Creating a Five-Minute Conversation About Cyberinfrastructure

Thoughtful consideration of the issues relevant to cyberinfrastructure in higher education will help you pull out key points to discuss with specific audiences

By **Klara Jelinkova, Terezsa Carvalho, Dorette Kerian, Boyd Knosp, Kent Percival,** and **Stan Yagi**

Attending a higher education conference today without hearing about cyberinfrastructure seems impossible. It is coming, it is here, it is everywhere. But where is cyberinfrastructure, exactly, and how does it apply to *my* campus? Educational institutions can take different approaches to it, of course; this article gives you a few ideas to consider in your approach to cyberinfrastructure. The goal is to help you compose a five-minute conversation on cyberinfrastructure appropriate for various audiences. This article builds on the work of the Campus CyberInfrastructure (CCI) Working Group sponsored by EDUCAUSE.

What Is Cyberinfrastructure?

While there is no single definition of cyberinfrastructure, the concept was described in a National Science Foundation report released in 2003.[1] One definition, written by Daniel Atkins for that report and paraphrased here, sums up the issues by taking a broad view:

> Cyberinfrastructure includes computing cycles and broadband networking, massive storage and managed information, observation and measurement tools, and leadership on shared standards, middleware, and common applications for scientific computation. It also focuses on sharing, efficiency, and making greater capabilities available across the science and engineering research communities. It facilitates new applications, collaboration, and interoperability across institutions and disciplines. It can be summed up as follows: Cyberinfrastructure is the IT infrastructure that enables scientific inquiry.

Cyberinfrastructure anticipates a scientific and scholarly world that is increasingly dependent on information technology. It has many facets, and each institution will need to review its own strengths and weaknesses to decide on areas of concentration.

Why Do We Need It? What Difference Will It Make?

In higher education, cyberinfrastructure is required for conducting research, obtaining a competitive edge, participating in national and global projects, and addressing important trends. Each of these needs involves multiple issues.

A Requirement for Research

Researchers routinely use information technology in their work. Whether their focus is science, engineering, liberal arts, business, or any other discipline, they expect to have easy access to the cyberinfrastructure resources needed to successfully conduct their research. The ability to provide this access will increasingly become the differentiating factor when institutions compete for top faculty and students.

Cyberinfrastructure can also be seen as an equalizing factor. It can enable researchers at smaller institutions to access data sets from different schools and computational resources and results from large national centers. It can also allow faculty to collaborate with colleagues at institutions in different countries. This ability can be crucial to address issues such as global health research. These capabilities lower the barriers to entry for scientific inquiry.

A Competitive Edge

An institution's cyberinfrastructure can be a differentiating factor in getting the grants that help new faculty succeed. Increasingly, researchers who have access to resources, or who can provide resources to others, have an advantage in collaborative research opportunities offered by funding agencies. These resources can include systems, instruments, observatories, storage, or computational environments. As the costs of these resources continue to rise, however, institutions can gain a competitive edge not only by providing internal resources but also by provid-

ing access to external ones. This can be accomplished by extending existing services such as identity management for seamless authentication to external resources or integrating research tool support into the mission of existing skilled support staff. By lowering the cost of doing research, an institution remains competitive to granting agencies and can attract top researchers. World-class researchers, in turn, attract high-quality graduate (and undergraduate) students.

Participating in National and Global Efforts

A university needs to adopt a strategy for cyberinfrastructure in order to participate in solving national and global priorities. These might include research projects to understand global climate change, protect the natural environment, apply genomics/proteomics to human health, maintain national security, understand the world of nanotechnology, and predict and protect against natural and human-caused disasters. Other projects address some of the most fundamental intellectual questions, such as the formation of the universe and the nature of matter.

As the availability of access to information and resources grows on a global scale, universities can offer greater research capability to their researchers and faculty regardless of local resources available. Inter-institutional collaborations are more common, challenging local technical, administrative, and infrastructure support. Researchers can collaborate across institutional boundaries regardless of the depth or size of the respective disciplines at a particular institution.

Addressing Important Trends

From one day to the next, technology becomes more embedded in solutions, development, and research involving most areas of knowledge and science. It has changed the ways people study, research, and teach. Some of the most important trends in research influenced by technology and the widespread availability of cyberinfrastructure follow.

Multidisciplinary Research. Moving beyond the more common collaborations between different areas of science, multidisciplinary research now encompasses collaboration with the arts and humanities in areas such as visual studies. Many researchers are turning to other disciplines for new applications of their research. In the growing world of interdisciplinary studies, liberal arts or linguistic faculty can start to take advantage of advanced computer science language models.

