EDUCAUSE is a nonprofit association and the foremost community of IT leaders and professionals committed to advancing higher education. EDUCAUSE programs and services are focused on analysis, advocacy, community building, professional development, and knowledge creation because IT plays a transformative role in higher education. EDUCAUSE supports those who lead, manage, and use information technology through a comprehensive range of resources and activities. For more information, visit http://www.educause.edu.

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Citation


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Introduction

Contemporary scientific and scholarly research is highly dependent on technology, and information technology units play a primary role in enabling research in higher education. Some of the recent “sensational products and technologies” that came out of higher education research investments are “bar code scanners, cloud computing, computer-assisted design, deep-sea drilling, forensic DNA analysis, functional magnetic resonance imaging, Google's search engine algorithms, the Internet and web browsers, nanotechnology, discoveries leading to better understanding of global climate change, the retina chip, public key cryptography, technologies enabling deep-sea exploration, social science databases, speech recognition technology, and tumor detection.”\(^1\) Strong research computing resources can provide a competitive advantage in securing research grant funding that leads to scientific discoveries with PR value for the institution.\(^2\)

College and university research faculty are responsible for these innovations. IT can support faculty’s data-intensive research through its specialized staff and infrastructure. EDUCAUSE collects data on institutional practices that support research computing, as well as data about the experiences of faculty as the consumers of these resources. Together, the findings from these sources provide a two-dimensional perspective of the research computing ecosystem in higher education. This report uses two primary data sources:

- A 2014 ECAR study that collected data about faculty experiences and expectations with technology and included 6,137 U.S. respondents (from 133 institutions) with experience using technology for research and scholarship.\(^3\)
- The 2013 Core Data Service (CDS), which collected data about institutional practices concerning IT support, staffing, and expenditures from 339 institutions that offer research computing services.

Each source can independently help institutions make data-informed decisions about research computing. Combined findings from these two sources allow institutions to better understand the contemporary landscape of research computing practices while giving faculty a voice to influence IT service design around research computing.
Findings

Faculty conducting research or scholarly work have different experiences with technology than nonresearch faculty.

College and university research faculty are a diverse group of individual scientists, scholars, and academicians, and each has unique technology needs. Such diversity makes it difficult for an institution to know what to improve, how to improve, or where to start on improving their users’ experiences. A starting point is to look at how these researchers differ from nonresearch faculty. To do so, we looked at ECAR’s 2014 study of faculty and technology. Figure 1 shows the percentage of faculty (research versus nonresearch) rating their institution good or excellent on various technology-related resources provided to faculty. Research faculty rated all of these resources less favorably than did their nonresearch counterparts. This could mean that research faculty have greater technology needs, higher expectations about their technology-related resource options, and/or a fundamentally different (poorer) experience than their counterparts.

Figure 1. Research and nonresearch faculty with good or excellent experiences with technology resources, services, and spaces
Management responsibilities for services that support research and scholarly work activities are highly decentralized, and institutional strategies for providing research computing services often align with the management unit that is best positioned to deliver the resources.

Who is responsible for providing resources and services to research faculty? “On average, central IT manages any individual research service in 25% of institutions offering that service.” Accordingly, IT support for academic research is highly decentralized (figure 2). About two in three institutions (64%) that support research computing have departments that independently provide research computing services. Research computing services that are potentially best leveraged at scale (e.g., high-performance network provisioning, data-center facilities, and support for storage and data access) have some of the highest reported rates for central IT provisioning. Research computing services that are potentially best provided by local subject-matter experts (e.g., assistance with grant applications, statistical consulting, and access to specialized scientific apparatuses) have some of the highest reported rates for provisioning by other units, such as administrative or academic units.

