OSCER
State of the Center

Henry Neeman, OSCER Director

hneeman@ou.edu

OU Supercomputing Center for Education & Research
A Division of OU Information Technology
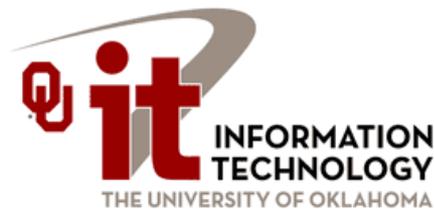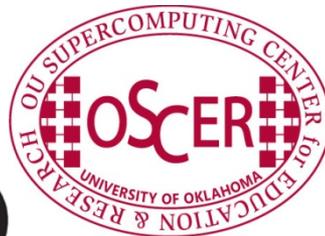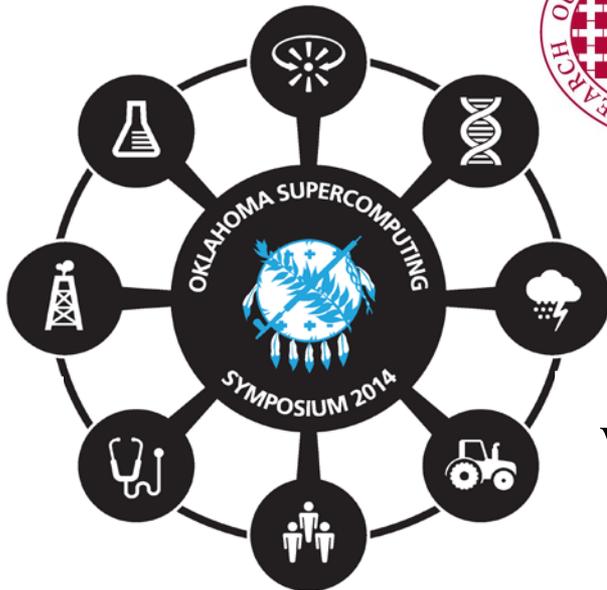
Wednesday September 24 2014
University of Oklahoma

Preregistration Profile 2014

- **<u>Organizations</u>**: 77 preregistered (or speaking)
  - **<u>Academic</u>**: preregistered 36 institutions in 11 states (IA,KS,LA,MO,MS,ND,OK,SD,TN,TX,WA)
    - Includes 27 institutions in 8 EPSCoR states (IA,KS,LA,MO,MS,ND,OK,SD)
  - **<u>Industry</u>**: preregistered 36 private companies
  - **<u>Government</u>**: preregistered 9 agencies (federal, state)
  - **<u>Non-governmental</u>**: preregistered 4 organizations
- **<u>Demographics</u>**: 275 preregistered (and/or speaking)
  - 32% OU, 68% non-OU (or unknown)
  - 67% Oklahoma, 33% non-Oklahoma (or unknown)
  - 83% from EPSCoR states, 17% non-EPSCoR (or unknown)
  - 74% academic, 26% non-academic (or unknown)

Attendee Profile 2002-2013

- Over 3000 attendees at the previous 12 Symposia
  - 69 in 2002, 225-325 per year thereafter
- Organizations: 290 through 2013
  - **Academic**: from 106 institutions in 27 US states & territories
    - 70 institutions in 14 EPSCoR jurisdictions
    - 32 institutions in Oklahoma
      - PhD-granting, masters-granting, bachelors-granting, community colleges, career techs, high school
      - Historically Black University, Tribal College, 3 Native American Serving Non-tribal Institutions
      - public, private, for-profit
  - **Industry**: attendees from 129 firms
  - **Government**: attendees from 36 agencies (federal, state, municipal, foreign)
  - **Non-governmental**: attendees from 19 organizations

Symposium 2014 Sponsors: Thank You!

- Academic sponsor (1)
  - Great Plains Network
- Industry sponsors (21) – **a new record**! (previous: 15)
  - Platinum (1): Intel
  - Gold (4): **Arista Networks**, Cray Inc, Dell, Mellanox Technologies
  - Silver (8): **Adaptive Computing**, **CenturyLink**, Ciena, Cisco Systems, DataDirect Networks, EMC, **Huron Consulting Group**, **Violin Memory**
  - Bronze (7): Advanced Clustering Technologies, **Cycle Computing**, Open Technologies, Oracle, **RogueWave**, **Seagate**, SGI
  - Meal (1): **Dropbox**

Thank you all! Without you, the Symposium couldn't happen.
Over the past 13 Symposia, we've had a total of 79 companies as sponsors – and more than half have repeated.

Thanks!

- OU IT
  - OU CIO/VPIT Loretta Early
  - Symposium committee: Josh Alexander (OU), Dana Brunson (OSU), Debi Gentis (OU)
  - Symposium coordinator: Debi Gentis
  - Sponsorship coordinator: Chance Grubb
  - OSCER Operations Team: Brandon George, Dave Akin, Brett Zimmerman, Josh Alexander, Patrick Calhoun
  - All of the OU IT folks who helped put this together
- CCE Forum
  - Jake Maurer, Kristin Livingston
  - The whole Forum crew who helped put this together

OSCER State of the Center Address
Wed Sep 24 2014

Thanks: Plenary Speakers

- Irene Qualters, NSF Advanced Cyberinfrastructure Division
- Addison Snell, Intersect360 Research
- Stephen Wheat, Intel (Platinum sponsor)

Thanks: Gold Sponsor Speakers

- Saeed Iqbal, Dell

- Robert Kern, Mellanox Technologies

- Don Schulte, Cray, Inc.

- Mickey Stewart, Arista Networks

Thanks: Breakout Speakers

1. Erik Alred, OU
2. Dan Andresen, KSU
3. Workalemahu Berhanu, OU
4. Manikanthan Bhavaraju, OU
5. Keith Brewster, OU
6. Dana Brunson, OSU
7. Nick Davis, OU Tulsa
8. James Ferguson, NICS
9. Karl Frinkle & Mike Morris, SEOSU
10. Zane Gray, OU
11. Houssain Kettani, FHSU
12. Evan Lemley, UCO
13. Greg Monaco, GPN
14. Chris Stackpole, FRB
15. Bin Wang, OU

Thanks!

To all of your for participating, and to those many of you who've shown us so much loyalty over the past 13 years.

Some Accomplishments

- **NEW!** Funded grants
  - NSF CC*IIE networking personnel grant @ OU
    - Starts next week!
  - NSF CC*IIE networking collaboration grant @ GPN, OneNet
    - Started Sep 1!
  - NSF MRI cluster grant @ UCO
    - Will become a OneOCII resource provider site
- "A Day in the Life of an IT Professional" talks: including this semester's bookings, we expect to exceed 100 events for 38 institutions, closing in on 2000 students served.

Outline

- OU
  - Resources
  - Accomplishments
- OCII/OneOCII

Resources

Dell Intel Xeon Linux Cluster

874 Intel Xeon CPU chips/6992 cores

Photo: Jawanza Bassue

412 dual socket/oct core Sandy Bridge 2.0 GHz, 32 GB
23 dual socket/oct core Sandy Bridge 2.0 GHz, 64 GB
1 quad socket/oct core Westmere, 2.13 GHz, 1 TB

15,680 GB RAM

~360 TB global disk

QLogic Infiniband

(16.67 Gbps, ~1 microsec latency)

Dell Force10 Gigabit/10G Ethernet

Red Hat Enterprise Linux 6

Peak speed: 111.6 TFLOPs*

*TFLOPs: trillion calculations per second

Just over 3x (300%) as fast as our 2008-12 supercomputer.

Just over 100x (10,000%) as fast as our first cluster supercomputer in 2002.

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Dell Intel Xeon Linux Cluster

874 Intel Xeon CPU chips/6992 cores

Photo: Jawanza Bassue

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*TFLOPs: trillion calculations per second

19% of the nodes are "condominium" (owned by individual research teams): ~4x as many as all OSCER's previous clusters combined.

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OU Research IT Personnel

- OSCER
  - Director: Henry Neeman
  - Associate Director for Remote & Heterogeneous Computing: Horst Severini
  - Manager of Operations: Brandon George
  - Senior System Administrator: David Akin
  - Senior System Administrator: Brett Zimmerman
  - HPC Application Software Specialist: Josh Alexander
  - Research IT Coordinator: Debi Gentis
  - Petascale Storage Administrator: Patrick Calhoun
  - Student Techs: Paulius Velesko, Katy Franks

OU Research IT Personnel

- Integrated Robust Assured Data Services (IRADS)
  - Carl Sinclair
- Informatics*
  - Jonah Duckles
  - Mark Stacy

* Informatics is evolving ….

Back to the Future

Four Partners Place data center: just past SRTC, where we were last night. We moved Boomer into the data center in Jan 2013.

One Partners Place: Where our office is now.

Accomplishments

External Research Grants

1. J. Wicksted, A. Knoedler et al, "Adapting Socio-ecological Systems to Increased Climate Variability," NSF, $20M + $4M Regents (total), $7.0M + $1.9M Regents (OU)

2. M. Engle et al, "Resilience and vulnerability of beef cattle production in the Southern Great Plains under changing climate, land use and markets," $9.5M (total), $1.9M (OU)

3. R. Palmer, G. Zhang, Y. Zhang, T. Yu, M. Yeary, S. Karimkashi, C. Fulton, B. Cheong, "Multi-Mission Phased Array Radar Risk Reduction: A Collaborative Effort with the ARRC at the University of Oklahoma," NOAA, $1.5M

4. R. Palmer, G. Zhang, Y. Zhang, T. Yu, M. Yeary, Y. Hong, J. Crain, P. Chilson, "Next Generation Weather Radar Technology," NOAA, $900K

5. R. Palmer, D. Bodine, S. Torres, B. Cheong, C. Fulton, "Understanding Polarimetric Radar Tornadic Debris Signatures Using Modeling, Simulations, and Field Measurements,," NSF, $860K

6. A. Callaghan, "Elucidation of Alkene Metabolism in Two Sulfate-reducing Isolates via Metabolite Profiling and Transcriptomics," NSF, $848K

7. D. LaDue, K. Kloesel, "REU Site: Research Experiences for Undergraduates at the National Weather Center," NSF, $822K

8. J. Brotzge, M. Xue, N. Snook, Y. Jung, A. McGovern, "The Severe Hail Analysis, Representation, and Prediction (SHARP) Project," NSF, $819K

9. L. Krumholz, J. Zhou, M. McInerney, J. Wall, "Characteristics of H2 Producing Biological Systems Operating at 1 nM H2 Concentration," DOE, $819K (total), $693K (OU)

10. P. Chilson, E. Fedorovich, R. Palmer, "Studies of the Atmospheric Boundary Layer Using Numerical Simulations Coupled With Radar/Sodar-Based Field Experiments," NSF, $757K

11. M. Xue, K. Brewster, F. Kong, "Establishment of Precision Weather Analysis and Forecasting Systems (PWAFS) for the Jiangsu Province Meteorological Bureau (JSMB)," NRIET, $505K

12. H. Neeman, D. /Brunson, J. Deaton, S. Radhakrishnan et al, "CC-NIE: OneOklahoma Friction Free Network," NSF, $500K

13. F. Kong, M. Xue, "Further Development of the Storm-Scale Numerical Weather Prediction Capability for Shenzhen Meteorological Bureau," Shenzhen, $479K

14. E. Bridge, J. Kelly, "Optimizing Grassland Bird Conservation in an Era of Biofuel Production," USDA, $466K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

15. R. Kolar, "Dynamic Integration of Natural, Human, and Instructure Systems for Hurricane Evacuation and Sheltering," NSF, $456K

16. L. Ding, "Neuroimaging Study of Mental Fatigue," FAA, $430K

17. U. Hansmann, "Development of Generalized-Ensemble Algorithms and their Application in Protein Studies," NSF, $410K

18. L. Ding, "Large-Scale Computational Neuroimaging of Brain Electrical Activity," NSF CAREER, $400K

19. P. Attar, "Optimal Spatiotemporal Reduced Order Modeling for Nonlinear Structural Dynamics," NSF, $360K

20. B. L. Cheong, Y. Jung, G. Zhang,, "Support for X-band Solid-state Weather Radar Development," WeatherLink, $334K

21. P. Vedula, P. J. Attar, "Fast simulations of turbulent flows based on spatiotemporal statistical information," NSF, $330K

22. M. Xue, K. Brewster, F. Kong, "Development of a Short-Range Realtime Analysis and Forecasting System based on the ARPS for Taiwan Region Year 3 (IA#24) and Year 4 (IA #25)," NOAA, $310K

23. E. Bridge, J. Kelly, X. Xiao, "Enhancing and disseminating miniaturized tracking technology for widespread use on small migratory songbirds," NSF, $302K

24. J. Kelly, L. Gruenwald, P. Chilson, V. Lakshmanan, E. Bridge, "Advancing Biological Interpretations of Radar Data," NSF EAGER, $299K

25. L. Ding, "High-Resolution Noninvasive Computational Neuroimaging," OCAST, $283K

26. F. Kong, "Further Development to the Storm-Scale Numerical Weather Prediction Capability for Shenzhen Meteorological Bureau," SIATCAS, $251K

27. R. Slatt, Consortium from 14 oil and gas company, $245K

28. J. Brotzge, F. Carr, "Protyping and Evaluating Key Network-of-Networks Technologies: Project Extension," NOAA, $210K

29. Y. Jung, M. Xue, G. Zhang, "Development of a Polarimetric Radar Data Simulator for KLAPS," KMA, $176K

30. J. Ruyle, "BRIGE: Investigation of Slot Antenna Recon figuration Mechanisms," NSF, $175K

31. J. Brotzge, F. Carr, "CASA Warning System Innovation Institute," U Mass, $160K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

32. J. Kelly, "Developing Innovative Tools to Use Weather Radar Data to Assess and Monitor Impacts of Existing and Future Energy Facilities on Aerial Faunas in California," CIEE, $150K (total), $49K (OU)

33. J. Brotzge, F. Carr, "Prototyping and Evaluating Key Network-of-Networks Technologies," NOAA, $145K

34. T. Yu, Y. Wang, R. Palmer, B. Cheong, „Algorithm development for solid-state polarimetric weather radars," Toshiba, $130K

35. M. Xue, K. Brewster, F. Kong, "Establishment of an Urban-Scale Weather Forecasting System (USWFS) for the Su Zhou Meteorological Bureau (SZMB)," $127K

