Report on the EPSCoR Cyberinfrastructure Assessment Workshop
Lexington KY Oct 15-16, 2007

Co-sponsored by the EPSCoR and OCI of NSF.

Summary:

Representatives of all EPSCoR states and territories gathered together in Lexington to explore the state of CI in EPSCoR. The needs of each were explored and a number of recommendations were made, with the aim of bringing the EPSCoR/CI up to national standards in order to increase the competitiveness of their researchers and educators. We found that there is indeed a significant gap in cyberinfrastructure between EPSCoR and non-EPSCoR jurisdictions, and that it may even be getting larger. It is the mission of the EPSCoR to maximize the research infrastructure in its states to improve their competitiveness with respect to the non-EPSCoR states. Several recommendations for closing this gap were made, including:

1. Setting aside EPSCoR funds to build CI and develop applications which use CI. (Note: This has already been done through the establishment of the EPSCoR RII Track 2 initiative.)
2. Targeting EPSCoR , OCI and/or co-funding budgets,
3. Building on existing regional partnerships
4. Partnerships with other agencies such as the NIH/IDEA program, and
5. International partnerships, such as with the CANARIE network of Canada.

A glossary of all abbreviations and acronyms used in this report can be found at its end.

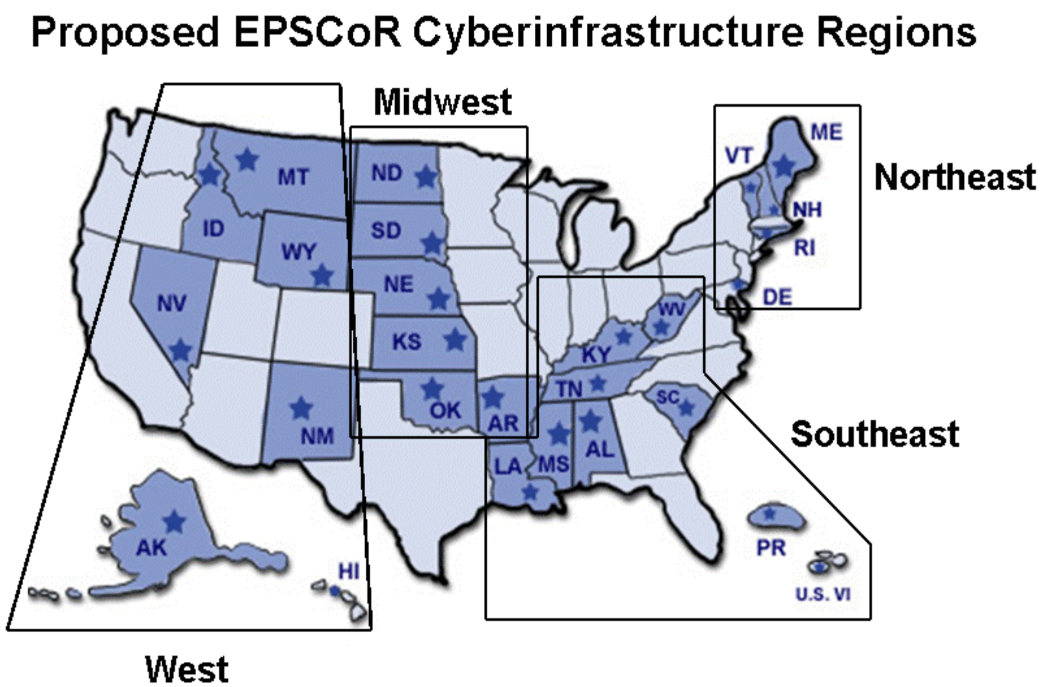
Workshop Details:

The workshop agenda included a plenary session on the first morning. The purpose was to give the federal perspective through presentations by representatives of NSF and NIH. We also heard from some of the role models for EPSCoR, such as a state model (Louisiana); two regional models (Lariat and SURAgrid) and a national infrastructure (TeraGrid). On the first afternoon, there were presentations on the state of cyber-infrastructure in each EPSCoR jurisdiction.

