

Key Findings

IT Engagement in Research

Harvey Blustain, with Sandra Braman, Richard N. Katz, and Gail Salaway

Research has long been one of the pillars of higher education. The creation and dissemination of new knowledge has been prized both for its intrinsic value and for its contribution to the betterment of society. Until recently, the Carnegie classification system categorized institutions largely on the basis of their research capacity, with the implicit assumption that major research universities—the R-1s—were at the top of the heap.

Over the past decade, research has assumed an even greater importance in the academic mind-set, and universities are increasingly looking to research as their avenue to expansion, revenue, and prestige. At the same time, the cost, complexity, and competitiveness of “playing in the big leagues” have increased. Many universities have made public bets that they will break into the top echelons of research institutions, and this has set off an arms race to find new sources of funding, to construct new research centers, and to attract star researchers with proven grant-magnet abilities.

What makes this relevant to the world of information technology (IT), of course, is that research is increasingly computational and data-intensive. Ever-larger data sets are being collected and shared across larger and more geographically dispersed teams of researchers from diverse disciplines. Simulation and visualization software are becoming routine tools. The co-evolution of science and computing increasingly requires scientists to have solid grounding in information management and complex software.

The ECAR study *IT Engagement in Research* focuses on the practices and perspectives of IT organizations that support the academic research enterprise. Among the central questions it poses are:

- How has data-intensive research evolved since World War II, and how has that evolution led to the current concept of “cyberinfrastructure”?
- What does the research landscape look like from the perspective of IT professionals within higher education? What are they seeing in terms of interdisciplinary, multi-institutional, and undergraduate research, as well as the use of IT in traditionally non-data-intensive disciplines such as the arts and humanities?

- What investments are colleges and universities making in IT research infrastructure, especially networks, high-performance computation, and data storage?
- How are central IT organizations staffed to support research?
- How is the responsibility for support services for researchers distributed across central and local IT organizations?
- How are IT organizations adapting to accommodate both the growing needs of researchers and the growing sophistication of research-related technologies?

The overarching story presented in this study is that IT and research are at a critical point in their intertwined history. The past 50 years have seen dramatic growth in a research agenda that has been increasingly enabled by ever-more sophisticated and powerful technologies. We are at a juncture at which both IT professionals and the researchers they support are asking fundamental questions about how research can best be conducted with increasingly limited resources. This has created an opportunity for central IT organizations to rethink how IT is organized and deployed in support of research.

Methodology

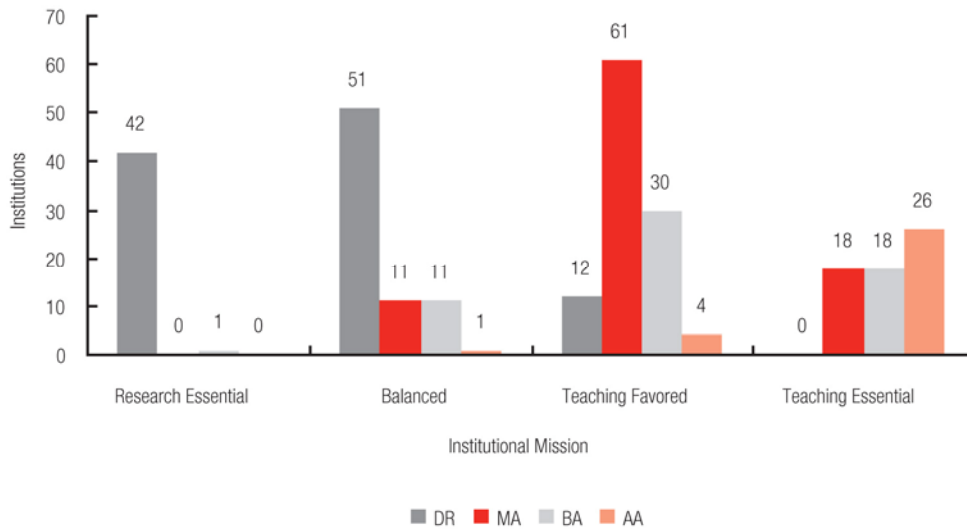
We undertook four data-collection and analytical approaches: a literature review, a quantitative Web-based survey of 328 institutions, qualitative telephone and e-mail interviews, and five case studies.

