.6M (OU)
60. K. Droegemeier et al., "Linked Environments for Atmospheric Discovery (LEAD)," NSF, $11.25M (total), $2.5M (OU)
61. M. Strauss, P. Skubic et al., "Oklahoma Center for High Energy Physics", DOE EPSCoR, $3.4M (total), $1.6M (OU)
62. M. Richman, A. White, V. Lakshmanan, V. DeBrunner, P. Skubic, "Real Time Mining of Integrated Weather Data," NSF, $950K
63. D. Weber, K. Droegemeier, H. Neeman, "Modeling Environment for Atmospheric Discovery," NCSA, $435K
64. H. Neeman, K. Droegemeier, K. Mish, D. Papavassiliou, P. Skubic, "Acquisition of an Itanium Cluster for Grid Computing," NSF, $340K
65. J. Levit, D. Ebert (Purdue), C. Hansen (U Utah), "Advanced Weather Data Visualization," NSF, $300K
66. D. Papavassiliou, "Turbulent Transport in Wall Turbulence," NSF, $165K
67. L. Lee, J. Mullen (Worcester Polytechnic), H. Neeman, G.K. Newman, "Integration of High Performance Computing in Nanotechnology," NSF, $400K
68. R. Wheeler, "Principal mode analysis and its application to polypeptide vibrations," NSF, $385K
69. R. Kolar, J. Antonio, S. Dhall, S. Lakshmivarahan, "A Parallel, Baroclinic 3D Shallow Water Model," DoD - DEPSCoR (via ONR), $312K
70. R. Luettich (UNC), R. Kolar, B. Vieux, J. Gourley, "The Center for Natural Disasters, Coastal Infrastructure, and Emergency Management," DHS, $699K
71. D. Papavassiliou, M. Zaman, H. Neeman, "Integrated, Scalable MBS for Flow Through Porous Media," NSF, $150K
72. Y. Wang, P. Mukherjee, "Wavelet based analysis of WMAP data," NASA, $150K
73. E. Mansell, C. L. Ziegler, J. M. Straka, D. R. MacGorman, "Numerical modeling studies of storm electrification and lightning," $605K

OSCER-RELATED FUNDING TO DATE: $144M total, $76M to OU

External Research Grants (cont'd)

74. K. Brewster, J. Gao, F. Carr, W. Lapenta, G. Jedlovec, "Impact of the Assimilation of AIRS Soundings and AMSR-E Rainfall on Short Term Forecasts of Mesoscale Weather," NASA, $458K
75. R. Wheeler, T. Click, "National Institutes of Health/Predoctoral Fellowships for Students with Disabilties," NIH/NIGMS, $80K
76. K. Pathasarathy, D. Papavassiliou, L. Lee, G. Newman, "Drag reduction using surface-attached polymer chains and nanotubes," ONR, $730K
77. D. Papavassiliou, "Turbulent transport in non-homogeneous turbulence, " NSF, $320K
78. C. Doswell, D. Weber, H. Neeman, "A Study of Moist Deep Convection: Generation of Multiple Updrafts in Association with Mesoscale Forcing," NSF, $430K
79. D. Papavassiliou, "Melt-Blowing: Advance modeling and experimental verification," NSF, $321K
80. R. Kol,ar et al., "A Coupled Hydrodynamic/Hydrologic Model with Adaptive Gridding," ONR, $595K
81. D. Papavassiliou, "Scalar Transport in Porous Media," ACS-PRF, $80K
82. M. Xue, F. Carr, A. Shapiro, K. Brewster, J. Gao, "Research on Optimal Utilization and Impact of Water Vapor and Other High Resolution Observations in Storm-Scale QPF," NSF, $880K.
83. J. Gao, K. Droegemeier, M. Xue, "On the Optimal Use of WSR-88D Doppler Radar Data for Variational Storm-Scale Data Assimilation," NSF, $600K.
84. K. Mish, K. Muraleetharan, "Computational Modeling of Blast Loading on Bridges," OTC, $125K
85. V. DeBrunner, L. DeBrunner, D. Baldwin, K. Mish, "Intelligent Bridge System," FHWA, $3M
86. D. Papavassiliou, "Scalar Transport in Porous Media," ACS-PRF, $80K
87. Y. Wang, P. Mukherjee, "Wavelet based analysis of WMAP data," NASA, $150K
88. R. Wheeler et al., "Testing new methods for structure prediction and free energy calculations (Predoctoral Fellowship for Students with Disabilities)," NIH/NIGMS, $24K
89. L. White et al., "Modeling Studies in the Duke Forest Free-Air CO2 Enrichment (FACE) Program," DOE, $730K