The top 3 research computing services central IT tends to offer are data-center facilities for academic units to operate their servers (55%, arguably a support function for decentralized IT services rather than direct support of faculty research computing), videoconferencing services (56%), and high-performance networking within the institution (60%). The services central IT is least likely to provide for academic research are access to specialized scientific apparatuses (2%), statistical consulting (4%), and assistance in preparing research grant applications (6%). In all three of these cases, these services are most often offered by another administrative or academic unit(s). These data suggest that current institutional strategies for providing research computing services align with the management unit that is best positioned to deliver them.
<table>
<thead>
<tr>
<th>Service</th>
<th>Central IT</th>
<th>System Shared</th>
<th>Other</th>
<th>Outsourced</th>
<th>Not Provided</th>
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<td>Videoconferencing</td>
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<td>Assistance with research grant applications</td>
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<td>Technical reviews/approvals (e.g., hardware, software, systems management, networking)</td>
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<td>Support for storage and data access, including federal grant mandates</td>
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<td>Information security plan reviews/approval for research involving sensitive data</td>
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<td>Management of academic research servers</td>
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<td>Data-center facilities for academic servers</td>
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<td>Data management, storage, and curation</td>
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<td>Review of NSF-required data management plans</td>
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<td>Access to specialized scientific apparatus (e.g., telescope, sensor network)</td>
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<td>High-performance computing configuration and operation support</td>
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<td>Software development and software porting support</td>
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<td>Statistical consulting</td>
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<td>Events for researchers to introduce new technologies and share experiences</td>
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<td>Internal high-performance network provisioning</td>
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<td>Support for access to commercial cloud resources</td>
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<td>External high-performance network provisioning</td>
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<td>Support for access to federally funded research resources (e.g., XSEDE, Open Science Grid, iPlant)</td>
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<td>Visualization support</td>
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<td>High-performance computing services</td>
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<td>High-throughput computing services</td>
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<td>E-science support: integrated system of research-related services/cyberinfrastructure</td>
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<td>Institutional grid-computing services</td>
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**Figure 2. Management responsibility for research computing services**
Faculty are highly critical of their experiences with technology services related to research and scholarly activities. No single management practice proved better than any other at delivering service excellence.

ECAR asked faculty to rate their experiences with technology services related to research and scholarly activities. We found that a minority of faculty with research and scholarly responsibility rated their experiences with these services as good or excellent (figure 3). Even among faculty at doctoral institutions, who are most likely to conduct research that can benefit from technology-supported computing activities, the ratings were similarly low. A forthcoming ECAR publication about the top strategic technologies for 2015 will show significant growth projected for the deployment of technologies that support research and scholarly work. ECAR predicts that by 2017–18, nearly two in five institutions will have digital preservation of research data and/or digital repositories for researchers and scholars. About one in three will have high-performance computing as a core research service. And one in four will have cloud-based high-performance computing.9

Figure 3. Faculty ratings of experiences with technologies that support research and scholarship10
ECAR looked at relationships between units responsible for providing research computing services (i.e., central IT, shared IT, other units, etc.) and faculty experiences with research computing support and technical needs. We did not identify associations between faculty experiences with research computing and institutions’ management practices for providing research computing services. This was true for research faculty in general and for those conducting data-intensive research that requires high-performance computing software or equipment.

Figure 4 shows faculty agreement with general statements about IT support for research, and figure 5 shows agreement with statements about data-intensive research experiences. Although faculty ratings are not overwhelmingly positive with the items displayed in these figures, they are not overwhelmingly negative either. Importantly, our data don’t show significant differences in faculty satisfaction for services provided by central IT compared to those provided by distributed units. For example, among services generally provided by central IT such as bandwidth and data storage capacity, small majorities of faculty found these services adequate (59% and 51%, respectively), while less than one in three found them inadequate (22% and 31%, respectively). Among services such as access to specialized software or hardware to conduct research, which are typically provided by administrative or academic units, we see similar rates—nearly half of faculty reported having access to specialized software and hardware (51% and 48%, respectively), while less than one in three said they did not have access (29% and 28%, respectively). Although faculty experiences will vary at individual colleges and universities based on the technologies and support provided to conduct research, these data provide typical experiences by which to benchmark faculty experience at an individual institution.