When we ran statistical tests of our survey population, a question about institutional mission turned out to be a more powerful independent explanatory variable than Carnegie classification. The survey asked which of the following four statements best describes the respondent's institution. Each descriptor is preceded by the shorthand name we later assigned to each category and is followed by the number of institutions assigning themselves to it.

- *Research Essential*: Research and teaching are the primary missions, but research is what really drives faculty and institutional success. (48)
- *Balanced*: Research and teaching are both primary missions, and they are equally important for faculty and institutional success. (90)
- *Teaching Favored*: Teaching is the primary mission, but faculty research is rewarded. (115)
- *Teaching Essential*: Teaching is the primary mission, and faculty research does not factor heavily in faculty and institutional success. (73)

Figure 1 shows the relationship between Carnegie classification and self-reported institutional mission.

Figure 1. Distribution of Carnegie Classes, by Institutional Mission



Significant Findings

The past half century has seen remarkable innovations in how IT has both enabled research and generated new approaches to research. Computational science has come into its own as an approach distinct from computer science, and the social sciences and humanities have joined the physical and life sciences in the development of computationally intensive research methods. Through funding, laws, and regulations, both federal and state governments have played—and continue to play—a significant role in the conduct of research. The current visions of cyberinfrastructure extend these trends in data-intensive research toward the transformation of science itself.

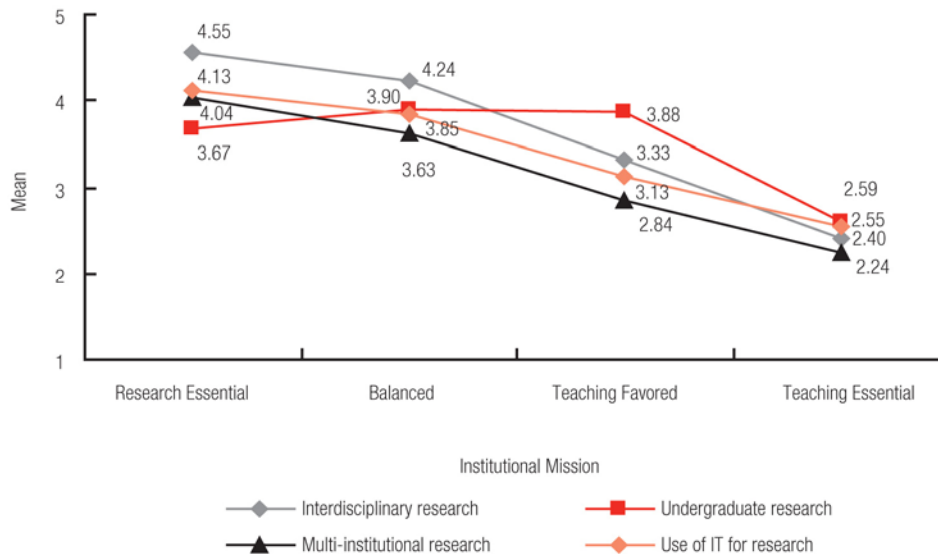
The Changing Research Landscape

We asked respondents a series of questions about the importance of new trends in research at their institutions. The statements began “My institution place high priority on...” and continued with

- the use of information technology for research
- interdisciplinary research
- multi-institutional research
- undergraduate research

Figure 2 compares the means across institutional missions for these four types of “nouvelle research.”

Figure 2. Research Priorities, by Institutional Mission (Mean Value)



Q: My institution places high priority on... (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

As expected, there was a healthy relationship between priorities and institutional mission. The more central research is to the mission of an institution, the more likely it is to place a priority on interdisciplinary research, multi-institutional research, and the use of IT for research. One interesting divergence in the figure is the notable bulge in the undergraduate research line, especially among the Teaching Favored institutions. This rising prevalence of research among undergraduates reflects a number of trends: faculty interest in involving students in their research as a form of pedagogy, student appreciation of the learning opportunities accruing from closer contact with faculty, and institutions' awareness of the competitive advantages of having a credible undergraduate research program.

