

# The Oklahoma Cyberinfrastructure Initiative

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## ABSTRACT

The Oklahoma Cyberinfrastructure Initiative (OCII) is a mechanism by which institutions in the state can share resources, both physical and human, to enable research and education statewide to utilize advanced computing technologies. OCII provides eight kinds of service: access to cyberinfrastructure; dissemination via an annual conference that has reached over 2500 participants in 11 years; education via a workshop series in person and via videoconferencing; faculty/staff development via summer weeklong workshops; outreach via a supercomputing talk suitable for non-technical audiences; proposal support in the form of both letters of commitment and direct collaboration; technology acquired for institutions or assisting those institutions in acquiring it; workforce development in the form of a mentorship program for Information Technology and Computer Science students statewide. To date, OCII has reached 50 academic and 47 non-academic institutions and organizations.

## Categories and Subject Descriptors

K.m [Computing Milieux]: Miscellaneous.

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## General Terms

Management, Economics

## Keywords

Cyberinfrastructure, statewide, sharing

## 1. INTRODUCTION

The Oklahoma Cyberinfrastructure Initiative (OCII) is means for institutions statewide can share physical and human resources, to enable research and education statewide to take advantage of advanced computing technologies. Triggered by Oklahoma's 2008-13 National Science Foundation (NSF) EPSCoR Research Infrastructure Improvement (RII) Track-1 grant, OCII encourages Oklahoma academics to use centrally owned Cyberinfrastructure (CI) resources at the University of Oklahoma (OU) and Oklahoma State University (OSU): supercomputers, a Condor pool, storage resources, an emerging virtualized server pool, and Education, Outreach & Training (EOT) and Workforce Development activities. These resources are also available to some of Oklahoma's non-academic institutions. In most cases, remote users are able to access these capabilities on par with locals.

Grants that are serving OCII include:

Oklahoma's NSF EPSCoR RII Inter-campus and Intra-campus Cyber Connectivity (C2) grant ("Oklahoma Optical Initiative," EPS-1006919), a collaboration among OU, OSU, Langston U (LU, Oklahoma's only Historically Black College or University), the Samuel Roberts Noble Foundation (SRNF) and OneNet, Oklahoma's Regional Optical Network.

OU's NSF Major Research Instrumentation (MRI) grant ("Acquisition of Extensible Petascale Storage for Data Intensive Research," OCI-1039829): multiple PB of disk and tape to academics statewide; no usage charges, only media costs (disk drives and tape cartridges).

OSU's NSF MRI grant ("Acquisition of a High Performance Compute Cluster for Multidisciplinary Research," OCI-1126330): 48 TFLOPs cluster supercomputer.

## 2. SERVICES PROVIDED

OCII capabilities and activities, which have been enabling a tremendous span of research and education statewide, include:

(A) Access to Cyberinfrastructure. Currently, OCII has over 800 High Performance Computing (HPC) users in Oklahoma: over 500 at OU, over 200 at OSU, and over 75 at 23 other Oklahoma academic and non-academic institutions and organizations, plus over 150 out of state. New users are being added constantly.

(D) Dissemination: The Oklahoma Supercomputing Symposium (below), an annual conference started in 2002, has hosted over 2500 attendees from 101 academic institutions in 27 US states and territories, 61 of these institutions in 14 EPSCoR jurisdictions, including 25 in Oklahoma; 119 commercial firms including several headquartered in Oklahoma; 35 government agencies (federal, military, state, municipal, foreign), 19 of them in Oklahoma; 17 non-governmental organizations, 6 of them in Oklahoma.

(E) Education: "Supercomputing in Plain English" (SiPE) workshop series: These 11 talks about advanced computing, taught with stories, analogies and play rather than deep technical jargon, have reached 248 institutions (academic, government, industry, non-governmental) in 47 US states and territories and 10 other countries (15 academic institutions in Oklahoma to date, 6 Oklahoma commercial firms, 6 Oklahoma government agencies, 3 Oklahoma non-governmental organizations). Exercises are also provided. The most recent full series was Spring 2013, with 35 participants onsite and over 500 remotely via videoconferencing.