36. L. Ding, "Neurophysiological Assessment of Mental Fatigue and Cognitive Performance," FAA, $115K

37. K. Dresback, R. Kolar, "Next Generation ADCIRC Tidal Database: Phase 2 - West Coast," DOD, $75K

38. K. Dresback, R. Kolar, "Next Generation ADCIRC Tidal Database," NOAA, $75K

39. P. Risser, J. Duckles, J. Bratton, NSF I-Corps, $50K

40. R. Palmer, M. Yeary, "System and Software Engineering Support Services for CGI," CGI, $46K

41. M. Yeary, M. Xue, "GRDS: Request to support a Native American Indian graduate student beginning his PhD within the CASA Engineering Research Center," NSF, $32K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

42. I.Y. Akkutlu, J. Callard, C. Rai, C. Sondergeld, "OU Shale Gas and Unconventional Reservoir Research Cooperative," $2.8M per year

43. J. P. Shaffer, T. Pfau, "A Rydberg Atom Electric Field Sensor," DARPA-ARO, $1.18M (total),$1.06M (OU)

44. Y. Luo, "Data Synthesis and Data Assimilation at Global Change Experiments and Fluxnet toward Improving Land Process Models," DOE, $1.05M

45. F. Kong, M. Xue, K. Brewster, "Establishment of an Improved Numerical Weather Forecasting System for Chongqing Meteorological Service," Chongqing Institute of Green and Intelligent Technology, China, $852K

46. G. Zhang, M. Xue, B. L. Cheong, T. J. Schurr, "Advanced Study of Precipitation Microphysics with Multi-Frequency Polarimetric Radar Observations and Data Assimilation," NSF, $637K

47. J. P. Shaffer, "A Quantum Hybrid System for Linking Rydberg Atom Quantum Gates. NSF, $465K

48. J. P. Shaffer, "Rydberg Atom Interactions and Collective Behavior," NSF, $436K

49. J. P. Shaffer, "Interactions in Cold Rydberg Gases," NSF, $422K

50. J. Cruz, "CIF: Small: Two-Dimensional Channel Modeling, Detection and Coding for Shingled Magnetic Recording," NSF, $418K

51. M. Yuan, "Supplement to Developing and Evaluating the Effectiveness of the Location-based Offender Monitoring System for Offender Supervision," National Institute of Justice, $396K

52. X. Wang, M. Xue, F. Kong, "Optimal Design of Multi-scale Ensemble Systems for Convective-Scale Probabalistic Forecasting," NSF, $359K

53. F. Kong, M. Xue, "Further Development of the Storm-Scale Numerical Weather Prediction Capability for Shenzhen Meteorological Bureau," Shenzhen Institute of Advanced Technology, China, $251K

54. J. Snow & F. Fondjo Fotou (Langston U), "MRI: Acquisition of a High Performance Computing Cluster for Research and Education," NSF, $250K

55. M. Xue, K. Brewster, Y. Jung, "Advanced Data Assimilation and Prediction Research for Convective-Scale Warn-on-Forecast," NOAA, $243K

56. I.Y. Akkutlu, "Multi-scale Characterization of Transport Phenomena in Shales for Improved Gas Recovery," Devon Energy, $200K

57. M. Xue, R. McPherson, J. Brotzge, B. Moore, "Very High-Resolution Dynamic Downscaling of Regional Climate and Hydrology," USG, $24K

58. J. Brotzge, F. Carr, "CASA DFW Testbed Enchancement: Task B of National Mesonet Program (NWP)," Earth Networks Inc., $25K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

59. R. Voronov, "Intra-Thrombus Chemo-Transport and Local Stress Mechanics under Flow," American Heart Association Postdoctoral Fellowship, $150K

60. X. Wang, M. Xue, "Improving High Resolution Tropical Cyclone Prediction using GSI-based Hybrid Ensemble-Variational Data Assimilation System for HWRF," NOAA, $150K

61. I. Y. Akkutlu, "Molecular Theory of Capillarity in Kerogen - A Multi-component Approach to Predict Shale Gas/Liquid In-place and Transport in Nanopores," Devon Energy, $150K

62. S. Dhall, L. Gruenwald, "Autonomous Database Partitioning using Data Mining for High End Computing," NSF, $150K

63. M. Xue, K. Brewster, F. Kong, "Ensemble Simulation of GOES-R Proxy Radiance Data from CONUS Storm-Scale Ensemble Forecasts, Product Demonstration and Assessment at the Hazardous Weather Testbed GOES-R Proving Ground," NOAA, $126K

64. M. Xue, K. Brewster, F. Kong, "Ensemble Simulation of GOES-R Proxy Radiance Data from CONUS Storm-Scale Ensemble Forecasts, Product Demonstration and Assessment at the Hazardous Weather Testbed GOES-R Proving Ground," NOAA, $94K

65. K. Brewster, M. Xue, "High Resolution Data Assimilation for Trajectory Improvement," DOD-Air Force, $79K

66. F. Kong, "CAPS support to the WRF Lightning Forecast Algorithm for the NOAA R3 effort," NOAA GOES-R/Universities Space Research Assn, $48K

67. R. McPherson, M. Shafer, Y. Hong, "Utilization of Regional Climate Science Programs in Reservoir and Watershed Impact Assessments," OSU Water Resources Responses to Climate Change: Pilot Study, $43K

68. P. Attar, "Numerical Simulation of a Membrane Micro Air Vehicle in a Gust Field, Ohio Aerospace Institute, $35K

69. J.R. Cruz, "Signal Processing for Magnetic Recording Channels," Hitachi Global Storage Technologies, Inc., Director, $30K

70. J.R. Cruz, "Equalization, Detection, and Coding Algorithms for Bit Patterned Media Recording," Advanced Storage Technology Consortium, $17K

71. L. Sells, J. Goulden, H. Aboudja, "LittleFe grant," LittleFe project, $2.5K

72. L. Sells, J. Goulden, "Early Adopter Grant," NSF/TCPP, $2.5K

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73. B. Moore III et al, "Department of the Interior South-Central Regional Climate Science Center," US Dept of the Interior, $3.5M (total), $1.4M (OU)

74. A. Striolo, D. Resasco et al, "Center for Application of Single-Walled Carbon Nanotubes," DOE, $1M

75. J. K. Shen, "CAREER: Electrostatic Mechanisms in Protein Stability and Folding, NSF, $773K

76. Y. Kogan, "Parameterization of cumulus convective cloud systems in mesoscale forecast models," ONR, $594K

77. X. Wang, M. Xue, F. Kong, "Optimal Design of Multi-scale Ensemble Systems for Convective-Scale Probabilistic Forecasting," NSF, $395K

78. R. D. Palmer, T.-Y. Yu, "NMQ and WDSS-II for the KMA radar network: Real-time, effective, and integrated weather products," Space Environment Laboratory, Inc., $361K

79. B. Grady, A. Striolo, "Novel Supramolecular Structures of Laterally Confined Amphiphilic Molecules," NSF, $335K

80. D. Resasco, D. Papavassiliou et al, "Interfacially active SWNT/silica nanohybrids," Advanced Energy Consortium, $331K

81. C. Y. Tang , R. Ramakumar, N. Jiang , "Control and Operation of Large-Scale Wind Farms in the Power System", NSF, $231K

82. J. Shen, "Electrostatic Modulationof Protein Stability and Folding," NIH, $1.4M

83. Y. Wang, "Theoretical Tools for Measuring Dark Energy from Galaxy Clustering," DOE, $230K

84. F. Kong, M. Xue, "Further Enhancement to the Hourly Assimilation and Prediction System (HAPS) for Shenzhen Meteorological Bureau." Shenzhen Institute of Advanced Technology, Chinese Academy of Science, $228K

85. P. Attar, P. Vedula, "Multi-fidelity Modeling and Simulation (M&S) Tool for Nonlinear Aeroelasticity," Advanced Dynamics, $160K

86. B. Eskridge, "CDI-TYPE I: RUI: Emergent Hierarchies of Leaders in Multi-Robot Systems," NSF, $159K

87. A. Striolo, "Mixed-Volatile Fluids Relevant to Subsurface Energy Systems," DOE, $120K

88. P. Skubic, M. Strauss, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center (Supplement)," NSF, $110K

89. P. Attar, "High-Fidelity Computational Aeroelastic Solver Research," Ohio Aerospace Institute, $53K

90. P. Skubic, M. Strauss, "OU Contribution to the ATLAS Southwest Tier 2 Computing Center (Supplement)," NSF, $50K

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91. P. Skubic, M. Strauss, "University of Oklahoma Contribution to OSG Software Development," Brookhaven National Laboratory, $50K.

92. P. Attar, "Computational Model Development and Experimental Validation Measurements for Membrane-Batten Wing," Ohio Aerospace Institute, $43K

93. A. Striolo, "Reduced Carbon in Earth's Crust and Mantle I," Alfred P. Sloan Foundation, $39K.

94. J. Gao, "Advancing Research on Realtime Weather-Adaptive 3DVAR Analyses with Automatic Storm Positioning and On-demand Capability," NOAA, $36K

95. M. Xue, "Probabilistic Forecasting for Aviation Decision Aid Applications," Impact Technologies,$20K

96. P. Attar, P. Vedula, "Towards Better Modeling and Simulation of Nonlinear Aeroelasticity On and Beyond Transonic Regimes," Advanced Dynamics, $20K

97. P. Attar, P. Vedula, "High-Fidelity Computational Aeroelastic Models in Support of Certification Airworthiness of Control Surfaces with Freeplay and Other Nonlinear Features," Advanced Dynamics, $9K

OSCER-FACILITATED FUNDING TO DATE:
$277M total, $165M to OU

External Research Grants (cont'd)

98. H. Neeman, D. Brunson (OSU), J. Deaton (OneNet), J. He (Noble Foundation), D. Schoenefeld (TU), J. Snow (Langston U), M. Strauss (OU), X. Xiao (OU), M. Xue (OU), "Oklahoma Optical Initiative," NSF, $1.17M

99. H. Neeman, M. Jensen, M. Strauss, X. Xiao, M. Xue, E. Baron, K. Dresback, R. Kolar, A. McGovern, R. Palmer, D. Papavassiliou, H. Severini, P. Skubic, T. Trafalis, M. Wenger, R. Wheeler (Duquesne U), "MRI: Acquisition of Extensible Petascale Storage for Data Intensive Research," NSF, $793K

100. D. Resasco, J. Harwell, F. Jentoft, K. Gasem, S. Wang, "Center for Interfacial Reaction Engineering (CIRE)," DOE EPSCoR, $2.4M ($1.97M OU)

101. P. Skubic, M. Strauss, B. Abbott, P. Gutierrez, "Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the Large Hadron Collider (LHC) (TASK A) 2010-2013 Renewal," DOE, $2.8M

102. R. Palmer, Y. Zhang, G. Zhang, T. Yu, M. Yeary, Y. Hong, J. Crain, P. Chilson, "Next Generation Phased Array," NSSL, $2M

103. P. Skubic, M. Strauss, B. Abbott, P. Gutierrez, "Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the Large Hadron Collider (LHC) (TASK A) 2010-2013 Renewal-Revision," DOE, $1.52M

104. D. Cole, Alberto Striolo, "Structure and Dynamics of Earth Materials, Interfaces and Reactions," DOE, $1.5M ($90K OU)

105. R. Sigal, F. Civan, D. Devegowda, "Simulation of Shale Gas Reservoirs Incorporating the Correct Physics of Capillarity and Fluid Transport," Research Partnership to Secure Energy for America (RPSEA), $1.05M

106. M. Biggerstaff , J. Straka, L. Wicker, Zrnic, Zahari, "MRI Development of C-Band Mobile Polarimetric Weather Radars," NSF, $989K ($439K OU)

107. D. Resasco, D. Papavassiliou et al, "Carbon Nanotube Technology Center," DOE, $925K

108. M. Saha, D. Papavassiliou, A. Striolo, K. Mullen, B. Grady, C. Altan, D. Resasco, "Experimental and theoretical studies of carbon nanotube hierarchical structures in multifunctional polymer composites," DoD-EPSCoR, $897K

109. E. Mansell , J. Straka, C. Ziegler, D. MacGorman, "Numerical modeling studies of storm electrification and lightning," NSF, $817K

110. E. Rasmussen, J. Straka, K. Kanak, "Collaborative Research: Challenges in understanding tornadogenesis and associated phenomena, $755K ($489K OU)

111. J. Straka, K. Kanak, "Challenges in tornadogenesis and associated phenomena," NSF, $584K

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$277M total, $165M to OU

112. M. Xue, F. Kong, "Advanced Multi-Moment Microphysics for Precipitation and Tropical Cyclone Forecast Improvement with COAMPS," ONR, $592K

113. J. Straka, K. Kanak, "Collaborative Research: Challenges in Understanding Tornadogenesis and Associated Phenomena," NSF, $515K

114. D. MacGorman, E. Mansell, C. Ziegler, A. Fierro, M. Xue, "Techniques for Assimilating Geostationary Lightening Mapper Data and Assessment of the Resulting Impact on Forecasts," NOAA, $415K

115. M. Xue, F. Kong, K. Brewster, X. Wang, "A Partnership to Develop, Conduct, and Evaluate Realtime High-Resolution Ensemble and Deterministic Forecasts for Convective-scale Hazardous Weather: Moving to the Next Level," NOAA CSTAR, $375K

116. M. Xue, K. Brewster, J. Gao, X. Wang, "Advanced Data Assimilation and Prediction Research for Convective-Scale 'Warn-on-Forecast,'" $500K, NOAA

117. X. Wang, "Improving satellite radiance data assimilation using a hybrid ensemble-Gridpoint Statistical Interpolation (GSI) method for global numerical weather prediction," NASA, $276K

118. X. Wang, M. Xue, "Improving NOAA operational global numerical weather prediction using a hybrid-ensemble Kalman filter data assimilation and ensemble forecast system," NOAA, $207K

119. D. Resasco, D. Papavassiliou et al, "Interfacially active SWNT/silica nanohybrids," Advanced Energy Consortium (AEC), $333K

120. D. Oliver, "Data analysis and inversion for mobile nanosensors," AEC, $320K

121. R. Palmer, T. Yu, G. Zhang, M. Yeary, P. Chilson, Y. Zhang, J. Crain, "Advancements in Phased Array Weather Radar Research at OU," NOAA National Severe Storms Laboratory (NSSL), $270K