One of the more eagerly anticipated trends in the cyberinfrastructure vision is the expansion of data-intensive research into the arts, humanities, social sciences, and other disciplines that traditionally have not relied heavily on IT as a research mechanism. Our survey confirmed the trend. More than half of respondents expected growth in the use of IT in nontraditional disciplines, compared with 37.3 percent of respondents who observed an increase over the previous three years. The Research Essential and Balanced institutions were more likely to see a greater increase in the use of IT in traditionally non-data-intensive disciplines.

To gain greater clarity on the demands from the various disciplines, we gave respondents a list of disciplines and asked these questions:

- Which three have displayed the fastest growth in demand for central IT infrastructure and support services for research?
- Which three currently generate the greatest demands for centrally maintained IT infrastructure and support for research?

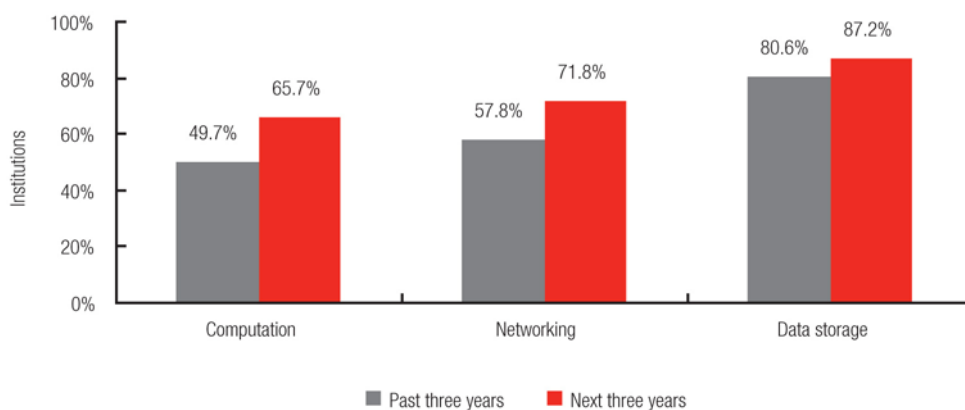
For both questions, the traditionally non-IT-intensive disciplines fell to the bottom. What the data means to us is that as quickly as these “new” disciplines are turning to computation, the more traditionally IT-heavy disciplines demand IT resources at an even greater pace.

Infrastructure

Infrastructure—which we defined largely in terms of networks, high-performance computation, and data storage—continues to grow in importance to the research enterprise. We asked survey questions about the decrease or increase in the use of infrastructure at their institutions over the past three years. Data storage showed the highest levels of increase, with almost half of the institutions (49.9 percent) reporting an increase and another 30.8 percent claiming a great increase.

When we asked about the next three years, respondents projected that growth in infrastructure would be greater than past growth, with data storage continuing to be the fastest-growing infrastructure element. Even in computation, however, which was the slowest growing of the three categories, two-thirds of institutions projected increasing levels of activity over the next three years. Figure 3 shows the percentage of respondents who reported past and projected increases in the use of infrastructure.

Figure 3. Increase in Use of Infrastructure, Past and Projected Three Years



The Central IT Organization

To understand how central IT units organize and staff their support of research, we asked how many full-time equivalent (FTE) staff within central IT were currently assigned to the support of research. Among the 310 institutions responding, more than half (55.9 percent) had fewer than one FTE, and an additional 23.2 percent had between one and three FTE dedicated to research support. About one-fifth (20.9 percent) had four or more FTEs, with 13 (4.2 percent) reporting more than 20 FTE.