In both figures 4 and 5, IT staffing items are highlighted to call out the human elements of support for research computing. The items cover staffing practices and patterns, such as adequate staffing and response time, as well as staffing and service levels. Understanding the potential impact that IT staff service and support of research activities have on faculty satisfaction can help IT managers identify professional development opportunities for staff. Related findings are discussed in the ECAR study about the current IT workforce; technical proficiency is important for staff but does not trump soft skills, such as the ability to communicate collegially and effectively.
All of the items in figure 4 and most of the items in figure 5 ("wait time is too long" being the exception) are positively and significantly correlated with general faculty satisfaction with research computing support. In figure 4, faculty satisfaction is most strongly related to the institution's providing IT support throughout research faculty's promotion and tenure process, cross-institutional support, access to specialized software/applications, and adequate and appropriate support from IT staff. With regard to effect size, each 1-point increase in satisfaction with any of these items is associated with about a 0.2-point increase in general satisfaction (on a 5-point scale) with research computing support. For the high-performance computing items in figure 5, faculty satisfaction is most strongly related to adequate and appropriate communication with IT staff, adequate data storage, and adequate bandwidth. A 1-point increase in satisfaction with the first two items is associated with about a 0.3-point increase in general satisfaction; the effect was an approximately 0.2-point increase for the last item. While we cannot claim a causal relationship from the survey data, satisfaction ratings are not independent from item to item—improving multiple aspects of research computing support is likely to have a compound, positive effect on the
general satisfaction rating. As IT leaders make decisions about the limited resources available to improve services, knowing which IT services have the strongest relationship to faculty satisfaction is valuable information.

Figure 5. Faculty agreement about the adequacy of support for high-performance computing activities

Generally, faculty are moderately satisfied with the research computing services they receive: 42% agreed or strongly agreed that they are satisfied with their institution’s support for their research needs, and 36% agreed or strongly agreed they are satisfied with the provision of research computing technologies at their institution. There is indeed much room to improve faculty’s IT support experiences, regardless of the unit responsible for providing the service.
Improving faculty experiences with support services requires strong IT leadership that leverages the CIO as the "chief connector"; this connector can build support and infrastructure for scholarly work and research globally and support it locally.

College and university research computing services support the diverse needs of communities of users, from individual scientists and scholars to international collaborations and crowdsourcing, and each faculty member has a seemingly unique set of needs. Such diversity makes it difficult to know what to improve, how to improve, or where to start. One approach is to integrate systems of research-related services—and this practice is growing. In 2011, 30% of institutions were providing or planning to provide an integrated set of IT research services; this grew to 40% in 2013. Other ideas for moving to service-oriented research computing (suggested by attendees of the 2014 ECAR Annual Meeting) include:

- Bundling research computing support with the common network services "head tax."
- Setting institution-wide consultation rates for specific software development, especially for data modeling or custom development.
- Focusing central services on scalable, common-denominator approaches.
- Identifying and funding centers of excellence and chartering them to provide services to the entire institution, not just the department in which they may have originated.
- Adopting ITIL service management practices to effectively and consistently manage services.
- Designating the CIO as the chief connector to forge partnerships with IT, the Office of Research, the library, department services providers, and others. The role would include developing good governance mechanisms to facilitate effective collaborations and coordination.
- Hiring people who understand data, data mining, analysis, and visualizations, which addresses the challenge of finding people with a mix of domain expertise and computer science and math expertise.

Of all of the items noted in the list above, the standout is the CIO as the chief connector. The CIO is best positioned to build an explicit or simply virtual integration layer for decentralized research services and systems within institutions, as well as to explore shared resources through collaborative partnerships across institutions. This requires the CIO to have a broad (or even global) perspective about IT connection opportunities and the ability to implement these connections at the campus (or local) level.
As demand for research computing services increases, the proportion of IT expenditures that are dedicated to grow or transform the institution will need to increase as well.

With academic research in the United States experiencing “unprecedented growth over the past century,” colleges and universities need to invest in ways to keep pace with these needs to remain competitive. This can be a challenge when total IT expenditures primarily cover ongoing operational expenses—those required to run the institution (such as administrative computing). In FY2012–13, a median of 79% of total IT expenditures was spent on activities to run the institution, 13% was spent to grow the institution (i.e., spending to accommodate incremental growth and improvement), and 6% was spent to transform the institution (i.e., spending to plan and implement transformative change).

Looking more specifically at IT expenditures on research computing, we know from CDS data that “greater proportions of IT spending devoted to research computing are associated with greater offerings of research services” (figure 6). That said, ECAR did not find conclusive relationships between faculty experiences and the percentage of institutional IT spend devoted to research computing—faculty experiences with IT support and services are seemingly independent of the IT spend. To optimize the impact that IT has on academic research experiences, IT leaders will need to find ways to address the growing demand for research computing services while simultaneously looking for ways to improve the suboptimal experiences that many research faculty currently report.
Investment in research computing could lead to increased productivity and innovation in science and the humanities.

