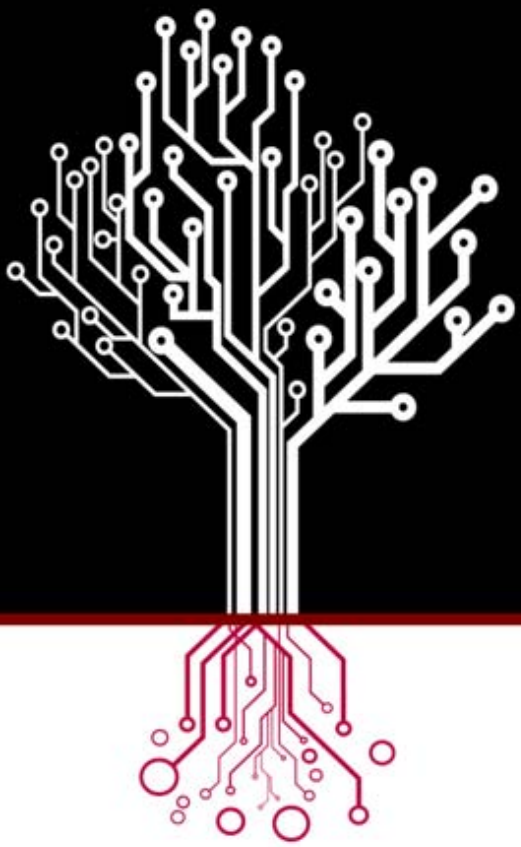
Accelerating the Journey

Indiana University's Strategic Plan
for Information Technology
2008

PRELIMINARY DRAFT



INDIANA UNIVERSITY

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Section A1. Setting the Context

Foreword

Dear Colleagues,

In 1998, Michael McRobbie, Indiana University's first Vice President for Information Technology, wrote:

> *"Information Technology is today one of the most critical tools in higher education. It permeates every aspect of a University from the first contact a student has with its Web site through the myriad systems that manage and provide access to its information..."*

Ten years hence those words resonate even more as almost every part of modern scholarship is touched by the tools of information technology. The devices envisioned in 1998 are increasingly the common tools of teaching, learning, research, and social communications today. Humanities scholars use high definition video, advanced visualizations, imagery of precious texts, and find passages of digitized books as they work from anywhere. The life and health sciences work from deepening stores of data that map human genomics and the proteomics, metabolomics, and cytomics that inform disease prevention and treatment. Before arriving for a first class, students assess potential roommates via social networking sites, arrange group social gatherings with a few short messages, and have a growing world of open educational resources at their fingertips.

Greater connectivity brings both opportunity and challenge for leading universities. Students have access to a world of instructional resources and information, yet they must develop the skills to assess the veracity of information. Finding a needed bit of information or service even within a large university can be a challenge. Greater connectivity and advanced devices can do seemingly miraculous things, but mastering each new device requires additional skills and time. Integrated communications for voice/telephone, video, presence signaling, and data sharing can enable remarkable forms of distributed collaboration, but they also beg changes in long-held work habits and effective work processes within and beyond organizational hierarchies.

The 1998 "*Information Technology Strategic Plan: Architecture for the 21st Century*" set forth bold and ambitious goals for Indiana University. Myles Brand, then IU's president, sought a plan to enable Indiana University to become a leader in absolute terms in the use and application of IT. In the past 10 years, IU has made unprecedented strides in developing areas of excellence in advanced networking, cyberinfrastructure and support for university research, tools to broadly support teaching and learning, digital libraries, and ensuring a sound fiscal basis for IT equipment and services (see Accomplishments Summary in Appendix E2). On May 20, 2008 IU held a celebration event commemorating the 10th anniversary of IU's 1998 IT Strategic Plan. Over 400 members of the IU community were in attendance, celebrating the accomplishments of the first plan and launching the second planning effort.[1]

In March 2008, President Michael McRobbie charged the Vice President for IT to work with the IU community on a plan "…to develop the pervasive use of IT to help build excellence in education and research in all disciplines, in administration, in IU's engagement in the life of the State, across all campuses, and in collaboration with IU's key partners such as Clarian Health and other institutions

of higher education." Over 140 members of the IU community from all campuses and from the ranks of students, faculty, staff, and alumni have contributed to the development of this plan. It has included input from essential partners such as Clarian Health, the Ivy Tech Community College of Indiana, and campus communities. The plan is to be "visionary, realistic, and relevant to the missions of the campuses of Indiana University." Assuming that with renewed guidance IU could continue to improve its IT infrastructure, this plan was to be a human-centered plan to mobilize the opportunity to take IU to the next level in effective use of human-centered IT systems and services.

This plan, "Accelerating the Journey," is IU's second strategic plan for IT, and it will guide the university's investments in IT for the upcoming years. It is both aspirational and practical in its roadmap for IU. It provides a basis for coordinated action across the university in pursuit of excellence and leadership for Indiana.

I am grateful to the extraordinary work of Professor Frank Acito who directed this monumental effort as Chairman of the University Information Technology Committee. He spent countless hours gathering information on national trends, attending hundreds of hours of meetings, and many weekends in leading this work. I am also grateful to four sets of taskforce co-chairs: Sarita Soni and Alfred Guillaume (Faculty and Scholarly Excellence), Roger Thompson and Jeffrey Watt (Student Success), Nasser Paydar and David Zaret (Effective Community), and Jim Perin and Susan Sutton (Engagement Beyond) for their service to vet many ideas and lead their taskforce contributions to this plan. My team in OVPIT of Garland Elmore, Christine Fitzpatrick, Kim Milford, and Jan Holloway also labored hours in shaping the geyser of input into a coherent plan.

It is my hope that this 2008 plan will again contribute to moving IU to the next level just as the successful 1998 plan so aptly did. IU begins in a sound position for this work based on its own capabilities and strong positions of national and international engagement. The aspirations of this plan are within our reach, and in the years ahead we can turn these aspirations into IU's reality.

Brad Wheeler
Vice President for Information Technology and Professor

Introductory Letter from the Chair

Dear Vice President Wheeler:

The draft of the second information technology strategic plan for Indiana University, "Accelerating the Journey," is now complete and follows this letter. The word "acceleration" in the title reflects the need to continue IT development at Indiana University in a manner that keeps pace with the increasing speed of change and innovation in technology. The ability to take advantage of rapid developments in IT at IU is possible because of the achievements stemming from the plan, "Architecture for the 21st Century," published in 1998 that became the guide that for moving Indiana University to a position of leadership in IT infrastructure and architecture. The principal thrust of this new plan is to continue building upon the foundations established through implementation of the 1998 plan and, furthermore, to speed the adoption and installation of exciting new IT applications in support of the university's missions.

The second strategic plan is organized into three broad sets of recommendations and actions. The first set of recommendations is concerned with maintaining and continuing to develop the outstanding IT programs, services, networks, and management practices that are already in place. The foundation for IT must be kept strong and up-to-date in order to provide a platform for future innovative applications. Current and planned activities for infrastructure improvement and application deployment must be continued and supported.

The second set of recommendations is directed at making IT resources more "human centric," so that the activities of students, faculty, and staff can be performed more effectively and efficiently. The full potential of IT for collaboration, for access to information, for improved support of decision making, and for many other possible applications can only be realized to the extent that people can understand them and conveniently use them. There are many opportunities for improving the accessibility and power of technology applications that can materially enhance the ability of all members of the IU community to better contribute to the university's missions. To make these applications truly valuable, efforts should be directed toward insuring that they integrate well with existing practices, provide demonstrable, relevant, and important advantages, and are cost effective, both in terms of financial and human resource investments.

The third section of the plan presents recommendations that are "grand challenges and opportunities." These represent stretch goals which are demanding but worthwhile, with difficulties that can be overcome. These involve longer term programs and projects which will require considerable creativity and perhaps must await future technological developments. However, these grand challenges and opportunities should serve to inspire and focus technology efforts at IU on areas that can lead to true distinction and leadership in making important contributions.

This plan is the result of the combined efforts of more than 140 members of four task forces, the University Information Technology Committee (UITC), and the entire team of the Office of the Vice President for Information Technology. I want to express my extreme gratitude to the task force leaders, the members of the task forces, and the others who participated in meetings, read drafts, and offered creative ideas and helpful comments. The entire communications team from the OVPIT provided outstanding support, did excellent work, and displayed what appeared to be infinite patience in working on this project.

I appreciate your personal attention to detail and excellent collaborative work with me in writing the final document. Your passion for Indiana University and the role of IT in the future of the

university, knowledge and creativity, and clear leadership inspire confidence that this plan, "Accelerating the Journey," will be a blueprint for continued excellence.

Frank Acito
Chair, University Information Technology Committee
Associate Dean for Academic Programs and Professor
Kelley School of Business
Indiana University

Process Used to Develop the Plan

President McRobbie, in his 2008 charge to the Vice President for Information Technology, directed oversight of a university-wide strategic planning process to plan for "the pervasive use of IT to help build excellence in education and research in all disciplines, in administration, in IU's engagement in the life of the State, across all campuses, and in collaboration with IU's key partners such as Clarian Health and institutions of higher education in the State." He also directed that development of the plan draw on broad consultation from across all areas of the university and from key constituencies.

The planning process has largely followed the successful template of the 1998 IT Strategic Plan. IT was driven by, and engaged the dialogue and ideas of, more than 140 faculty, staff, and students from across IU, as well as several representatives of external stakeholder organizations. As members of the specially convened University Information Technology Planning Committee (UITC) and four task forces, they worked with the leadership team in the Office of the Vice President for IT to chart the future course for IT at IU. Associate Dean Frank Acito of the Kelley School of Business chaired the substantial endeavor. Under his leadership and with the taskforce co-chairs, the taskforces were charged with developing ideas regarding how IT can be used within and across various roles and missions of the university.

An overarching goal of this new plan is to focus IT investments at IU to create the very best digital experience for the university community. The 1998 plan successfully established a sustainable technology infrastructure and essential services for the university. Looking ahead, this plan purposefully emphasizes a human-centered approach and called for ideas that are visionary, realistic, and relevant for the missions of Indiana University. Its themes and recommendations were generated by those who use the technology, and spring from their direct experiences using IT in the classroom, in the research lab, in the office, in the residence halls, in the libraries and around the world. Discussions during the planning process also centered on identifying the resources and services that could best support the IU community in achieving future excellence in the university's missions of education and research.

The planning teams were organized into four task forces that focused on key constituencies and roles for Indiana University. Appendix E3 has membership lists of the UITC and task forces. For each task force, statements were developed that articulated human-centered general recommendations that contribute to achieving the overall goals for IT in the service of the IU community.

> *Faculty and Scholarly Excellence:* The charge to this task force asked: "How can information technology continue to enable Indiana University's faculty and scholars to pursue and achieve academic excellence in teaching, discovery, and creative activity, including path-breaking research and scholarship? How can information technology optimize their pursuits?"
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> *Student Success:* The charge to this taskforce stated: "IU seeks to provide the best possible education to all students, and make it accessible and affordable, while providing a student living and learning environment of the highest quality. What vision for information technology supports the success of IU's students, those who are currently enrolled and those who will enroll in the next decade?"
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> *Effective Community:* The charge to this task force was: "To engage as an effective community, faculty, students, and staff on the IU campuses require access to information and capabilities

for communication and collaboration. How can IU's infrastructure support and enable the institutional missions of the university?"

Engagement Beyond: This taskforce was charged with the following: "Engagement in the life of the State of Indiana is a third mission of IU, building upon excellence in education and research and focusing especially on economic development. IU is also an international university. How can IU's information technology plan support the university's efforts to widen the scope and impact of its role as a public university and strengthen its global relationships?"

The planning process was designed to be iterative so that members of the task forces and others consulted could review and make suggestions for improvement in successive versions of the written document. Initial meetings of the UITC and taskforces commenced in March 2008. Early meetings focused on reviewing the 10 original recommendations in the first strategic plan, and determining those to carry forward and modify to sustain IU's IT foundation.

Draft reports of the task forces and the UITC recommendations were submitted to VP Wheeler at the end of June 2008. Discussions and development of ideas continued within the task forces and UITC through the summer months. A status report was presented to attendees of IU's annual Statewide IT Conference, September 11-12, 2008, at IU Bloomington.