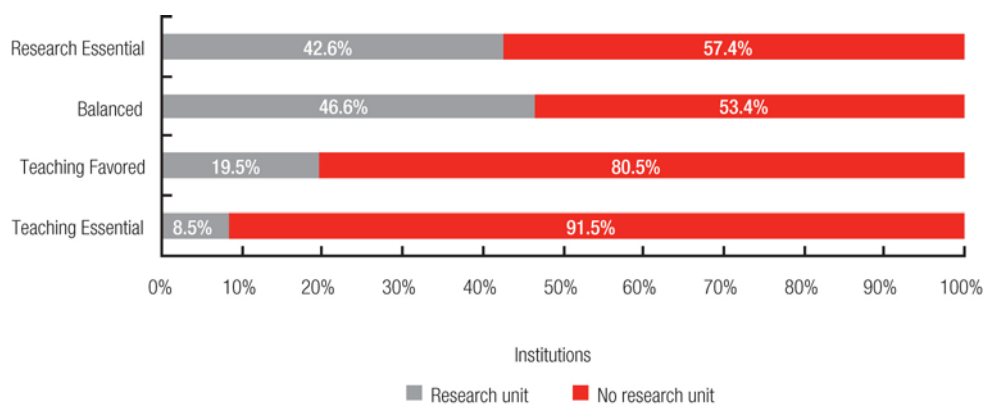
The central IT organizations at the more research-intensive institutions were more likely to have bigger research-related staffs, with 10 of 45 (22.2 percent) Research Essential and 20 of 88 (22.7 percent) Balanced institutions having seven or more such staff. It is also worth noting that 11 (24.4 percent) of the Research Essential institutions had fewer than one FTE assigned to research, and an additional 24 (53.3 percent) had one to six staff. Among the Balanced institutions, 25 (28.4 percent) had fewer than one research IT FTE, and an additional 43 (48.9 percent) had one to six. This means

that 77.7 percent of the Research Essential and 77.3 percent of the Balanced schools had fewer than seven people assigned to research in their central IT organizations.

As a further gauge of an IT organization’s commitment to research, we asked if the central IT organization has “a distinct unit with the explicit mission of supporting faculty, clinicians, or other researchers with their research needs.” Of the 321 institutions that responded to the question, 90 (28 percent) had such a central unit, while 231 (72 percent) did not.

There was a strong association between the presence of a research unit and the institution’s research mission. As shown in Figure 4, almost half of both the Research Essential and the Balanced institutions had a research IT unit, compared with only one-fifth of Teaching Favoreds and less than one-tenth of the Teaching Essentials.

Figure 4. Presence of Research Unit in Central IT, by Institutional Mission



The slightly larger percentage of Balanced institutions with a central research IT unit may seem incongruous, but it highlights a phenomenon that emerged frequently through the survey data: the great similarity in organizational structures and behaviors among the Research Essential and the Balanced institutions. Other examples include the level of staffing (as we have seen), the rate of increase in data-intensive research, the extent to which central IT has a formal mechanism for engaging researchers, the use of long-term planning for research IT infrastructure and support services, and the presence of an institutional research office. We believe that this is the case because, regardless of the differences in the espoused *teaching* missions of these two categories, a commitment to research triggers required investments in the research enterprise if the institution is to be effective.

Funding for Infrastructure and Services

We asked survey participants to tell us where spending has increased or decreased over the past three years and how they expect spending to change over the next three years. Over the past three years, institutions saw funding grow the most in data storage (57.6 percent of responding institutions). This is entirely consistent with respondents’ view that data storage experienced the fastest growth among the infrastructure elements. The next highest-growth areas were high-performance networking (57.2 percent) and operations (50.8 percent). Funding grew the least in applications and tools

(31.7 percent), high-performance computing (27.6 percent), and IT support (24.6 percent). There was no statistically significant relationship with institutional mission, most likely reflecting a common set of pressures and priorities across categories.

Looking ahead to the next three years, respondents once again said that the three areas with the most anticipated growth in funding would be data storage (64.6 percent of institutions), operations (61.0 percent), and high-performance networking (60.8 percent). They expected that IT support, consisting of training and consulting, would continue to trail, with just 40.6 percent of institutions expecting any kind of increase in funding for that area.

We also sought to discover the extent to which IT leaders believe that they have a sustainable budget model for maintaining and evolving key components of the infrastructure and for services (such as applications, tools, training, and consulting) related to research IT. Half (49.9 percent) said they do not have a sustainable budget model for infrastructure, while 54.4 percent maintained that the budget for services was unsustainable.

Local IT Support for Research

A focus on the central IT organization is a partial view because, as the EDUCAUSE Core Data Service indicates, local IT units abound within schools, centers, and departments (Hawkins, Rudy, & Nicolich, 2005). We sought to understand, from the perspective of our central IT respondents, the level at which those local units were growing. We asked whether over the past three years the number of IT staff in the schools, centers, and departments who support research had decreased, stayed the same, or increased. The responses revealed that a negligible percentage (2.3 percent) of institutions saw any decrease in research-related IT support resources at the local level.