On the second day, we looked at regional needs. For this purpose, we divided EPSCoR into four parts:

(1) Northeast (DE, ME, NH, RI, VT);
(2) Southeast (AL,KY,LA,MS,SC,TN,WV, PR,VI);
(3) Midwest (AR,KS,ND,NE,OK,SD);
(4) West (AK, HI, ID, MT, NM, NV, WY)

Each region gave an overview, and then the group split into discussion sections before a final session to present findings and recommendations. There was also a breakout session for the "cyberisolated" jurisdictions. (AK, HI, PR, VI).



Seventy-seven participants attended, consisting of CI experts and EPSCoR leaders from every jurisdiction, 25 states and 2 territories. A list of attendees is attached to this report.

There is a repository of all the presentations at the following url:
http://www.kynsfepscor.org/cyber07/cyberppts/

This is, we believe, the first such repository of the state of CI in the EPSCoR jurisdictions, and it should be valuable for future studies and budget strategies.

Findings:

The individual presentations focused on the nature of the gap, relative to cyberinfrastructure, between the EPSCoR and the non-EPSCoR jurisdictions. Several indications were found:

1. **OCI Budget:**

An analysis of the Office of Cyberinfrastructure 2007 budget shows that 97% of its funding goes to non-EPSCoR states. This shows that the EPSCoR states have not come up to the level where their cyberinfrastructure is adequate to support competitive efforts in emerging cyber-enabled research.

2. **TeraGrid Access:**

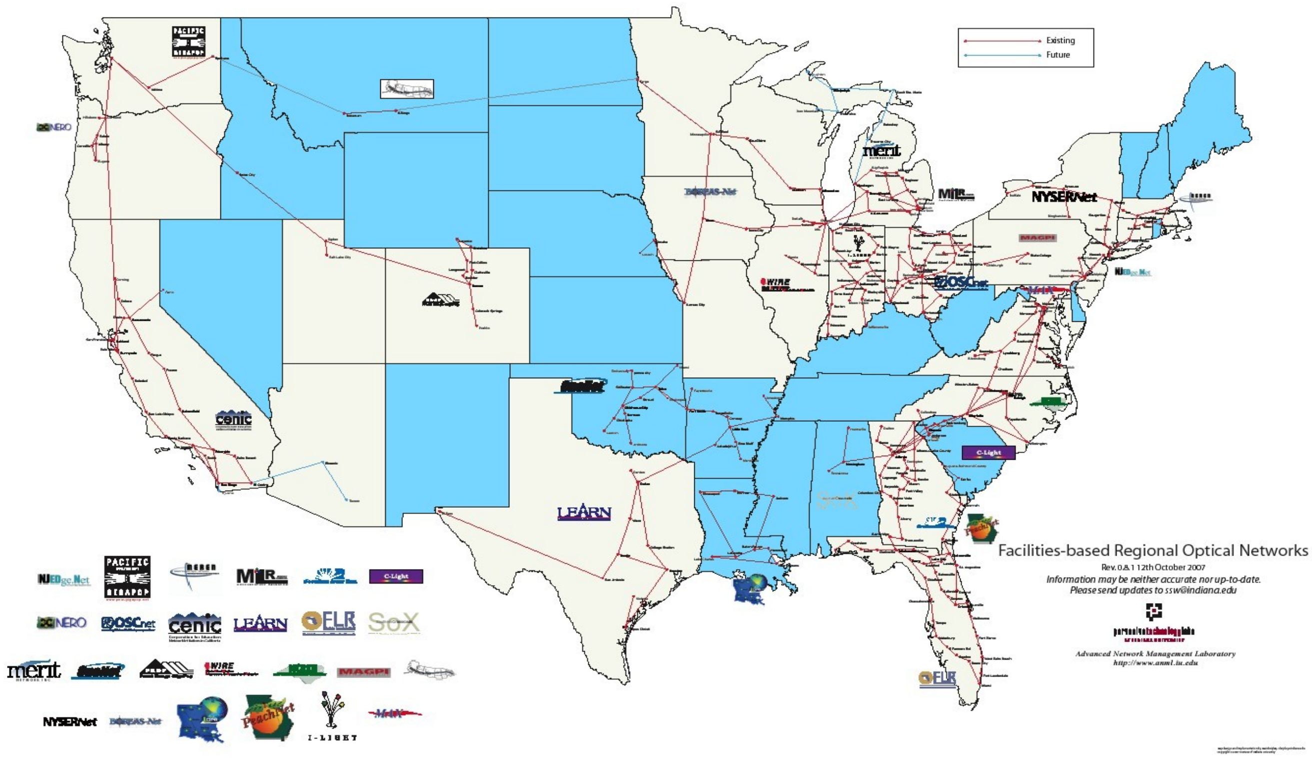
In the allocations of time on the TeraGrid group of supercomputers, 89% goes to non-EPSCoR states. This gap shows some indication of widening. EPSCoR states have 20% of the population but only 11% of the allocations in 2005, dropping to 6% in 2006. This indicates that researchers in EPSCoR states lack the background, skills and support to perform research based on advanced HPC technologies, such as simulation and modeling.