OSCER-RELATED FUNDING TO DATE:
$144M total, $76M to OU

External Research Grants (cont'd)

90. Neeman, Severini, "Cyberinfrastructure for Distributed Rapid Response to National Emergencies", NSF, $132K
91. Neeman, Roe, Severini, Wu et al., "Cyberinfrastructure Education for Bioinformatics and Beyond," NSF, $250K
92. K. Milton, C. Kao, "Non-perturbative Quantum Field Theory and Particle Theory Beyond the Standard Model," DOE, $150K
93. J. Snow, "Oklahoma Center for High Energy Physics", DOE EPSCoR, $3.4M (total), $169K (LU)
94. M. Xue, F. Kong, "OSSE Experiments for airborne weather sensors," Boeing, $90K
95. M. Xue, K. Brewster, J. Gao, A. Shapiro, "Storm-Scale Quantitative Precipitation Forecasting Using Advanced Data Assimilation Techniques: Methods, Impacts and Sensitivities," NSF, $835K
96. Y. Kogan, D. Mechem, "Improvement in the cloud physics formulation in the U.S. Navy Coupled Ocean-Atmosphere Mesoscale Prediction System," ONR, $889K
97. G. Zhang, M. Xue, P. Chilson, T. Schuur, "Improving Microphysics Parameterizations and Quantitative Precipitation Forecast through Optimal Use of Video Disdrometer, Profiler and Polarimetric Radar Observations," NSF, $464K
98. T. Yu, M. Xue, M. Yeay, R. Palmer, S. Torres, M. Biggerstaff, "Meteorological Studies with the Phased Array Weather Radar and Data Assimilation using the Ensemble Kalman Filter," ONR/Defense EPSCOR/OK State Regents, $560K
99. B. Wanner, T. Conway, et al., "Development of the www.EcoliCommunity.org Information Resource," NIH, $1.5M (total), $150K (OU)
100. T. Ibrahim et al., "A Demonstration of Low-Cost Reliable Wireless Sensor for Health Monitoring of a Precast Prestressed Concrete Bridge Girder," OK Transportation Center, $80K
101. T. Ibrahim et al., "Micro-Neural Interface," OCAST, $135K
102. J. Snow, "Langston University High Energy Physics," $155K (LU)

OSCER-RELATED FUNDING TO DATE:
$144M total, $76M to OU

External Research Grants (cont'd)

103. L.M. Leslie, M.B. Richman, C. Doswell, "Detecting Synoptic-Scale Precursors Tornado Outbreaks," NSF, $548K
104. L.M. Leslie, M.B. Richman, "Use of Kernel Methods in Data Selection and Thinning for Satellite Data Assimilation in NWP Models," NOAA, $342K
105. J. Gao, K. Brewster, M. Xue, K. Droegemeier, "Assimilating Doppler Radar Data for Storm-Scale Numerical Prediction Using an Ensemble-based Variational Method," NSF, $200K
106. E. Chesnokov, "Fracture Prediction Methodology Based On Surface Seismic Data," Devon Energy, $1M
107. E. Chesnokov, "Scenario of Fracture Event Development in the Barnett Shale (Laboratory Measurements and Theoretical Investigation)," Devon Energy, $1.3M
108. M. Xue, K. Brewster, J. Gao, "Study of Tornado and Tornadic Thunderstorm Dynamics and Predictability through High-Resolution Simulation, Prediction and Advanced Data Assimilation," NSF, $780K
109. A. Striolo, "Heat Transfer in Graphene-Oil Nanocomposites: A Molecular Understanding to Overcome Practical Barriers." ACS Petroleum Research Fund, $40K
110. D.V. Papavassiliou, "Turbulent Transport in Anisotropic Velocity Fields," NSF, $292.5K
111. D. Oliver, software license grant, $1.5M
112. R. Broughton et al, "Assembling the Eutelost Tree of Life – Addressing the Major Unresolved Problem in Vertebrate Phylogeny," NSF, $3M ($654K to OU)
113. A. Fagg, "Development of a Bidirectional CNS Interface or Robotic Control," NIH, $600K
114. M. Xue, J. Gao, "An Investigation on the Importance of Environmental Variability to Storm-scale Radar Data Assimilation," NSSL, $72K
115. JV. Sikavistsas and D.V. Papavassiliou , "Flow Effects on Porous Scaffolds for Tissue Regeneration," NSF, $400K
116. P. Skubic, M. Strauss, et al., "Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the LHC," DOE, $503K