(F) Faculty/Staff Development: Workshops held at OU and OSU on advanced computing and Computational & Data Enabled Science & Engineering pedagogy have been sponsored by the SC supercomputing conference series, the National Computational Science Institute (NCSI), the Linux Clusters Institute (LCI) and the Virtual School for Computational Science & Engineering (VSCSE). Currently, Oklahoma is the only state to have hosted multiple events sponsored by each of these and to have co-taught for all but VSCSE (18 Oklahoma academic institutions so far).

(O) Outreach: "Supercomputing in Plain English" (SiPE) overview talk (24 Oklahoma academic, including every Oklahoma public university).

(P) Proposal Support: Letters of commitment for access to OCII resources; collaborations with OCII lead institutions (4 Oklahoma academic, 1 Oklahoma non-governmental).

(T) Technology: Acquired or helped acquire technology (e.g., network upgrade, mini- or full HPC cluster, high definition video camera for telepresence) for several institutions (14 Oklahoma academic so far).

(W) Workforce Development: The Oklahoma Information Technology Mentorship Program (OITMP) [1] provides "A Day in the Life of an IT Professional" presentations to courses across the full spectrum of postsecondary education (and even some secondary), as well as job shadowing opportunities and direct mentoring of individual students. Institution types have included career techs, community colleges, regional colleges and universities, and PhD-granting universities. So far, 35 institutions have had 78 visits, plus 3 institutions have visited OU for activities and presentations, for a total of 36 institutions served.

## 3. INSTITUTIONS SERVED BY OCII

To date, OCII has served a total of 97 institutions and organizations in Oklahoma. So far, 50 academic institutions have been served by at least one each of the 8 OCII services, with typically ~3 services per institution, including Oklahoma's Historically Black University (HBCU), 3 Native American Serving Non-Tribal Institutions (NASNI), 3 Tribal Colleges, and one other Minority Serving Institution (MSI). The full list of institutions can be found in the Appendix. These institutions serve many American Indian (AI, 8.9% of Oklahoma population and 1.2% of US population in 2011 [2]), African American (AA, 7.7% Oklahoma, 13.1% US) and Hispanic (H, 9.2% Oklahoma, 16.7% US) students. The only non-PhD-granting institutions to have received all 8 services are the HBCU and one of the NASNIs. (Oklahoma enrollment demographic data are from [3] and [4].) OCII also has been providing HPC accounts to courses at: Cameron U, East Central U, Northeastern State U, Oklahoma City U, Rogers State U, Southern Nazarene U, Southwestern Oklahoma State U and OU. And, 47 non-academic institutions (government, military, non-governmental, commercial) have been served (mostly Dissemination and/or Outreach): 16 commercial firms, 20 government agencies (federal, state, municipal, foreign, military), and 11 non-governmental/not-for-profit organizations.

## 4. DESCRIPTIONS OF OCII SERVICES

### 4.1 Access to Cyberinfrastructure

Academic and non-academic research and education users at institutions statewide can access centrally-owned resources at OU and OSU, typically on par with local users, including:

- High Performance Computing (HPC): HPC clusters are at OU (111.6 TFLOPs) and OSU (48 TFLOPs).
- High Throughput Computing: OU has a Condor pool of approximately 1600 CPU cores, via which the Oklahoma Center for High Energy Physics (OCHEP), a collaboration among OU, OSU and LU that was founded under a US Department of Energy EPSCoR grant, and the ATLAS Southwest Tier2 Center, have, since 2006, been among the most productive US academic sites for the D0 and ATLAS projects.
- Large Scale Archival Storage: The Oklahoma PetaStore, funded by an NSF MRI grant, provides media slot capacity sufficient for at least 1.9 PB disk and over 4 PB tape, the latter expandable to over 55 PB. The grant funds hardware, software and 3 years of maintenance; OU funds space, power, cooling, labor and post-MRI maintenance; research teams buy their own tape cartridges and disk drives.
- High Performance Networking: Oklahoma's NSF EPSCoR RII C2 grant, the "Oklahoma Optical Initiative," led by OU's and OSU's CI leads and the Chief Technology Officer (CTO) of OneNet (Oklahoma's education, research and government network), has not only been providing connectivity upgrades to several institutions statewide, including 5 MSIs, but is also enabling a bandwidth upgrade at OU, an emerging Shared Services Initiative within OU and between OU and OSU, and a now-deployed connection to the new national 100G backbone (initially benefitting meteorology and OCHEP).
- Informatics: OU IT has 2 informatics professionals – research facilitators, not researchers – who have been focusing on the RII Track-2 ecological informatics project, and who will soon transition to other projects.

## 4.2 Dissemination

The Oklahoma Supercomputing Symposium: The 12th annual free Symposium [5], the only CI event held annually in an EPSCoR jurisdiction, is scheduled for October 1-2, 2013. The 11 Symposia to date have had over 2500 attendees from 101 academic institutions in 27 US states and territories (including 61 academic institutions from 14 EPSCoR jurisdictions), 119 private companies, 35 government agencies (federal, state, municipal, foreign) and 17 non-governmental organizations. Plenary speakers are major figures in the national CI community, from government, academia and industry. The Symposia have provided undergraduate and graduate students with unique free opportunities to network with potential employers and mentors.

## 4.3 Education

“Supercomputing in Plain English” (SiPE) [6,7,8,9,10,11] is a workshop series that targets an audience of not only computer scientists, but especially researchers across Science, Technology, Engineering & Mathematics (STEM) disciplines – including undergraduate and graduate students, staff, faculty and non-academic professionals – by avoiding deep technical topics, instead using analogies, storytelling and play to convey key CI issues: the storage hierarchy; instruction level parallelism; shared memory parallelism (e.g., OpenMP); distributed parallelism (e.g., MPI); parallelism paradigms (e.g., embarrassingly parallel, N-body, transport); multicore; high throughput computing; accelerators; scientific libraries; I/O libraries; visualization.

To date, the SiPE series has reached over 1500 people at 248 institutions and organizations: 178 academic institutions in 44 US states, DC, Puerto Rico, Argentina, Brazil, China, Mexico, Pakistan and Poland, including 71 institutions in 23 EPSCoR jurisdictions, among them 15 institutions in Oklahoma; 26 private firms (US, India); 29 government agencies (US federal and state plus Mexico, India, Italy, Switzerland); 15 non-governmental organizations (US, Norway). Some of the SiPE materials have been adopted by the National Computational Science Institute (for which OU has hosted summer weeklong workshops in 2004-5 and 2008-12 and daylong workshops in 2003 and 2007-11), the Linux Clusters Institute (for which OU hosted workshops in 2005 and 2007 and their national conference in 2006), and the SC Education Program (for which, in collaboration with NCSI, OU hosted workshops in 2008-9 and 2011); Oklahoma is the only state to have hosted and co-instructed at multiple events by all three. In addition, in 2012 OU hosted remote sites for two summer workshops by the Virtual School for Computational Science & Engineering (though these haven’t adopted SiPE materials).

## 4.4 Faculty/Staff Development

The National Computational Science Institute (NCSI) [12] tutorial workshops held in Oklahoma have focused on parallel computing (at both introductory and intermediate levels) and computational chemistry. These workshops, part of a much larger series that has been active for over a decade across the US, have been co-sponsored by Oklahoma EPSCoR under Oklahoma’s 2008-13 NSF EPSCoR Research Infrastructure Improvement Track-1 grant (see Acknowledgements).