In October the complete preliminary draft was submitted to President McRobbie. In October and November, the draft was presented to numerous groups representing schools, units, and campuses across IU for comment and suggestions. The final planning document was submitted to President McRobbie in early December 2008. Going forward, the IU Vice President for Information Technology and CIO is charged with realizing the objectives of the plan in partnerships and coordination with many parts of the university.

Section A2. Looking to IU's Future

Strategic Positioning

Since information technology is a critical resource that lies at the very essence of the university's functions of knowledge creation and instruction, it follows that investments must continue in IT if Indiana University is to remain competitive. Major research universities will continue to face formidable competition in " … virtually all aspects of the education and research enterprise… The competition will be for faculty, for students, for funding, for intellectual property rights and for recognition and visibility, and each aspect of this competition will be global."[2]

A question arises about the role that IT could play in providing a competitive *advantage* for IU. The visionary 1998 plan "Architecture for the 21st Century" (ITSP1 hereafter) positioned IU among the leaders in the provision of information technology infrastructure and services. In the ensuing years many other universities have also recognized the critical role that IT plays and have made substantial investments in IT. Sharply reduced cost/performance ratios and the commoditization of many aspects of IT that were cutting edge only a few years ago continue to encourage widespread adoption.

The net result is that while a strong IT infrastructure and the provision of services are necessary to compete with major research universities, it is unlikely that general investment in IT alone could provide competitive or strategic distinction. However, the innovative use and application of information technology can be a strategic advantage for IU if IT investments are made in concert with the strategic objectives of the university, its human skills, organizational structure, and operational capabilities. After years of substantial investment, IU appears to have a considerable head start on IT infrastructure. The challenge is to identify the optimal strategy to advance these interdependent areas going forward.

John Seely Brown and John Hagel provided some useful perspectives in a 2003 letter published in the *Harvard Business Review* that offers relevant ideas regarding the strategic role of IT for universities today.[3]

- Extracting value from continuing investment in IT requires changes and innovations in institutional practices and processes. The differentiation is not in IT itself, but in the possibilities for new activities that are not performed optimally or were not previously feasible.
- Opportunities for extracting value from IT may be greater across institutions rather than within institutions. IT enables new possibilities for multi-institutional collaboration across universities that would have been prohibitively expensive or impossible just a few years ago. IU's leading investments in Sakai, Kuali, EVIA, HathiTrust, and grids are early indicators of the potential for such collaborations.
- The most successful IT initiatives showing tangible results have developed from incremental waves of innovation of six to twelve months, rather than from complicated, expensive, and very risky "big bang" efforts. Smaller projects afford opportunities for refinement and learning, and reduce financial risk.
- Real strategic advantage will come from the cumulative effects of focused investments in IT rather than from dispersing efforts across too many programs. There are more technology options than any single university can or should pursue. IU can achieve strategic differentiation by adopting a long-term view of opportunities and focusing efforts on achieving advantage in the basic functions of the university through IT.

The implication is that while IU must continue on the evolutionary path of IT development begun in 1998, this alone will not result in distinctive excellence for the university. Instead, a three-part strategy is recommended for the next five years which aims to achieve leadership and distinction by:

1. Continuing to invest in IU's IT infrastructure and services, ensuring its position of leadership and providing its faculty, students, and staff with needed IT resources. Sustained investment in IT to maintain IU's leadership is necessary and can be further strengthened by:
    - Continuing to provide a reliable and stable computing infrastructure.
    - Continuing to develop the foundation of standard teaching/learning hardware, software, and devices, as established in ITSP1.
    - Sustaining IU's successful practices in maintaining a solid financial basis for information technology and for supporting and protecting all physical and intangible assets associated with IT.
    - Continuing efforts to attend to a constellation of issues that include social behaviors, supportive policies, balance between continuity and innovation, engaging

communities, forming partnerships and networks, and creating environments that offer incentives for innovation and building trust.

2. Adopting a human-centered approach to developing and implementing IT systems and applications, in order to achieve more pervasive and creative use of these systems and applications. Creating a user-centered approach to information technology involves:

   - Continuing to seek the input from the IU community and other stakeholders and continuing IU's tradition of transparency in IT expenditures, not only at the university level, but also by campuses and schools.
   - Focusing on IT investments that enhance IU's effectiveness and/or efficiency in achieving its core mission in the long or short run and that carefully balance gain versus risk, agility versus stability, and long- and short-term perspectives.
   - Striving for "frictionless use of IT," hiding complexity while maximizing functionality. Applications need to be accessible and perceived as easy to use. Technological sophistication can be made to enhance, not encumber research, teaching, creative activity, and university operations. With proper support and training, the IU community will be able to employ state-of-the-art technologies without unduly diverting time and effort from fundamental activities. Creative and innovative ideas for IT applications can also be stimulated by keeping IU faculty, staff, and students up to date regarding new and forthcoming technological developments.
   - Recognizing that one size does not fit all. Substantial heterogeneity of IT needs, capabilities, and resources exists among the various constituencies at IU and explicit recognition and consideration of such differences will aid the diffusion and adoption of IT applications.
   - Collaborating with other institutions and organizations. Much more can be achieved through collaboration and partnerships than by working alone. A continuing strong commitment to working with partners will further strengthen IU's ability to provision new and powerful tools that promote innovation in teaching, learning, research, and administrative services.

3. Focusing on a few key areas where IU can achieve true distinction rather than attempting to lead in all areas of IT. Areas for leadership investments are those that:

   - Align with university priorities for the future.
   - Contribute to IU's distinction by strengthening areas in which IU has established leadership and expertise.
   - Are important in an absolute sense. Application areas that have major impacts on the achievement of the university's missions related to research, creative activity, teaching, outreach, and engagement with the community and beyond are much more likely to create paths to true leadership.
   - Leverage IU faculty research and innovation leadership. IU can be most effective at the research, development, and delivery pipeline if IU starts with areas of faculty thought leadership, supports faculty innovation with investment of staff time and facilities, and speeds development of new tools into enhancements for the university community, state, nation, and world.
   - Present challenges amenable to improvement with technologies that are newly becoming available or are likely to emerge in the next five to ten years.

- Leverage the information technology infrastructure to more broadly support IU faculty, staff, students, academic disciplines and key university partners.
- Are visionary, inspiring, and creative.

With continued investment in the infrastructure, attention to human-centered use and application, and focused efforts to attain distinction in specific areas, IU can achieve leadership in the creative use and application of IT in key areas with broad progress across the entire university. This strategic positioning will enable IU to lead from a position of strength as a contributor and partner in the best academic opportunities.

Aspirational Visions for IT at IU

Envisioning aspirational scenarios for the future provides a useful tool to establish goals and direct progress. Imagine the state of IT at Indiana University a few years into the future. The following scenarios, written in the present tense, provide a look into the future of IT at work at IU.

Since the adoption of ITSP2 in 2009, sustained investment in information technology on all IU campuses has created a digital technology environment in which teaching, learning, research, creative activity, and virtually all university activities have become more effective and more efficient. IU continues to be regarded as a leader among universities in providing pervasive information technology resources. Importantly, IU is recognized as being without peer in creating and deploying innovative applications of IT in several key areas of research and instruction.

Vision for Faculty and Scholarly Excellence

All IU faculty members have access to state-of-the-art personal computing devices, many of which are transportable so that work can be conducted in the office, at home, or while traveling. These devices enable creative work and revision, either individually or in collaboration with others and access to a vast array of functional data and systems that support instruction, research, decision-making, and creative and administrative activities. These devices are updated or replaced as needed via a sound fiscal process of lifecycle funding.

Collaboration with groups of colleagues for meetings across IU campuses is enabled through advanced communications systems that provide high-resolution video and high-fidelity audio – creating a virtual sense of presence. Advanced collaboration technologies, integrated with personal devices, afford high-quality audio and video, visual displays, and low latency for convenient communications. Immersive technologies enable visualizing results in ways that afford paths to new insights. Faculty work routines move seamlessly between research and teaching activities. For example, scholarly work by faculty that generates primary data is placed in IU's public data utility, and it is available to be incorporated in teaching and research in other parts of the world. IU faculty draw on similar utilities and educational resources to incorporate material in their classes. [4]

The university has implemented a program that provides IT devices that are tailored to meet individual faculty requirements. For example, one cultural anthropologist's device includes video- and audio-editing software and multiple displays. Another faculty member, a visual artist, designs on a high-resolution work surface, scaled for dimensional accuracy, and calibrated for color fidelity. This artist also requires enhanced network connectivity and bandwidth so that she can easily move and process with reduced latency the large datasets that she transmits to colleagues and external displays.

IU research scientists are able to store massive amounts of computational data in a secure data storage area that allows setting permissions for specific subgroups of colleagues at IU and beyond. Scientists using the data are able track and retrieve multiple versions of the data, including the raw data, the cleaned version, and subsets, in formats readable by the various statistical packages used by colleagues. Integration with data analysis tools makes it easy to extract data subsets and test various scenarios.

Another IU professor is a member of an interdisciplinary team comprised of a group of researchers in the humanities, informatics, and senior IT support professionals. The team is developing a special cross-disciplinary collection of resources, IT tools, and methods for studying and analyzing the collections of digitally captured and born-digital documents, videos, and images. The idea for this project came about as a result of a special forum IU routinely provides to keep faculty, staff, and researchers informed about emerging IT developments and their possible merits and applications in teaching and research. This forum is one part of a multi-faceted approach to IT support, training, and personal assistance that can be tailored to individual levels of expertise, and delivered in modes that suit individual preferences. Faculty and staff can get help in the office, in the classroom, in the lab, or on research trips abroad. A variety of digital tools that are easy to use create efficiencies of time and are flexible enough to fit a variety of preferences and needs.

Vision for Student Success

Students at IU bring their own computing and communication devices (in a variety of form factors) and are quickly able to connect to IU's vast array of services and software. In fact, many students begin interacting with and using IU's technology resources long before coming to campus through outreach initiatives with elementary and high schools throughout the state of Indiana. Facilities throughout IU complement these student devices to provide space to work in informal environments where students can connect their personal devices to larger displays and keyboards, recharge batteries, or secure computing devices between uses. Modern technology centers and labs are also available on IU's campuses for students to access community devices.

IU students view IT as an ally in helping them use their time efficiently for learning and participating in various student activities. A unified, student-centered, personal dashboard enables the virtual management of all aspects of student life at IU. The dashboard is accessible from the smallest technology devices as well as larger, sophisticated visualization displays. Using the personal dashboard, a student on the run, with an hour between classes, can request that her team reschedule a study session until after the just-announced exam prep session, vote in a class poll regarding a case study dilemma, update her off-campus work schedule, check her academic progress in a tough class, and decide to purchase an opera ticket for the weekend.

From the same dashboard, she can connect with the various facets of her academic life from registration through graduation, with an interface that has been favorably compared with the best available, such as those from Amazon.com and other leading service providers. The student dashboard uses natural, conversation-like interactivity, like the example shown here:

"Welcome back, Annie Student. Since you enrolled in Writing Composition II, the instructor has posted the syllabus and two assignments here. Course books from the bookstore and digital reference materials from the library are also available here. Have you signed up for a study group yet? There's a forum here, with four other students currently available. You might also be interested in registering for Victorian Poetry. There are currently two spaces left in the 2:00 session for the next term, which fits in your current schedule. Would you like to register?"

Using personal IT devices students can log the requirements for their major, schedule a meeting with an advisor, and stay in touch with faculty. Many students use the IT system to develop a portfolio of work in their major and build collections of reference materials. The environment on each student's IT device provides access to course syllabi, allows online submission of assignments, provides access to self-paced tutorials, lectures or reading lists, and supports tools for discussions and collaborations with other students. Underpinning the environment is a system of ever-present support, including timely access to advisors and 24-hour IT help.

The IT environment at IU supports and enriches students' academic lives, inside and outside the classroom, at any time and any location, in any configuration of people. Students who are enrolled in distributed learning courses find a depth and breadth of IT-supported opportunities as instructors chose among a variety of teaching techniques and media resources. On IU campuses, flexible learning spaces encourage interactive, participatory learning and support a variety of teaching and learning modalities, all designed to support specific instructional goals, the nature of the subject being taught, and students' learning styles. Some classes meet for an entire semester, while others run for only a few weeks – the use of technology has liberated the teaching schedule from the standard 15-week semester. A few courses run for a year or more to support large-scale experiences and projects. Some courses include students from other universities within and outside of the United States.