OSCER-RELATED FUNDING TO DATE:
$144M total, $76M to OU

External Funding Summary

- External research funding enabled by OSCER (Fall 2001- Fall 2009): $144M total, $76M to OU
- Funded projects: 116
- 87 OU faculty and staff in 14 academic departments and 6 other campus organizations (research centers etc)
- Fiscal Year 2002-9 (July 2001 – June 2009): OU Norman externally funded research expenditure: $525M

Since being founded in fall of 2001, OSCER has enabled research projects comprising more than 1 / 7 of OU Norman's total externally funded research expenditure.

Papers from OSCER

- **116** publications enabled by OSCER rounds/help sessions
  - **2009: 5 papers** (so far)
  - 2008: 22
  - 2007: 13
  - 2006: 31
  - 2005: 17
  - 2004: 12
  - 2003: 5
  - 2002: 8
  - 2001: 3

These papers would have been impossible, or much more difficult, or would have taken much longer, without OSCER's direct, hands-on help.

- **330** publications enabled by OSCER resources only
  - **2009: 83 papers** (so far)
  - 2008: 80
  - 2007: 56
  - 2006: 55
  - 2005: 42
  - 2004: 11
  - 2003: 3

Includes:

- 16 MS theses
- 13 PhD dissertations

TOTAL: 446 publications

http://www.oscer.ou.edu/papers_from_rounds.php

OK Cyberinfrastructure Initiative

- Oklahoma is an EPSCoR state.
- Oklahoma submitted an NSF EPSCoR Research Infrastructure Proposal in Jan 2008 ($15M).
- Starting that year, all NSF EPSCoR RII "Track 1" proposals HAD TO include a statewide Cyberinfrastructure plan.
- Oklahoma's plan – the Oklahoma Cyberinfrastructure Initiative (OCII) – involves:
  - all academic institutions in the state are eligible to sign up for free use of OU's and OSU's centrally-owned CI resources;
  - other kinds of institutions (government, NGO, commercial) are eligible to use, though not necessarily for free.
- To join: See Henry after this talk.

NSF CI-TEAM Grant

"Cyberinfrastructure Education for Bioinformatics and Beyond" ($250,000, 12/01/2006 – 11/30/2008)

OSCER received a grant from the National Science Foundation's Cyberinfrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce (CI-TEAM) program.

NSF CI-TEAM Grant

"Cyberinfrastructure Education for Bioinformatics and Beyond" ($250,000)

Objectives:

- Provide Condor resources to the national community
- Teach users to use Condor
- Teach sysadmins to deploy and administer Condor
- Teach bioinformatics students to use BLAST on Condor

NSF CI-TEAM Grant

Participants at OU
(29 faculty/staff in 16 depts)

- Information Technology
  - OSCER: Neeman (PI)
- College of Arts & Sciences
  - Botany & Microbiology: Conway, Wren
  - Chemistry & Biochemistry: Roe (Co-PI), Wheeler
  - Mathematics: White
  - Physics & Astronomy: Kao, Severini (Co-PI), Skubic, Strauss
  - Zoology: Ray
- College of Earth & Energy
  - Sarkeys Energy Center: Chesnokov
- College of Engineering
  - Aerospace & Mechanical Engr: Striz
  - Chemical, Biological & Materials Engr: Papavassiliou
  - Civil Engr & Environmental Science: Vieux
  - Computer Science: Dhall, Fagg, Hougen, Lakshmivarahan, McGovern, Radhakrishnan
  - Electrical & Computer Engr: Cruz, Todd, Yeary, Yu
  - Industrial Engr: Trafalis
- Health Sciences Center
  - Biochemistry & Molecular Biology: Zlotnick
  - Radiological Sciences: Wu (Co-PI)
  - Surgery: Gusev

Participants at other institutions
(31 institutions in 18 states)