The content of these tutorial workshops has varied from instance to instance; for example, the summer 2012 Introduction to Parallel Programming & Cluster Computing tutorial workshop [13] covered the following:

- Talk: Introduction to NCSI
- Talk: HPC Overview (SiPE)
- Tour: OU Cyberinfrastructure
- Talk: MPI Programming Model: Desert Islands Analogy (from the SiPE Distributed Multiprocessing presentation)
- Talk: Introduction to MPI: The First Six Routines  
MPI\_Init MPI\_Comm\_rank, MPI\_Comm\_size, MPI\_Send, MPI\_Recv, MPI\_Finalize
- Exercise: MPI Hello World (covers how to run a batch job)
- Exercise: MPI Greetings [14]
- Talk: Storage Hierarchy (SiPE)
- Exercise: Tiling
- Group Coding Exercise: MPI Area Under the Curve
- Talk: MPI Collective Communications
- Talk: Applications & Types of Parallelism (SiPE)
- Group Coding Exercise: MPI N-body via collective communications
- Talk: Computation Across the Curriculum
- Demonstration: Bootable Cluster CD [15,16,17]
- Demonstration: LittleFe: The HPC Education Appliance [17]
- Lecture-Demonstration: Parallel Debugging
- Lecture-Demonstration: Profiling
- Lecture-Demonstration: OpenMP
- Exercise: OpenMP Area Under the Curve
- Group Coding Exercise: MPI Game of Life
- Roundtable: Parallel Programming Pedagogy
- Talk: Multicore Madness (SiPE)
- Lecture-Demonstration: Blocking and Non-blocking MPI
- Talk: Scientific Libraries (from SiPE Grab Bag presentation)
- Exercise: Scientific Libraries
- Talk: GPGPU (SiPE)

## 4.5 Outreach

The first SiPE presentation, a CI overview, has been presented to dozens of groups, ranging from CI experts to gradeschoolers. In such contexts, use of non-technical language, analogies, storytelling and play are crucial. Recipients have included:

- graduate and undergraduate courses locally at OU and OSU;
- Research Experiences for Undergraduates at OU;
- 33 academic institutions in 7 US states, including 18 in Oklahoma, with some of the remote institutions via videoconferencing;
- conferences such as:
  - the 2010 Oklahoma Louis Stokes Alliance for Minority Participation symposium at OSU (as keynote);
  - the SC07-12 conferences;
  - the Society for Information Technology and Teacher Education (SITE) 2008-11;
  - National School Boards Association Technology and Learning (T+L) 2010;
  - Tech Forum Texas 2010;
  - Texas Computer Education Association (TCEA) 2011;
  - Consortium for School Networking (CoSN) 2011;
- non-academic organizations such as:
  - the American Society of Mechanical Engineers Oklahoma City chapter;
  - the Engineering Club of Oklahoma City;
  - the Oklahoma Chamber of Commerce;
  - Norman Oklahoma Science Café;
  - the Lions Clubs of Norman and Shawnee Oklahoma.

## 4.6 Proposal Support

OU has provided letters of commitment to several institutions in the state for access to CI resources and services. In addition, the OU Supercomputing Center for Education & Research (OSCER) has collaborated directly with several institutions in the state on research proposals with significant CI aspects.

## 4.7 Technology

Oklahoma's RII C2 networking grant is led by Principal Investigator (PI) Henry Neeman, OSCER Director, alongside Co-PIs Dana Brunson, OSU High Performance Computing Center Director, and James Deaton, Chief Technology Officer of OneNet, Oklahoma's education, research and government network. The C2 grant has several components:

The networking aspects of the C2, collectively known as the Oklahoma Optical Initiative, are as follows:

**Statewide ring upgrade:** Overlapping the C2 grant period, OneNet increased the statewide ring from 3 sites (Tulsa, Stillwater and Oklahoma City, plus a separate spur of lower robustness to Norman) to 5 sites (including Norman and a second site in Oklahoma City). The C2 grant funded a conversion of the hardware from routed mux/demux components to Reconfigurable Optical Add Drop Modules (ROADMs), transforming Oklahoma's existing research ring from routed to optical, leveraging existing infrastructure – chassis and fibers – while advancing optical switching components to a new level, facilitating substantial improvement in reliability, robustness and availability, as well as enabling the ability to provision dedicated lambdas straightforwardly and affordably.