Technologies that support multiple communication modes and one-to-one and one-to-many interactions bolster opportunities for meaningful faculty-student communication, including discussion and feedback. Other systems support assessment tools and processes, enabling measurement of learning and promoting accountability. IU students interact with a world of IT services and demonstrate good habits in protecting their own privacy and the intellectual property of others.

As participants in a global, connected community of learning, IU students benefit from the backgrounds and perspectives of a spectrum of international faculty and students with whom they interact on campus and remotely. Class sessions often include dialogue with experts at IU and beyond, via rich, reliable communication technologies. In many cases topical experts and IU alumni from Asia, Europe, Africa, and elsewhere join with IU instructors to provide truly global perspectives. For appropriate projects, students use these communication tools to collaborate with mentors in private industry, research agencies, and state and local governments.

Students can track their progress toward majors and degrees by consulting the personal dashboard. As they take classes, engage in IU's rich learning environment, and participate in campus clubs, they can also log their experiences in an electronic portfolio that is accessible from their dashboard. The portfolios are also used in some cases to demonstrate competency levels in areas such as written communication, critical thinking, quantitative analysis, and the like. Students are able to include course-related work and other experiences (e.g., internships, study abroad) in their portfolios to provide evidence of their skills. The portfolios are also useful in demonstrating accomplishments in job interviews and graduate school applications.

Vision for Supporting the IU Community

Information and communication technologies have become more pervasive in community activities. Systems focus on making easy and reliable some common forms of communication across distance – whether to the next building or another campus with interfaces to common services that simplify coordinating work, team, and personal activities. For example, a flexible, customizable calendaring tool allows individuals to learn of the many events on IU campuses and see how these relate to

personal calendars. IT systems make access to essential administrative services and tools easier and more user-oriented. Purchasing tickets for events, paying parking fines, requesting advising appointments, switching course sections and conducting many other day-to-day student, faculty, and staff activities are handled via well-designed IT systems.

For example, when an IU scientist is preparing a grant application for government funding for her research, she can easily complete preparatory data gathering, electronically submit her research protocols for appropriate institutional review, develop budget scenarios for the grant, and collaborate with co-investigators – all without having to re-enter data or wonder about the status of any necessary approvals.

University systems have vastly improved the ability of those in the IU community to support data-driven decision making. For example, an associate dean can use a graphical interface or a plain English query to ask a question and obtain a report regarding graduation rates for certain majors over a five-year period. Financial analysts can use the university data systems to check any department's past expenditures relative to budget and create a guidance report that maps expenditures against credit-hour trends.

IU constituencies have access to rich, multimedia collections of many of the activities and events that comprise the scholarly life at IU. A student can search for video clips of presidential speeches that refer to initiatives in the humanities. A graduate student can find a podcast of a lecture by a visiting distinguished scholar from years ago to assess how his theorizing work began and has evolved over time. IU alumni around the world have access to a substantial portion of the performing arts and cultural events at IU.

Alumni also experience greater support in their transactions with the university. For example, a group of IU alumni and friends who live across the country are able to get tickets to a Jacobs School of Music opera performance via a gateway that shows calendars and schedules. The system allows ticketing and seat selection, lets them book rooms at the Indiana Memorial Union, and completes the transaction with a secure payment utility.

Vision for Engaging the Community Beyond IU

As one of the great universities of the 21st century, IU is highly connected via communities, alliances, and engagements that extend far beyond it campus borders. Through its advanced networks, IU combines the advantages of its location, such as high quality of life, modest cost of living, and strong Midwest work ethic, with the ability to project the skills and interests of its faculty, staff, students, and alumni almost anywhere. IU has contributed to an economic revitalization of the State of Indiana that has moved the state from the lower third of the nation to well above the median, IU has partnered with the State Government and other institutions of higher education to take major indicators of public health from the bottom 10% of the nation into the middle third. The benefits of IU scholarship extend far beyond to borders of Indiana through the US generally and the world as a whole.

IU's engagement with the state and beyond takes many forms. For example, a professor in the School of Education at IUPUI collaborates with teachers in high schools across the state, sharing statistical information and co-authoring instructional materials for high school students. IU scientist and research technologists provide students in primary and secondary school the opportunity to participate in authentic science learning opportunities. This engagement helps inspire students to pursue higher education and careers in science, technology, engineering, and math (STEM) in ever

greater numbers. Staff members working in university financial aid offices provide scholarship, grant, and loan information to Federal and State regulatory bodies in the secure format they require. Common formats for data exchange or system integration further ease the transfer and articulation agreements for students taking courses at Ivy Tech Community College of Indiana and IU East. As an example, student interns working in Informatics in Indianapolis are able to receive funding for their research project from a private corporation in South Bend, and managers from the corporation can regularly interact with the interns to provide input on their work.

IT systems have been integrated with the extensive health and medical care institutions in the state. A physician at the IU School of Medicine in Indianapolis can log on to her personal device and use it to set up a syllabus and assignments for a class she teaches, submit travel expenses to the finance department of her clinic at Clarian Health, review a former patient's x-ray results stored at the Regenstrief Institute, and then check on the status of a grant submission that is being led by a co-investigator at Purdue University. IU expertise in advanced networks also helps with remote diagnostics for a new academic digital education network in Liberia. While learning about another part of the world, IU School of Dentistry students can share newly developed techniques with colleagues in Kazakhstan who are building a rural clinic.

Similarly, many Indiana and national companies are now able to effectively and appropriately tap into IU's expertise and form mutually valuable alliances that advance the Indiana economy. IU research and expertise in data informatics, advanced visualization, and networks has become more integrated with key health partners, such as Clarian Health, to improve the lives of Hoosiers.

Realizing the Aspirations Via Sustained Effort

The scenarios presented above provide a vision for the future of IU that is ambitious, yet achievable over time. It is achievable because of the rapid developments in IT that will continue in the coming years and, importantly, because Indiana University has much of its IT house in good order in 2008 as an outcome of the 1998 IT Strategic Plan and the sustained efforts to implement its recommendations over the past 10 years. It is essential that the university not fail to sustain the momentum that has enabled progress thus far as it moves to even greater levels of creative use and application of information technology among its faculty, staff, and students,.

Reader's Guide

Indiana University's next Strategic Plan for Information Technology follows in three sections. Section B, *Sustaining the Foundation*, focuses on sustaining and enhancing the progress that was set in motion by the 1998 IT Strategic Plan. It includes recommendations and actions to ensure continuity and to redirect efforts to contemporary needs at IU. Section C, *Towards Human-Centric IT*, addresses four essential areas to improve how IT systems can more efficiently serve the needs of the IU community. It focuses on making systems and services that are perceived as easy to use and useful. Section D, *Grand Challenges and Opportunities for IU Leadership*, proposes that IU strives to find better paths in areas of grand challenge or great opportunity.

Throughout the document, the style is to propose a broad recommendation to set a general direction and then follow with a series of action items for planning and execution. As IU's plan for IT, progress in many of these areas will rely on coordinated efforts across the university. The Office of the Vice President for Information Technology (OVPIT) is charged with overall leadership of

implementing the plan, but progress for IU in this century relies on the university's effective adaptation to new possibilities.

In this plan, references to University Information Technology Services (UITS) are expressed to be inclusive of the Extended IT Team of all IT professionals across the university. The term *provision* implies that an IT-enabled service could be sourced via home grown software, purchased as a package, contracted as a cloud service, or commercially outsourced entirely depending upon the best fit for IU. The term *device* is inclusive of all information and communication technologies devices in whatever form they may evolve (personal computers, mobile phones, personal digital assistants, telematics in automobiles, etc.). The term *enterprise system* refers to systems that serve common needs across multiple IU campuses.

Section B. Sustaining the Foundations for IT Leadership

This section focuses on sustaining the IT infrastructure, processes, and services that currently enable IU based on the work of the 1998 IT Strategic Plan.

B1. IT Infrastructure and Fiscal Planning

Indiana University's formulae for building and leveraging core IT resources and services provide IU students, faculty, and staff the most current electronic tools for scholarship, creative activity, and university business. IU's success in forging fruitful relationships with hardware vendors, sustaining broad software licensing agreements, and building networks have provided the IU community with steady, reliable access to essential tools and connectivity.

> **Recommendation 1:** Indiana University's national and international leadership should be sustained through continued maintenance and advancement of its IT infrastructure that is supported by sound fiscal planning.

To build upon these accomplishments IU should continue to provide next-generation IT infrastructure and services (where "infrastructure" refers to physical facilities, hardware, software, equipment, devices, networking, systems, applications, support, and professional staff). IU should maintain an information technology infrastructure that supports all academic disciplines, with the goal of remaining at the forefront of the creative application and use of information and communication technologies.

Lifecycle Funding

The 1998 ground-breaking program of lifecycle funding (LCF) and university-wide deployment of workstations for faculty and staff initiated with ITSP1 has played an important role in helping IU to attain IT leadership. This program explicitly recognized the need for a budgeting and funding model that fit the rapidly changing IT environment, and that approach remains to be essential to sustain IU's competitiveness.

Action 1: IU should continue a lifecycle replacement model similar to the one established in ITSP1 to provide baseline support for computing devices and the maintenance of university-provisioned student computing labs.

Even with the widespread success of the LCF program to provide faculty and full-time staff with up-to-date personal workstations, there is still more to be done. Differential needs associated with specific disciplines, user IT sophistication, and system complexity should be incorporated into a new faculty/staff resource allocation methodology for those whose needs exceed the basic level. Some faculty members need more advanced or highly specialized computing equipment and software and have been unable to rely on university-level funding sources. For example, in facilities that serve disciplines that must move and process large datasets, sufficient connectivity, and bandwidth are needed to process data with minimal latency. In disciplines that require close examination of images, highly advanced digital displays are needed that offer a greater dynamic range of exposure (high dynamic range) capabilities, broad color spectrums, and high resolution. A LCF model is needed that can encompass the acquisition, maintenance, and replacement of technologies that are essential to IU's scholarly missions.

Likewise, critical IT resources that are funded and directed at the departmental and school level, both for individuals and specialized computing labs, have in some cases fallen behind due to an ad-hoc or episodic approach to investments in these resources. This concern was also expressed in the 2005 Cyberinfrastructure Research Taskforce Report.[5] Whereas ITSP1 recommended that lifecycle funding be applied to all levels of IT investment, explicit mechanisms and funds for carrying this out have not been developed. The next action calls for renewed efforts to broaden the lifecycle funding approach to essential devices that are needed to support research and teaching on recurring basis.

Action 2: The lifecycle-funding model should be expanded to cover school, department, and discipline-specific needs and variations to more fully support the diversity of research and creative activity across the university.

Physical Infrastructure

IU has made great strides in developing its physical infrastructure to house critical IT assets. The machine room space in the Informatics and Communications Technology Complex (ICTC) building in Indianapolis and the Data Center now under construction in Bloomington are fulfilling this essential need. To sustain their purpose, however, these facilities require robust and fault-tolerant electrical power and essential utilities without any single point of failure that could disable critical IT services. Disruptive weather events of recent years have revealed that IU must reconsider long-standing assumptions and adopt new approaches that can ensure reliable power.

Action 3: IU must adopt planning approaches and actions that ensure reliable physical protection and provision of utility services to critical IT facilities while minimizing possibility of any single point of failure.

Pursuing a Philosophy of Abundance

Metaphorically speaking, IU scholars should be able to conduct their work without thought of IT constraints. While financial resources must always shape reality, the university should consider all possible approaches that develop IT services in unmetered and unrestricted ways that *approximate a philosophy of abundance*. UITS should refine its baseline, common good suite of IT services (those funded from allocations to UITS as opposed to metered charge-back) to include comprehensive

voice, video, data, text, image, and collaboration services and forms of convergence. IU should develop funding models that are consistent with best practices for supporting common good services.

Approaches to achieving this may include developing efficiencies via scale in common services for computation, storage, communication, and procurement; discovering new functionality in current resources; consolidating services to enhance offerings; and adopting a variety of sourcing strategies via home grown systems, grids and cloud services of today and their successors, through university consortia, or from private sector offerings.

Action 4: IU should pursue strategies that approximate a philosophy of abundance within reason, towards unmetered availability of IT services, support, and infrastructure for creative activity, storage, computation, communication, and other activities fundamental to the work of the university via any appropriate sourcing strategy.