122. A. Striolo, "The Emergent Behavior of Solid Nanoparticles at Oil-Water Interfaces: A Multi-Scale Thermodynamic Approach to Enable Bio-Oil Upgrade," NSF, $238K

123. M. Xue, K. Brewster, F. Kong, "Development of a Short-Range Realtime Analysis and Forecasting System based on the ARPS for Taiwan Region," NOAA, $200K

124. J. Straka, K. Kanak, "Formative dynamics of the mammatus clouds in thunderstorm cirrus," NSF, $318K

125. M. Yeary, C. Tang, "Computationally Efficient Linear Transforms for Remote Sensing Systems," NSF, $299K

126. A. Striolo, "Probing regular solution theory for mixed amphoteric/ionic surfactant systems by molecular dynamics simulations," ACS, $100K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

127. K. Brewster, M. Xue, F. Kong, meteorology project, $211K
128. M. Xue, meteorology project, $120K
129. A. McGovern, "Learning to guide search in large state spaces," IBM DARPA, $95K
130. J. Straka, K. Kanak, "Supplement: Challenges in tornadogenesis and associated phenomena (VORTEX2)," NSF, $87K
131. F. Kong, M. Xue, "Establishment of an Experimental Real-Time Short-Term Storm Prediction System for Shenzhen Meteorological Bureau," $58K
132. J. Straka, "Improved Understanding/Prediction of Severe Convective Storms and Attendant Phenomena through Advanced Numerical Simulation," NSF, $58K
133. M. Xue, "Assimilation of NEXRAD Radial Winds in a Regional Mesoscale Model," Miss State U, $79K
134. J. Cruz, R. Todd, "Medium-Density Parity-Check Codes for Tape Systems," INSIC, $36K
135. M. Xue, D. Stensrud, J. Gao, "Advancing Warn on Forecast – Storm-scale Analysis of Vortex 2 Thunderstorms," NSSL, $70K
136. P. Attar, "High-Fidelity Computational Aeroelastic Solver Research," Ohio Aerospace Institute, $60K
137. J. Straka, K. Kanak, "Development of Unmanned Aircraft System for Research in a Severe Storm Environment and Deployment within the VORTEX 2," NSF, $44K
138. J. Cruz, "Equalization, Detection, and Coding Algorithms for Bit Patterned Media Recording Channels," International Storage Industry Consortium (INSIC), $35K
139. J. Cruz, R. Todd, "Signal Processing for Magnetic Recording Channels," private company, $30K
140. P. Attar, P. Vedula, "Deterministic and Statistical Characterization of the Impact of Control Surface Freeplay on Flutter and Limit-Cycle Oscillation (LCO) using Efficient Computational Modeling," Advanced Dynamics, $30K
141. P. Attar, P. Vedula, "Novel Reduced Order in time Models for Problems in Nonlinear Aeroelasticity," Advanced Dynamics, $29K
142. F. Carr, J. Straka, "Severe storm research," Jonathon Merage Foundation, $21K
143. F. Carr, J. Straka, "Severe storm research," Jonathon Merage Foundation, $20K

OSCER-FACILITATED FUNDING TO DATE:
$277M total, $165M to OU

External Research Grants (cont'd)

144. A. Striolo, "Electrolytes at Solid-Water Interfaces: Theoretical Studies for Practical Applications," DOE EPSCoR, $450K

145. A. Striolo, Saha, "Experimental and Theoretical Studies of Carbon Nanotube Hierarchical Structures in Multifunctional Polymer Composites," DOD EPSCoR, $450K

146. D. Cole (ORNL), A. Striolo, "Structure and Dynamics of Earth Materials, Interfaces and Reactions," DOE, $1.5M ($75K OU)

147. D. Papavassiliou, A. Striolo, "Effects of Hydrophobicity-Induced Wall Slip on Turbulence Drag and Turbulence Structure," NSF, $230K

148. A. Striolo, D. Resasco, U. Nollert, "Understanding the Interactions between Carbon Nanotubes and Cellular Membranes," NSF, $380K

149. M. Xue, Y. Hong, X. Hu (GSU), "Integrated Weather and Wildfire Simulation and Optimization for Wildfire Management," NSF, $997K ($483K OU)

150. 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

151. R. Palmer, Y. Hong, "Phased Array Technology for Weather Radar Applications," NOAA/OAR/NSSL via CIMMS, $426K

152. Y. Hong, Baski (OSU), "Proactive approach to transportation resource allocation under severe winter weather emergencies," OK-DOT/OTC, $261K ($101K OU)

153. R. Palmer, Y. Hong, "Atmospheric Observations using PhasedArray Technology," $340K

154. Y. Hong, "Toward Improved Flood Prediction and Risk Mitigation: Capacity Building for Africa," NASA, $87K

155. Y. Hong, "Improving NASA Global Hazard System and Implementing SERVIR-Africa," NASA, $272K

156. 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

157. R. Adler (NASA), Y. Hong, "Global Hazard (Flood-Landslide) Decision-Support System," NASA, $900K

158. S. Schroeder, "CAREER: Advancing Viral RNA Structure Prediction," NSF, $750K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

159. P. Attar, "High Fidelity Computational Aeroelastic Analysis of a Flexible Membrane Airfoil Undergoing Dynamic Motion," Ohio Aerospace Institute, $35K

160. P. Attar, "Computational Model Development and Experimental Validation Measurements for Membrane-Batten Wing" Flexible Membrane Airfoil Undergoing Dynamic Motion," Ohio Aerospace Institute, $43K

161. 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

162. 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, $476K; OK Board of Regents $100K

163. S. Ahalt, A. Apon, D. Lifka, H. Neeman, "NSF Workshop High Performance Computing Center Sustainability," NSF, $49K ($0 OU)

164. Y. Luo, S. Lakshmivarahan, "Development of a Data Assimilation Capability towards Ecological Forecasting in a Data-Rich Era," NSF, $1.08M

165. 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

166. J. Straka, K. Kanak, Davies-Jones, H. Neeman, "Challenges in understanding tornadogenesis and associated phenomena," NSF, $854K

167. P. Risser et al, "A cyberCommons for Ecological Forecasting," NSF, $6M ($2.78M OU)

168. 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)

169. P. Skubic, B. Abbott, P. Gutierrez, M. Strauss, "ATLAS Southwest Tier 2 Computing Center," NSF, $600K/year ($60K/year OU)

170. Y. Hong, "Evaluation of NASA Global Hazard System," NASA, $45K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

External Research Grants (cont'd)

171. J Wickstrom, F. Waxman et al, "Building Oklahoma's Leadership Role in Cellulosic Bioenergy," NSF EPSCoR, $15M ($5.7M OU)
172. D.S. Oliver, software, $16.7M
173. 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)
174. K. Droegemeier, F. Kong, "Multisensor Studies of Precipitation for Model Verification and Data Assimilation," U Minn, ($7K OU)
175. K. Droegemeier, M. Xue, F. Kong, "Observing System Simulation Experiments for Airborne Weather Sensors," HRL, ($33K OU)
176. M. Nollert, Scholarship, FD-OMRF, $12K
177. R. Sigal, R. Philp, C. Rai,, S. Shah, R. Slatt, C. Sondergeld, D. Zhang, energy company, $1.9M
178. B. Grady, D. Schmidtke, A. Striolo, A. Cheville, D. Teeters, "Polymer Nanostructures on Solid Surfaces,"$208K ($125K OU)
179. T. Conway, "E. coli Model Organism Resource," UN-Purdue, ($685K OU)
180. R. Kolar, "Storm Surge Modeling in SE Liousiana - 2006," ARCADIS, ($37K OU)
181. D. Cole (ORNL), A. Striolo, "Rates and Mechanisms of Mineral-Fluid Interactions at the Nanoscale," DOE, $1.65M (total), ($55K OU)
182. R. Kolar, "A Prototype Operational Modeling System for Waves, Coastal Currents, Inundation and Hydrologic Flooding for Eastern North Carolina," UN-UNC-CH, ($209K OU)
183. R. Kolar, "A Coupled Regional-Coastal Ocean Model: HYCOM/CG-ADCIRC," DOD-NRL, ($333K OU)
184. M. Xue, "Contribution to WRF Model Development by the Center for Analysis and Prediction of Storms," DOC-NOAA, $821K
185. K. Marfurt, "Improving Geologic and Engineering Models of Midcontinent Fracture and Karst Modified Reservoirs Using 3-D Seismic Attributes," UKCRINC, ($61K OU)
186. P. Attar, P. Vedula, "Novel, Optimal, Physics-based Reduced Order Models for Nonlinear Aeroelasticity," Advanced Dynamics, $49K
187. S. Dhall, "Autonomous Data Partitioning using Data Mining for High Performance Computing," NSF, ($125K OU)

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

External Research Grants (cont'd)

188. 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

189. M. Xue, "Contribution to Model Development and Enhancement Research Team by the Center for Analysis and Prediction of Storms," DOC-NOAA, $620K

190. M. Xue, K. Brewster, "Ensemble-based Data Assimilation for Convective Storms and Hurricanes," DOC-NOAA, $100,000

191. S. Schroeder, "Discovering Satellite Tobacco Mosaic Virus Structure," OCAST, $85K

192. S. Schroeder, "Computational Advacnes Toward Predicting Encapsidated Viral RNA Structure," Pharmaceutical Research and Manufactuerer's Association of America, $60K

193. R. Kolar, "Outer Boundary Forcing for Texas Coastal Models," Texas Water Development Board, $20K

194. K. Milton, "Collaborative Research: Quantum Vacuum Energy", NSF, $250K

195. A. McGovern, "Developing Spatiotemporal Relational Models to Anticipate Tornado Formation," NSF, $500K

196. Y. Kogan, "Midlatitude Aerosol-Cloud-Radiation Feedbacks in Marine Boundary Layer Clouds", ONR, $638K

197. J. Straka, K. Kanak, Davies-Jones, "Challenges in understanding tornadogenesis and associated phenomena," NSF, $854K (total), $584K (OU)

198. Y. Hong, "Improvement of the NASA Global Hazard System and Implement Server-Africa," NASA, $272K

199. 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

200. A. Striolo, "Electrolytes at Solid-Water Interfaces: Theoretical Studies for Practical Applications," OSRHE Nanotechnology, $15K

201. D. Papavassiliou, "Turbulent transport in non-homogeneous turbulence, " NSF, $320K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

OSCER State of the Center Address
Wed Sep 24 2014

External Research Grants (cont'd)

202. K. Droegemeier et al., "Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere," NSF, $17M (total), $5.6M (OU)

203. K. Droegemeier et al., "Linked Environments for Atmospheric Discovery (LEAD)," NSF, $11.25M (total), $2.5M (OU)

204. M. Strauss, P. Skubic et al., "Oklahoma Center for High Energy Physics", DOE EPSCoR, $3.4M (total), $1.6M (OU)

205. M. Richman, A. White, V. Lakshmanan, V. DeBrunner, P. Skubic, "Real Time Mining of Integrated Weather Data," NSF, $950K

206. D. Weber, K. Droegemeier, H. Neeman, "Modeling Environment for Atmospheric Discovery," NCSA, $435K

207. H. Neeman, K. Droegemeier, K. Mish, D. Papavassiliou, P. Skubic, "Acquisition of an Itanium Cluster for Grid Computing," NSF, $340K

208. J. Levit, D. Ebert (Purdue), C. Hansen (U Utah), "Advanced Weather Data Visualization," NSF, $300K

209. D. Papavassiliou, "Turbulent Transport in Wall Turbulence," NSF, $165K

210. L. Lee, J. Mullen (Worcester Polytechnic), H. Neeman, G.K. Newman, "Integration of High Performance Computing in Nanotechnology," NSF, $400K

211. R. Wheeler, "Principal mode analysis and its application to polypeptide vibrations," NSF, $385K

212. R. Kolar, J. Antonio, S. Dhall, S. Lakshmivarahan, "A Parallel, Baroclinic 3D Shallow Water Model," DoD - DEPSCoR (via ONR), $312K

213. R. Luettich (UNC), R. Kolar, B. Vieux, J. Gourley, "The Center for Natural Disasters, Coastal Infrastructure, and Emergency Management," DHS, $699K

214. D. Papavassiliou, M. Zaman, H. Neeman, "Integrated, Scalable MBS for Flow Through Porous Media," NSF, $150K

215. Y. Wang, P. Mukherjee, "Wavelet based analysis of WMAP data," NASA, $150K

216. E. Mansell, C. L. Ziegler, J. M. Straka, D. R. MacGorman, "Numerical modeling studies of storm electrification and lightning," $605K

OSCER-FACILITATED FUNDING TO DATE:
$277M total, $165M to OU

External Research Grants (cont'd)

217. 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

218. R. Wheeler, T. Click, "National Institutes of Health/Predoctoral Fellowships for Students with Disabilties," NIH/NIGMS, $80K

219. K. Pathasarathy, D. Papavassiliou, L. Lee, G. Newman, "Drag reduction using surface-attached polymer chains and nanotubes," ONR, $730K

220. D. Papavassiliou, "Turbulent transport in non-homogeneous turbulence," NSF, $320K

221. C. Doswell, D. Weber, H. Neeman, "A Study of Moist Deep Convection: Generation of Multiple Updrafts in Association with Mesoscale Forcing," NSF, $430K

222. D. Papavassiliou, "Melt-Blowing: Advance modeling and experimental verification," NSF, $321K

223. R. Kol,ar et al., "A Coupled Hydrodynamic/Hydrologic Model with Adaptive Gridding," ONR, $595K

224. D. Papavassiliou, "Scalar Transport in Porous Media," ACS-PRF, $80K

225. 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.

226. J. Gao, K. Droegemeier, M. Xue, "On the Optimal Use of WSR-88D Doppler Radar Data for Variational Storm-Scale Data Assimilation," NSF, $600K.