**Institutional upgrades** (no institutional increase in recurring costs):

- **OU:** upgraded the HPC cluster connection from 1 Gbps to 10 Gbps (10X increase, completed), paid by OU IT as institutional commitment to the C2 grant. The OU Health Sciences Center in Oklahoma City also upgraded to 10 Gbps from 1 Gbps (10X increase), but not via the C2.
- **OSU:** upgraded the HPC cluster connection from 1 Gbps to 10 Gbps (10X increase, completed).
- **U Tulsa:** upgraded the campus connection for research from 200 Mbps to 1 Gbps (5X increase, completed).
- **Samuel Roberts Noble Foundation:** upgraded research networking from 45 Mbps to 1 Gbps (22X increase) and commodity Internet to 100 Mbps (2X increase, completed).
- **Langston U:** upgraded the High Energy Physics world-facing networking equipment from 100 Mbps to 10 Gbps (100X upgrade), and likewise a 10 Gbps connection for a newly announced MRI-funded cluster (completion imminent).
- **College of the Muscogee Nation** (Tribal College): provided networking components and deployment assistance for a new residence hall (completed).
- **Bacone College** (Minority Serving Institution with a Tribal mission): provided an internal campus backbone upgrade to 100 Mbps with a Gbps core (completed).
- **Pawnee Nation College** (Tribal College): providing components and services for educational media (equipment delivered, deployment pending).
- **Comanche Nation College** (Tribal College): provided equipment for distance learning (completed).
- **Additional C2 upgrades:** deploying 2 x 10 Gbps from OneNet to OU Norman and a Science DMZ at OU Norman, both serving OU's HPC cluster, and facilitating a 100 Gbps upgrade at OSU (substantially funded by OneNet).

## OU and OU+OSU Shared Services

In August 2011, OU Information Technology (IT) initiated a comprehensive Shared Services program [18] spanning OU's campuses in Norman, Oklahoma City, and Tulsa, utilizing new data center facilities now active at each campus. The program encompasses a complete redesign of OU's IT infrastructure, including connectivity, IP address management, identity management, storage, security, voice, virtualization and solution platforms for web, application, database and collaboration.

Utilizing private cloud architecture, the OU IT Shared Services platform will provide a secure, cost efficient, standardized, geographically redundant foundation for hosting academic, administrative, clinical and research data, workloads and services. OU IT considers this to be a single virtual infrastructure, located across its three campuses, and is utilizing shared staffing and virtual teams to design, implement and operate the private cloud.

In December 2011, OU IT began collaborative discussion with the OSU IT leadership across multiple campuses, identifying a number of cross-institutional projects with significant potential for efficiency gains via sharing resources, including infrastructure, applications, volume purchasing, and specialized resources and services. This cross-jurisdictional sharing is a natural extension of OU IT Shared Services, and the impact footprint is expected to extend to other postsecondary institutions in Oklahoma.

A single virtual data center across multiple physical locations requires a great deal of redundant bandwidth to implement. To this end, OU IT needed to provision a total of nine new 10G lambdas, both between the multiple data centers and to the Internet. Further, these new lambdas provide the basis for connecting to OSU Tulsa and OSU Stillwater at 10 Gbps, unlocking the potential for cross-institutional resource sharing to support the growing technology collaborations between Oklahoma's two higher education research systems.