Approximately two-thirds (67.1 percent) stayed the same over the same period, and less than one-third (30.6 percent) saw any kind of increase. Significantly, the same pattern holds for the next three years, although there is a shift in expectations toward growth in local resources, from 30.6 percent to 38.3 percent of institutions.

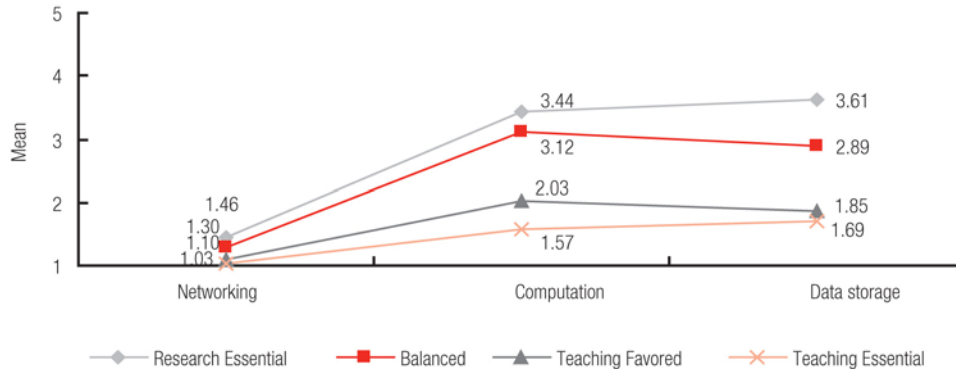
The Research Essential and Balanced institutions will continue to experience the greatest growth in the local research IT staff. Over the next three years, however, the Teaching Favored institutions are also expecting a small surge in local research IT staff. It would be interesting to speculate that much of the growth is being driven by the demands of undergraduate research, but we did not have the data to support that hypothesis.

Distribution of Responsibility

We sought to understand how central and local IT organizations divide the responsibility for key infrastructure elements: high-performance networking, high-performance computation, and data storage. The network is managed mostly or completely centrally at almost 96 percent of institutions. This makes sense, given that the network is an institutional resource, enjoys economies of scale, and benefits from consistency of standards. The other two elements showed more variability, with both high-performance computation and data storage being managed mostly or completely locally at almost one-third of institutions. Slightly more than 10 percent of institutions viewed these two

elements as equally shared, and between 57 percent (for computation) and 61 percent (for data storage) indicated primarily central responsibility. When we compared the means of the locus of responsibility across institutional mission (Figure 5), there was a striking divergence among the four categories of schools.

Figure 5. Division of Responsibilities for Infrastructure, by Institutional Mission (Mean Value)



Q: Where does responsibility lie for the following IT infrastructure elements related to research? (1 = almost all central, 2 = mostly central IT/some school, center, and department IT; 3 = equally shared between central IT and school, center, and department IT; 4 = mostly school, center, and department IT/some central IT; 5 = almost all school, center, and department IT)

With the exception of the network, which continued to be managed centrally, the greater the focus on research, the greater the local responsibility for computation and data storage. For computation, the mean was 3.44 among the Research Essential institutions, meaning that responsibility lay somewhere between shared between central and local and mostly local; for the Teaching Essential institutions, the mean was 1.57, halfway between all and mostly central. The means for data storage were comparably differentiated.