Another rapidly growing area, medicine and science, attempts to move science to a patient's "bedside" more effectively, giving doctors tools they can use immediately in patient diagnosis and care. These collaborations will require convergent technology in the area of media—data, voice, and video—as well as large computational resources and collaborative applications to allow orchestration of experiments on a global scale.

Multi-Institutional Research and International Collaborations. Advances in technology have enabled cooperation between researchers from different institutes, cities, countries, and continents. Internationally, researchers use audioconferencing, videoconferencing, chat, and e-mail as communication channels.

Cyberinfrastructure that supports multiple communication channels crosses international boundaries, unlimited by place or language. It also allows sharing of specialized equipment by researchers and students in different countries, some of whom could not otherwise afford the tools needed for their research.

Advanced Modeling and Simulations Supported by Massive Data and Computational Resources. Cyberinfrastructure's advanced processing and large-scale storage capacities enable the creation of highly complex and realistic models and simulations to mimic real-world experience and projections. Such access advances research in development of new drugs, for example, or environmental modeling.

The computing and data storage capabilities offer the ability to store, search, and manipulate data sets for analysis and synthesis. The cyberinfrastructure is often more cost-effective if shared across research groups.

Business Uses. Technology contributes to solutions for problems in health, engineering, architecture, banking, education, and many other branches of knowledge. Electronic patient records, for example, which make information about patients accessible to doctors anywhere and at any time, are supported by cyberinfrastructure solutions for mobility and for ubiquitous information environments in hospitals.

Security and Privacy. Despite the pervasive use of information technology, people expect personal, research, and business information to be securely managed and with appropriate privacy ensured. Security and privacy considerations must be taken into account in all stages of planning for and implementing cyberinfrastructure, including policy development and middleware implementation.

Skills. Cyberinfrastructure skills (such as the ability to execute code at national centers) are becoming necessary for researchers at institutions working on certain types of problems. The availability of skilled support staff allows researchers to become more effective in their research. Where those support staff have knowledge of multiple levels of infrastructure, researchers can move research seamlessly between departmental, campus, and national resources. Obtaining such skilled support staff has training, funding, and employment considerations that must be included in planning for research that relies on cyberinfrastructure.

Management. Many higher education institutions have limited planning or oversight for managing research-specific IT support. Some cyberinfrastructure components (clusters, high-performance computers, optical networks) are expensive and need regular maintenance and upgrades. Many research areas (physics, chemistry, astronomy, bioinformatics) can benefit from high-performance computing and optical networking, providing an opportunity to improve efficiency, reduce costs, and improve data security through a well-planned, shared cyberinfrastructure. Management structures and policies should be part of cyberinfrastructure planning from the beginning and embedded in the implementation.

How Can It Be Implemented?

Each institution's implementation of cyberinfrastructure will differ, but strategic planning is the key to success. Each institution needs to look through three lenses during this planning exercise: discipline, technology, and culture.

The *discipline lens* allows an institution to decide which disciplines should be the primary recipients of institutional cyberinfrastructure investment. These could be core institutional strengths or perhaps areas that the institution wants to develop. The best way to identify the disciplines is to identify key scholars.

The *technology lens* allows an institution to evaluate the current and future states of the technology supporting these disciplines. An institution might want to establish a particle physics department, for example, but the supporting technology could be prohibitively expensive, or perhaps a better solution would be giving researchers access to existing national resources. A strategic planning process is the most effective way to address future technology capabilities and needs.

The *culture lens* should allow for a frank conversation about the types of changes an institution can embrace and what risks it can take with its investment. Funding support will be needed for the initiative, and the institutional culture can favor or inhibit efforts to obtain financial resources.

Moving through the implementation process efficiently is possible by following common steps: identify key scholars, create a vision, address funding, and identify low-hanging fruit.

Identify Key Scholars

Identify and engage key scholars in the cyberinfrastructure implementation process and make sure that they remain involved. A good way to keep them involved is participation in a committee that acts as a governing or advisory body for campus cyberinfrastructure development.

Create a Vision

Part of your strategic planning will be developing a vision. Russ Hobby of Internet2 spoke of a vision for cyberinfrastructure[2] that universities might consider:

- Computation and storage to easily allow transition from the desktop to the campus resource, the regional center, and national supercomputing centers using the same software.
- Data repositories in formats and locations to allow ease of sharing, indexing, and searching between all interested disciplines (the real digital library!).
- Tools to allow people to easily construct systems to analyze, visualize, and simulate their research subjects.
- Collaboration tools that allow people to work across institutional and international boundaries.

Address Funding

Funding for cyberinfrastructure development is an important and potentially difficult issue. Most of the time it should be based on a shared or hybrid model with some central, some departmental/collegiate, and some grant funding. Larger resources such as data centers, supercomputers, or massive storage and backup systems should be managed centrally, with most of the costs underwritten by central funds (depending on resource and funding allocations at that university).