Technology resources can be extended through an ever-evolving, community-based infrastructure that includes leveraging enterprise common goods services and edge services to meet specific needs in departments, schools and administrative units. Effectively balancing what is done at the *edge* and what is done with *leverage* requires a deep relationship of *trust* among IT service providers across IU. While services unique to local functions are often best hosted and maintained at the edge, IT resources maintained by campuses, schools, or departments that duplicate leveraged enterprise services reduce efficiencies, increase costs and complexity, and may pose substantial risks to data and IU's public reputation.

Proper uses of leveraged services actually increase abundance and enable more unique activities that can be done at the edge. Where infrastructure services exist or can be achieved in a timely manner, IU should not duplicate or develop shadow edge systems in the absence of compelling business reasons and in consultation with UITS.

Action 5: IU should maintain and refresh its IT infrastructure by consolidating enterprise-scale (multi-campus) services for software systems, server and data hosting, networks, backup, messaging, support services, and training, while also enabling innovative departmental-scale technology services provided at the edge.

Achieving the appropriate balance between leveraged and edge services will require careful and ongoing guidance, among administrators and IT service providers. Clear policies and standards should be established per the president's directive that support the optimum balance of leveraged and edge technology services across the university. Transitions of innovative edge services that may migrate to leveraged services over time should be seamless to edge service providers and users.

B2. Access to Network Resources

The Indiana University digital network is an instrument of excellence. Academic work relies on electronic access to information and expertise. Teaching, research, creative activity, and university business are inescapably connectionist endeavors. President McRobbie has said that his goal of honoring faculty excellence requires a "renewed commitment to building collaboration and cooperation among our campuses.[6]" The vitality of the IU network will continue to be a major force in fostering that connectedness. Collaboration and connectedness — between IU students, across IU

campuses, and among national research teams on which IU faculty serve — all rely on stable, robust, and ample network connectivity. IU constituents and their collaborators count on unimpeded, appropriate access to IU's information assets —specialized research data, digital humanities collections unique to IU, and the teaching resources for classes, wherever they are developed. The network is a conduit linking IU's human expertise to its information assets. Ensuring access, reliability, capacity, and support must remain among the university's highest priorities.

Recommendation 2: Indiana University should ensure that its wired and wireless campus networks continually evolve just ahead of the needs of IU's faculty, staff, and students. The network must provide secure, reliable, effective, and appropriate access to support the missions of the university.

IU has nationally recognized expertise in the configuration and management of advanced digital networks. IU's physical network and human expertise together represent a valuable, strategic asset that will continue to make a major contribution to IU's prominence as an IT leader. Continual upgrades and links to local ("to the desktop"), national, and international networking systems are key to enabling state-of-the-art communication and collaboration for faculty, staff, and students.

Action 6: IU should continue to maintain and upgrade its networks to accommodate the increase in demand for capacity, speed, security, and stability.

IU's deep network expertise – particularly in the Global Research Network Operation Center – has been developed through economies of scope across a range of advanced network engagements, from its founding relationship with Internet2 to other state, national, and international networks. IU's development and oversight of the I-Light network, in partnership with Purdue, provides an essential means of engagement with many partners of higher education across the state. It also enables distributed medical education via the IU School of Medicine and School of Nursing, and supports the large-scale Clinical Translational Science Initiative funded by the National Institutes of Health. Pursuing abundance through strategic partnerships for developing and leveraging advanced networks is essential for ongoing IU leadership in networking infrastructure and staff.

Action 7: IU should continue to pursue opportunities for strategic partnerships that can provide services for advanced networks to further the missions of the university.

Perceived social boundaries between home and office, work and play, and traveling and staying home are all giving way via the capabilities of advanced networks that enable a range of activity in almost any place. High-speed connectivity is essential to fully embracing the possibilities of this era, yet in many cases, connectivity costs and speed vary greatly. In some cases this can impede the ability of faculty, staff, and students to study or work at home while interacting with IU services. The university may be able to use its scale and volume purchasing arrangements to overcome these limitations and thus enhance the ability of individuals to achieve better connectivity.

Action 8: Whenever feasible, IU should develop prudent agreements, partnerships, and other mechanisms (e.g., strategic alliances, negotiations with service providers) that allow faculty, staff, and students to acquire low-cost access to high-speed home and mobile connectivity.

B3. Collaboration and Communication Systems

Scholarly work, teaching and learning, creative activity, discovery, and the conduct of university business all involve limitless opportunities for collaboration. The increasingly interdisciplinary nature of research, the creation of multi-institutional research teams, the growth in distributed learning, and the expansion of public/private sector integration of business practices all demand greater need for collaboration capabilities that are unimpeded by geographical distance.

Recommendation 3: Indiana University should provide systems and connections to devices that support communication in a variety of forms — text, voice, audio, images video, chat, virtual presence – to overcome the productivity challenges of location.

IU should pursue a goal of enabling effective communication without barriers for its highly mobile community. Collaboration technologies should fit the needs of the IU community and be perceived as easy to use and invoke. Tools should support a broad range of capabilities, such as allowing groups to create and revise shared documents as well as effectively conveying and presenting ideas so that shared understanding and consensus can be achieved.

Action 9: IU should continue to evaluate, provide, and support technologies that promote efficient, seamless communication and promote effective collaboration within and beyond IU.

Cost-effective systems with high-definition video, high-quality displays, and high-fidelity audio create a sense of presence and realism for group conferencing. Availability of such systems in campus offices, labs, and classrooms and other university workspaces can increase the productivity and effectiveness of collaborative work. These can be integrated with desktop communication tools for one-to-one and one-to-many conferences and collaborations

Action 10: IU should provide a reliable, widely available infrastructure of next-generation telecollaboration systems that simulate virtual presence via high-quality video and audio with reduced latency while ensuring simplicity of setup and operation.

Much university business is conducted on or through the web. The web has become an integral and important aspect of many of the IT services and applications used by the IU community. It provides information, supports the use of technology, and acts as a gateway into many enterprise systems.

As the use of the web has broadened, so too have the responsibilities of web administration. Content creators are often dissatisfied with their ability to provide timely, updated information on web sites when working through current web environments and administration processes. The use of content management technologies allows creators convenient, user-friendly tools for contributing and publishing information on web sites under a carefully managed system of authorization and control.

Action 11: IU should implement a comprehensive, integrated university-wide web presence by developing policies and best practices. The IU web should respect the unique missions of each campus while simplifying access to information for internal and external constituencies. Technical and design assistance should be made available to units to support the development and implementation of the web presence.

This effort should include research, development, implementation, and ongoing improvement for a variety of content creation and site management tools. Plans should support the content authors and the technologists who support them. Activities should include services for web site analysis, identifying appropriate target audiences, design, optimization for usability and navigation, and content management for creators with all levels of technical expertise.

The intent of this action is not to establish a "command and control" central agency that oversees web content activities, but rather to create a resource that can help make the web environment at IU that is truly outstanding for both internal and external constituencies. Searching for web-based information at IU cannot be improved until the university addresses the issues created by its near 15-year web legacy and adopts a coherent approach for maintaining web-based information. Technical support will be needed in units, departments, and schools that seek help when developing and maintaining web sites.

B4. Financial Stewardship

Indiana University's investment in information technology is an investment in the skills, passions, and productivity of the people IU serves. The IU community is a direct beneficiary of IT's contribution to expanding human achievement. Indirect beneficiaries include the state of Indiana and the countless industrial, commercial, medical, scientific, artistic, academic, and professional communities in which IU and its people participate.

Careful financial planning is essential to ensure continued progress. To meet needs that exceed the base budget, IU must continue to pursue other sources of funding for IT, and concurrently, take a measured approach to IT investments relative to all university needs and priorities. Fundamentals of careful stewardship include clarity and transparency of IT expenditures across the university.

Recommendation 4: Indiana University should continue to practice responsible stewardship of all financial resources devoted to information technology across the university by providing transparency and accountability in support of wise decision making.

UITS plays the university's largest IT role in providing leveraged services across all campuses and in partnership with many academic and administrative units. Since its consolidation in 1997, UITS has completed six Expenditure Revue Committee cycles to make internal cuts in budget for reallocation. That money – often derived from reconfigurations of services, sharing of staff, and reductions in positions – has been essential to fund a myriad of new IT needs.

Action 12: UITS should continue its successful reporting practices, including the annual Activity Based Costing report on the cost of each IT service, findings from user satisfaction surveys of IT quality, and reporting on explicit uses of Student Technology Fees. Reports should continue to be made openly available to the IU community and other stakeholders.

Similarly, the total IU investment in IT also includes edge services in schools, departments, and administrative units. Holistic understanding of IT expenditures, including student technology fees, requires transparency for sound decisions in balancing leveraged and edge services.

Action 13: Academic and administrative units should implement clear accounting processes and reporting for IT expenditures for hardware, software, staff, and services. Uses of any student fees for technology or specific course technology fees should be clearly identified and transparently reported.

Good stewardship also includes striking and sustaining deals that are in the best interest of the university. Increasingly, the best overall value for IT hardware, software, services, and even contributions to the scholarly mission can be sustained through strategic alliances and enterprise agreements. IU should continue to bring the university's vast scale and expertise to bear in negotiating favorable contracts or alliances with companies that provide products and services of interest.

Action 14: IU should continue its highly successful program of relationships with hardware, software, and services vendors, and seek additional partnerships and creative exchanges that provide mutual benefits.

Finally, another form of good stewardship is growing the resource base beyond internal sources. During the past 10 years, the Office of the Vice President for Information Technology has amassed a strong record of taking leadership or partnering roles in contracts and grants from federal, state, and private sources. IU should continue its aggressive pursuit of external sources of funding that enhance IU's IT capabilities and advance the missions of the university. Many opportunities for IT funding may be embedded in disciplinary research that calls for proposals or calls for improving instruction or cyberinfrastructure.

Action 15: OVPIT should continue to lead and expand its efforts to effectively partner with academic units, campuses, or individual investigators for external funding opportunities.

B5. Security, Privacy and Availability

The issues of security and privacy have become increasingly complex and difficult to manage as more information is stored digitally and heightened regulations direct its safekeeping. Despite these challenges, it is critically important that rigorous policies and procedures are developed and used to protect the security and availability of Indiana University information technology resources, institutional data, and safeguard personal privacy. At the same time, these policies and procedures must promote two traditional university values associated with academic freedom: access to information and freedom of discourse.

IU must strive to minimize the growing risk inherent in its environment of tens of thousands of distributed networked computer systems across a large geographical area. The network connectivity to the world that enables the opportunities previously described also exposes IU to threats and malicious activity from afar. These risks require careful consideration of physical and technical security for leveraged infrastructure and devices at the edge. Duplication of data stores extracted from enterprise systems and stored on edge devices vastly increases risk of a sensitive data exposure.

Recommendation 5: Indiana University should provide a secure, resilient, policy-based information and infrastructure environment to protect the security, integrity, and privacy of data. Ongoing upgrades to the environment and policies should enhance personal confidence in the security of data and privacy of individuals in the pursuit of institutional and individual goals.

IU was among the first in the nation to establish a Chief IT Security Officer and Chief IT Policy Officer. The IU Trustees Resolution of May, 2001 established university-wide authority for IT security in the Office of the Vice President for Information Technology. As threats to security and privacy continue to multiply, IU should continue its leadership in policy, security, and organizational capabilities to provide critical assurance for these areas of concern.

Action 16: IU should develop and coordinate the implementation of a strategic and comprehensive security and privacy program that fulfills legal and policy obligations as well as obligations to individuals. The program should protect institutional assets, engender confidence from members of the university community, and continue to facilitate appropriate access to data for the legitimate needs of the IU community.

Policies are needed that recognize the university's dependence on its critical technology and information assets and that assign responsibilities for their administration. In addition, detailed guidance is needed in the form of standards and procedures for ensuring appropriate deployment, management, and use of institutional systems and information, covering various aspects of integrity, availability, and confidentiality. The need to communicate these policies and guidance about them is fundamental to the success of the comprehensive security and privacy program and will require unwavering support from academic and administrative leaders.

Action 17: IU should continue its program of outreach and education to increase the awareness and understanding of security and privacy issues among all members of the university community. Individuals who interact with sensitive, important and/or private resources should have appropriate training to fully understand their responsibilities regarding privacy and periodically receive updated training.