227. K. Mish, K. Muraleetharan, "Computational Modeling of Blast Loading on Bridges," OTC, $125K

228. V. DeBrunner, L. DeBrunner, D. Baldwin, K. Mish, "Intelligent Bridge System," FHWA, $3M

229. D. Papavassiliou, "Scalar Transport in Porous Media," ACS-PRF, $80K

230. Y. Wang, P. Mukherjee, "Wavelet based analysis of WMAP data," NASA, $150K

231. R. Wheeler et al., "Testing new methods for structure prediction and free energy calculations (Predoctoral Fellowship for Students with Disabilities)," NIH/NIGMS, $24K

232. L. White et al., "Modeling Studies in the Duke Forest Free-Air CO_2 Enrichment (FACE) Program," DOE, $730K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU ᴇ ᴍ ᴣ ᴍ

External Research Grants (cont'd)

233. Neeman, Severini, "Cyberinfrastructure for Distributed Rapid Response to National Emergencies", NSF, $132K

234. Neeman, Roe, Severini, Wu et al., "Cyberinfrastructure Education for Bioinformatics and Beyond," NSF, $250K

235. K. Milton, C. Kao, "Non-perturbative Quantum Field Theory and Particle Theory Beyond the Standard Model," DOE, $150K

236. J. Snow, "Oklahoma Center for High Energy Physics", DOE EPSCoR, $3.4M (total), $169K (LU)

237. M. Xue, F. Kong, "OSSE Experiments for airborne weather sensors," Boeing, $90K

238. M. Xue, K. Brewster, J. Gao, A. Shapiro, "Storm-Scale Quantitative Precipitation Forecasting Using Advanced Data Assimilation Techniques: Methods, Impacts and Sensitivities," NSF, $835K

239. Y. Kogan, D. Mechem, "Improvement in the cloud physics formulation in the U.S. Navy Coupled Ocean-Atmosphere Mesoscale Prediction System," ONR, $889K

240. 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

241. 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

242. B. Wanner, T. Conway, et al., "Development of the www.EcoliCommunity.org Information Resource," NIH, $1.5M (total), $150K (OU)

243. 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

244. T. Ibrahim et al., "Micro-Neural Interface," OCAST, $135K

245. J. Snow, "Langston University High Energy Physics," $155K (LU)

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

246. L.M. Leslie, M.B. Richman, C. Doswell, "Detecting Synoptic-Scale Precursors Tornado Outbreaks," NSF, $548K

247. L.M. Leslie, M.B. Richman, "Use of Kernel Methods in Data Selection and Thinning for Satellite Data Assimilation in NWP Models," NOAA, $342K

248. 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

249. E. Chesnokov, "Fracture Prediction Methodology Based On Surface Seismic Data," Devon Energy, $1M

250. E. Chesnokov, "Scenario of Fracture Event Development in the Barnett Shale (Laboratory Measurements and Theoretical Investigation)," Devon Energy, $1.3M

251. 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

252. A. Striolo, "Heat Transfer in Graphene-Oil Nanocomposites: A Molecular Understanding to Overcome Practical Barriers." ACS Petroleum Research Fund, $40K

253. D.V. Papavassiliou, "Turbulent Transport in Anisotropic Velocity Fields," NSF, $292.5K

254. D. Oliver, software license grant, $1.5M

255. R. Broughton et al, "Assembling the Eutelost Tree of Life – Addressing the Major Unresolved Problem in Vertebrate Phylogeny," NSF, $3M ($654K to OU)

256. A. Fagg, "Development of a Bidirectional CNS Interface or Robotic Control," NIH, $600K

257. M. Xue, J. Gao, "An Investigation on the Importance of Environmental Variability to Storm-scale Radar Data Assimilation," NSSL, $72K

258. JV. Sikavistsas and D.V. Papavassiliou , "Flow Effects on Porous Scaffolds for Tissue Regeneration," NSF, $400K

259. P. Skubic, M. Strauss, et al., "Experimental Physics Investigations Using Colliding Beam Detectors at Fermilab and the LHC," DOE, $503K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

260. Y. Wang, "Science for the Euclid Mission", NASA/JPL, $52K (2014)
261. D. LaDue, K. Kloesel, "EPSCoR Funded Participant in the National Weather Center Research Experiences for Undergraduates Program," Oklahoma EPSCoR, $9K
262. V. Sikavitsas, D. Papavassiliou, "The influence of fluid shear forces, oxygen and nutrient mass transport in the development of bone grafts in perfusion bioreactors," OCAST,, $45K
263. D. Schmidtke, D. Papavassiliou, "Development of a Miniature Right Heart Support Device," NIH, $347K
264. D. Resasco, D. Papavassiliou, "Interfacially active SWNT/silica nanohybrids," Advanced Energy Consortium, $688K
265. B. L. Cheong, T.-Y. Yu, R. .D. Palmer, "Instrumental Support for the Winter Experiment Campaign," SELab Inc, $215K
266. E. Bridge, "CAREER: Unwrapping the Migratory Gene Package," NSF, $760K
267. E. Bridge, "The Electronic Transponder Analysis Gateway (ETAG): An Animal Behavior Observatory," NSF, $315K
268. E. Bridge, "An Open-Source Radio Frequency Identification System for Animal Monitoring," NSF, $331K
269. R. McPherson, E. White, M. Shafer, D. Rosendahl, M. Richman, "Trends in cold temperature extremes and winter weather for the SPTC region," USDOT, $132K
270. R. Palmer, B. Cheong, C. Fulton, J. Salarzar, M. Yeary, T.-Y. Yu, Y. Zhang,. "Meeting the Technical Challenges of the Multi-Mission Phased Array Radar," NOAA, $1.65M
271. M. J. McInerney, L. Krumholz, Bioremediation of Chromium and Arsenic from Industrial Wastewater," Nat'l Academies of Science, $162K
272. M. Coniglio (PI), C. Doswell III, R. J. Trapp
273. "Improved understanding of convective-storm predictability and environment feedbacks from observations during the Mesoscale Predictability Experiment (MPEX)," NSF, $272K
274. Y. Kogan, "Parameterization of Cumulus Convective Cloud Systems in Mesoscale Forecast Models," ONR, $267K
275. S. Schroeder, "Predicting Viral RNA Structures, Function, and Drug Targets from Sequence," OCAST, $145K

OSCER-FACILITATED FUNDING TO DATE:
$277M total, $165M to OU

External Research Grants (cont'd)

276. L. Ding, "NRI-Small: Robot Assistants for Promoting Crawling and Walking in Children at Risk of Cerebral Palsy," NSF, $1.135M

277. M. Elwood Madden, G. Soreghan, A. Callaghan, J. Volz, M. Nannny, "Acquisition of a High Resolution Raman Mapping Microscope," NSF, $294K

278. E. Baron, "Collaborative Research: Three-Dimensional Simulations of Type Ia Supernovae Constraining Models with Observations," NSF, $26K

279. H. Neeman, K. Brewster, A. McGovern, H. Severini, T. Yu, M. Atiquzzaman, G. Creager, B. George, Z. Gray, S. Radhakrishnan, P. Skubic, M. Strauss, X. Xiao, M. Xue, "A Model for Advanced Cyberinfrastructure Research and Education Facilitators," NSF, $400K

280. E. Lemley, G. Qian, "MRI: Acquisition of a High Performance Computing Cluster for Research at a Predominantly Undergraduate Institution," NSF, $305K

281. R. Floyd, J. Pei, "Understanding the Behavior of Prestressed Concrete Girders after Years of Service," OK DOT, $327K

282. G. Zhang, S. Arani, "Polarimetric Phased Array Radar Research in Support for MPAR Strategy," NOAA, $438K

283. A. Fierro, M. DeMaria, E. Mansell, C./ Ziegler, D. MacGorman, A.Schumacher, R. Brummer. "Using total lightning data from GLM/GOES-R to improve real-time tropical cyclone genesis and intensity forecasts," NOAA, $268K ($123K to OU)

284. U. Hansmann, "Folding, Mis-folding and Aggregation of Proteins," NIH, $887K

285. G. R. Keller, S. Holloway, D. Devegowda, K. Crain, A. Holland, A. Ghassemi, "4D Integrated Study Using Geology, Geophysics, Reservoir Modeling and Rock Mechanics to Development Assessment Models for Potential Induced Seismicity Risk,." $1.478M

286. J. Gao, D. Stensrud, X. Wang, "Assimilation of Doppler Radar Data with an Ensemble-based Variational Method for Storm-scale NWP," NSF, $481K

287. M. Soe (RSU), "Unitary Qubit Lattice Algorithms for Quantum Turbulence with Non-Abeliam Vortices," NSF, $75K,

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

External Research Grants (cont'd)

288. J. Cruz, "Two-Dimensional Channel Modeling, Detection and Coding for Shingled Magnetic Recording," NSF, $419K,

289. J. Shaffer, "Laser Stabilization System for Rydberg Atom Physics," Army Research Office, $75K

OSCER-FACILITATED FUNDING TO DATE: $277M total, $165M to OU

External Funding Summary

- External research funding facilitated by OSCER (Fall 2001- Fall 2013): **$277M total, $165M to OU** (60%)

- Funded projects: **OVER 280**

- **134** OU faculty and staff in **21** academic departments and **6** non-academic units

- Comparison: Fiscal Year 2002-14 (July 2001 – June 2014): OU Norman externally funded research expenditure: $984M

Since being founded in fall of 2001, OSCER has enabled research projects comprising better than **1 / 6 of OU Norman's total externally funded research expenditure**, with an **8-to-1 return on investment**.

Publications Facilitated by Research IT

- Publications facilitated by Research IT resources
    - **2014: 188** (so far)
    - 2013: 207
    - 2012: 283
    - 2011: 204
    - 2010: 142
    - 2009: 107
    - 2008: 109
    - 2007: 77
    - 2006: 94
    - 2005: 64
    - 2004: 26
    - 2003: 9
    - 2002: 8
    - 2001: 3

TOTAL SO FAR: 1521 publications

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

Includes 32 MS theses, 30 PhD dissertations.

Oklahoma Cyberinfrastructure Initiative

2008-13

OK Cyberinfrastructure Initiative

- All academic institutions in Oklahoma are eligible to sign up for free use of OU's and OSU's centrally-owned CI resources.

- Other kinds of institutions (government, non-governmental) are eligible to use, though not necessarily for free.

- Everyone can participate in our CI education initiative.

- The Oklahoma Supercomputing Symposium, our annual conference, continues to be offered to all.

- Triggered by OK's NSF EPSCoR RII Track-1 2008-13.

OCII Goals

- **<u>Reach</u>** institutions outside the mainstream of advanced computing.

- **<u>Serve</u>** every higher education institution in Oklahoma that has relevant curricula.

- **<u>Educate</u>** Oklahomans about advanced computing.

- **<u>Attract</u>** underrepresented populations and institution types into advanced computing.

OCII Service Methodologies Part 1

- **<u>Access (A)</u>**: to supercomputers and related technologies (20 OK academic institutions to date).

- **<u>Dissemination (D)</u>**: Oklahoma Supercomputing Symposium – annual advanced computing conference (25 OK academic institutions to date).

- **<u>Education (E)</u>**: "Supercomputing in Plain English" (SiPE) workshop series: 11 talks about advanced computing, taught with stories, analogies and play rather than deep technical jargon. Have reached 248 institutions (academic, government, industry, nonprofit) in 47 US states and territories and 10 other countries (14 OK academic institutions to date).

OCII Service Methodologies Part 2

- **<u>Faculty/Staff Development (F)</u>**: Workshops held at OU and OSU on advanced computing and computational science topics, sponsored by the National Computational Science Institute, the SC supercomputing conference series, the Linux Clusters Institute, the Virtual School for Computational Science & Engineering. Oklahoma is the only state to have hosted multiple events sponsored by each of these (18 OK academic to date).

- **<u>Outreach (O)</u>**: "Supercomputing in Plain English" (SiPE) overview talk (24 OK academic to date).

- **<u>Proposal Support (P)</u>**: Letters of commitment for access to OCII resources; collaborations with OCII lead institutions (4 OK academic, 1 nongovernmental).

OCII Service Methodologies Part 3

- **Technology (T)**: Got or helped get technology (e.g., network upgrade, mini-supercomputer, hi def video camera for telepresence) for that institution (14 OK academic to date).
- **Workforce Development (W)** – (36 OK academic)
  - Oklahoma Information Technology Mentorship Program (OITMP)
  - "A Day in the Life of an IT Professional" presentations to courses across the full spectrum of higher education.
  - Job shadowing opportunities and direct mentoring of individual students.
  - Institution Types: high schools, career techs, community colleges, regional universities, PhD-granting universities.
- Special effort to reach underrepresented populations: underrepresented minorities, non-PhD-granting, rural

OCII Institution Profile

To date, OCII has served 100 Oklahoma institutions, agencies and organizations:

- 52 OK academic (2 more booked this semester)
- 48 OK non-academic

OCII Institution Profile

To date, OCII has served 100 Oklahoma institutions, agencies and organizations:

- 52 OK academic
  - Universities & Colleges
    - 3 comprehensive PhD-granting
    - 20 regional non-PhD-granting
  - Community Colleges: 10
  - Career techs: 13
  - Secondary schools: 4
  - Public school systems: 2
- 48 OK non-academic

OCII Institution Profile

So far, OCII has served:

- 52 OK academic
  - 9 Minority Serving Institutions
  - 15 other institutions with above state average and national average for one or more underrepresented minorities
- 48 OK non-academic

Minority Serving Institutions

- Oklahoma's only Historically Black College or University
  - Langston U (Langston)
- Native American Serving Non-tribal Institutions
  - East Central U (Ada)
  - Northeastern Oklahoma A&M College (Miami)
  - Northeastern State U (Tahlequah)
  - Southeastern Oklahoma State U (Durant)
- Tribal Colleges
  - College of the Muscogee Nation (Okmulgee)
  - Comanche Nation College (Lawton)
  - Pawnee Nation College (Pawnee)
- Other Minority Serving Insitution
  - Bacone College (Muskogee)

OCII Institution Profile

To date, OCII has served 100 Oklahoma institutions, agencies and organizations:

- 52 OK academic institutions
- 48 OK non-academic organizations
  - 16 commercial
  - 19 government
  - 2 military
  - 11 non-governmental

OCII Academic Institutions

1. **Bacone College (<u>MSI</u>, 25.0% AI, 29.8% AA): T**

2. **Cameron U (16.6% AA): A, D, E, F, O, T, W**

   Taught <u>advanced computing course</u> using OSCER's supercomputer (multiple times).

3. Canadian Valley Tech Center: W

4. Chisholm Trail Tech Center: W

5. **College of the Muscogee Nation (<u>Tribal</u>): O, T**

6. **Comanche Nation College (<u>Tribal</u>): D, O, T**

7. DeVry U Oklahoma City: D, F, O

8. **East Central U (<u>NASNI</u>, 16.9% AI, <u>rural</u>): A, D, E, F, O, P, T, W**

   Taught <u>advanced computing course</u> using OSCER's supercomputer.