Improving faculty experiences with technology related to their research pursuits could facilitate more scientific discovery in U.S. higher education. Over the past few years, the mean number of research computing staff and the percentage of research computing staff among the total IT staff at high-intensity research institutions have decreased. While this could help explain why so few faculty reported having adequate, appropriate, and proactive IT support of their research computing needs, additional analysis of ECAR and CDS data found that faculty experiences with IT support and services are seemingly independent of IT staffing levels.

Figure 6. Relationship of IT expenditures on research and offerings of research services
<table>
<thead>
<tr>
<th>Research Intensity</th>
<th>Average Number of Research Computing Staff</th>
<th>Percentage of Total IT Staff</th>
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</thead>
<tbody>
<tr>
<td>High</td>
<td>3.0 staff</td>
<td>1.3%</td>
</tr>
<tr>
<td>Med.</td>
<td>0.3</td>
<td>0.4%</td>
</tr>
<tr>
<td>Low</td>
<td>0.2</td>
<td>0.3%</td>
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</table>

Figure 7. Research computing staffing at high, medium, and low research intensity institutions.
Conclusion and Recommendations

This report discusses the growth in research computing activities in colleges and universities while documenting research faculty's critical opinion of their technology-related research computing experiences. Management responsibility for services that support research and scholarly work activities is highly decentralized, and institutional strategies for providing research computing services often align with the management unit that is best positioned to leverage the resources. Faculty opinions don't vary by IT management model, which suggests that their experiences are independent of service providers. This presents an interesting opportunity for centralized IT and distributed IT to collaborate on solutions that address faculty's increasing needs for research computing services and/or their perception that their current IT resource/support experience is substandard.

The growth in research computing needs will require new ways of funding, staffing, and collaborating, as well as integrating systems of research-related services. The CIO will play a critical role in these transformations as the “chief connector” to optimize the impact of IT on research and scholarly activities. Strong leadership, reliable assessment metrics, and clear goals are also critical components in this equation. Participation in the EDUCAUSE Core Data Service and annual ECAR faculty survey provides opportunities to benchmark against peers’ practices, aspirational goals, and institutional priorities and can support accountability efforts for fiduciary responsibilities. Using the combined information from CDS and the ECAR study, IT departments can foster collaboration with faculty, the consumers of university IT research computing services, to improve IT service design and extend resources to better support faculty’s research and scholarly activities. A successful research computing program will find ways for the units that provide IT services and resources to cultivate proactive, collegial, and to some extent symbiotic relationships with the faculty consumers of these resources.
Notes


3. Eden Dahlstrom and D. Christopher Brooks, with a foreword by Diana Oblinger, *ECAR Study of Faculty and Information Technology, 2014*, research report (Louisville, CO: ECAR, July 2014), available from the ECAR Student and Faculty Study research hub.

4. Dahlstrom and Brooks, *ECAR Study of Faculty*.

5. Ibid.


7. Ibid.

8. EDUCAUSE Core Data Service, 2013. For more information, please see the CDS website.


10. Dahlstrom and Brooks, *ECAR Study of Faculty*.

11. EDUCAUSE looked at the relationships between the percentage of faculty agreeing or strongly agreeing with selected items from figures 4 and 5 and institutional management practices shown in figure 2. The associations between these variables were not significant. We looked at the following statements, “In general, I am satisfied with my institution’s support for my research needs” and “I am generally satisfied with the provision of research computing technologies at my institution” across additional CDS results (i.e., IT staffing devoted to research computing, percentage of the IT spend devoted to research computing, etc.) and found no significant associations there either.


13. Dahlstrom and Brooks, *ECAR Study of Faculty*.

14. Ibid.


16. Ibid.

17. Ibid.


20. EDUCAUSE Core Data Service, 2013.

21. Research intensity is calculated using IPEDS data on research expenditures for the whole institution/student FTE: low = $0, med. <= $500 per FTE, high > $500 per FTE.