Methods for ensuring the security of non-public data are essential. The means to accomplish this vary with the type of data, storage location, and security controls in place for the data and storage device. Although the mechanisms of protection may differ, the manner in which data are secured on a portable or desktop device is just as important as for an enterprise system. Non-public data that is downloaded to a personal workstation or portable storage device creates significant risks in the absence of rigorous encryption and physical security of the device itself.

Action 18: IU should provision data storage that provides appropriate physical and electronic protection. Sensitive, non-public, and/or important university information should be rigorously governed by policies and processes that ensure appropriate maintenance and retention.

Another aspect of privacy and security is ensuring the availability of critical information technology resources in the event of a disaster or other disruptive event. Every unit in the university should have the capability to continue providing critical functions if adverse events cause disruptions in IU's IT infrastructure. Continuity plans and procedures are needed that cover technology, human resources, and facilities. They should be accompanied by a mechanism for setting the priorities for critical service redundancy and recovery.

Action 19: IU should continue development of an enterprise-level business continuity program that includes emergency response, operations recovery, and disaster recovery across all critical functions, based upon university-wide risk assessment and management.

B6. Environmental Stewardship

Computers and related equipment – and the way they are used – represent one of the fastest-growing sources of electric energy consumption. Computer hardware, due to its ubiquity and rapid replacement cycles, creates substantial solid waste that can strain the capacities of landfills and, in some cases, leach toxic compounds into the air, soil, or water. The pervasiveness of IT at Indiana University and the critical challenges to the global physical environment make environmental stewardship an imperative.

Recommendation 6: Indiana University should develop and implement plans for responsible environmental stewardship for information technology.

Environmental stewardship is an important effort for the whole of IU, and IT will be a major component of that effort. IT-related energy-saving activities should include leveraging data centers to reduce the number of individual servers; promoting energy-efficient computing habits; considering environmental conservation and sustainability in agreements with suppliers and vendors; developing policies for conserving, recycling, and increasing efficiency in the use of IT resources; and encouraging the use of renewable resources.

The IT organization can play an important role in promoting a green university community. The IT organization should support the IU community in its efforts related to environmental stewardship by launching or supporting programs that build awareness and suggest solutions.

Action 20: IU should establish and promote high standards of environmental stewardship by providing support for and communication regarding best practices in energy-efficient computing.

Initiatives such as the IU Intelligent Infrastructure, which offer IU units remote access to high performance, high availability hardware and services, contribute to achieving greener computing. IU should further explore and leverage such models to lessen capital costs; reduce expenses related to

energy consumption, space, and maintenance; pare duplication of investment across the university; and reduce the university's overall demand for power and cooling.

Action 21: IU should promote widespread use of its extensive investments in hardened data centers, networks, virtualized servers, and virtualized storage to promote energy efficiency by reducing the number of required servers and enabling longer equipment lifecycles. Similarly, technologies such as desktop virtualization should be explored to help reduce the costs and extend the lifecycles of personal computing devices.

IU should consider environmental responsibility in its relationships with commercial vendors and suppliers, and where possible, build issues of recycling and sustainability into purchasing agreements. Whenever practicable, RFPs and RFQs should include requests for statements regarding companies' environmental responsibility practices and outcomes.

Action 22: IU should carefully assess the relative "environmental friendliness" of all its IT-related purchases and factor this into purchasing decisions.

B7. World-class IT Staff for a World-class University

Information technology professionals at Indiana University are instrumental in creating excellent, efficient IT-enabled services. The successful implementation of the ambitious recommendations and action items from the 1998 IT Strategic Plan is a credit to the professional IT prowess across the university. These IT professionals have played a major role in furthering the state of the at IU and nationally.

IU must continue deliberate and systematic efforts to recruit, develop, and retain outstanding IT professionals in all parts of the university. This includes attention to technical, managerial, and leadership skills. In 2006, Vice President Wheeler began promoting the concept of "The Extended IT Team" to refer to the entire community of IT professionals in UITS, the schools, departments, and administrative units. At the 2008 Statewide IT Conference, he renewed a call for IU to enhance IT professionals' career path options within UITS and among other units. Retaining the very best talent within IU will require a long-view perspective among all administrators as IT professionals develop and advance their careers. IT professionals can develop a richer understanding of the university by gaining experience in UITS as a leveraged service provider across the university and also in positions or on assignments in an academic or administrative unit that has a particular focus on edge services. Likewise, career steps within UITS among the various units, e.g., Research Technologies, Support, Enterprise Software, etc., can also be a means to develop a broader perspective of skills for IU's needs.

Recommendation 7: Indiana University should continue and strengthen its efforts to develop world-class IT professional and technical staff across the university.

IU must have salaries, benefits and facilities that attract a world-class staff. The skills of technical and professional staff, skills that are in demand nationally and regionally, are at the core of IU's information technology distinction. It is important that IU provide a high quality of institutional life

to attract, hire, train, and retain its excellent staff. Where significant discrepancies in salary between the university and private/public sectors exist, these often cannot be completely compensated by quality of workplace benefits.

Action 23: IU should remain competitive with regard to compensation, benefits, facilities, workplace climate, and quality of life offerings through funding choices to attract and retain the very best technical and professional staff.

The outstanding technical staff in IU's IT community have made numerous contributions at national and international forums and publications. Such efforts are important in building a world-class IT organization. Presentations and articles help build IU's national and international reputation for excellence in IT, putting the university in a good position to partner with other leading institutions, and linking our top technical people with those in other places. Making IU's IT achievements more visible will help IU recruit top professionals. Supporting staff research will help encourage professional development and build staff engagement.

Action 24: IU should support and pursue research into information technology itself. IT professionals and faculty should seek partnership opportunities for scholarly publication and invention disclosure that document meritorious research and discovery.

Areas for research might include, but are not limited to: models for community source software development and maintenance; advanced network management; applications of visualization in many academic disciplines; knowledge creation, management, and acquisition; network and information security; grids, portals, and gateways; and applications in IT support across time and distance. Publishing the outcomes of these insights through appropriate scholarly and applied outlets will further enhance the reputation of IU thus attracting IT professionals and advancing human knowledge.

These seven recommendations and 24 action items provide a basis for sustaining the successful IT foundations at IU. The next section addresses recommendations and actions to improve the human-centered effectiveness of the university's IT capabilities.

Section C. Toward Human-centric Information Technology

While information technology has already revolutionized the ways in which the work of the university is conducted, the full potential of IT will not be realized until computers, software, and the growing diversity of new devices are much easier to use and more reliable. This has created what Dertouzos has called "the unfinished revolution".[7] The Indiana University computing environment needs to become "human centric," or, as Hayes-Roth and Amor have called it, "Me-Centric".[8]

Many of the inventions and developments that will create truly human-centric computing will be created independently of Indiana University. Computers themselves will become easier to use,

though we will want to do more and more with them as their form factor evolves and they become integrated into many common devices. Wireless connectivity will continue its evolution toward greater geographic reach, speed and bandwidth, thus creating more opportunities for using IT. The continued march toward ever smaller, more powerful processors, better displays, cheaper storage, and enhanced connectivity will create more potential for IT to help people do more by doing less – often through delegation of tasks to technology.

By adopting a human-centered approach to developing and implementing IT, IU will be able to achieve more pervasive and creative use of IT. In 1987, Apple Computers created a concept video of a futuristic, highly interactive computer envisioned as the "Knowledge Navigator".[9] It is unlikely that this vision portrayed in Apple's video will be fully realized within the time horizon of this plan. However, much of what was entirely aspirational in the 1987 Knowledge Navigator (which was pre-Internet) is now feasible or within sight. The essential insight of the Knowledge Navigator concept was to make the professor more productive by helping him or her explore ideas for inquiry, gather and update scholarly materials, communicate, and manage daily minutia. Those aspirational goals remain absolutely relevant for IU faculty, staff, and students today.

As IU makes investments in new hardware, software, and services from outside the university, investments and system designs need to be purposefully steered and incentivized to yield a more usable, easier, and more efficient information environment at IU. Likewise, the ceaseless evolution of technology also necessitates continued advancement of human skills. Humans can gain skills for IT use through self-directed exploration, in context tutorials, help documentation, formal training sessions, or through one-to-one help from a guide. IU must continue to develop its mature foundations for support and training, but it must also assess the constantly changing needs of all constituencies, expand and develop those services that target special interests, groups, and needs, and assess the effectiveness of its communication and support initiatives. All of this will be essential to advance the human side of knowledge as efforts purposefully shape the IT side.

Empowering people to make full use of IU's IT infrastructure must be a core element of a human-centered strategic plan for IT. As IU engages an ever-expanding community — students, faculty, staff, alumni, parents, potential students, partners, alliances, and state-affiliated partners — IU has opportunities to build new models for communicating, supporting, and teaching at the intersection of people and technology. These support services must keep pace with the growth of the community and with the expanding complexity, breadth, and depth of IU's IT resources.

This section addresses four domains to improve a human-centered approach for IT services at IU. Unlike a specific action item to improve network connectivity or provide modern computing devices, the recommendations and action items in this section cut across a variety of areas in the university. These are problems that have not yet been solved because they are complex and involve diverse areas of responsibility and control, yet progress on exactly these difficult problems is essential to move IU to the next level.

C8. Human-Centered IT

Information technology is advancing along several trajectories concurrently, and all have implications for how the university conducts its work. Some advances promise to add efficiencies to familiar work processes and activities, while other emerging metatrends presage fundamental changes in our relationship to content – how we create it, share it, and access it; and in how we connect to each other through new forms of social computing.[10] Mobile access to content, virtualized networking,

collaboration technologies, information access anytime anywhere, petascale resources, the democratization of content production – all have impacts on the human relationship to information and to IT. Added to this is the continual influx of students for whom the web and graphical web browser pre-dated their birth and who, for the most part, have a profoundly different relationship with and expectations of IT than many university faculty and staff.

IU faculty and staff who are aware of and versed in the IT applications that support their work in advancing university missions can work more effectively and efficiently – especially in areas requiring extensive collaboration with others. Faculty and staff who are conversant with emerging trends that affect our relationship to content and to human connectivity can also play a more informed role in shaping these trends.

The human-centric focus of this plan puts first the people who use IT. Programs of education, communication, and support must address the areas in which people need help and the ways they like to learn. They must make learning convenient, and make it tailored to learners' levels of IT expertise and interests. By tailoring modes of communication, support, and instruction to the preferences and IT experience of its users, IU increases its chances of designing effective programs and reaching more users. However different these programs, they should share the same goals: build sufficient proficiency in IT skills such that faculty and staff can leverage technology in support of their responsibilities for IU's missions and increase awareness of the appropriate use of technologies. Likewise, IU constituents must share responsibility for continued development of their own skills and avail themselves of these resources.

Recommendation 8: Indiana University should implement a variety of approaches to IT education, skills acquisition, support, and communication that enable any willing learner to efficiently acquire desired IT skills.

IU should design learning, communication, and support programs around the needs and preferences of the IU community. To determine those preferences, IU should develop well-publicized avenues for gathering input on needs, preferred learning and communication styles, convenience, and other criteria. Programs should be tested by users for effectiveness and interest to support the goal of optimizing user productivity and investment in IT. Similarly, establishing mechanisms for gathering continual evaluation of IT support, education and communication programs will enable IU to closely tailor initiatives to the needs of its constituents. Such initiatives will serve to build interconnections among the IU community and IT providers, and help make IT resources more effective in supporting the university's missions.

Training delivery modalities should be developed that match the ways faculty and staff like to learn. Classes and tutorials can be designed for delivery in the most effective ways for individual and group learners, including at departmental meetings or for administrative units. IU's instructional programs then have the potential to reach more learners when and where they want to learn -- virtually, in person, on paper, and perhaps even in ways not yet currently known.

Action 25: IU should develop innovative programs that consider user preferences and learning styles to advance the skills of faculty, staff and students to use IT resources. Programs should be suited to varying skill levels and modalities for delivery including delivery on demand.

IU has been at the forefront of developing comprehensive IT support through its 24x7 call center, dynamic KnowledeBase of 16,000 help documents, online support options, and relationships with Local Support Providers. Advances in human-centered IT will continue to benefit from support services that adapt to IU's needs. This will likely be a blend of self-service resources and human assistance via a variety of communications media.