Because of the network upgrades to OneNet that were designed and completed largely via, and as a key component of, Oklahoma's C2 project, and leveraging the deepened relationship among OU, OSU and OneNet Cyberinfrastructure teams that the C2 has fostered, OU IT has been able to partner with OneNet to build upon that existing foundation, by incorporating the additional optics needed to achieve the required bandwidth and redundancy to support the Shared Services initiative. By leveraging the network upgrades provided by the C2, OU IT is now able to accomplish additional initiatives that will provide benefits and capabilities across the OU system, at no increased cost to the C2 grant or to the statewide research enterprise.

In many ways, the OU IT Shared Services program, including its collaboration with OSU in partnership with Onenet, is following the successful model established by OCII. Without OCII's previous success, and the investments made by the C2, OU IT and OSU IT would be obligated to make the very same levels of investment with OneNet as the C2 has already done, in order to obtain the redundant, high-speed bandwidth required to build its Shared Services private cloud.

That is, an unanticipated side effect of the C2 is that, beyond enabling the key research capabilities that are the C2's direct mission, the C2 has also enabled, at zero cost to its own budget, a revolutionary change not only in the statewide cyberinfrastructure foundation but also the breadth of vision and depth of collaboration among institutions statewide, in support of not just research but the full spectrum of IT capabilities, substantially increasing efficiency while dramatically curtailing costs.

## OneNet 100G Upgrade

Many of the same catalysts that led to the OU+OSU Shared Services initiative have been leveraged to dramatically shift Oklahoma's interconnection with national research networks. By enabling new levels of research bandwidth, the C2 has driven the need to increase connectivity to these networks.

Emerging research data requirements have led OneNet to invest in additional infrastructure, building more resilient paths and much greater capacity to both the National LambdaRail and Internet2. This new infrastructure, combined with the capabilities provided by new technology from the C2, paved the way for OneNet and OU to participate in Internet2's Innovation Platform Pilot, a program that brought 100G connectivity into the state in 2012.

Under Oklahoma's C2 grant, OU's and OSU's HPC clusters will be connected to the Innovation Platform at initially 20 Gbps each: the C2 grant has purchased and will deploy 2 x 10 Gbps from OU to OneNet's chassis in Tulsa that connects to the Innovation Platform, and OneNet is deploying 100 Gbps connectivity from that chassis to its location on OSU's Stillwater campus, with 2 x 10 Gbps from OSU's HPC cluster to that 100G-enabled chassis.

## 4.8 Workforce Development

The "Day in the Life of an IT Professional" presentations have been provided on networking, security, software development, support, web development, system administration, systems engineering, HPC, infrastructure, services and partnerships, and IT considerations for the National Weather Center, located at OU.

## 5. DIVERSITY

As shown above and in the appendix below, OCII has developed strong ties to a variety of institutions, both statewide and nationally, and thus is able to reach a very diverse audience, as the percentages of African American and Native American students, below, demonstrate. And, in the context of our C2 grant, OCII has been strengthening ties with some of the institutions with high enrollments of underrepresented minorities (especially Langston U, College of the Muscogee Nation, Pawnee Nation College, Comanche Nation College and Bacone College), specifically in providing networking capability that plays a strong role in, for example, Langston U's new NSF MRI cluster grant. In addition, via the Oklahoma Information Technology Mentorship Program (OITMP), which to date has served 36 academic institutions, OCII is reaching community colleges and career techs that might not evince a strong interest in large scale advanced computing. And, via OU's NSF MRI grant, OCII is able to provide petascale storage to all Oklahoma academics.

## 6. ACKNOWLEDGMENTS

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## 7. APPENDIX: OCII ACADEMIC INSTITUTIONS

4+ year non-PhD-granting unless otherwise labeled or named.