3. **Network Capacity:**

Many EPSCoR jurisdictions do not reach the current standard for Internet2 or NLR of about 10 gigabits per second (Gbps). One 10Gbps connection is typically required for participation in many emerging modes of imaging, visualization and advanced collaboration, and multiple 10Gbps links may be needed to become a service provider in major national and international programs, such as the TeraGrid extensions, which continue to be deployed mostly in non-EPSCoR states (note the Louisiana exception below).

A contributing factor is the lack of optical networks within EPSCoR jurisdictions, which represent the current practice in connection technology. Almost all non-EPSCoR states have an optical network that connects its research universities. 12 EPSCoR states have no nodes, and another eight have only one node, usually connected to a neighboring state's Optical Network. (See map below)

Only AR, LA and OK have optical connections to all their EPSCoR institutions. AL has a partial network that connects some of their EPSCoR institutions. And the "cyber-isolated" jurisdictions that are non-contiguous to the 48 states face unique challenges due to their reliance on submarine fiber. This drives dramatically higher costs for connectivity and may make it impossible to directly participate in certain kinds of optical networking initiatives available elsewhere in the country, such as NLR.



Parts of this map may be illegible, and it is shown here to show the pattern of high speed networks throughout the country. The full map with all details may be found at http://paintsquirrel.ucs.indiana.edu/RON/archive/fiber_map_current.pdf

4. Human and Support Infrastructure:

Nearly all the EPSCoR participants noted that a limited percentage of their researchers actively participate in cyber-enabled research initiatives at the investigator, team or national level. This lack of a cyber-research culture is attributed to the lack of physical facilities, such as advanced networks, as well as a lack of resources committed to institution-wide outreach to researchers and a lack of dedicated technical support for researchers who wish to engage in these new modes of research. The lack of shared support affects everything from the ability to understand and access national resources to the ability to contribute data and collaborate in the broad multi-disciplinary teams that are advancing the frontiers in many areas.

Recommendations:

Networking:

When NSF started its cyberinfrastructure initiative in the 1980s, it funded national networking infrastructure through its NSFnet program and then through the NSF Connections program. With the emergence of the commercial Internet in the 1990s, it was assumed that the private sector and internal university funding would suffice. That has worked for urban areas of high population density and states that have made substantial capital investments. But for the rural and disconnected areas, which are heavily represented in the EPSCoR jurisdictions, the economics have served as an enormous barrier; a dollar spent on connectivity in many EPSCoR jurisdictions buys just a fraction of the capability routinely deployed in more developed regions. One possibility is that NSF should resume its investment in networks for EPSCoR jurisdictions that have been unable to develop full optical connectivity. This could be done through an EPSCoR-based "Connections" program that provides differential levels of funding based on the actual cost of deployment of optical networking capabilities comparable to that found in the successful non-EPSCoR states.

These funds could be deployed in different ways based on the unique challenges and opportunities within EPSCoR states. In some regions connectivity may be most effectively provided by working with international partners. For example some of the northern states might be more cost-effectively served in partnership with Canada's CANARIE program, the Caribbean jurisdictions might benefit from partnership with Latin America networking initiatives, and Hawaii might be served in the context of Asia-Pacific networking opportunities.