Action 26: IU should continue to pioneer and provision effective means of user support through advanced tools for self-service and connection to IU experts to help faculty, staff, and students effectively use IT. IU should continue its work as a support infrastructure provider for national research projects and services.

Faculty, staff, and students clearly cannot make effective use of IT investments if they are unaware that services exist. In the age of information overload and media saturation, it is challenging to get the right service news to the right individuals, at the right times. IU should create an enhanced communication process that is designed to build awareness of available IT resources and the potential benefits of their use. The communications process should be designed and tested around user preferences to help ensure that the right types of messages reach the right audience. For example, notices of upgrades to classroom technologies in buildings on various IU campuses should reach instructors who teach in those buildings.

Action 27: IU should develop a process to effectively communicate timely news regarding existing services, upgrades, and new IT capabilities that can be targeted to appropriate constituencies via user controlled preferences.

The IU community should have easy access to information about the current and anticipated roadmap for developing IT services. UITS can help foster broad understanding and enable wise choices through broad and continuous engagement with existing faculty, staff, and student groups, essential partners in services (e.g., Libraries, Facilities, Finance, etc.), communities of interest (e.g., a Linux user group, high performance computing users, etc.), and other constituencies. UITS and IU constituencies should strive for effective and timely interactions to advance human centric computing, while remaining cognizant of the challenges inherent in an institution as large and complex as IU.

Action 28: UITS should expand its formal and informal engagements with the IU community to ensure a continuous, timely dialogue, and flow of information to effectively adapt IT services to user needs.

C9. Enhancing the Value of Institutional Data and Information

Data and information are critical assets for Indiana University. They are an essential input for IU's scholarly, academic, creative, research, and administrative endeavors. Data and information are at the core of IU's enterprise and administrative functions, and they are the currency of engagement with individuals and other institutions.

All members of the IU community and its collaborators must have appropriate and timely access to the information their work requires. Students require information access to manage many aspects of university life, such as enrolling for courses, applying for financial aid, and interacting with academic advisers. Faculty rely on enterprise information in applying for grants; managing courses; accessing local and remote data for research and creative activity; and building, manipulating, and sharing their

own data in research collaborations. IU's vast digital library holdings are a point of institutional distinction, as they represent unique collections that showcase some special areas of the university's excellence. These collections of data and associated services play an enormous role in the countless decisions and actions required to manage a complex university. While we often speak of the Admissions Systems or the Course Management System, in essence, these are simply tools to manage the data and information that are essential to IU.

Recommendation 9: Indiana University should provision appropriate "data utilities" for administrative data/information, research data, teaching and learning resources, and multimedia scholarly life. These utilities should provide convenient, timely, frictionless, and secure access to university data/information by the IU community and authorized collaborators beyond IU.

The term *Data Utility* is used here in the abstract to describe a domain for a set of services and an outcome. In practice, these Data Utilities may exist using a variety of systems and processes to achieve a desired outcome.

Administrative Data

Administrative data are used almost constantly by the IU community. The reengineering of administrative systems called for in the 1998 IT Strategic Plan consolidated many disparate campus and university systems using products from (then) PeopleSoft and Oracle. In 2008, IU completed its move from PeopleSoft 8.0 to Oracle Campus Edition 9.0 after forgoing interruptions that various interim upgrades could have imposed. These systems now process the bulk of university student and human resources data. IU is beginning its implementation of the Kuali Financial System that it helped to design and develop based on IU's existing Financial Information System.

With these core systems in place, it is now time for IU to substantially improve its business reporting and decision support capabilities – commonly known today as Business Intelligence Tools. This will require a two-pronged effort for an effective administrative data utility. The first effort is to improve the reporting and decision support tools that can produce standardized reports and ad-hoc queries. To enhance and facilitate human interactions with data, IU should develop improved means of accessing and analyzing university data, including developing complexity-hiding interfaces and developing functionality that allows English-language queries and language translation, and that enables non-experts in IT to perform complex analysis and computations. IU should also develop and maintain well-defined IT system interfaces that enable appropriate data access to secure systems for local and departmental uses when necessary.

Action 29: IU should provision and support modern tools for report writing, ad-hoc queries, and decision support. Suitable tools should address the needs of professional functional and IT staff as well as non-IT professionals who have needs for administrative data.

The second, and much more substantial effort, necessitates that IU further rationalize its decades-old data model that underlies its core systems. In many cases, the legacy data model greatly complicates the ability to easily select and manipulate appropriate data for a particular report or query. This is a large-scale endeavor that was purposefully not undertaken in the first wave of system consolidation

and business process reengineering efforts. While many university-wide systems are now in place, developing needed reports remains complicated. It is time for an updated model that more precisely reflects IU's needs and processes.

Action 30: IU should begin a process with its administrative users to update its core data model to match the current and likely needs of a 21st-century IU, including essential relationships beyond IU (e.g., the IU Foundation, Clarian Health, other colleges and universities, etc.). Changes should be implemented in a fashion that is evolutionary, yet deliberate, and least disruptive to ongoing IU operations.

Beyond reporting and ad-hoc queries is the use of the university's many systems in support of day-to-day activities. Though purchased and homegrown systems often represent the state of the art or best choice at the time of their selection, users' expectations continue to change as they desire newer technologies or more integration. It is difficult to back into improved user interfaces and integration with other systems after the fact. Thus, the university should evaluate all choices for widely-used campus and enterprise systems so that they are perceived as useful, easy to use, and integrate well with other relevant systems to avoid redundant work.

Action 31: IU should ensure that any system developed, acquired, or being revised maximizes perceived ease of use, functionality, flexibility and aesthetic appeal to the greatest extent possible.

Faculty, staff, students, and alumni are increasingly using a variety of handheld and mobile devices to connect to university systems. These devices often provide access at critical times and places where people need to retrieve data or update information. Most systems developed prior to 2007 give very little consideration to the small screen sizes, limited or relatively awkward input mechanisms, and slower connection speeds that characterize most hand-held devices. IU should adapt its systems to support information access and enable transactions using mobile devices.

Action 32: To the extent practicable, IU should adapt current systems and require new systems to work effectively with a multitude of commonly-used devices.

Research Data

Research data represent one of the university's greatest scholarly treasures. It is created, analyzed, manipulated, and codified in many forms, from simple text to complex data relationships and multimedia. The recent launch of the Large Hadron Collider in Europe points to a new evolution in the much discussed Data Deluge.[11] The collider generates more than a terabyte per second of data that must be transmitted, stored, analyzed, and updated by distributed individual researchers and teams. Similarly, humanities and the performing arts are creating high-definition video recordings of research and creative works that can consume enormous storage and require substantial connectivity in bandwidth and processing power. The journal *Nature* recently featured a series of articles regarding the PetaCenter and the rise of massive data collections.[12]

Large advances in high performance computing (supercomputing) may sometimes obscure another trend: the rise of *human computation*. Especially in certain fields in the humanities, researchers use shared data repositories and specialized software to annotate manuscripts, apply metadata to video and audio, and refine collective knowledge – today's so called wiki gardeners. These approaches in

social connectivism to advance scholarship may be broadly applicable across many areas of research, and they are enabled by robust abilities to store, share, and improve data resources.

While many research endeavors will continue to benefit from favorable prices for local storage systems, IU should expand its efforts, in partnership with the deep skills in the libraries, School of Informatics, and School of Library and Information Science, to create a scalable data utility for IU researchers. This data utility will need to offer a range of services for securing data, providing authorized access within and beyond IU, and ensuring metadata description, annotation, and provenance, as well as providing backup/recovery services. This utility may emerge as an IU service or in partnership with other institutions.

Action 33: In order to enhance the research productivity of individuals and teams, IU should provision a full-featured and robust data utility service for research data that affords abundant near- and long-term storage, ease of use, and preservation capabilities.

Teaching and Learning Resources

The Internet has connected instructors and students with a world of resources. Likewise, IU scholars are producing many courses and learning modules that are either partially or fully online. On the national level, MIT led with its Open Courseware initiative to share the contents of MIT courses with the world.[13] It was a pioneering effort backed by tens of millions of grant dollars over many years. More recently, attention has turned to open educational resources (OER) that are smaller, modular components of a course or topic, e.g., a module on business ethics or an exercise on bilinear transformations. Efforts like the Connexions project from Rice University exemplify a new way for instructors to share vetted educational resources.[14]

Some textbook publishers are also exploring ways to provide digital content and exercises that may be free or licensed. It is widely understood that the current high cost model for textbooks is of great concern to students and many others. A new approach is needed that takes cost out of the system while preserving the elements of the model that work for students and content authors. IU should be at the forefront of enabling its faculty to creatively experiment with and adopt new models for providing educational resources to students.

At present, digital teaching and learning resources at IU are often deeply embedded in a course in the university's Course Management System (e.g., today's Oncourse CL) and cannot be readily shared. Some materials represent proprietary value to faculty members and should not be shared, but faculty and other instructors would often willingly share course materials if there were a convenient and reliable means to do so. IU needs to provision an appropriate data utility for the university to create, share, and update open educational resources while also connecting more easily to a world of open educational resources. This utility needs to work with institutional course management system tools and evolving learning environments.

Action 34: IU should develop a full-featured and robust data utility service for teaching and learning materials that affords instructors abundant near- and long-term storage, ease of use across a variety of courses, rigorous control of access to their materials or open sharing, and simple import/export/reuse in Course Management System/Learning Environments.

Action 35: IU should adapt its Course Management System/Learning Environments to easily import, use, and export open educational resources from a variety of digital sources.

Scholarly Life

Over the decades, the intellectual life of the university has become far more than its courses and scholarly papers. Countless symposia, visiting distinguished scholars, presidential and dean speeches, presentations by alumni, student presentations at case competitions, and great lectures comprise another essential element of the scholarly life of IU. Some of these important events are captured in the IU Archives, but countless others perish in the moment.

The commoditization of tools to record, edit, annotate, and transmit audio and video provide a new opportunity to preserve the cultural heritage of the scholarly life at IU. Podcast.iu.edu is a start for a gateway to IU audio and video content, but a data utility is needed that can ensure long-term preservation, searching, and retrieval of the many events at IU. Standardized processes to capture, ensure permission rights, and archive events are an essential part of a reliable service.

Action 36: IU should provision a full-featured and robust multi-media utility service to preserve the many events that enrich the scholarly life at IU. The utility should enable abundant near- and long-term storage, ease of use across a variety of audio and video endeavors, permissions and rights management, and provide search and retrieval for whole and partial clips based on terms or associations.

Creative Works

Similarly, IU has many treasures of film, performance, and other recordings of complete works. Each year it adds to these collections. While some of these can only be experienced as intended in the full setting of a theater or performance hall, they also represent great resources for instruction and cultural preservation.

Some of these are already available in digital form via IU's Digital Library Project or other efforts, and many more may become digitized over time. The work of the Variations Project in music and the EVIA Digital Archive Project for Ethnomusicology are leading exemplars of bridging scholarship, instruction, and preservation of rich media. IU should develop a capability to bridge preservation of these works with presentation in a variety of individual or group settings.

Action 37: IU should provision a full-featured and robust multi-media utility service to digitize and preserve film, audio, and complete creative works. The utility should enable abundant near- and long-term storage, presentation in variety of individual or group settings, permissions and rights management, and provide search and retrieval for whole and partial clips based on terms or associations.

The Data Utilities and Identity Management

Collectively, these data utilities – in whatever form they best emerge – should enable the IU community to realize the full value of university data, information, and the systems that maintain them. Users should be able to gather, search, manipulate, analyze, manage, visualize, archive, and

curate data in any format over time, e.g., digital text, photographic images, audio and video, maps and architectural records, web documents, and electronic messages, as well as images of books and other digitized materials. (See the Scholarly Record discussion in Section D.)

Access to these data utilities should support a range of human-centric interfaces that make them useful and easy to use – especially for the many repetitive, record-keeping and functional tasks, such as, teaching, research, grant development, administrative transactions, committee work, time management, calendaring, procuring tickets for events, and university life. IU should direct the development of the systems and data utilities toward increasing the proportion of time faculty and staff can spend on research, creative activity, teaching, and university business— the activities that require human intellect.