1. Bacone College (**MSI, 28.3% AI, 27.3% AA**): T
2. Cameron U (**15.3% AA**): A, D, E, F, O, T, W  
*Taught advanced computing courses using OSCER's supercomputer.*
3. Canadian Valley Tech Ctr: W
4. College of the Muscogee Nation (**Tribal**, community college): O, T
5. Comanche Nation College (**Tribal**, community college): D, O, T
6. DeVry U Oklahoma City: D, F, O
7. East Central U (**NASNI, rural, 20.4% AI**): A, D, E, F, O, P, T, W  
*Taught advanced computing course using OSCER's supercomputer.*
8. Eastern Oklahoma State College (**23.7% AI**): W
9. Eastern Oklahoma County Tech Ctr (**10.4% AI**): W
10. Elgin Middle School: O (tour only)
11. Francis Tuttle Tech Ctr: D, W
12. Gordon Cooper Tech Ctr (**18.5% AI**): D, O, W
13. Great Plains Tech Ctr (**11.7% AI**): T, W
14. Kiamichi Tech Ctr (**18.6% AI**): W
15. Langston U (**HBCU, 81.6% AA**): A, D, E, F, O, P, T, W  
*NSF Major Research Instrumentation supercomputer grant funded in 2012.*
16. Lawton Christian School (high school): W
17. Metro Tech Ctrs (**30.6% AA**): D
18. Mid-America Tech Ctr (**23.6% AI**): D, T, W
19. Mid-Del Public Schools: D
20. Moore Norman Tech Ctr: D, W
21. Northeast Tech Ctr (**20.9% AI**): W
22. Northeastern Oklahoma A&M College (**NASNI, 22.8% AI**, community college): W
23. Northeastern State U (**NASNI, 27.2% AI**): A, D, E, F, O, T, W; *Taught computational chemistry course using OSCER's supercomputer.*
24. Northwestern Oklahoma State U: A, F, O
25. Oklahoma Baptist U: A, D, E, F, O, W
26. Oklahoma Christian U: W
27. Oklahoma City U: A, D, E, F, O, T, W  
*Educational Alliance for a Parallel Future mini-supercomputer proposal funded in 2011; teaching advanced computing course using OSCER's supercomputer (often).*
28. Oklahoma City Community College: W
29. Oklahoma Panhandle State U (**rural**): A, D, O, W
30. Oklahoma School of Science & Mathematics (high school): A, D, E, O, W
31. Oklahoma State U (PhD): A, D, E, F, O, T, W  
*NSF Major Research Instrumentation cluster supercomputer grant funded in 2011.*
32. Oklahoma State U Institute of Technology (**21.4% AI**, community college): W
33. Oklahoma State U-Oklahoma City (community college): O, W
34. Oral Roberts U: A, F, O, W
35. Panola Public Schools: D
36. Pawnee Nation College (**Tribal**, community college): T
37. Pontotoc Tech Ctr (**30.4% AI**): W
38. Rogers State U (**13.6% AI**): A, D, F, O  
*Taught computational chemistry course using OSCER's supercomputer.*
39. Rose State College (**17.4% AA**): F, W

40. St. Gregory's U: A, D, E, F, O
41. Southeastern Oklahoma State U (**NASNI, 26.0% AI**): A, D, E, F, O, T, W  
*Educational Alliance for a Parallel Future mini-supercomputer grant funded in 2011.*
42. Southern Nazarene U: A, D, F, O, P, T, W  
*Taught computational chemistry course using OSCER's supercomputer.*
43. Southern Oklahoma Tech Ctr (**9.1% AI**): W
44. Southwestern Oklahoma State U (**rural**): A, D, E, F, O, W
45. Tulsa Community College: W
46. U Central Oklahoma: A, D, E, F, O, W  
*NSF Major Research Instrumentation supercomputer proposals submitted in 2011-13.*
47. U Oklahoma (PhD): A, D, E, F, O, P, T, W  
*NSF Major Research Instrumentation large scale storage grant funded in 2010; Educational Alliance for a Parallel Future mini-supercomputer proposal funded in 2011.*
48. U Phoenix: D
49. U Science & Arts of Oklahoma (**9.7% AI**): A, O
50. U Tulsa (PhD): A, D, E, F, O, W  
*Taught bioinformatics course using OSCER's supercomputer.*

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