Identify Low-Hanging Fruit

Often central IT units offer services that researchers underutilize. List activities central IT already does that can be categorized as research support and services, or existing resources that can be leveraged. This list can be used for marketing, planning, and execution. It is important to start with the nucleus of a services and capabilities portfolio. A simple example can include:

- Networking services for high-speed access to national resources.
- Identity management services that allow researchers to use their campus credentials for seamless access to resources at other institutions or at regional or national centers.
- Existing campus collaboration tools such as e-mail lists, wikis, or document storage easily used by researchers to set up virtual organizations for inter-institutional collaborations.

EDUCAUSE Cyberinfrastructure Resources

The EDUCAUSE website hosts a variety of resources on cyberinfrastructure. A site search calls up papers, reports, conference presentations, and working groups. The following resources, pulled from the major EDUCAUSE initiatives, provide further information to assist you in creating short conversations on cyberinfrastructure for different audiences on your campus.

Campus Cyberinfrastructure Working Group

Information on the Net@EDU CCI Working Group, including the mission statement, contact information, and opportunities to participate, http://www.educause.edu/CampusCyberinfrastructure(CCI)WorkingGroup/10288

EDUCAUSE Learning Initiative

ELI 7 Things… Series:

"7 Things You Should Know About Cyberinfrastructure," http://connect.educause.edu/library/abstract/7ThingsYouShouldKnow/44951

ELI Web Seminars:

"Cyberinfrastructure: A Campus Perspective on What It Is and Why You Should Care" with Peter M. Siegel, http://www.educause.edu/LIVE0715

EDUCAUSE Center for Applied Research

ECAR Case Studies (by subscription), http://www.educause.edu/CaseStudies/1006:

"A Collaborative Support Model for Research at Georgetown University," Judith A. Pirani and Donald Z. Spicer

"Supporting Research Computing Through Collaboration at Princeton University," Judith A. Pirani, Donald Z. Spicer, and Ronald Yanosky

"A New Model for Supporting Research at Purdue University," Donald Spicer and Bruce Metz

"Calit2: A Case Study in a Next-Generation Research Environment" (Donald Spicer and Bruce Metz)

ECAR Key Findings:

"IT Engagement in Research a Baseline Study—Key Findings," Harvey Blustain, Sandra Braman, Richard N. Katz, and Gail Salaway, http://connect.educause.edu/Library/ECAR/ITEngagementinResearchABa/39102

ECAR Roadmaps:

"IT Engagement in Research: A Baseline Study Roadmap," Harvey Blustain, Sandra Braman, Richard N. Katz, and Gail Salaway, http://connect.educause.edu/Library/ECAR/ITEngagementinResearchABa/37613

ECAR Occasional Papers:

"What do Researchers Need? Higher Education IT from the Researcher's Perspective," Sandra Braman, http://connect.educause.edu/Library/ECAR/WhatDoResearchersNeedHigh/37617

ECAR Survey Instruments:

"IT Engagement in Research at Medical Schools and Colleges," http://connect.educause.edu/Library/ECAR/ITEngagementinResearchatM/41202

ECAR Research Studies (by subscription), http://www.educause.edu/ResearchStudies/1010:

ECAR will publish a research study on cyberinfrastructure in mid-2008

- Instructions and support for access to computational resources at national or regional centers or at other institutions.
- Software licensing services for research software.
- Data repository support for researchers.
- Pre-proposal consultation and standardized content such as templates for proposals explaining IT services.
- A forum for departmental IT staff currently supporting research.

The Conversation

The preceding paragraphs cover far too many topics for a single five-minute conversation that, in generic form, would not be effective, anyway. Much better is to select a few areas that are especially pertinent to your school and highlight them in several five-minute conversations, tailoring each to the intended audience.

The additional resources in the sidebar, besides covering the topics in more depth, provide ideas from other institutions. With this article, and the highlighted resources, you have the information needed to put together several five-minute conversations on cyberinfrastructure that can inform discussions on your campus about cyberinfrastructure initiatives and implementations. *e*

Endnotes

1. Daniel E. Atkins, Kelvin K. Droegemeier, Stuart I. Feldman, Hector Garcia-Molina, Michael L. Klein, David G. Messerschmitt, Paul Messina, Jeremiah P. Ostriker, and Margaret H. Wright, "Revolutionizing Science and Engineering Through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure," January 2003, http://www.nsf.gov/od/oci/reports/atkins.pdf.
2. Russ Hobby, "Cyberinfrastructure Days: Planning Your Campus Cyberinfrastructure Strategy," given at the ND/SD EPSCoR (Experimental Program to Stimulate Competitive Research) 6th Biennial Joint Conference, September 7, 2007.

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