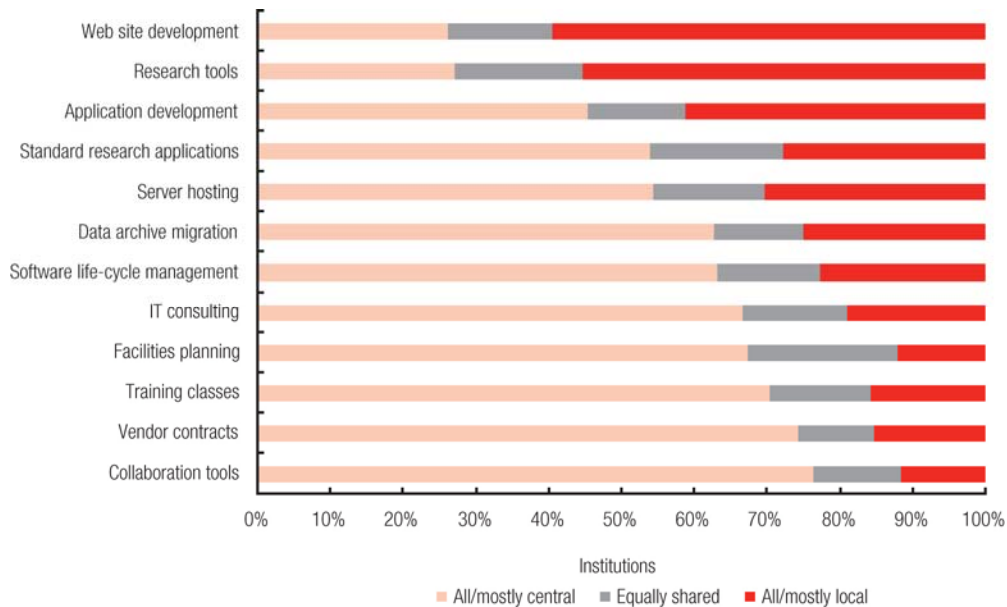
We asked a similar set of questions about the locus of responsibility for 12 research-related IT support services:

- Selection and use of standard research applications (such as SPSS and research databases)
- Software application programming and development
- Selection and use of research tools (such as visualization, data mining, and statistical analysis)
- Providing collaboration tools (such as videoconferencing and whiteboarding)
- Data archive migration through media and software evolution
- Software life-cycle management (such as upgrades and version control)
- Training classes (such as on database use, security, and digital video)
- Consulting services (such as issue-specific problem solving)

- Hosting services for individual researchers' servers
- Development and maintenance of Web sites related to their research
- Maintaining vendor contracts for hardware and software purchases
- Planning for IT infrastructure in new facilities

The association was not perfect, but there was a marked tendency for the more discipline-specific services to be done locally. Figure 6 illustrates the distribution of responsibility for support services.

Figure 6. Distribution of Responsibility for Support Services



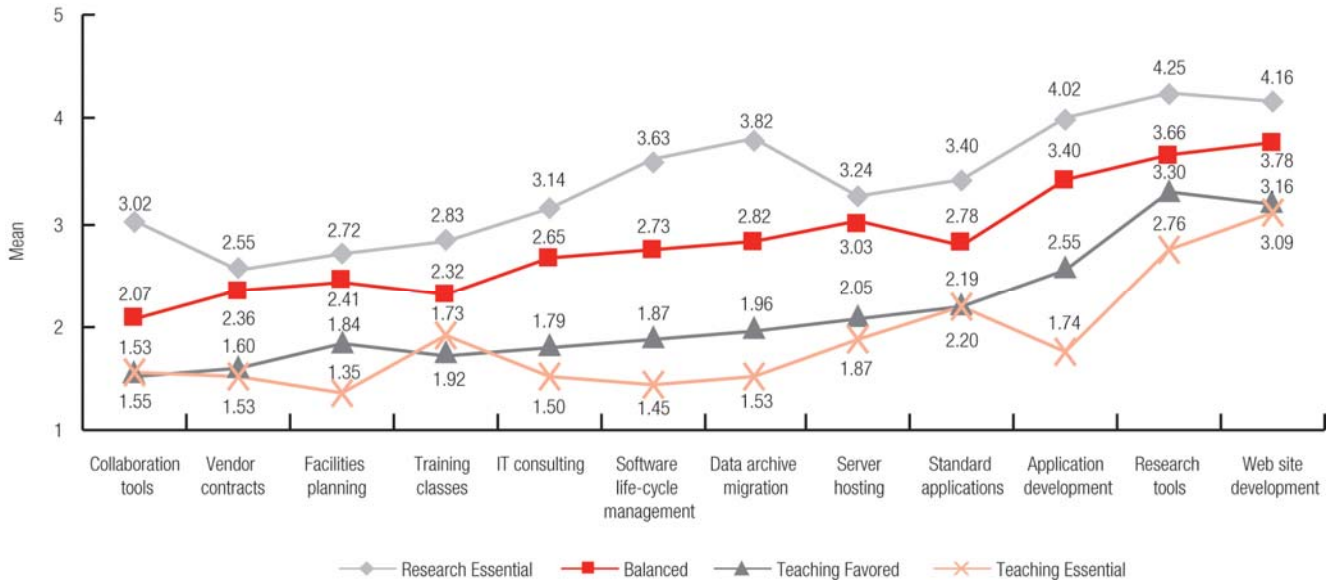
Q: Which IT organization(s) are responsible for providing the following research-related IT support services? (1 = almost all central; 2 = mostly central IT/some school, center, and department IT; 3 = equally shared between central IT and school, center, and department IT; 4 = mostly school, center, and department IT/some central IT; 5 = almost all school, center, and department IT)