A second possibility is to leverage previous investments by other funding agencies and support a joint effort to continue to fund regional and national network initiatives. For example, the Lariat Project funded by the NIH-NCRR/IDeA program, made a huge impact by enhancing the connectivity for five EPSCoR/IDeA institutions in the West. Several states have used this investment to catalyze research efforts, most notably the University of Wyoming which has bid to house a new $60M National Center for Atmospheric Research Supercomputing Center. Without the upgrade in the network capabilities provided by the Lariat Project, University of Wyoming would not be able to compete for this award. Many NIH researchers benefit from NSF investments in the high performance computing centers as well. The NSF/EPSCoR and NIH/IDEA programs have very similar missions and can be considered to be complementary in their cyberinfrastructure plans. Coordinating the investments of these two programs through a joint program would provide scientists in EPSCoR states with the opportunity to develop their state and regional cyberinfrastructure programs by leveraging funding opportunities in these two programs. The DoD DREN, DoE ESNet, and NASA Research and Education networks could also play a role in this approach.

Education Regarding High Performance Computing and Related Cyberinfrastructure Technologies

Researchers in EPSCoR jurisdictions need additional support at every stage of the adoption of these new technologies for research. First, they must be educated on the ways in which Cyberinfrastructure technologies can make them more effective and competitive. EPSCoR researchers should be supported to participate in the major national CI initiatives within their disciplines as part of outreach from those projects or EPSCoR.

High Performance Computing

The NSF should consider programs to increase the access for researchers who need it. This could involve training sessions for faculty and students who need high performance computing to achieve scientific progress. One mechanism could be TeraGrid organized CI days to bring the expertise to EPSCoR institution campuses. One could also encourage researchers to visit the TeraGrid sites. Another suggestion would be to expand the TeraGrid program to include Tier 3 supercomputers in EPSCoR states.

Software

Many EPSCoR institutions have not taken advantage of the successful national efforts to develop middleware that enables collaboration and access to national resources. Some of this is due to a lack of awareness, in other cases, the lack of adoption is due to critical shortages in the number of central IT staff and the training and professional development opportunities available to them. While this is not a unique challenge to EPSCoR jurisdictions, this was a recurring theme in the workshop presentations.

Support Infrastructure and Workforce Development

Advancing research through cyberinfrastructure requires much more than access to HPC cycles. EPSCoR states noted particular challenges in the physical and especially human support infrastructure that sustains clusters, large storage systems, visualization facilities, collaboration tools, data modeling and metadata, etc. Several of the EPSCoR jurisdictions expressed the need to recruit and retain qualified experienced cyberinfrastructure personnel. They almost universally expressed the frustration in losing such people to higher income areas. The recruitment, retention and continued professional development of both central IT staff and professional computational scientists is critical to supporting the research efforts of domain scientists at these institutions. Providing training programs (and funding opportunities for them) designed to keep IT personnel current with national standards will provide IT staff with professional development opportunities that may encourage them to stay in their university positions rather than seeking jobs elsewhere.

Regional collaborations

One of the most important results of the workshop was the recognition of the importance of regional collaborations**.** Each of the four regions has already organized into a regional initiative. For example:

(1) **Northeast.** This group has already organized the NENI (North East Network Infrastructure). This is a group of institutions in five EPSCoR states (DE, ME, NH, RI and VT) initially formed by the NIH/INBRE directors. Some of their initiatives consist of "The Digital Patient" which connects academia with health centers, bioinformatics, life sciences, remote education and telecommuting.

(2) **Southeast.** This is a subset (AL, KY, LA, MS, SC, TN, and WV) of the ten EPSCoR jurisdictions which are part of the Southeastern Universities Research Association (SURA), plus the two territories in the Caribbean (PR and VI). Six (all of the subset except TN) of these have a history of collaboration through the NSF-EPSCoR sponsored SEPSCoR (South East Partnership to Share Computational Resources) project. SURAgrid is an existing SURA region grid computing collaboration that is focused on improving the cyberinfrastructure for the SURA region. SURA coordinates a number of other collaborative projects such as SERON (South Eastern Regional Optical Networks), a forum for collaboration between SURA region academic optical network service providers and SCOOP (SURA Coastal Ocean Observing and Prediction), a collaboration of regional coastal ocean scientists utilizing cyberinfrastructure tools to improve the ability to predict the impact of severe coastal storms. Other regional projects include storm surge simulation, bioinformatics in genomics, climate modeling and computational chemistry.