1. California State U Pomona (masters-granting, minority serving): Lee
2. Colorado State U: Kalkhan
3. Contra Costa College (CA, 2-year, minority serving): Murphy
4. Delaware State U (masters, EPSCoR): Lin, Mulik, Multnovic, Pokrajac, Rasamny
5. Earlham College (IN, bachelors): Peck
6. East Central U (OK, masters, EPSCoR): Crittell,Ferdinand, Myers, Walker, Weirick, Williams
7. Emporia State U (KS, masters-granting, EPSCoR): Ballester, Pheatt
8. Harvard U (MA): King
9. Kansas State U (EPSCoR): Andresen, Monaco
10. Langston U (OK, masters, minority serving, EPSCoR): Snow, Tadesse
11. Longwood U (VA, masters): Talaiver
12. Marshall U (WV, masters, EPSCoR): Richards
13. Navajo Technical College (NM, 2-year, tribal, EPSCoR): Ribble
14. Oklahoma Baptist U (bachelors, EPSCoR): Chen, Jett, Jordan
15. Oklahoma Medical Research Foundation (EPSCoR): Wren
16. Oklahoma School of Science & Mathematics (high school, EPSCoR): Samadzadeh
17. Purdue U (IN): Chaubey
18. Riverside Community College (CA, 2-year): Smith
19. St. Cloud State University (MN, masters): J. Herath, S. Herath, Guster
20. St. Gregory's U (OK, 4-year, EPSCoR): Meyer
21. Southwestern Oklahoma State U (masters, EPSCoR, tribal): Linder, Moseley, Pereira
22. Syracuse U (NY): Stanton
23. Texas A&M U-Corpus Christi (masters): Scherger
24. U Arkansas Fayetteville (EPSCoR): Apon
25. U Arkansas Little Rock (masters, EPSCoR): Hall, Jennings, Ramaswamy
26. U Central Oklahoma (masters-granting, EPSCoR): Lemley, Wilson
27. U Illinois Urbana-Champaign: Wang
28. U Kansas (EPSCoR): Bishop, Cheung, Harris, Ryan
29. U Nebraska-Lincoln (EPSCoR): Swanson
30. U North Dakota (EPSCoR): Bergstrom, Hoffman, Majidi, Moreno, Peterson, Simmons, Wiggen, Zhou
31. U Northern Iowa (masters-granting): Gray

NSF CI-TEAM Grant

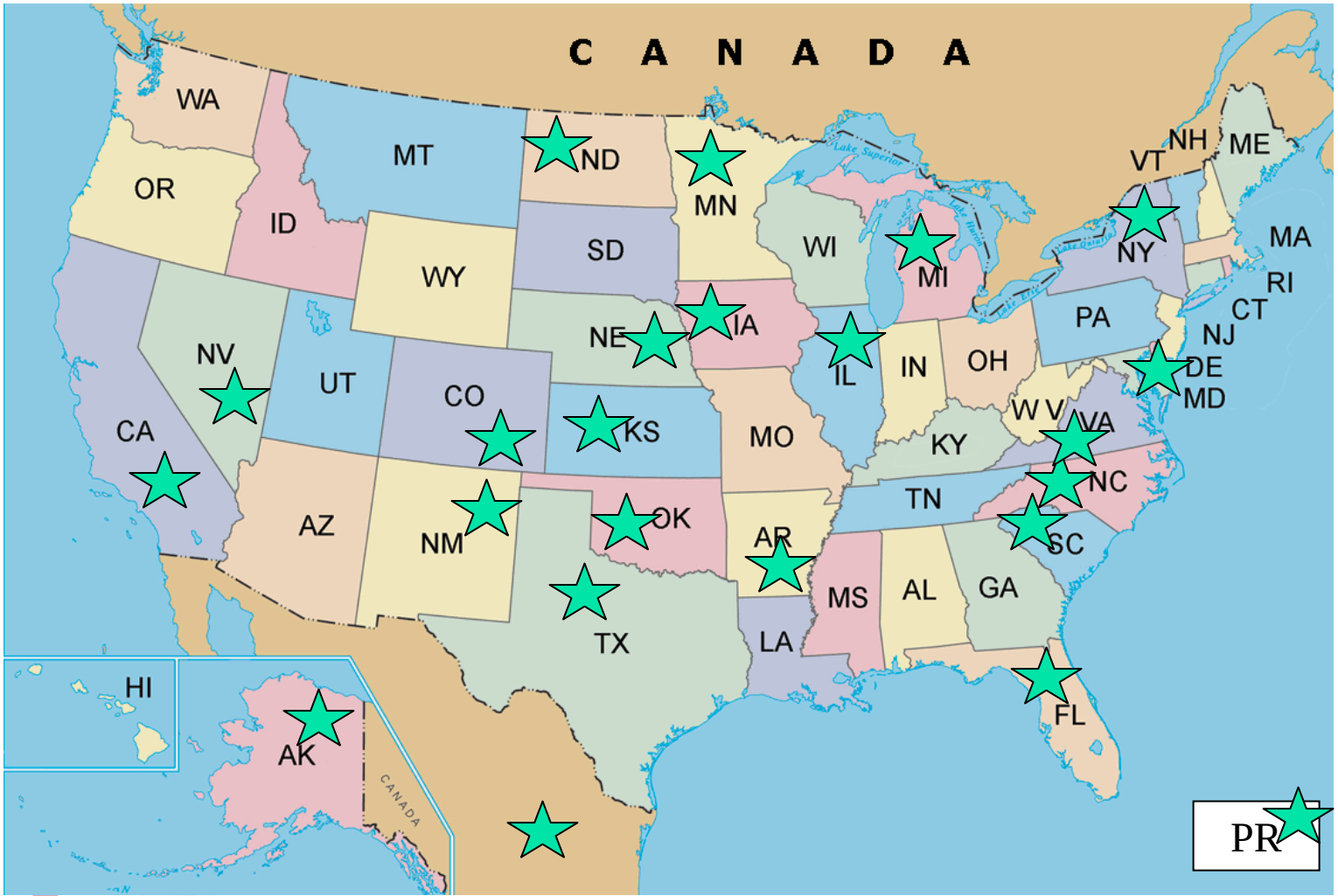
"Cyberinfrastructure Education for Bioinformatics and Beyond" ($250,000)