These data utilities for storage and sharing – especially for administrative data – can provide several advantages: (a) enable data analysis across currently disparate silos of information; (b) facilitate the preservation of "institutional memory" related to key decisions and processes; (c) enable IU decision makers to get the right information more quickly without requiring assistance from technology expert intermediaries; (d) improve the control of and access to sensitive data; (e) reduce maintenance and administrative needs, and (f) eliminate unnecessary duplication of data, processes, and systems ("shadow systems") that have been developed throughout the university community. The data utilities could also share some common hardware, system administrators, tiers of faster and slower storage, and backup/restore facilities.

One essential missing element needed to realize this vision is an ability to know the identity of a user (if a restricted data source is involved) and his/her appropriate authorizations. The developing area of Identity Management represents a substantial topic for research, development, and deployment. Identity, or who someone is, such as a professor in the School of Liberal Arts at IUPUI or an admissions officer at IU Kokomo, may be asserted at institutions beyond IU's borders. For example, a student attending Ivy Tech in Columbus may need access and be entitled to library resources in an IU-managed library. A physician's assistant who works for Clarian may also be helping with an IU Clinical and Translational Science research project involving joint work between a team at IU Bloomington and Purdue West Lafayette. Her Clarian credentials are her identity.

Much work is needed for university systems and the envisioned data utilities to understand the notion of federated identity – an identity credential for someone outside IU, but which can be trusted like an IU credential.

Action 38: IU should provision a robust and secure ability to support federated identity and authentication across a range of trusted institutions and partners.

The second major component of identity management is a robust ability to manage fine-grained access and restrictions to distinct resources – or authorization. Authorization presents an even greater challenge as it requires revision in each system to seek and make use of more details than simple authentication. Systems must understand who has access to which resources or services at what points in time. As the university becomes increasingly connected and partnered in its core missions of research and education, it will need a more sophisticated means to manage authorizations in a world of federated identity.

Action 39: IU should provision a robust and secure ability to support fine-grained authorization to specific systems and data utilities across a range of internal users and trusted partners.

These steps to a new strategy for comprehensive identity management must be developed with the same rigor and attention to security that have guided internal accounts systems to date. Careful assessment of risks and appropriate protections are needed to safeguard the vital information assets of the university. Identity and access management should improve the user experience by automating creation of accounts and reducing the number of accounts and passwords. Security can be enhanced by properly closing or disabling accounts when the individual's relationship with the university is terminated or changed, and by maintaining access rights as appropriate for their current role. Privacy can be improved by reducing the number of systems storing personal identity information and tying the appropriate levels of access to university roles. Users can be granted delegated and self-service rights to more easily keep identity information updated. IU's electronic identity can be extended beyond campus borders to support seamless external collaborations.

C10. Enhancing Student Success

In order to create an environment in which information technology serves as an instrument of student success, the university must continue to provide a sound infrastructure for the productivity tools basic to student work. State-of-the-art network services and support, including ubiquitous access to resources regardless of the user's location or device, are also needed and must continue to be made available and upgraded.

Beyond these fundamentals, most students who come to Indiana University have already experienced and will continue to experience many of the latest IT developments. They are likely to move nimbly ahead, solidly in step with the pace of IT change. Despite their familiarity with the latest communication tools and social aspects of technology, however studies have shown that today's students do not necessarily have a deep understanding of technology for activities and applications such as accurate modeling of problems, searching to find credible sources, and sophisticated tools for visual expression.[15]

IU will need to find ways to attract and retain students of the Net generation and generations to come while also helping them gain depth in skills in new areas. Students expect innovative, engaging learning experiences that involve IT tools for creating content, for expressing viewpoints, for virtualizing experiences, and for collaborating. They expect to find ubiquitous IT help. Their experience in handling administrative activities like enrolling, advising, tracking their progress, and paying tuition should involve online interactions that are as integrated and user friendly as, for example, their dealings with Amazon.com or the Apple iTunes Store.

The IT organization needs to stay current with student IT experiences and expectations as it develops IT programs and services, and in order to advise students on the wise, legal, and appropriate use of each new IT development.

> **Recommendation 10:** Indiana University should develop student-centric IT applications and systems that can contribute to student success through support of academics, administrative tasks, and student life.

A strategic plan that is truly user-centric must have means for knowing and understanding the behaviors of its users. A university-sanctioned program of student representatives or liaisons working

with the IT organization can help provide information and timely insight that will be valuable in designing student services and initiatives. These liaisons would systematically provide information, advice, and updates to the IT organization about various aspects of student IT use, such as help, communications, and learning technologies. They could also serve as a regular source of student feedback on IU's IT initiatives and programs.

Action 40: IU should continue to establish and maintain ongoing, formal relationships with students and student groups who can serve as liaisons to the IT organization.

The plan sets a goal for IU to achieve leadership in IT-enhanced teaching and learning. (See recommendation 13.) That goal will involve creating new learning environments and experiences that include mobile devices, designing collaborative, participatory learning activities, and experimenting with various new classroom environments. These new environments will also provide ideal settings for modeling good judgment in such activities as using tools to create content, conducting successful collaborations; judging the veracity of material found online; and using social computing responsibly.

Action 41: IU should support the creation of learning experiences that attract and engage IT-savvy students. In addition to promoting participatory learning, these experiences can also serve to help students develop IT behaviors that are academically, legally, and socially responsible.

IU technology should enable students to maximize the time that is spent on the tasks associated with learning. Information systems should enable quick, integrated, logical, accurate, and convenient access to, and processing of, the many administrative duties associated with being an IU student. Technology should free up time to spend on the important task of learning. The class registration process is one area of current concern and of great long-term potential. Students need sound information and advice from a variety of sources to make wise choices for courses, level of workload, sequence, instructors, and other matters that may affect their success. A well-designed decision support system can be of considerable benefit to all IU students.

Action 42: IU should develop a decision support system to help students easily navigate relevant data sources for choosing classes, with support for modeling class schedule scenarios and access to advising. The system should have a human-centric, easy interface to assess alternate scenarios and options.

The technologies used to meet student needs should be consistent with, and support various modes of, personal planning and modes of access and interaction. Scheduling and managing student activities, including classes, clubs, teams and groups, and social and sporting events should be made convenient and integrated.

Action 43: IU should provide and support technology that enables students to effectively manage their time through calendaring systems, automated reminders, and/or other personal productivity applications.

Just as with its faculty and staff communities, enhanced communication program designed for students will help to build awareness of IT resources and their contributions to productivity and achievement, allowing students to make informed choices about IT and benefit from available resources. A communications program designed and tested around user preferences should help

increase readership and ensure broader awareness of current and new technology tools and their use in teaching, research, and administrative work.

An area of particular focus for student communication is ongoing outreach concerning intellectual property rights. Intellectual property is governed by a complex set of laws, but students will benefit from at least some understanding of the relevant legal and policy issues. This sort of outreach could potentially protect students from lawsuits and legal problems while instilling a respect for the rights associated with intellectual property.

Action 44: IU should accelerate its communication programs that help students understand the potential and limitations of information technology, highlight new technologies and uses, promote effective and efficient use practices, and recommend practices for protecting intellectual privacy and property.

Finally, perhaps one of the greatest opportunities and challenges for universities is moving beyond the fixed-time interval, 15 week semester. The answer lies not in a shift to quarters or other fixed interval, but rather, in evolving systems and university processes to enable schools and departments to teach courses in flexible "learning units" that best suit the topic, learning experience, and credit for completion. Some courses may best span a two year experience for five credits or an intensive three week program with all day weekend sessions and distributed work through the week may earn two credits. IU's systems should support continuity of current approaches and also enable curricular innovation that improves educational outcomes. Faculty and school should be able to creatively blend elements of resident-based and distributed learning experiences, time interval, schedule over weeks or years, and assign any appropriate increment of credit for suitable learning experiences.

Action 45: Software and systems applications for scheduling, course management, and other teaching-related activities supported by IT should enable flexible learning units of variable schedules, meeting times, credit, and prerequisite structures.

C11. Engagement Beyond through IT Leadership

Information technology has created opportunities for universities to become more engaged with a variety of institutions and constituencies. Indiana University is exceptionally well positioned to become a leading force in developing such engagements with its alumni, with entities in the state of Indiana, and with individuals and organizations throughout the United States and around the world. As a result of the IT foundation created by the implementation of ITSP1, IU has formidable IT capacity and world-class capabilities in networking. Through its work with national network consortia and community-source development projects, IU has a reputation as a leader in research networks and collaboration.

IU is developing a remarkable track record and capacity to work across boundaries, locally and internationally. Its eight campuses create a statewide network of education and outreach, producing a large percentage of Indiana leaders and professionals. IU's networking infrastructure and expertise enable worldwide communications and collaborations that can effectively transcend the barriers of geographic distances. By capitalizing on these investments and expertise, and supporting continued investments to maintain state-of-the-art communication and networking capabilities, IU can continue to lead in IT-enabled engagements of interest.

Recommendation 11: Indiana University should work within its missions as a public institution to deepen its technology-supported engagement with institutions and communities beyond IU that advance public health, education, and economic development in the State of Indiana.

The campuses, schools, departments, and individuals that comprise IU have a wealth of expertise that various programs offer to constituencies and initiatives beyond IU. For example, the School of Law offers free legal assistance through its Community Legal Clinic. The IU Kokomo Division of Continuing Studies identifies students to help companies develop business and marketing plans. The IU Simon Cancer Center at IUPUI provides physicians and the public with updates about the prevention and understanding of cancer. The College Preparatory/Student Outreach Program at IU Southeast in New Albany partners with surrounding counties to inform and help students (and their families) who aspire to college. Examples of such educational opportunities, outreach programs, and activities are countless. The interactions, collaborations, and partnerships they engender build engagement and connectedness beyond the physical locations of IU's campuses, and across organizational, cultural, and disciplinary boundaries.

Even with these many good outreach and engagement efforts, many in the university and community remain unaware of the opportunities. IU should take steps to raise awareness of the array of outreach resources available across the university by creating and maintaining access to and information about them in one searchable location. By making expertise easy to find, IU will maximize awareness of such services, extend the contributions they can make to human lives, and augment its profile as an engaged, connected university.

Action 46: IU should provision a comprehensive, fully searchable database of its capabilities and outreach programs that are available or could be made available to external constituencies. The database should enable processes and program owners to seamlessly keep the information current and accurate.

There is ample research to support the broad claim that information technology, when combined with traditional instruction, produces higher rates of engagement than traditional instruction does by itself. As a designer of IT applications that can aid learning, IU is in a good position to share ideas across the state for promoting learning through the use of IT.

It is also true that better education at all grade levels in science, technology, and math stands to directly improve the future economic vitality of the state by preparing young people to learn the 21st-century skills they will eventually bring to the workplace. IU is in a position to add to the contributions it makes to K-12 educational programs in the state. Communication networks can bring the resources of IU in science, language, mathematics, the life sciences, international relations, and other areas to elementary and high schools. IU should continue efforts to combine the resources of such entities as the School of Education with its IT resources, to share educational materials with Indiana schools and communities. Collaborating with the school systems in the state, IU should also develop ideas and models for building exposure to IT — as a subject of study, and as a tool — in secondary education. Building IT awareness will help further the work of the IU Institute for Science, Technology, Engineering and Mathematics Education (ISTEME), which is focused on improving Hoosier literacy in science, technology, engineering, and math for K-12 students across the state.

IU should also build an ongoing dialog with state school systems as a means of determining how IU's IT capabilities can best be applied to serve students in the state.

Action 47: IU should use its distinct capabilities in education and technology to reach out to K-12 teachers, administrators, and students in ways that further an effective P-20 approach to improve Hoosier education.

As of 2008 IU does not yet enjoy a widespread reputation for excellence in technology transfer. Renewed efforts of the IU Research and Technology Corporation under IU's Vice President for Engagement offer opportunities to improve technology transfer from IU researchers and innovators. These efforts can play a crucial role in developing a 21st Century economy in the State of Indiana.

Action 48: IU should develop its IT capabilities to support and enhance the flow of innovation from researchers and innovators to the practical use of the public and private sectors of the State of Indiana and beyond.

Finally, IU has one of the largest, most loyal alumni groups in existence, and they live all over the world. The networking and communications capabilities now in place and planned for the future provide unprecedented opportunities for strengthening and expanding alumni relationships.