(3) **Midwest.** This is a group of six states (AR, KS, ND, NE, OK, SD); which self organized as the Great Plains network, originally sponsored by NSF/EPSCoR. They have organized a number of collaborative projects in earth science, bioinformatics, collaborative middleware, grid computing, networking research, and disaster management.

(4) **West.** The Lariat Networking Project provided an initial investment in developing the critical backbone networks necessary for institutions within the west (AK, HI, ID, MT, NV, and WY). This effort has been a catalyst for the build out of the network. However it did not fully connect the major EPSCoR institutions in these states, nor did it complete the backbone network to connect these regions to the national network. The Northern Tier Networking Consortium (ntnc.org) that includes 12 states (AK, ID, IA, MI, MN, MT, NE, ND, SD, WA, WI, and WY), is leveraging on the Lariat investment with the goal of building the east-west span, from Washington to Minneapolis to complete the national backbone in this region. Each state is working to secure resources to fund the part of the backbone traversing the state. Strategic investments in this effort will insure that all states,

especially those in the rural west can participate in national cyberinfrastructure efforts. There are ample examples of regional centers of research excellence in these states, many that can provide unique types of data and research from both underserved populations (Native Americans and Hispanics) and geographically unique resources, such as large river ecosystems, the Yellowstone Ecosystem, Polar Regions and others. Much collaboration, which has been fostered and supported by EPSCoR RII and NIH INBRE/COBRE funds, already exists between researchers in these states.

(5) Cyberisolated. Four EPSCoR states (AK, HI, PR and VI) face unique networking needs. In addition to unique challenges to deploying internal optical networks (vast distances in Alaska, multi-island geography in Hawaii), all four jurisdictions face immense costs to connect to the “mainland” or “lower 48”. Alaska and Hawaii have been assisted at various times by the DREN (Defense Research and Engineering Network). NIH and International networking programs have also been of assistance. PR and VI have made substantially less progress and continue to make do with inadequate bandwidth. Major scientific facilities in these jurisdictions, like the Arecibo and Mauna Kea Observatories, absolutely require first-rate connectivity.

The Louisiana Model:

Since 2001, the state government of Louisiana has invested almost $100 million in cyberinfrastructure, including a statewide IT initiative, the LONI (Louisiana Optical Network Infrastructure) and the associated LONI Institute. The local commitment in CI is larger than any other EPSCoR jurisdiction, and it will be used to build CI at all levels--hardware, software, networking and workforce development. Three important components of this program are the Center for Computation and Technology (CCT), Louisiana Immersive Technology Enterprise (LITE) and the Center for Entrepreneurship in Information Technology (CENIT).

This investment is already paying dividends, both in terms of research grants (LONI has just been awarded a TeraGrid grant) and in the establishment of new centers such as the new $50 million USAF Cybercommand Center in Shreveport, a new $50 million Center for Cyber Innovation, and a $8 million Center for Cyber Security. All of these developments will have a significant effect on the Louisiana economy and will repay the investment with interest. Louisiana could be used as a model state which shows the value of investing in cyberinfrastructure.

A Rural Cyber Infrastructure Act?

In the early 1930's, 90% of rural homes had no electricity. The electric companies didn't see enough profit in building the electrical infrastructure into remote regions. Not only did this reduce the country's agricultural competitiveness, it cut off the rural areas of the country from the primary form of communication—radio—the 1930's version of an asynchronous wireless network.

The response of the US government in 1936 was to establish the Rural Electrification Administration, which funded local collaborative networks of farms and rural homes.
So, in analogy to the REA, the government could establish a RCIA, a Rural Cyber Infrastructure Administration, which would greatly increase the research and economic competitiveness of the rural regions of the country. Many of these regions would be found in the EPSCoR jurisdictions. In addition, this would open up these areas to the twenty-first century level of communication--broadband internet access.

And it should be pointed out, that it is not only research universities and industry which would benefit, but also museums, libraries and other places with much to offer the greater community who are not adequately connected at present.

General Recommendations:

The workshop demonstrated that there is a significant difference between EPSCoR and non-EPSCoR states when it comes to the availability and use of CI tools and services, which greatly affects their research and economic competitiveness. It was also demonstrated that there is a significant variation in the availability of Cyberinfrastructure capabilities among the EPSCoR states. Any EPSCoR CI program should take into account this wide variation.

