



# 3 Core Capacity Units for Cyberinfrastructures

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## Introduction

Cyberinfrastructure (CI), also known as e-science, is a huge database and platform technology that allows users such as scientists to communicate and collaborate with each other by storing and organizing data and information to be able to share research, results, data, and more. However, to successfully collaborate with other CI users on this platform technology can be full of challenges. This poster examines three key communication strategies to make CI implementation for new users less challenging. The three strategies are (a) informing new users that CI exist and is a free resource, (b) keeping the technologies open source and transparent to the user community, (c) persuading to ensure sufficient and continuous funding. These concepts when put in place, help to contribute to highly functioning cyberinfrastructure.

## Literature Review

Creating a collaborative environment that allows people within an organization to share ideas with one another and feel connected across different parts of the organization, is a big challenge in today's society. It helps when there is a positive organizational culture among members. As research has shown, a positive culture will lead to a more productive organization with higher performing members (Aragon, 1993; Blatter & Walter, 2015; Wilkins, 2006). This organizational challenge is pronounced in the case of CI, as it is still an emerging technology, and the culture is still evolving and dynamic. Furthermore, the challenge is further compounded when the main funded source, the National Science Foundation, tends to put funding towards science and not the technology, which can lead to many issues (Kee & Browning, 2010). The disconnect between funding science and limited on technology is still evident today. This lead us to ask the research question: *“What communication strategies are necessary to be put in place for cyberinfrastructure implementation to be less challenging, more efficient, more effective, and more successful, for new users?”*

## Methodology

This poster employed the grounded theory approach (Corbin & Strauss, 1990), analyzing 20 interview transcripts conducted with domain scientists (e.g., informatics researchers, computational chemists, theoretical physicists.) and computational technologists. Thirty-five of these interviews were member check interviews conducted in the final phase of the investigation. Participants were from across the US (including CA, IL, IN, SC, MI, TX, etc.) and one from Germany. Interviews were conducted either in person or by telephone. Following the grounded theory coding techniques, we performed multiple iterations of data analysis and literature integration, yielding preliminary findings presented in this poster.

## Findings

Throughout the analyzation of interviews, three common themes were found including:

### Informing New Users that CI Exists and It Is a Free Resource

CI is a federally funded computing, data, and technology resources for scientists to do big data research. However, while the technology exists and most of it is free, many scientists do not know that CI exists. The analysis of the transcripts suggests that the first communication strategy is to get scientists to become aware of CI's existence, so they can consider becoming users of this technology resource.

- “I think also the materials would be the software tools that we have and the data, the databases. We do a lot of biology work, so there's a lot of public databases that we deal with [that are all free]... They have put a lot of money into buying hardware, and we have a lot of compute available, and a lot of storage, and they have worked well to—we do charge for some things, but mostly we don't charge so that then smoothes the transition for people trying to do their work. We don't charge by the CPU hour or anything like that. We provide a lot of ... storage for free so people don't have to buy terabytes here and there” (Professor, AZ, 5/10/2016)
- “So these are some of the – so to me, making people aware or knowledgeable about the cyberinfrastructure and the tools that are available would actually be one of the best strategies to move this [adoption] curve into a skewed one” (Scientific Applications Analyst, IN, 11/7/2017).
- “Outreach is key in raising awareness” As in seeking help from others in the organization is the most important thing, having network of easily accessible people to help” (Particle Physicist/Developer, D.C, 4/19/2016).

### Keeping the Technologies Open Source and Transparent to the User Community

Communication is a key factor because CI is most successful when people are involved and connected with each other. A strong user community can create the foundation of how the users of this infrastructure communicate across different parts of the organization and/or inter-organizational collaborations. Being open source allows for a shared understanding and multiple contributions and editing that can lead to improvements and expansion, making the technology transparent to all the users.

- “An essential component of making anything work in cyberinfrastructure is the people who build it, the people who operate it, the people who make people aware...The people arrangements are as important, a distributed infrastructure, as the hardware arrangements are distributed infrastructure” (Particle Physicist/Developer, D.C, 4/19/2016).
- “I'd also say someone that I work with in networking who's really taken a lot of time to help me understand exactly how our research network is laid out and how it connects to and nationally so that we can start improving some of those things.” (Director of Indiana University's Center for Applied Cybersecurity Research, IN, 7/12/2017)
- “One thing that's important to me is just the open science, open source, open documents, open whatever. You know, insert your descriptor there. But then just the sharing. Kind of the philosophy that everyone's better off if software's free and accessible to everyone.” (Chief Customer Officer, IL, 7/19/2016).

### Persuading to Ensure Sufficient and Continuous Funding

There has to be sufficient and continuous funding because cyber infrastructure relies on ongoing access to material resources and staff. With proper funding CI can be updated on the newest software applications and technologies. Moreover, having sustainable technology and sufficient hardware plays another important role in CI because CI was made to bring together people and information via technology. This is a communication strategy because getting funding requires persuasion.

- “a great idea and great information and great direction in a ready project are all wonderful, but when it's impossible to get a funding source, projects don't go anywhere. That, to me, that's the biggest one” (Germany, 7/11/2017).
- “whether you're just starting up, you know, external funding like from National Science Foundation and you're familiar with their—it could be Office of Scientific Research, the Army Research Office, the Department of Defense, et cetera, Department of Energy. If you don't have funding from them because you're starting or because, you know, grants come and go. You have a grant that expires and you have trouble getting a renewal. In our area of the National Science Foundation only about sometimes 10 to 15% of the grants submitted get funded so it's very, very competitive” (End User Software Support, WY, 7/24/2017).

## Conclusion

Throughout our analysis of the 20 interviews we concluded that the most important communication strategies to help make CI implementation less challenging, more efficient, more effective, and more successful are (a) informing new users that CI exist and it is a free resource, (b) keeping the technologies open source and transparent to the user community, (c) persuading to ensure sufficient and continuous funding. We would like to further expand on a few thoughts. Firstly, opening up each individual project to the internet, allowing other developers and technically capable users to tweak and improve your work, is critical to most projects, this is known as being open source. This allows for the maximum input, opinions, and ideas to be incorporated into all CI projects. Having a strong network of intelligent individuals is also very important to most, if not all, projects. This allows for the best minds and most knowledgeable people on the subject around the world are involved in solving whatever problem is being examined. Additionally, we discovered that communication plays an essential role in effective cyberinfrastructure implementation. Communication between project members ensures that each individual is on the same page at all times and is fully updated. Lastly, structural distribution and motivation can make or break a project. Quality in the project means that each member is given a task and no members have overlapping tasks as well as ensuring that the end product or finding is deliverable to other scientists in the community, the public, or whomever it is aimed to help. Motivation keeps all members excited to do their work as well as inspired to do quality work efficiently. Over the case studies and interviews that we have examined, we have concluded that if a CI project with new users goes about their work as a unit following these communication strategies, their chances of efficiency, effectiveness, and success are significantly more likely.

## References

(Aragon, 1993; Blatter & Walter, 2015; Wilkins, 2006) (Kee & Browning, 2010)