9. **Eastern Oklahoma State College (24.9% AI): W**

10. Eastern Oklahoma County Tech Center: W

11. Elgin Middle School: O (tour only)

12. Francis Tuttle Tech Center: D, T, W

13. **Gordon Cooper Tech Center (13.5% AI, <u>nonmetro</u>): D, O, W**

14. **Great Plains Tech Center (11.5% AI): W**

15. **Kiamichi Tech Center (18.5% AI): T, W**

16. **Langston U (<u>HBCU</u>, 77.2% AA): A, D, E, F, O, P, T, W**

    *<u>NSF Major Research Instrumentation</u> grant for supercomputer <u>**awarded**</u> in 2012.*

    <u>Note</u>: Langston U (HBCU), East Central U (NASNI) and U Central Oklahoma are the only non-PhD-granting institutions to have benefited from every category of service that OCII provides.

Average: ~3 (mean 3.5, median 3, mode 1)

AA = African American (7.7% OK population, 13.2% US population)
AI = American Indian (9.0% OK, 1.2% US)
H = Hispanic (9.6% OK, 17.1% US)
ALL = 26.3% OK, 31.5% US

HBCU: Historically Black College or University
NASNI = Native American Serving Non-Tribal Institution
MSI = Minority Serving Institution

OSCER State of the Center Address
Wed Sep 24 2014

17. Lawton Christian School (high school): W
18. **Metro Tech Centers (29.3% AA): D**
19. Mid-America Tech Center: D, W
20. Mid-Del Public Schools: D
21. Moore Norman Tech Center: D, W
22. **Northeast Tech Center (21.5% AI): W**
23. **Northeastern Oklahoma A&M College (NASNI, 22.6% AI): T, W**
24. **Northeastern State U (NASNI, 22.4% AI, nonmetro): A, D, E, F, O, T, W**

    Taught computational chemistry course using OSCER's supercomputer (multiple).

25. Northwestern Oklahoma State U: A, F, O
26. Oklahoma Baptist U (nonmetro): A, D, E, F, O, T, W
27. Oklahoma Christian U: O, W

28. Oklahoma City Community College: O, T, W
29. Oklahoma City U: A, D, E, F, O, T, W

    *Educational Alliance for a Parallel Future mini-supercomputer proposal **funded** in 2011.*

    Taught advanced computing course using OSCER's supercomputer (multiple).

30. **Oklahoma Panhandle State U (rural): A,D,O,W**
31. Oklahoma School of Science & Mathematics (high school): A, D, E, O, W
32. Oklahoma State U (PhD): A, D, E, F, O, P, T, W

    *NSF Major Research Instrumentation proposal for supercomputer **funded** in 2011.*

33. **Oklahoma State U Institute of Technology (community college, 19.9% AI): W**

    Average: ~3 (mean 3.5, median 3, mode 1)

AA = African American (7.7% OK population, 13.2% US population)
AI = American Indian (9.0% OK, 1.2% US)
H = Hispanic (9.6% OK, 17.1% US)
ALL = 26.3% OK, 31.5% US

HBCU: Historically Black College or University
NASNI = Native American Serving Non-Tribal Institution
MSI = Minority Serving Institution

OSCER State of the Center Address
Wed Sep 24 2014

34. **Oklahoma State U OKC (16.0% AA, community college): O, T, W**
35. **Oral Roberts U (17.7% AA): A, F, O, W**
36. Panola Public Schools: D
37. **Pawnee Nation College (Tribal): T**
38. **Pontotoc Tech Center (41.6% AI): T, W**
39. **Rogers State U (12.9% AI): A, D, F, O**
    Taught computational chemistry course using OSCER's supercomputer.
34. **Rose State College (18.0% AA): F, W**
35. **Sequoia High School (Tribal): W**
36. St. Gregory's U (nonmetro): A, D, E, F, O
37. **Southeastern Oklahoma State U (NASNI, 21.0% AI, nonmetro): A, D, E, F, O, T, W**
    Educational Alliance for a Parallel Future mini-supercomputer grant funded in 2011.
44. **Southern Nazarene U (16.0% AA): A,D,F,O,P,T,W**
    Taught computational chemistry course using OSCER's supercomputer.

45. **Southern OK Tech Center (10.7% AI): T, W**
46. Southwestern Oklahoma State U (rural): A, D, E, F, O, T, W
    Taught advanced computing course using OSCER's supercomputer (multiple).
47. Tulsa Community College: F, W
48. U Central Oklahoma: A, D, E, F, O, P, T, W
    NSF Major Research Instrumentation proposal for supercomputer submitted in 2011-13.
49. U Oklahoma (PhD): A, D, E, F, O, P, T, W
    NSF Major Research Instrumentation grant for large scale storage funded in 2010.
50. U Phoenix: D
51. **U of Science & Arts of Oklahoma (11.7% AI): A, O**
52. U Tulsa (PhD): A, D, E, F, O, P, T, W
    Taught bioinformatics course using OSCER's supercomputer.

Average: ~3 (mean 3.5, median 3, mode 1)

AA = African American (7.7% OK population, 13.2% US population)
AI = American Indian (9.0% OK, 1.2% US)
H = Hispanic (9.6% OK, 17.1% US)
ALL = 26.3% OK, 31.5% US

HBCU: Historically Black College or University
NASNI = Native American Serving Non-Tribal Institution
MSI = Minority Serving Institution

OCII Non-academic

Commercial (16)

1. Andon Corp : D, F
2. Chesapeake Energy Corp : D
3. Creative Consultants : D
4. Fusion Geophysical: D
5. Indus Corp: D, E
6. Information Techknologic: D
7. KANresearch: D
8. KeyBridge Technologies: D
9. Lumenate: D
10. OGE Energy Corp: D
11. Perfect Order (now defunct): D
12. PowerJam Production Inc: D
13. Versatile: D
14. Visage Production Inc: D, E
15. Weather Decision Technologies Inc : A
16. Weathernews Americas Inc.: A, D

Government (19)

1. City of Duncan: D
2. City of Edmond: D
3. City of Nichols Hills: D
4. City of Tulsa: E
5. NOAA National Severe Storms Laboratory: A, D, E, F
6. NOAA Storm Prediction Center: D
7. NOAA National Weather Service: D
8. NOAA Radar Operations Center: D
9. OK Climatological Survey: D
10. OK Department of Health: D, E
11. OK Department of Human Services: D, E
12. OK Department of Libraries: D
13. OK Department of Mental Health and Substance Abuse Services: D
14. OK Office of State Finance: D
15. Oklahoma State Chamber of Commerce: D
16. OK State Regents for Higher Education: A, D, T
17. OK State Supreme Court: D
18. OK Tax Commission: D
19. Tulsa County Court Services: D

OCII Non-academic (cont'd)

- Military (2)
    1. Fort Sill Army Base: E
    2. Tinker Air Force Base: A, D, E, F, O
- Non-governmental/non-profit (11)
    1. American Society of Mechanical Engineers, Oklahoma City chapter: O
    2. Engineering Club of Oklahoma City: O
    3. Lions Club of Norman OK: O
    4. Lions Club of Shawnee OK: O
    5. Norman Science Café: O
    6. Oklahoma EPSCoR: D
    7. Oklahoma Historical Society: D
    8. Oklahoma Innovation Institute/Tulsa Research Partners: A, D, E, O, P
    9. Oklahoma Medical Research Foundation: A, D, P
    10. Oklahoma Nanotechnology Initiative: D
    11. Samuel Noble Roberts Foundation (**rural**): A, D, E, F, T

OCII Outcomes: Research

- External research funding to OK institutions facilitated by OCII lead institutions (Fall 2001- Summer 2013): **over $165M**
- Funded projects facilitated: **over 280**
- OK faculty and staff: **over 130** in **~20** academic disciplines
- Publications facilitated: **over 1500**

OCII Outcomes: Research

- Specifically needed OCII just to be funded: **over $42M** (OneOCII necessary but far from sufficient)
    1. NSF EPSCoR RII Track-1 (2008-13): $15M to OK
    2. NSF EPSCoR RII Track-1 (2013-18): $20M to OK (+$4M Regents)
    3. NSF EPSCoR RII Track-2: $3M to OK
    4. NSF EPSCoR RII C2: $1.17M to OK
    5. NSF MRI (OU): $793K
    6. NSF MRI (OSU): $908K
    7. NSF MRI (Langston U): $250K
    8. NSF CC-NIE (OU, OSU, LU, OII, OneNet): $500K
    9. NSF MRI (UCO): $305K
    10. NSF CC*IIE (OU): $400K
    11. NSF CC*IIE (GPN, OneNet, others): $130K

OCII Outcomes: MRI Grants

- NSF Major Research Instrumentation for CI: **over $2.5M**
    - NSF MRI (OU): $340K, 2003
    - NSF MRI (OU): $793K, 2010
    - NSF MRI (OSU): $908K, 2011
    - NSF MRI (Langston U): $250K, 2012
    - NSF MRI (UCO): $305K, 2014
- How do we stack up (since 2001 when OSCER was founded)?
    - OK: 15.5% of funding, 11% of PIs, 13% of awards
    - OU: 13.5% of funding
        - Among units, IT is 4th in number of awards, 4th in total funding.
        - Among PIs, Neeman is 1st in awards and 1st in funding (13.5%).
    - OSU: 18.5% of funding
    - Langston U: 100% of funding
    - UCO: 70% of funding; Lemley is 1st in funding

OCII Outcomes: Education

Teaching: 9 institutions including 3 MSIs

- Teaching/taught parallel computing using OneOCII resources:
  - Cameron U – multiple times
  - East Central U (NASNI)
  - Oklahoma City U – multiple times
  - Southwestern Oklahoma State U
- Taught parallel computing via LittleFe baby supercomputer and OneOCII resources:
  - Southeastern Oklahoma State U (NASNI) – multiple times
- Taught computational chemistry using OSCER resources:
  - Northeastern State U (NASNI) – multiple times
  - Southern Nazarene U
  - Rogers State U – multiple times
- Taught Bioinformatics using OCII resources:
  - U Tulsa – 2 semester sequence

OCII Outcomes: Resources

7 institutions including 2 MSIs, plus C2 institutions

- NSF Major Research Instrumentation grants: $1.95M
  - <u>OU</u>: Oklahoma PetaStore, $793K (in production)
  - <u>Oklahoma State U</u>: Cowboy cluster, $909K (in production)
  - <u>Langston U</u>: cluster, $250K (recently deployed)
  - **<u>NEW! U Central Oklahoma</u>**: cluster, $305K (just awarded)
- LittleFe baby supercomputer grants ($2500 each)
  - <u>OU</u>: Ron Barnes
  - <u>Oklahoma City U</u>: Larry Sells & John Goulden
  - <u>Southeastern Oklahoma State U</u>: Mike Morris & Karl Frinkle
- Networking: C2 grant: $1.17M, CC-NIE grant $500K

OK Optical Initiative (NSF EPSCoR C2)

- Hardware
  - <u>Statewide Ring upgrade</u>: replaced routed mux/demuxes with Reconfigurable Optical Add Drop Modules: much less expensive and much more straightforward to add new 10G circuits.
  - Institutional upgrades
    - <u>OU and OSU</u>: cluster upgraded to 10G shared from GigE (10X), then upgraded to 20G (2 x 10G) dedicated (20X), which is connected to Internet2's 100G Innovation Platform backbone.
    - <u>OU</u>: mini-Science DMZ.
    - <u>U Tulsa</u>: upgraded to GigE from 200 Mbps (5X).
    - <u>Samuel Roberts Noble Foundation</u>: (private non-profit research institutions): upgraded to GigE from 45 Mbps for research (22X), 100 Mbps for commodity (2X)

OK Optical Initiative (NSF EPSCoR C2)

- Hardware (continued)
  - Institutional Upgrades (continued)
    - <u>Langston U</u> (Oklahoma's only Historically Black College or University): upgraded to 10G from 100 Mbps (100X) for research.
    - <u>Bacone College</u> (Minority Serving Institution): campus backbone upgraded to 100 Mbps with GigE core from 10 Mbps (10X upgrade).
    - <u>College of the Muscogee Nation</u> (Tribal): network core for new residence hall.
    - <u>Comanche Nation College</u> (Tribal) distance learning system.
    - <u>Pawnee Nation College</u> (Tribal) Internet radio station, distance learning system, campus backbone upgrade to GigE.
- <u>OK IT Mentorship Program</u>

OK Optical Initiative Side Effects

- 100G connection to Internet2's Innovation Platform
- OU+OSU Shared Services initiative: leveraging C2 investments to create enterprise IT collaborations both within and between the institutions.
    - OU Virtual data center – highly robust
    - Virtualized services
    - Substantial savings from shared infrastructure and shared purchasing vehicles.
    - **NOT AT ALL FUNDED BY C2.**
    - But, leverages C2 capabilities – if not for the C2, Shared Services would have had to make the exact same investments in the state ring.