OSCER provided "Supercomputing in Plain English" workshops via videoconferencing starting in Fall 2007.

Roughly 195 people at 29 institutions nationwide, via:

- Access Grid
- VRVS
- iLinc
- QuickTime
- Phone bridge (land line)

SiPE Workshop Participants 2007



NSF CI-TEAM Grant

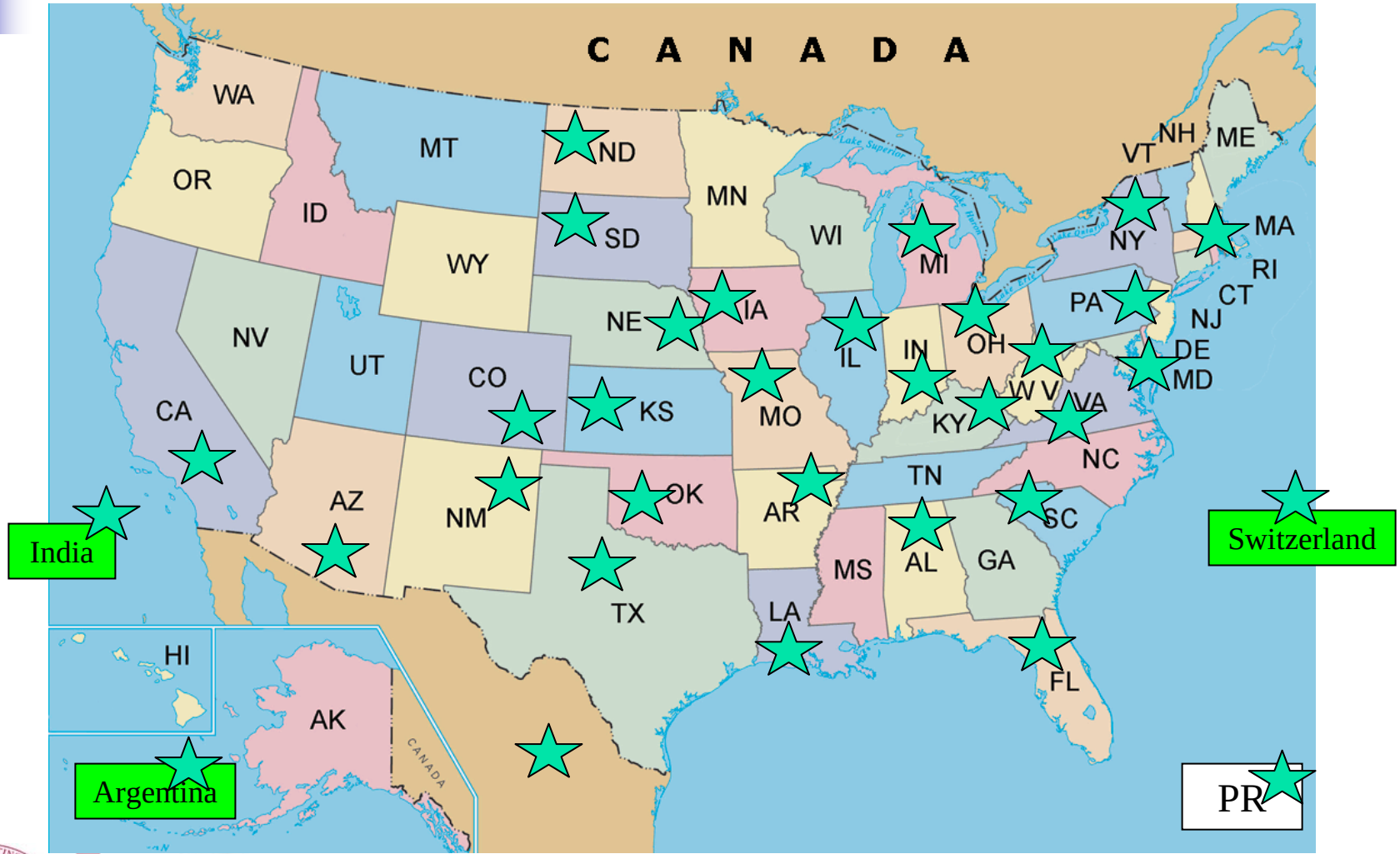
"Cyberinfrastructure Education for Bioinformatics and Beyond" ($250,000)