Web site development and maintenance was the most localized service, with almost 60 percent of institutions reporting this as a local responsibility, followed by research tools (55.3 percent), application development (41.1 percent), and standard research applications (27.8 percent). The most centralized support services were collaboration tools (76.5 percent all or mostly centralized), followed by maintenance of vendor contracts (74.1 percent), and training classes (70.3 percent). These are fairly generic services that can be applied across even a large, complex research institution. It makes sense that facilities planning is also centralized since it often involves institutional planning and standards.

As we did with infrastructure, we then looked at the means across categories of institutional mission (see Figure 7), with 1 signifying that the service is almost entirely the responsibility of central IT and 5

indicating the locus of responsibility to be all or almost entirely within the school, center, or department. Once again, there is a striking propensity for the Research Essential institutions to have responsibility for their services at the local level. In some cases, such as research tools (4.25), Web site development (4.16), and application development (4.02), the Research Essential schools display a marked preference for managing these discipline-specific services locally.

Figure 7. Responsibility for Services, by Institutional Mission (Mean Value)



Q: Which IT organization(s) are responsible for providing the following research-related IT support services? (1 = almost all central; 2 = mostly central IT/some school, center, and department IT; 3 = equally shared between central IT and school, center, and department IT; 4 = mostly school, center, and department IT/some central IT; 5 = almost all school, center, and department IT)

These findings should not be surprising. It makes sense for discipline-specific services to be done at the local level. Astronomers (or chemists, or demographers, or others) have a much greater appreciation for the research problems they are trying to solve, and local IT support staff are more likely to be attuned to the substance of the discipline. Further, central IT organizations typically have relatively few individuals dedicated to the support of research, and they simply cannot provide the necessary expertise in all disciplines and departments. Where research is supported by external funding, it is even more understandable that the researcher will recruit his or her own IT support, especially from among the ranks of graduate students.

This trend toward local support for IT services is even more pronounced in the large, complex, and decentralized environments that characterize the Research Essential institutions. The research problems are more likely to be specialized, there is more likely to be external funding, and the central IT organization is more likely to be hard-pressed to support the diverse needs of researchers across the institution.

The decentralization of services has its potential costs, including duplication of effort, gaps in service, diversion of people from substantive research, a multiplicity of standards, and security risks. Because collaboration between central and local IT organizations can alleviate some of the risks, we asked—using the same set of 12 services—which of these services is characterized by coordination between the central IT organization and the schools, centers, and departments. What was noteworthy is that of the six services done most locally, five are the services with the *least* active coordination: Web site development, research tools, application development, server hosting, and data-archive migration. The greatest amount of coordination occurred among the more centrally based services. This relationship—that services provided out in the units are provided with little coordination with central IT—should not be surprising, but it is a little disturbing. The decentralization of services without collaboration with central IT heightens the risk of duplication or suboptimal utilization of resources.

Central IT Engagement with Researchers

We triangulated on the issue of how well central IT organizations engage researchers in collaborative efforts by asking respondents about various mechanisms they employ, such as formal processes for engaging researchers, advisory groups, the use of long-term planning related to researcher infrastructure and support needs, involvement in faculty grant preparation, involvement in faculty recruitment, and cooperation with an institutional office of research.