OCII HPC (2008-12)

Just over 40 TFLOPs of HPC capacity across the state:

- OU: 34.5 TFLOPs (internally funded)
- OSU: 6.3 TFLOPs (internally funded)

Education, Outreach, Training, etc

- Education
  - Supercomputing in Plain English (SiPE)
- Outreach
  - SiPE Overview Talk, Cyberinfrastructure tours
- Training
  - Various technology trainings (run by vendors)
- Faculty/Staff Development
  - Summer workshops
- Workforce Development
  - Oklahoma IT Mentorship Program

Supercomputing in Plain English

- **FREE and OPEN TO ALL**
- Provided every other spring (upcoming Spring 2015)
- Available LIVE via videoconferencing
- Topics http://www.oscer.ou.edu/education/
    1. Overview: What the Heck is Supercomputing?
    2. The Tyranny of the Storage Hierarchy
    3. Instruction Level Parallelism
    4. Stupid Compiler Tricks
    5. Shared Memory Multithreading
    6. Distributed Multiprocessing
    7. Application Types and Parallel Paradigms
    8. Multicore Madness
    9. High Throughput Computing
    10. GPGPU: Number Crunching in Your Graphics Card
    11. Grab Bag: Scientific Libraries, I/O Libraries, Visualization

SiPE Participants

- 248 institutions, firms, agencies and organizations in 47 US states & territories and 10 other countries
  - Academic: 178 institutions in 46 US states & territories and 6 other countries
    - 69 institutions in 23 EPSCoR jurisdictions
      - 15 institutions in Oklahoma
  - Industry: 26 firms in the US and 1 other country
  - Government: 29 – US federal and state plus 4 other countries
  - Non-Governmental: 15 (US and 1 other country)
- Missing US states & territories
  - EPSCoR states: MT, NH, RI, VT, WY
  - EPSCoR territories: US Virgin Islands, Guam (no PhD-granting)
  - Other territories: American Samoa, Northern Marianas Islands

Outreach: Presentations & Tours

- Courses at OU
    1. Chem Engr: Industrial & Environmental Transport Processes (D. Papavassiliou)
    2. Engineering Numerical Methods (U. Nollert)
    3. Math: Advanced Numerical Methods (R. Landes)
    4. Electrical Engr: Computational Bioengineering (T. Ibrahim)
- Research Experience for Undergraduates at OU
    1. Ind Engr: Metrology REU (T. Reed Rhoads)
    2. Ind Engr: Human Technology Interaction Center REU (R. Shehab)
    3. Meteorology REU (D. Zaras)
- External
    1. American Society of Mechanical Engineers, OKC Chapter
    2. Engineering Club of Oklahoma City
    3. Association for Computing Machinery (ACM) Special Interest Group on Computer Science Education (SIGCSE) 2010
    4. Oklahoma State Chamber of Commerce
    5. National Educational Computing Conference 2006 (virtual tour via videoconference)
    6. Norman (OK) Lions Club
    7. Society for Information Technology & Teacher Education conference 2008, 2009, 2010
    8. Acxiom Conference on Applied Research in Information Technology 2008
    9. Shawnee (OK) Lions Club
    10. Oklahoma Louis Stokes Alliance for Minority Participation (@ OSU) 2010 (Keynote)
    11. Norman (OK) Science Café
    12. Tech Forum Texas 2010
    13. Texas Computer Education Association 2011
    14. Tinker Air Force Base
    15. Consortium for School Networking 2011
    16. Consortium for Computing Sciences in Colleges 2011 (Keynote)
    17. SC07-13

- Other Universities
    1. SUNY Binghamton (NY)
    2. Bradley University (IL)
    3. Cameron University (OK)
    4. The Citadel (SC)
    5. College of the Muscogee Nation (OK)
    6. Comanche Nation College (OK)
    7. DeVry University (OK)
    8. East Central University (OK)
    9. El Bosque University (Bogota Colombia)
    10. Southwestern University (TX)
    11. Langston University (OK)
    12. Louisiana State University
    13. Midwestern State University (TX)
    14. Northeastern Oklahoma State University
    15. Northwestern Oklahoma State University
    16. Oklahoma Baptist University
    17. Oklahoma City University
    18. Oklahoma State University x 2
    19. Oklahoma State University – OKC
    20. Oral Roberts University (OK) x 2
    21. Rogers State U (OK)
    22. Philander Smith College (AR)
    23. St. Gregory's University (OK) x 2
    24. Southeastern Oklahoma State University x 2
    25. Southern Nazarene University (OK)
    26. Southwestern Oklahoma State University x 2
    27. Texas A&M-Commerce
    28. University of Arkansas Fayetteville
    29. University of Arkansas at Little Rock
    30. University of Arkansas at Pine Bluff
    31. University of Central Oklahoma
    32. University of Oklahoma-Tulsa
    33. University of Science & Arts of Oklahoma
    34. University of Texas Brownsville
    35. University of Tulsa (OK)
- High Schools and High School Programs
    1. Oklahoma School of Science & Mathematics x 2
    2. Oklahoma Christian University's Opportunity Bytes Summer Academy
    3. Dept of Energy National Scholarship Finalists
    4. Ardmore High School (OK)
    5. Elgin Middle School

Fac/Staff Dev: Summer Workshops

- National Computational Science Institute workshops
  - Intro to Parallel Programming & Cluster Computing weeklong: summer 2004, summer 2005, summer 2008, summer 2009, summer 2012
  - Intro to Parallel Programming & Cluster Computing daylong: fall 2003, fall 2007-11
  - Intermediate Parallel Programming & Cluster Computing weeklong: summer 2010, summer 2011
    - LittleFe baby supercomputer buildout (summer 2011 – first ever anywhere; summer 2012)
  - Computational Chemistry for Chemistry Educators weeklong: summer 2009, summer 2011
  - Many of these were co-sponsored by Oklahoma EPSCoR (2008-2012) and/or the SC Education Program (2007-9, 2011)

Fac/Staff Dev: Summer Workshops

- Linux Clusters Institute workshops: June 2005, Feb 2007
  - Selected to host the next LCI workshop (2015)
- Virtual School for Computational Science & Engineering weeklong
  - 2012: Programming Heterogeneous Parallel Computing Systems; Proven Algorithmic Techniques for Many-core Processors (both on GPU computing)
  - 2013, 2014: Data Intensive Summer School (big data)
- Software Carpentry Bootcamp (2013): Python, scripting, version control etc
- Bioinformatics weeklong (2012, 2014)
- <u>SUMMARY</u>: Every summer 2004-2013 except 2006, 2007.

OK IT Mentorship Program

The <u>Oklahoma Information Technology Mentorship Program</u> is sending networking professionals to universities, colleges, career techs and even a high school statewide.

These professionals will give talks on the practicalities of being a networking professional – what that career choice means day by day.

We also provide both live and virtual job shadowing opportunities – students can follow networking professionals around to see what their work looks like, either in person or via Twitter and Facebook.

So far we've done 95 events for 36 institutions, with 2 new institutions scheduled in fall 2014.

OneOklahoma Cyberinfrastructure Initiative
## 2013-18

OneOklahoma Cyberinfrastructure Initiative

2013-18

Resource Providers: OU, OSU, TSC, Langston (HBCU, HEP)

- <u>All OCII Services</u>
- <u>Informatics</u>: Research facilitators (NOT researchers) who embed in specific research teams . Expands Informatics team from just OU to OSU, available to others statewide.
- <u>cyberCommons</u>: adaptable Big Data environment developed under OK-KS Track-2 (2009-13).
- <u>Data Stewardship Initiative</u>: collaboration among CI and Libraries.
- <u>OK STEM Mentorship Program</u>: extended OK IT Mentorship Program to other STEM disciplines.
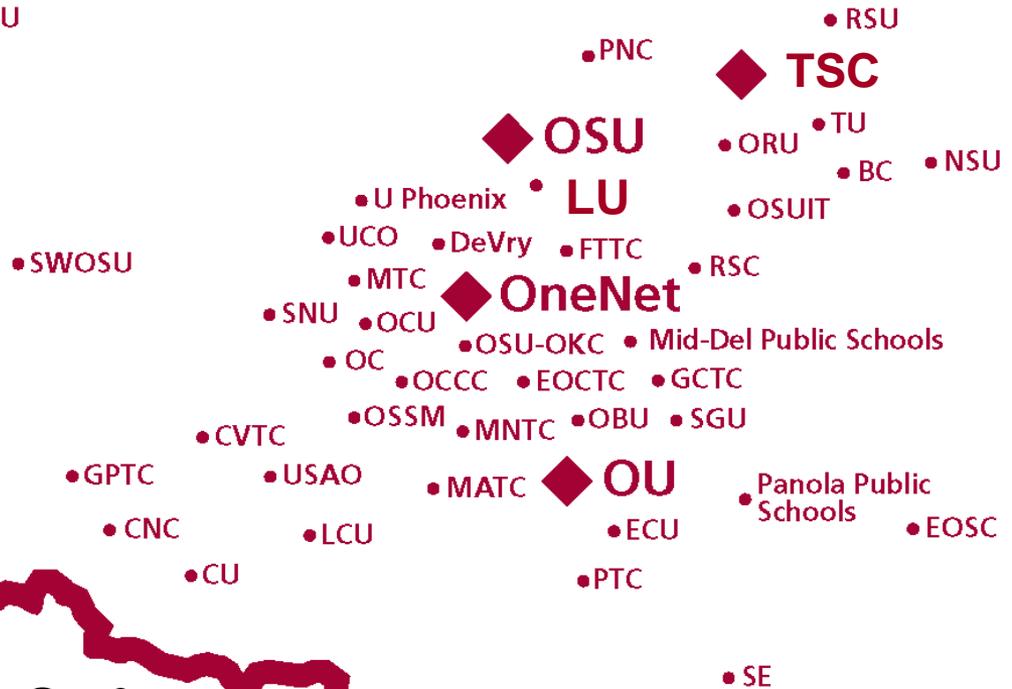
So far:
52 OK academic
48 OK non-academic

- OPSU
- NWOSU
- RSU
- PNC
- ◆ TSC
- ◆ OSU
- TU
- ORU
- BC
- NSU
- LU
- U Phoenix
- OSUIT
- SWOSU
- UCO
- DeVry
- FTTC
- RSC
- MTC
- ◆ OneNet
- SNU
- OCU
- OSU-OKC
- Mid-Del Public Schools
- OC
- OCCC
- EOCTC
- GCTC
- OSSM
- MNTC
- OBU
- SGU
- CVTC
- GPTC
- USAO
- MATC
- ◆ OU
- Panola Public Schools
- CNC
- LCU
- ECU
- EOSC
- CU
- PTC
- SE

OneOCII
OneOklahoma Cyberinfrastructure Initiative

NEW! OneOCII

All of OCII, plus:

- <u>Informatics</u> professionals: research facilitators embedded in specific research projects (and largely funded by them)
- <u>CyberCommons</u> (from old NSF EPSCoR RII Track-2 grant)
  - Software platform for end-to-end research workflow support
- Physical resources
  - <u>Research Cloud</u>: research teams can buy virtual servers
  - <u>Hadoop</u> cluster
- <u>Data Stewardship Initiative</u> (led by Libraries)
- <u>Oklahoma STEM Mentorship Program</u> (not just IT) – already 20 institutions signed up, including 3 new

NSF EPSCoR RII Track-1

- "Adapting Socio-ecological Systems to Increased Climate Variability"

- OU, OSU, U Tulsa, Noble Foundation

- $24M ($20M NSF, $4M State Regents) over 5 years

- Includes just under $1M for Informatics
    - OU: heavy in Year 1 and first half of Year 2, light thereafter
    - OSU: nothing in Year 1 and first half of Year 2, 1 FTE thereafter
    - Sustainability plan, in place, guarantees at least through 2021

OneOCII HPC

Just over 200 TFLOPs of HPC capacity across the state (5X increase from 2008-12)

- <u>OU</u>: 111.6 TFLOPs, acquired 2012 (internally funded)

- <u>OSU</u>: 48.8 TFLOPs, acquired 2012 (NSF MRI)

- <u>Langston U</u>: 8 TFLOPs CPU, 18.72 TFLOPs GPU, acquiring 2013 (NSF MRI)

- <u>Tandy Supercomputing Center</u> (Tulsa): 34.56 TFLOPs, acquired 2013 (independently of OCII/OneOCII)

- **<u>UCO</u>: coming soon!**

OK STEM Mentorship Program

- Already have presenters signed up for:
  - Agriculture
  - Earth Sciences
    - Atmospheric Sciences: Meteorology
    - Ecological Sciences: Ecology, Rangeland Ecology, Urban Ecology
    - Geographical Sciences: Geography, Geographic Information Systems
  - Engineering: IT/CS
  - Libraries
  - Life Sciences: Plant Biology
  - Social Sciences: Anthropology, Economics, Political Science

OneOklahoma Friction Free Network

2013-15

NSF CC-NIE Grant

48.8 TFLOPs (NSF MRI)
OSU (Stillwater)
8 TFLOPs (NSF MRI)
Langston

Cowboy

Innovation Platform

34.5 TFLOPs

OneNet IP Link

DYNES

Commodity ISP

OneNet Optical

OneNet Optical

Tulsa City Hall
Tandy

OF — OpenFlow Ctlr
SDN — SDN Switch
HPC Cluster
Research Ntwrk

OU (Norman)
111.6 TFLOPs PetaStore (NSF MRI)
Boomer
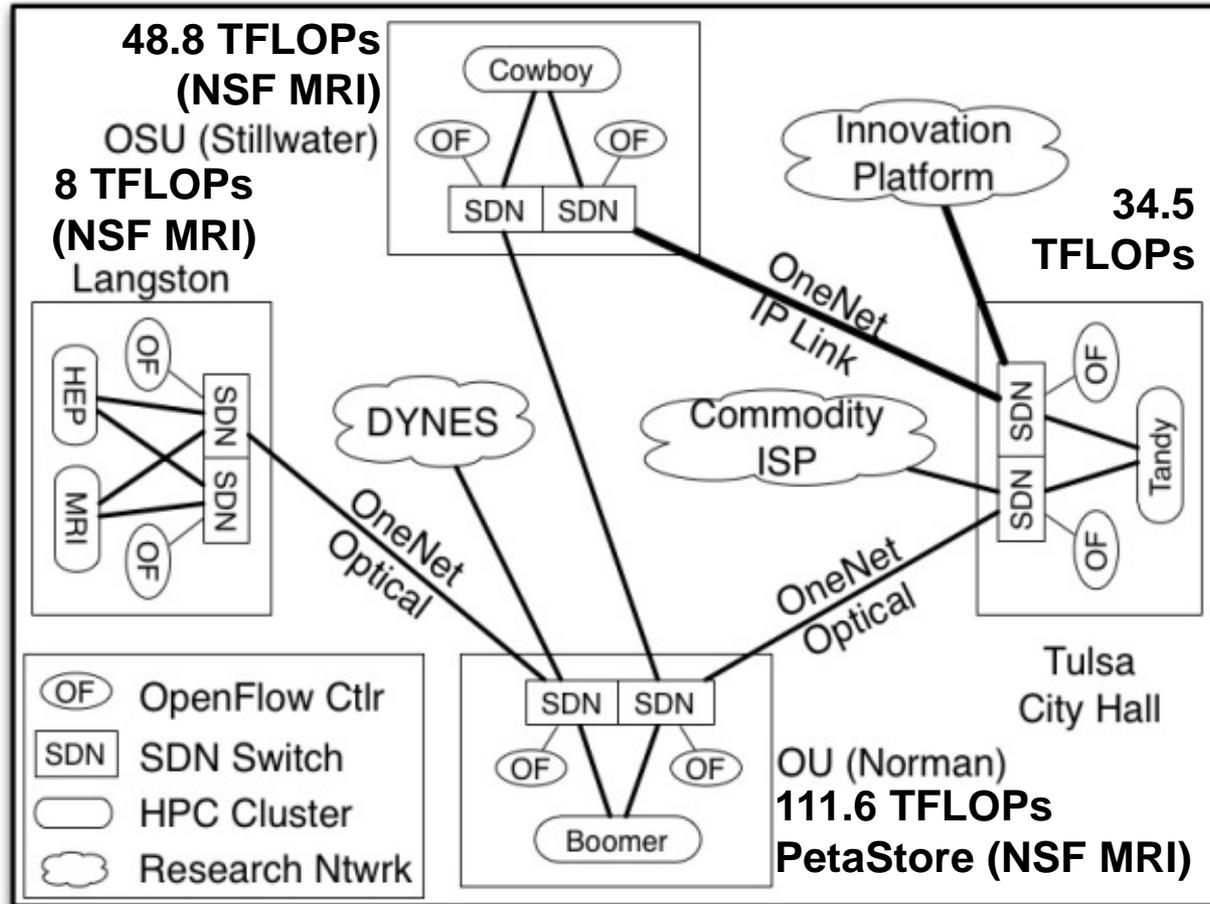
OneOklahoma Friction Free Network (OFFN)
- Multi-institutional Science DMZ
- Software Defined Networking
- Dedicated 10G among the participating sites
- Aggregate compute: just over 200 TFLOPs (peak)

Objectives

1. Deploy and maintain, at the four institutions, a <u>research-only network</u> consisting of institutional last mile components that are independent of enterprise networks, with its internal hub collocated with OneNet.