OSCER provided "Supercomputing in Plain English" workshops via videoconferencing starting in Spring 2009.

425 people at 90 institutions (academic, government, industry) in 29 US states plus Puerto Rico, as well as Mexico, Argentina, India and Switzerland, via:

- Access Grid
- H.323
- iLinc
- QuickTime
- Phone bridge (land line)

SiPE Workshop Participants 2009



A Bright Future

- OSCER's approach is unique, but it's the right way to go.
- People are taking notice nationally – e.g., you!
- We're seeing more and more OSCERs around the country:
  - local centers can react quickly to local needs;
  - inexperienced users need one-on-one interaction to learn how to use supercomputing in their research.
  - Coalition for Academic Scientific Computing (CASC): 58 academic and government supercomputing centers, mostly local

What a Bargain!

When you hand in a completed **EVALUATION FORM**, you'll get a beautiful new Oklahoma Supercomputing Symposium 2009 T-SHIRT, **FREE!**

Thanks!

- Academic sponsors: Oklahoma EPSCoR, Great Plains Network
- Industry sponsors
  - Platinum: Intel, Dell
  - Gold: Platform Computing, QLogic
  - Silver: Panasas
  - Bronze: Advanced Clustering Technologies, EnSight, Librato, Lumenate, Numerical Algorithms Group

Thanks!

- OU IT
  - OU CIO/VPIT Dennis Aebersold
  - Associate VPIT Loretta Early
  - Symposium coordinator Michelle Wiginton
  - Assistant to the CIO Pam Ketner and David Goodspeed
  - OSCER Operations Team: Brandon George, Dave Akin, Brett Zimmerman, Josh Alexander
  - All of the OU IT folks who helped put this together
- CCE Forum
  - Deb Corley
  - The whole Forum crew who helped put this together
- SC09 Education Program
  - Instructors Charlie Peck, Andrew Fitz Gibbon
  - SC09 Education Committee

Thanks!

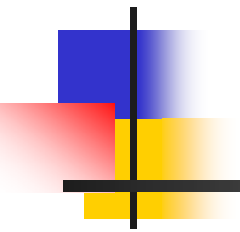
- Keynote speaker: Douglass Post
- Plenary Speakers: Ruth Pordes, Bill Magro
- Breakout speakers
  - Dan Andresen, Kansas Staet University
  - Amy Apon, University of Arkansas
  - Karthik Arunachalam, University of Oklahoma
  - Brady Black, QLogic
  - Keith Brewster, University of Oklahoma
  - Dana Brunson, Oklahoma State University
  - David Chaffin, University of Arkansas
  - Robert Ferdinand, East Central University
  - Andrew Fitz Gibbon, Earlham College
- Breakout speakers (continued)
  - Dan Fraser, University of Chicago
  - Thomas Hauser, Utah Staet University
  - Evan Lemley, University of Central Oklahoma
  - William Lu, Platform Computing
  - John Matrow, Wichita State University
  - Amy McGovern, University of Oklahoma
  - Charlie Peck, Earlham College
  - Jeff Pummill, University of Arkansas
  - Doug Spearot, University of Arkansas
  - Antonio Stanesic, Croatian Meteorological & Hydrological Service

Thanks!

- To all of your for participating, and to those many of you who've shown us so much loyalty over the past 8 years.

To Learn More About OSCER

http://www.oscer.ou.edu/



Thanks for your attention!

Questions?