The most striking finding was that more than half of the respondents (181 of 328, or 55.2 percent) said that there is no formal engagement and that most methods of engagement are overwhelmingly informal. Of all institutions participating in the survey, 64 percent do ad hoc consultations, and only a shade more than a third (34.8 percent) claim “regular and active informal networking.” Even the “formal consultations” associated with specific research grants are at one level ad hoc because they hinge on particular circumstances. The most common formal forms of engagement—consultations supported by specific grants and regular meetings with academic leaders—are maintained by less than one-fifth of the institutions. Only about 10 percent of institutions have advisory or working groups organized around research issues or platforms.

Other findings from the survey indicate the following:

- Less than half of respondents (42.7 percent) claimed to have an advisory group that addresses research IT issues.
- More than two-thirds of institutions, including over half of the Research Essential and Balanced institutions, do not engage in any form of long-term planning to determine researchers’ IT needs.
- More than three-quarters of respondents said that central IT is consulted never, rarely, or only sometimes in the pre-award process of contracts and grants to identify needs and resources.
- Slightly more than 90 percent of respondents said that central IT is never, rarely, or only sometimes involved in faculty or researcher recruitment processes to identify their IT needs and resources,

If higher education is indeed entering a vortex of a research revolution, the central IT organizations seem disconcertingly disengaged.

Conclusion

Technology organizations have gone through swings of centralization and decentralization. The central data center gave way to cheaper hardware and packaged software, ushering in a period of greater initiative and ownership by local units. The survey confirmed a marked pattern of locally maintained resources, especially among institutions that identified research as a primary element of their mission. Much of the centrifugal force has been generated by the academic culture and by the logical tendency to rely on people who know the discipline, understand the research problem, and live down the hall. Yet part of the reason, too, is that central IT organizations, for their part, have not made the support of research a major organizational imperative.

Several factors have now combined to cause a fundamental rethinking of the appropriate locus of responsibility for some core infrastructure. At the heart of the transition are changes in the nature of science itself. Scientists are posing bigger questions about more complex phenomena. Funding agencies have made clear their lack of interest in single-researcher approaches and are insisting on collaboration among researchers from many disciplines. Other considerations include the recognition of opportunities for greater efficiency, security, and space utilization, and the realization of the real opportunity cost to having graduate students and other local resources manage the infrastructure. The September 11 attacks and Hurricane Katrina were a wake-up call for researchers who asked themselves what would happen to years of work if their office servers were destroyed.

As a result, a number of institutions have begun realigning the roles of their central and local IT organizations in the support of research. Several ECAR studies have focused on how central IT organizations at Purdue University, Princeton University, Georgetown University, and the Universities of California at San Diego and Irvine have worked with researchers to enhance their research IT capabilities. But there are other examples as well of central IT organizations that have started to build a community of research IT support staff (University of Iowa), have developed cluster condominiums (Penn State University), or have become stronger advocates for faculty needs (Rice University). Central IT units that have begun the realignment process have done so through two major steps.

First, the central IT organizations have identified their source of value. Are researchers seeking access to national and regional networks? Are they looking to expand their access to high-performance computing? Are they concerned about limited IT expertise within their local support community? Are they seeking better facilities for their equipment or security for their data? Are they looking to expand research opportunities for undergraduates? There will be a variety of needs, but the central IT organization must align its activities with the most urgent priorities of the research community.

Second, the only way to really understand researcher needs and the value central IT can bring is to engage with them. One of the most striking findings from our study was the limited extent to which central IT organizations currently engage the research community through formal mechanisms, long-term planning, advisory groups, participation in grants, or involvement in faculty recruiting to identify potential needs. There have simply been too many other priorities. But the tide is turning, much of it driven by researchers and local support staff themselves. Researchers and the IT staff who support

them are often isolated by school, discipline, or campus geography. Research computing groups within central IT can play a mobilizing role to foster a forum for like-minded people to share practices, skills, ideas, and community.

References

Hawkins, B., Rudy, J. A., & Nicolich, R. (2005, September). *EDUCAUSE Core Data Service: Fiscal Year 2004 Summary Report*, 5.

Harvey Blustain (hblustain@earthlink.net) is President of Act IV Consulting, Inc.

A copy of the full study referenced above will be available via subscription or purchase through the EDUCAUSE Center for Applied Research (www.educause.edu/ecar/).