2. Apply <u>Software Defined Networking</u> (SDN) across OFFN, facilitating end-to-end management, by researchers, of high bandwidth/high performance data flows through a distributed hierarchy of open standards tools, giving researchers a new layer of transparency into network transport.

3. Provide these capabilities – OFFN's in particular and OneOCII's in general – to all relevant researchers and educators <u>statewide</u>, and facilitate their use.

Initial Science Drivers

- High Energy Physics (ATLAS, DØ): OU, LU, OSU

- Real Time Numerical Weather Prediction: OU

- Weather Radar: OU

- Bioinformatics: OSU

- Ecological Informatics: OU (added after grant started)

- … with more to come.

Identified aggregate bandwidth: 23+ Gbps (when everything is going full tilt at the same time)

Science Driver: High Energy Physics

- Senior Personnel
  - H. Severini (OU)
  - P. Skubic (OU)
  - J. Snow (LU)
  - M. Strauss (OU)
- Oklahoma Center for High Energy Physics (OCHEP)
- Funding: $1.7M current, $1M planned (NSF, DOE, Fermilab)
- 7 faculty, 2 staff, 4 postdocs, 3 graduate students
- Identified bandwidth need: up to 8 Gbps sustained

Science Driver: High Energy Physics

- OU and LU already do a lot of ATLAS computing (data analysis and Monte Carlo simulation).
- OU, LU and OSU constitute the Oklahoma Center for High Energy Physics (OCHEP).
  - OSU physicists aren't doing computational.
- OU, LU and U Texas Arlington constitute the NSF's ATLAS Southwest Tier2 Center (SWT2), which is consistently in the top 3 most productive US academic Tier2 sites (OU is consistently #6-#8 most productive US academic institution).
- OSU and TSC have agreed to provide their idle cycles for ATLAS jobs, but will kill them off in favor of local jobs.

Science Driver: Weather Prediction

- OU Center for Analysis & Prediction of Storms (CAPS)
- Senior Personnel
  - M. Xue (CAPS Director and faculty in OU's School of Meteorology)
  - K. Brewster (CAPS Associate Director)
- Funding: $2.5M per year current, $1M per year planned (NSF, NOAA)
- 6 faculty, 10 staff, 20 graduate students
- Identified bandwidth need: 12 Gbps sustained (during the annual Spring Realtime Storm Forecasting Experiment, mid-March – mid-June)

Science Driver: Weather Radar

- Advanced Radar Research Center (ARRC)

- Senior Personnel: Tian-You Yu et al

- Funding: $10M current, $5M pending, $25M planned (NOAA, NSF, NASA, industry)

- 15 faculty, 2 staff, 11 postdocs, ~60 graduate students, ~10 undergraduates

- Identified bandwidth need: 1.9 Gbps sustained

Science Driver: Bioinformatics

- OSU Bioinformatics program
- Senior Personnel Elshahed (OSU), Hoyt (OSU)
- Funding: $6.1M current, $4.4M pending (NSF, NIH, USDA, DOD, US Army, OCAST, OK Ag Experiment Station)
- 14 faculty, 6 postdocs, 35 graduate students
- Identified bandwidth need: likely 1.6+ Gbps – lesser of (a) bandwidth of OSU HPC cluster disk or (b) bandwidth of Oklahoma PetaStore disk

Network Deployment Goals

- Provide a proven, <u>commercial off-the-shelf</u> (COTS) hardware platform backed with vendor support.
- Realize the Science DMZ goals through the use of a truly <u>independent network at each campus site</u>.
  - The network deployment will consist of <u>dedicated optical pathways</u> to the optical transport provider (OneNet), as well as to the local campus backbone where desired.
- Deploy a <u>fully virtualized infrastructure</u>, to be used simultaneously by multiple research entities, presented to each entity as a dedicated "slice" of the overall resource.
- Leverage <u>federation</u> to provide oversight and visibility into the operations of the virtualized platform.

Network Deployment Goals (cont'd)

- Realize the full potential of OFFN through <u>awareness, training, site-specific hand-off, and communities of support</u> for OFFN adopters.

State Diagram (Conceptual)

State Diagram (Logical)
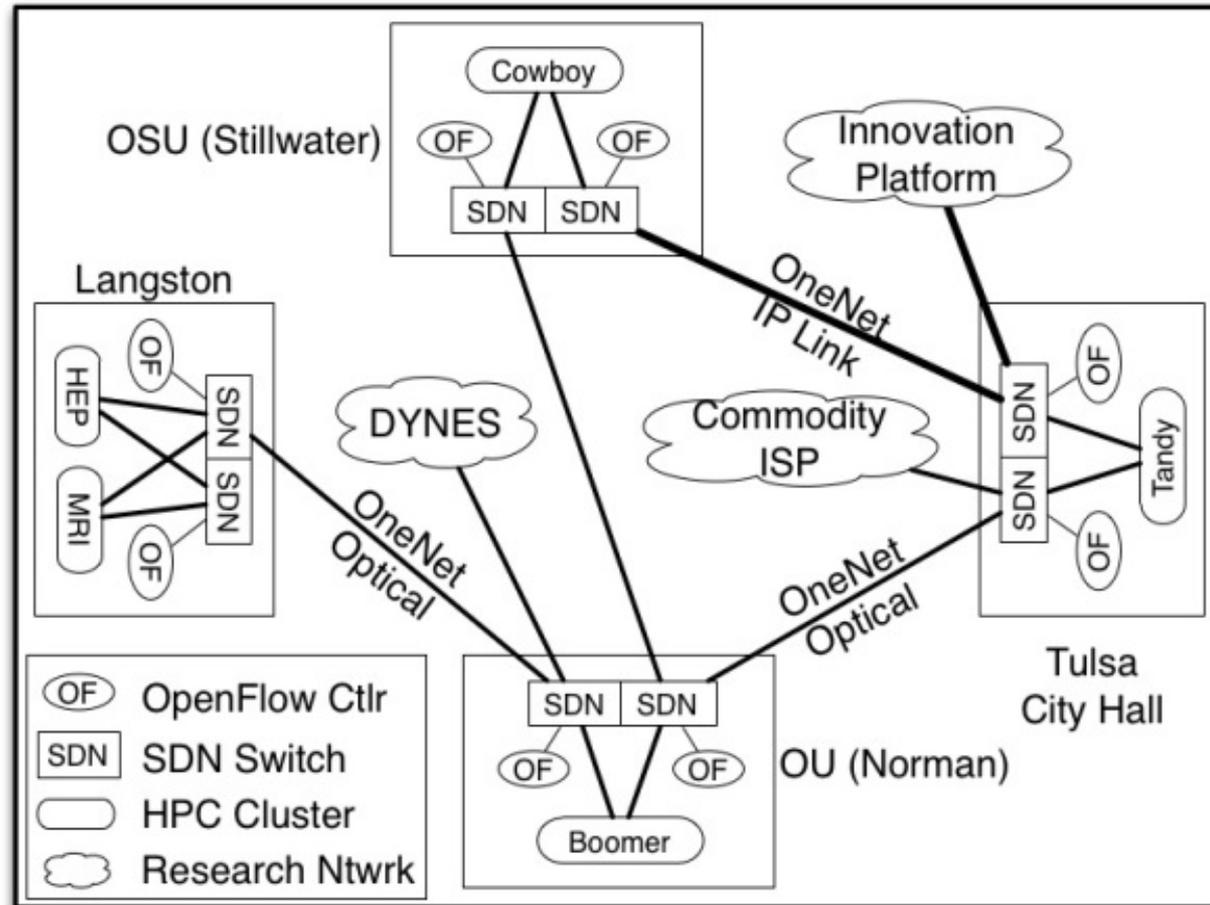
Institutional Design

- SDN switches provide a virtualized data plane resource, to effectively and efficiently forward Ethernet traffic based on rules configured on the SDN controller. (Note that TSC will use a 24-port SDN-capable Brocade linecard instead.)

- Platform support switches provide the connectivity required for out-of-band management functions, including server lights-out management, SDN switch component management, and Virtual Machine (VM) host management.

Institutional Design (cont'd)

- <u>Servers</u> provide multiple virtualized SDN controller resources, plus a virtualized platform for providing performance toolsets, management and monitoring utilities, and data transfer tools (e.g., perfSonar).

- <u>Software</u> (all Open Source and/or free)
    - OS virtualization platform (Xen, VirtualBox or Qemu)
    - Linux host and guest OS (Fedora or CentOS)
    - SDN controller (Beacon or Floodlight)
    - Performance testing (iPerf and the PSPerformance Toolkit)
    - Monitoring (Cacti or Nagios)

Institutional Diagram (Logical)
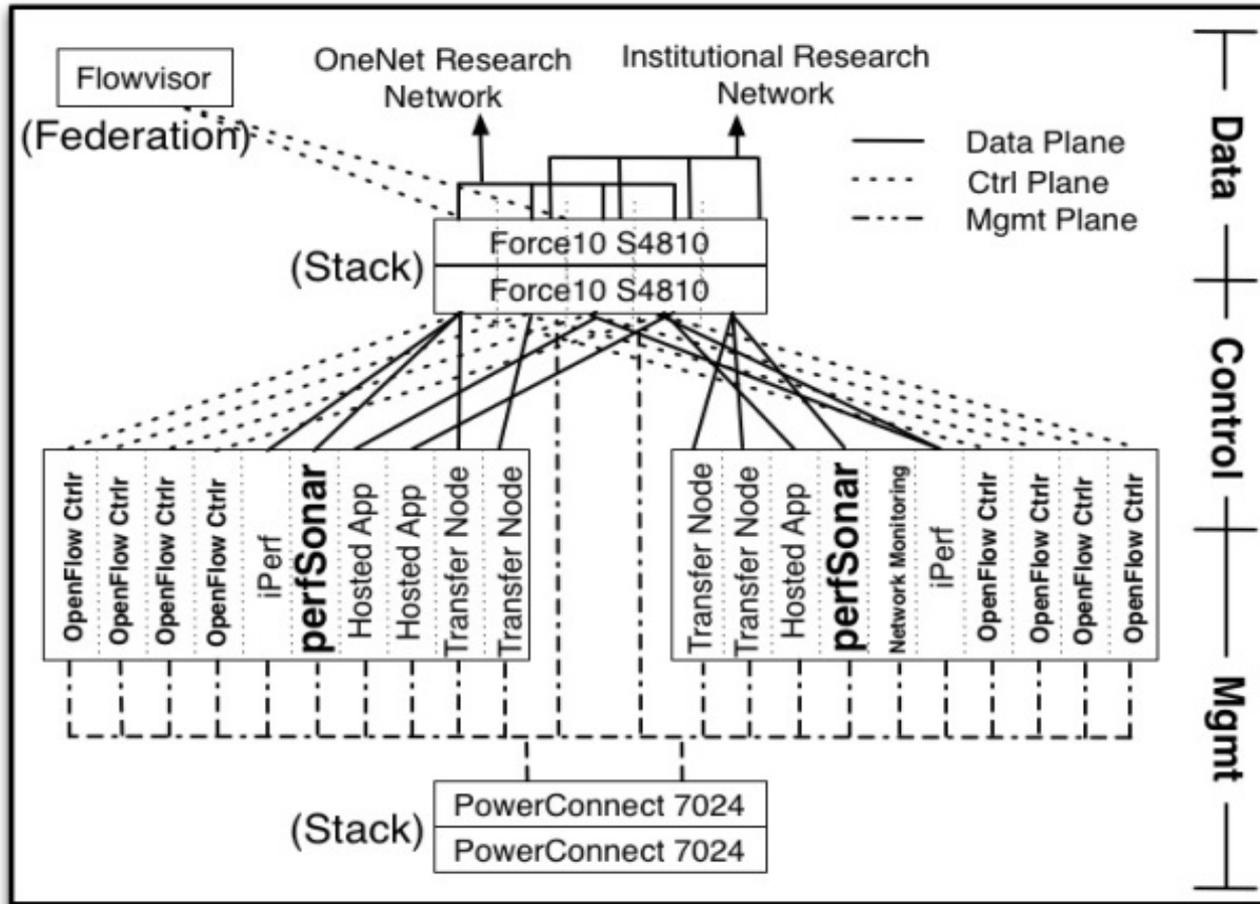
Institutional Diagram (Physical)
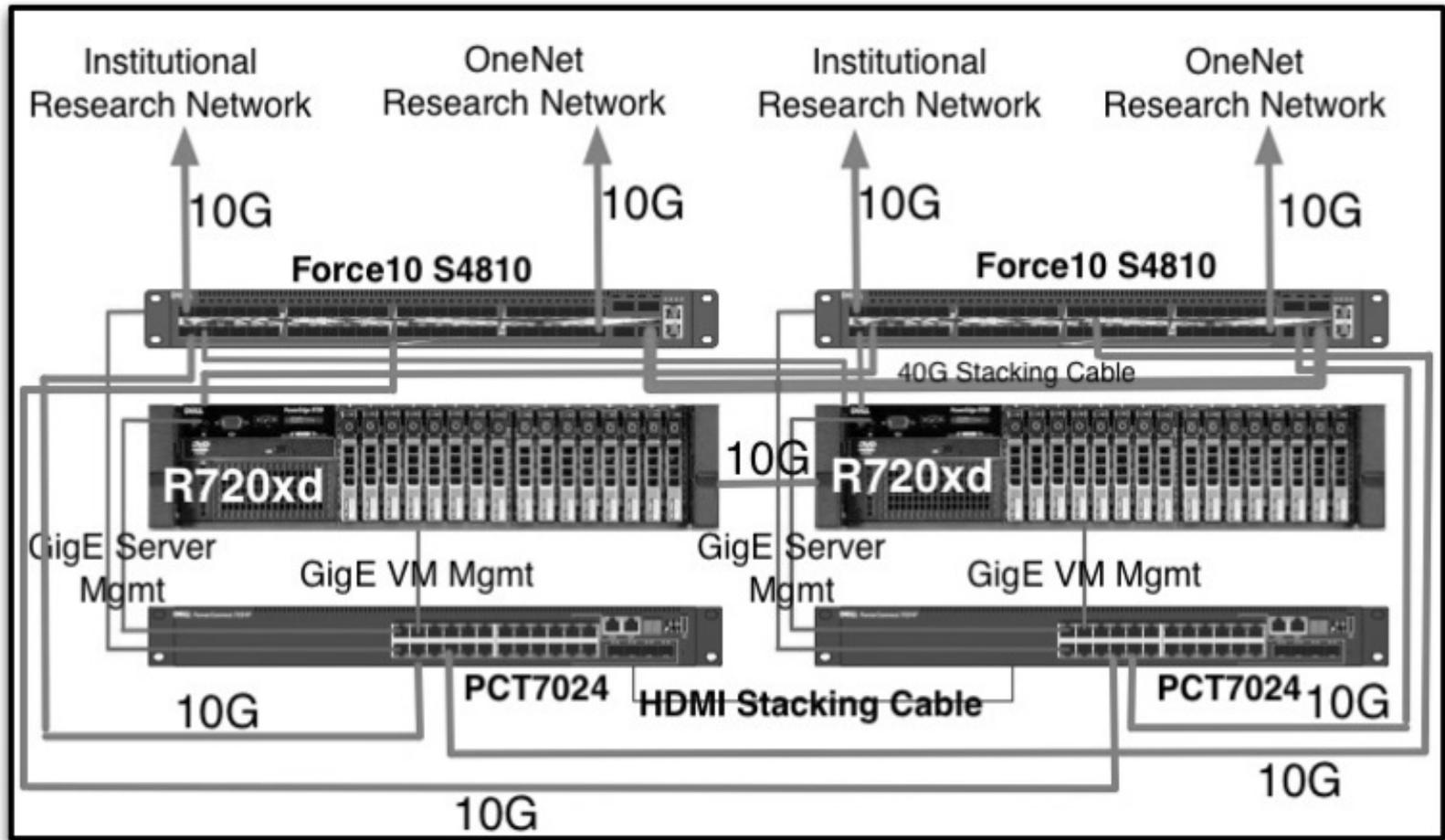
External Connectors