One possibility would be to target some of the EPSCoR funds--from the co-funding accounts, for example, in concert with OCI or the research directorates.

A second possibility is to take advantage of the portion of the 2008 NSF budget request listed under the category SBRC (Strength Based Research Collaborative) http://www.nsf.gov/about/budget/fy2008/pdf/27_fy2008.pdf According to the budget language, these funds are for "targeted projects of regional significance and national importance." Enabling science on collaborative EPSCoR cyberinfrastructure certainly fits this description. If the SBRC is written out of the NSF budget, then we recommend that equivalent funds be allocated to a similar program. We note that in the time since this workshop was held, the SBRC has been discontinued and a new program, the RII Track 2, has been established. Existing regional partnerships could be possible candidates for this program.

A third option would be to leverage NSF funds with those of other agencies. The NIH/IDEA representative at the workshop was enthusiastic about forming a partnership with NSF/EPSCoR to perhaps fund complementary parts of the national cyberinfrastructure. The DREN (Defense Research and Engineering Network) could also play a role as it does in AK and HI.

Specific Recommendations:

1. Take advantage of existing multi-state, regional CI collaborations by creating an EPSCoR funding program targeted at expanding regional EPSCoR CI programs to:

- Leverage existing regional CI infrastructure and CI communities to lower the barriers for deploying and utilizing local, regional and national CI services;
- Utilize existing training materials and CI tools from local, regional and national sources (NCSA, TeraGrid, TACC, LSU, SURA, etc.) to provide a variety of cyberinfrastructure training opportunities and practical experiences for EPSCoR faculty, staff and students;
- Host CI Discovery Day symposia at EPSCoR institutions' campuses to highlight the availability and advantages of utilizing local, regional and national CI services in support of research and education; and

• Leverage aggregate regional influence, and existing corporate partnerships, to deploy a significant CI resource (Teraflop class cluster) at participating EPSCoR institutions that will be integrated into the regional and national CI ecosystem.

2. Coordinate broader NSF (domain science) investments in CI components in EPSCoR states. This would allow a more coordinated approach to identifying all NSF investments in EPSCoR CI and lead to a more coordinated approach to deploying CI assets in EPSCoR states.
3. NSF EPSCoR could provide extra matching funds or additional co-funding for basic CI investments tied to other programs, i.e. domain science.
4. Fund programs focused on informing researchers of the importance of basic Cyber Infrastructure to their research. Identify top producing EPSCoR jurisdiction researchers and encourage them to articulate the need for CI. Alternatively identify rising stars.
5. Funding to support coordinated effort to clearly articulate the business case for state level investments in CI (what are the economic development drivers).

This report was written by John Connolly of the University of Kentucky, in collaboration with Barbara Kucera and Jeff Mossey, and the workshop discussion leaders of the four EPSCoR regions: Gary Crane of the Southeastern University Research Association, Gwen Jacobs of Montana State University, Greg Monaco of the Great Plains network, and Karl Steiner of the University of Delaware.

Glossary:

CANARIE	Canadian Advanced Network and Research for Industry and Education
CCT	Center for Computation and Technology
CENIT	Center for Entrepreneurship in Information Technology
CI	Cyber Infrastructure
COBRE	Center of Biological Research Excellence
DoD	Department of Defense
DoE	Department of Energy
DREN	Defense Research & Engineering Network
EPSCoR	Experimental Program to Stimulate Competitive Research
ESnet	Energy Science network
HPC	High Performance Computing
IDeA	Institutional Development Award
INBRE	IDeA Network of Biological Research Excellence
LITE	Louisiana Immersive Technology Enterprise
LONI	Louisiana Optical Network Initiative
LSU	Louisiana State University
NASA	National Aeronautics and Space Administration
NCRR	National Center for Research Resources
NIH	National Institutes of Health
NLR	National Lambda Rail
NSF	National Science Foundation
OCI	Office of Cyber Infrastructure
REA	Rural Electrification Administration
RII	Research Infrastructure Initiative
SCOOP	SURA Coastal Ocean Observing and Prediction
SEPSCoR	South Eastern Partnership to Share Computing Resources
SERON	South Eastern Regional Optical Networks
SURA	Southeastern University Research Association