- **<u>Innovation Platform</u>**: OneNet has secured a 100G connection onto Internet2's Innovation Platform (IP).
  - OSU has dedicated connectivity to connect to the IP at 100G.
  - OU is deploying 2 x 10G with Layer-2 and Layer-3 transport services, from OU to OneNet, connecting directly into the same OneNet chassis as the IP. Under OFFN, researchers statewide will straightforwardly be able to access the IP via OU and OSU.
- **<u>DYNES</u>**: OU hosts a "static" DYNES site deployment.
  - Primarily implemented as a dedicated path tool for OUHEP's SWT2 cluster to receive large datasets from LHCOne.
  - Can easily be migrated to the 4PP Science DMZ.

External Connectors (cont'd)

- **<u>XSEDE</u>**: OU's already-funded plan to connect to the Innovation Platform can also facilitate connection to XSEDEnet at no additional charge, by OneNet simply setting aside 10 Gbps of the 100 Gbps connection into the Innovation Platform (subject to OneNet's and XSEDE's approval).

- **<u>PlanetLab</u>** provides an overlay services network that can be decomposed into tangible resource pools used for network experimentation. Both OU and OSU provide dedicated PlanetLab hardware resources.

Advanced Cyberinfrastructure Research & Education Facilitators 2014-16

History

- March 2012: Clemson U creates "Condo of Condos" initiative.

- Apr 2013: Clemson U submits "Condo of Condos" proposal, including ACI-REFs and networking hardware:

  13 institutions, 4 years, $33M+

- March 2014: Proposal partially funded, ACI-REFs only:

  6 institutions (not OU), 2 years, $5.3M

- Apr 2014: OU submits ACI-REF CC*IIE proposal.

- Sep 2014: NSF announces OU ACI-REF proposal.

  - 2 years of 1.0 FTE (Oct 2014 – Sep 2016)

  - 2 summer workshops (2015, 2016) on how to be an ACI-REF

What's an ACI-REF?

- An Advanced Cyberinfrastructure – Research & Education Facilitator (ACI-REF) works directly with research teams to adopt advance cyberinfrastructure into their research and education.

- OSCER personnel have been providing a low-intensity version of this service since the beginning.

- OU Informatics personnel have been providing a high intensity version since fall 2010.

- OU's new ACI-REF will focus on high end networking, especially SDN via OFFN.

ACI-REF Grant Objectives #1

- <u>Data-Intensive Research Facilitation</u>: Via Software Defined Networking (SDN) across OFFN, facilitate end-to-end management, by researchers, of high bandwidth/high performance data flows through a distributed hierarchy of open standards tools, providing researchers with a new layer of transparency into network transport at OU, among OneOCII institutions, and with ACI-REF members.

- <u>Oklahoma ACI-REF project</u>: Lead and facilitate adoption of the ACI-REF approach across Oklahoma, leveraging extant and emerging capabilities within OneOCII.

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ACI-REF Grant Objectives #2

- <u>National training regime</u>: Provide a "virtual residency" program for Campus CI Engineers and other ACI-REFs, open to not only CC*IIE awardees and ACI-REF members but any institution that needs.

- <u>Research Experiences for Undergraduates</u> (REU) Sites/Supplements: Foster undergraduate research at OU via a culture of integrating REU sites and supplements into STEM research, including by all research themes on the ACI-REF grant.

Research Projects Part 1

- **High Energy Physics**
    - also on on DOE EPSCoR, C2, PetaStore, OFFN
    - 8 Gbps
    - $1.7M current, $1M pending/planned
    - 7 faculty, 2 staff, 4 postdocs, 9 grad students
- **Spring Realtime Storm Forecasting Experiment (CAPS)**
    - also on C2, PetaStore, OFFN
    - 12 Gbps
    - $2.5M current, $1M pending/planned
    - 6 faculty, 10 staff, 20 grad students
- **Weather Radar (ARRC)**
    - also on PetaStore, OFFN
    - 1.9 Gbps
    - $10M current, $30M pending/planned
    - 16 faculty, 7 staff, 16 postdocs, ~60 grad students, ~10 undergrads

Research Projects Part 2

- Tornado Models (IDEA)
  - also on EPSCoR RII Track-2, PetaStore, OFFN
  - 0.6 Gbps
  - $600K current, $500K pending/planned
- Warn on Forecast (CIMMS): NEW!
  - 0.5 Gbps
  - $677K current
  - 12 staff, 4 postdocs, 3 grad students
- Ecological Informatics (EOMF)
  - also on EPSCoR RII Track-2, OFFN
  - 0.2 Gbps
  - $5M current, $8M pending/planned
  - 1 faculty, 3 staff, 3 postdocs, 7 grad students, 1 undergrad

Research Projects Part 3

- Data Networks (CS)
  - also on OFFN
  - $720K current
  - 2 faculty, 3 grad students
- TOTALS
  - 23 Gbps
  - $21 current, $40M pending/planned
  - 33 faculty, 34 staff, 27 postdocs, ~108 grad students, ~14 undergrads

ACI-REF Virtual Residency

- This was part of OU's role in the original "Condo of Condos" proposal.

- We'll run two summer workshops, one in each of 2015 and 2016, on how to be an ACI-REF.

- Interest: 33 institutions in 23 states and territories have expressed interest:
  - 3 Minority Serving Institutions
  - 19 institutions in 13 EPSCoR jurisdictions
  - 7 non-PhD-granting institutions

- We can probably only fund about 20 participants, so we're already oversubscribed even before the grant starts.

Virtual Residency Workshop: Sun

Sunday Evening

- Welcome and virtual residency overview
- Introduction to research CI consulting
- How to Give a CI Tour

Virtual Residency Workshop: Mon

- Early AM: Effective Communication: How to Talk to Researchers about Their Research
- CDS&E Track
  - Mid AM: Deploying Community Codes
  - Early PM: Real users present CDESE research
  - Mid PM: Real users: CI consulting practicum
- Science DMZ Track
  - Mid AM: OpenFlow Lecture
  - Early PM: OpenFlow Lab
  - Mid PM: Facilitating Research on Your Science DMZ

Virtual Residency Workshop: Tue

- Very Early AM: Project Guidelines
- Early AM: Faculty: tenure, promotion, reward system (guest lecture)
- CDS&E Track
  - Mid AM: Benchmarking & Tuning
  - Early PM: Real users present CDESE research
  - Mid PM: Real users: CI consulting practicum
- Science DMZ Track
  - Mid AM: Northbound APIs Lecture
  - Early PM: Northbound APIs Lab
  - Mid PM: Real users' high bandwidth research

Virtual Residency Workshop: Wed

- Early AM: Using Videoconferencing and Collaboration Technologies for Consulting
- Mid AM: Writing Grant Proposals (OK EPSCoR presenter)
- PM: BREAK (free time)

Virtual Residency Workshop: Thu

- Early AM: Recruiting and Retaining Talent
- CDS&E Track
  - Mid AM: Finding and provisioning remote resources (XSEDE etc)
  - Early PM: Real users present research
  - Mid PM: Real users: rounds practicum

- Science DMZ Track
  - Mid AM: The Software in SDN Lecture
  - Early PM: The Software in SDN Lab
  - Mid PM: Real users' high bandwidth research

Virtual Residency Workshop: Fri

- Early AM: The Shifting Landscape of CI Funding Opportunities
- Mid AM: Panel: Stories from the Trenches

- Early PM: Project work time
- Mid PM: Project work time
- Late PM: Project presentations from early departers

Saturday

- AM: Project presentations

REU Participation

- Each project year, every research team on OU's ACI-REF grant will either mentor for one of OU's REU sites, or submit an REU supplement.

  - OU Physics REU site: HEP

  - National Weather Center REU site: CAPS, ARRC, CIMMS, EOMF (or supplement)

  - REU Supplement: IDEA, CS

Advisory Committees

- External
    - Jim Bottum, CIO, Clemson U – Clemson ACI-REF PI
    - Ron Hutchins, CTO/Assoc Vice Provost, George Tech
- OneOCII
    - Dana Brunson, OSU
    - James Deaton, OneNet
    - Franklin Fondjo Fotou and Joel Snow, Langston U
    - Evan Lemley, UCO
    - George Louthan, OII/TSC
- Internal
    - Daphne LaDue, National Weather Center REU PI/Director
    - Michael Thompson, Director of Broader Impacts in Research

OneOCII Strategy

- OneOCII doesn't exactly have a strategy; it'd be more accurate to say we have an approach:
    - Every CI project in the state is part of the larger whole.
    - Each new project advances a subset of OneOCII.
    - Not all parts of OneOCII advance at the same time.
    - Everyone works together on everything.

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Acknowledgements

Acknowledgements

Dell provided seed systems for the OU Research Cloud ("OURcloud") and the OU Science DMZ.

Symposium 2014 Sponsors: Thank You!

- Academic sponsor (1)
  - Great Plains Network
- Industry sponsors (21) – **a new record**! (previous: 15)
  - Platinum (1): Intel
  - Gold (4): **Arista Networks**, Cray Inc, Dell, Mellanox Technologies
  - Silver (8): **Adaptive Computing**, **CenturyLink**, Ciena, Cisco Systems, DataDirect Networks, EMC, **Huron Consulting Group**, **Violin Memory**
  - Bronze (7): Advanced Clustering Technologies, **Cycle Computing**, Open Technologies, Oracle, **RogueWave**, **Seagate**, SGI
  - Meal (1): **Dropbox**

Thank you all! Without you, the Symposium couldn't happen.
Over the past 13 Symposia, we've had a total of 79 companies
as sponsors – and more than half have repeated.

Thanks!

- OU IT
  - OU CIO/VPIT Loretta Early
  - Symposium commmittee: Josh Alexander (OU), Dana Brunson (OSU), Debi Gentis (OU)
  - Symposium coordinator: Debi Gentis
  - Sponsorship coordinator: Chance Grubb
  - OSCER Operations Team: Brandon George, Dave Akin, Brett Zimmerman, Josh Alexander, Patrick Calhoun
  - All of the OU IT folks who helped put this together
- CCE Forum
  - Kristin Livingston, Jake Maurer
  - The whole Forum crew who helped put this together

Thanks: Plenary Speakers

- Plenary Speakers
  - Irene Qualters, NSF ACI
  - Addison Snell, Intersect360 Research
  - Stephen Wheat, Intel (Platinum sponsor)

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Thanks: Gold Sponsor Speakers

- Saeed Iqbal, Dell

- Robert Kern, Mellanox Technologies

- Don Schulte, Cray, Inc.

- Mickey Stewart, Arista Networks

Thanks: Breakout Speakers

1. Erik Alred, OU
2. Dan Andresen, KSU
3. Workalemahu Berhanu, OU
4. Manikanthan Bhavaraju, OU
5. Keith Brewster, OU
6. Dana Brunson, OSU
7. Nick Davis, OU Tulsa
8. James Ferguson, NICS
9. Karl Frinkle & Mike Morris, SEOSU
10. Zane Gray, OU
11. Houssain Kettani, FHSU
12. Evan Lemley, UCO
13. Greg Monaco, GPN
14. Chris Stackpole, FRB
15. Bin Wang, OU

Thanks!

To all of your for participating, and to those many of you who've shown us so much loyalty over the past 13 years.

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http://oneocii.okepscor.org/

Thanks for your attention!

Questions?