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	NAME	TITLE	ORGANIZATION	ST
1	Ames, Daniel (Mr.)	Professor	Idaho State University	ID
2	Ashmore, Bill (Dr.)	Systems Analyst	Univ. of AR-Fayetteville	AR
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4	Aylward, Robert (Mr.)	VP and CIO	University of Wyoming	WY
5	Bedford, Virginia (Ms.)	Assoc. Director	Alaska EPSCoR	AK
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12	Crane, Gary (Mr.)	Director-IT Initiatives	Southeastern Univ. Research Assoc.	NY
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14	Evans, Joseph (Dr.)	Professor	University of Kansas	KS
15	Ford, Ray (Dr.)	Chief Information Tech. Officer	University of Montana	MT
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17	Gazula, Vikram (Mr.)	IT Manager	University of Kentucky	KY
18	Gemmill, Jill (Dr.)	Exec. Dir.-Cyberinfrastructure Technology Integration & Research Asst. Prof.	Clemson University	AL
19	Goodwin, Peter	Dir.-DeVlieg Presidental Prof.	University of Idaho-Boise	ID
20	Hale, Jason (Mr.)	Manager-Research Support	University of Mississippi	MS
21	Hanlin, Patia L. (Mrs.)	Project Coordinator	University of Kentucky	KY
22	Hogue, William (Dr.)	VP for Info. Tech. & CIO	University of South Carolina	SC
23	Iatridis, James (Dr.)	Associate Director	University of Vermont	VT
24	Itoga, Stephen (Dr.)	Professor	Univ. of Hawaii-Manoa	HI
25	Jacobs, Gwen (Dr.)	Asst. CIO/Dir.-Academic Comp.	Montana State University	MT
26	Kubeck, Lynn (Mrs.)	Chief Information Officer	Univ. of N. Dakota	ND
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33	Lombardo, Joseph (Mr.)	Dir.-Nat'l Supercomputing Ctr.	Univ. of Nevada-LV	NV
34	Mahmood, Akhtar (Dr.)	Assoc. Prof. of Physics	Bellarmine University	KY
35	Marsh, Ronald (Dr.)	Assoc. Professor	Univ. of North Dakota	ND
36	Maruvada, Padma (Dr.)	Assoc. Prof. Health Sc. Admin.	Nat'l Ctr. For Research Resources	MD
37	McLaughlin, Don (Mr.)	Research Associate	West Virginia University	WV
38	Meyer, Lloyd	SD Board of Regents	SD Bd. Of Regents	SD
39	Michener, William (Dr.)	Director	New Mexico EPSCoR	NM
40	Molinaro, Mary (Mrs.)	Dir.-Preservation & Digital Prog.	University of Kentucky Libraries	KY

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44	Mossey, Jeff (Mr.)	Asst. Director	University of Kentucky	KY
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46	Oldow, John (Dr.)	Professor	University of Idaho	ID
47	Orozco, Edusmildo	Assistant Professor	Univ. of Puerto Rico	PR
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60	Shin, Seungjae (Dr.)	Assistant Professor of IS	Mississippi State University	MS
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62	Smith, Steve (Mr.)	Exec. Chief Info Tech. Officer	University of Alaska	AK
63	Spruill, Joshua (Mr.)	Research Associate	Cell Bio Anat-MUSC	SC
64	Staben, Chuck (Mr.)	Associate VP for Research	University of Kentucky	KY
65	Steiner, Karl V. (Dr.)	Associate Director	Univ. of DE, DE Biotechnology Institute	DE
66	Swanson, David	Director-Res. Comp. Fac.	Univ. of Nebraska-Lincoln	NE
67	Taylor, Allen (Mr.)	Chief Technology Officer	Marshall University	WV
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72	Wallman, Marc (Mr.)	Dir.-IT Infrastructure Svcs.	ND State University	ND
73	Whitson, Carmen	Staff Assoc. Planning & Coord.	National Science Found.	VA
74	Williams, Timothy	Director	West Virginia University	WV
75	Zhang, Ye (Dr.)	Asst. Professor	University of Wyoming	WY
76	Zink, Steven	VP IT	University of Nevada-Reno	NV
77	Zuazaga, Humberto Ortiz	Acting Director	University of Puerto Rico	PR