Action 49: IU should use its IT capabilities and relationships with the IU Alumni Association for improved outreach to and engagement with its vast alumni population in ways that suit alumni preferences and desires.

Section C has addressed many human-centered opportunities to support IT skill development in the IU community, improve IU systems, and reach out to others beyond IU in the role of a great public university. The next section focuses attention on a few grand challenges and opportunities.

Section D. Grand Challenges and Opportunities for IU Leadership

Beyond *Sustaining the IT Foundation* and refocusing on a *Human-Centric IT* lies a set of seemingly intransigent challenges and substantial opportunities. The complexity of many interdependent participants and institutions, competing values, and the limited ability for incremental change to achieve large effect make these problems akin to *grand challenges*. Potential areas for improvement, ranging from very good to truly outstanding, share many of the same characteristics, resulting in *grand opportunities* for a large, diverse institution like Indiana University.

Substantial progress in meeting these grand challenges and realizing these opportunities could advance IU's core missions in ways not possible while these challenges persist. Real progress in doing so, however, is beyond the domain of information technology alone and will require the efforts of faculty, staff, students, alumni, and external partners as well as investments in physical facilities. In challenge is also opportunity. Indiana University is uniquely poised to make substantial progress if it focuses its energies on a few of these challenges and opportunities. In this section four such areas are identified: recapturing the scholarly record; leadership in health care delivery and medical education;

achieving leadership in IT-enhanced teaching and learning; and accelerating IT-intensive research and scholarship.

D12. Recapturing the Scholarly Record

For centuries, academic institutions and great libraries have collected, preserved, and disseminated the cumulative record of research and scholarship. As these historical records of scholarship have become digitized or are born digital, students and scholars increasingly expect any- time and any-place access to any content (e.g., journal articles, books, monographs, etc.) for research and teaching. The consumerization of both simple and sophisticated IT is influencing the ways scholarly content is created, disseminated, updated, and accessed. This, in turn, has prompted a transformation of traditional publishing models, resulting in consolidation among commercial publishers. Consolidation and aggregation have led to vastly increased scale, effectively shifting control of the distribution and pricing of the scholarly record from universities to commercial entities.

One consequence is that university libraries face year-over-year cost escalations for print and digital subscriptions that vastly exceed growth in library budgets, and libraries now find they are increasingly renting access to digital scholarship rather than the centuries-refined model of owning the content.[16] This imposes new challenges for the long-term since commercial licensing and other strictures may impede traditional approaches to preservation and access. The effects of restrictive licensing are already being felt at IU, where students and faculty on some campuses do not have electronic access to the scholarly works of IU's own researchers because of costly and restrictive licensing. Moreover, electronic access to an IU researcher's publication of today may not be available to his or her colleagues in the future without paying ongoing annual fees set at the discretion of the publisher.

Forces are combining to push scholarly publishing in new directions. The 2007 Ithaka Report, "University Publishing in a Digital Age," drew upon extensive surveys of the directors of US university presses, librarians, provosts, and other university administrators. It predicts:

> *"Publishing in the future will look very different than it has looked in the past. Consumption patterns have already changed dramatically, as many scholars have increasingly begun to rely on electronic resources to get information that is useful to their research and teaching[17]."*

New modes of publishing formats enabled by technology, the growth of shorter-cycle dissemination of preprints, and electronically updated content also suggest new ways of distributing content. Alternative distribution models are also influencing the way in which scholars access and exchange information. Scholars are increasingly relying on a range of electronic formats for research and teaching, alongside traditional peer-reviewed materials. These may include multimedia formats, primary-source material ("gray" literature), conference proceedings, collaborative workspaces, and message boards. Online repositories and open-access journals are widening access, reducing costs, and promoting the open sharing of scholarly content.

As creator, curator, funder, and conveyor of knowledge for teaching and research, the university and its faculty must be a key player in influencing the evolution of these new models of scholarly publishing. These models must be driven by and reflect academic values of knowledge creation, sharing, and long-term preservation over any other values that threaten those responsibilities. New models must also bridge the gap between the institutions that pay for the rising costs of access to scholarship through library budgets and the scholars and their professional societies who may choose publishing terms without complete insight to the full lifecycle costs imposed on institutions. This situation appears even more peculiar when considering that universities often pay the full costs of creating

research, may in some cases pay submission or publication fees to journals, and then are forced to pay rent for the ability to provide access the same material. Very strict licensing terms often impede access for all members of a university, and at the same time, limit long-term preservation.

In looking for ways out of this conundrum, universities, through their presses, libraries, and IT resources, already possess many of the capabilities needed to empower these new models. For example, libraries may direct more resources to creating and maintaining institutional repositories, expanding digital collections, and managing and searching data. University presses have expertise in selecting and credentialing scholarship – especially books and monographs, and their skills will likely continue to have a role in new models of scholarly communication. Presses have editorial services that can continue to sharpen and add value to content, and they have capabilities for marketing and distribution of physical books and electronic versions.

Countless papers and presentations have long chronicled the "crisis in scholarly publishing," but the grand-challenge nature of the problem has afforded very few opportunities for action by individual institutions or faculty members. There are some early signs of progress and innovation including Portico and LOCKSS.[18]

Recommendation 12: Indiana University should pursue a position of leadership in the development (with partners) of new, sustainable models for scholarly publication, dissemination, and curation that enable scholars — and their collective communities —to re-assert control over rights to the scholarly record and its institutional preservation.

A few premises are essential to frame the domain of possible constructive action. First, scholarly communities of faculty are best poised to choose effective means for reviewing, vetting, and credentialing their work – often through their professional associations and established journals. Second, scholarly publication in all forms – whether digital or hardcopy, fee-based or open access – requires a sound financial model for sustainability. Third, institutions of higher education, particularly public institutions, have a mission to create and broadly disseminate research and scholarship as a core value.

IU should engage a broad dialogue among its many scholars, librarians, administrators, and the IU press to assess if and how the university might work to improve scholarly communications to achieve and sustain its values of preservation and access. This dialogue should consider new publication venues, attractive offers to existing journals and professional societies that better meet the needs of all, and a platform to innovate new forms of scholarly communication, including multimedia, and a view of the scholarly record from data to post-publication annotation.

Action 50: IU, through its faculty, librarians, and administrative offices, should boldly assess potential new models to support the production, dissemination, curation, and preservation of the scholarly record within a fiscally sustainable approach that expresses IU's values.

As a grand-challenge domain IU has limited ability to unilaterally affect scholarly communication models. IU does, however, have great opportunities to lead like-minded institutions and other stakeholders in collective efforts to pioneer new models. These may include partnerships and

consortia with other universities that are also examining such directions, new relationships with publishers and the commercial sector, and new approaches for engagement with professional associations to help achieve mutual aims.

One area for exploration is the possibility of a publishing infrastructure that is owned (or managed as a back-office production contract) by colleges and universities. This "Big Digital Machine" could provide efficiencies and economies of scale as a means for professional societies, journal editors, university presses, and others to produce, distribute, and preserve their scholarly communications without a need to put university and commercial values in conflict. There are many questions regarding the feasibility, funding model, and efficacy of a universities-owned Big Digital Machine, and any such capability would need to be able to support a diverse set of journal funding and subscription models, for-fee and open access for monographs, and other means that afford business model control to each scholarly community. There is evidence for reasoned optimism in this approach, however, as many community source software development projects, library consortia, and other higher education collaborations have demonstrated that a cooperative approach can achieve economy-of-scale efficiencies while respecting and preserving institutional values.

Action 51: IU should rigorously explore collaborative approaches with other universities and organizations to create and sustain effective models for scholarly communications.

Creating new models and platforms to support scholarly communications, journals, and academic professional societies will likely take some time. There are actions that the university and researchers can take now to begin to ensure that all of the IU community can access the scholarship of IU. It can also establish a path to ensure that IU can preserve for decades and centuries the works of our own scholars no matter how publishing models may evolve in the future. The university already has a head start on this area when researchers deposit a copy of their work – text or multimedia – in *IU Scholarworks* that is a university-wide service of the libraries. There are likely win-win models with publishers that might enable short-term control of copyright to remain with a journal while still allowing an institution a right to preserve and provide content after an agreed upon period.

Action 52: IU should provision robust systems and services that enable researchers to easily provide an institutional deposit copy of any scholarly work in any media format.

Action 53: IU and individual researchers should press for an evolution of win-win publication agreements and conditions for copyright use that enable institutional preservation of the works of IU scholars.

It is also possible that collaborative models to own or contract for digital production and dissemination may have uses beyond traditional research and scholarly communications. Actions 34 and 35 direct the university to develop a data utility for the storage and dissemination of educational resources for courses. There may be considerable overlap in the capabilities of a Big Digital Machine to produce journals and monographs and the back office capabilities required for textbooks and course materials.

Action 54: IU should assess whether university and collaboratively owned (or contracted) infrastructure for scholarly communications could also provide a means for lower costs and better materials for the current role of traditional textbooks. If so, this resource should also be engaged to help mitigate the high costs of textbooks.

D15. Leadership in Health Care Delivery and Medical Education

Indiana University's health sciences schools and facilities – including the State of Indiana's only schools of medicine, optometry, and dentistry, and the country's largest school of nursing – are essential elements in achieving the state's life and health sciences goals. They extend IU's network of engagement with other universities in the state, to Clarian Health and other hospitals, and to many local communities. Hoosiers extensively depend on the graduates of these schools and the care provided through affiliated clinics and hospitals. Research conducted at IU and in partnership with other institutions is essential to achieve breakthroughs in prevention and treatment, and improved delivery of healthcare.

The university has a remarkable opportunity to engage in the grand-challenge problem of medical research and health care today given its extensive IT capabilities, multiple campuses across the state, medical education centers, health sciences schools, and information research in the School of Informatics and School of Library and Information Science. These resources, coupled with IU's leadership in distance education and simulation technologies, can help to enhance IU's position as one of the very best and most innovative universities in life sciences and medical education.

> **Recommendation 13:** Indiana University through work with its partners, should pioneer research, development, and application of information technology to healthcare delivery and medical education to improve human health.

The medical and life sciences communities have unique needs that require specialized services and resources. Considerations include:

- Faculty and students often teach and learn in organizations that are not managed by Indiana University (e.g., medical education centers, hospitals).
- The line between education and clinical service is illusory as learning takes place through clinical practice.
- Patient care must continue under any condition — network or system outages must not be permitted to imperil patient safety.
- Data generated by medical and health care research activities tend to be massive in volume and scale.
- Penalties for not properly protecting confidential information are severe.

In looking at current trends and extrapolating to the future, it seems clear that areas of life sciences research, translation to clinical practice, and health care delivery will grow in dependence on information technology and a high-functioning web of relationships among organizations. IU should pursue opportunities for achieving practical results in the use of technologies to enable frictionless efficacy among its research, translation, and practice applications for modern healthcare.

Whenever appropriate, IU IT resources should be available to its medical care partner organizations, and their resources available, in turn, to IU. The university should ensure that networks and support services are stable, reliable, and available 24/7. IU should provide the infrastructure and services necessary to support the advancement of distributed collaborative healthcare delivery and instructional activities.

Action 55: IU should develop policies, systems, and approaches with Clarian Health, the Regenstrief Institute, the Veteran's Administration Hospital, Wishard Hospital, and its other partners to simplify matters of identity management, authentication, and authorization as staff move among facilities and IT systems to conduct research and health care delivery.

Confidentiality of health information, the most sensitive of all personal information, must be ensured via rigorous policies and procedures to ensure privacy and appropriate access for medical care.

Action 56: IU should develop rigorous policies and procedures to ensure that confidential health information, the most sensitive of all personal information, is reliably protected during transport, while in use, and at rest in storage.

While system outages can be a great inconvenience or disruption for any IT-enabled IU service, nowhere is continuity of service more critical than in patient and clinical care. IU should ensure that all medical care systems and services can meet the rigorous requirement of 24/7 with backup of equipment and personnel for continuity of service.

Action 57: IU should develop approaches to ensure that the business of patient care can continue under any condition by providing both human and technology resources that are available 24/7.

Healthcare delivery, especially rural healthcare, is dependent on many relationships among hospitals, clinics, practitioners, and telecommunications network providers. Electronic medical records and city or area health information exchange networks are essential to share appropriate information, access expertise, and improve the efficiencies of healthcare delivery.

Action 58: IU should assertively engage with and through its partners to provide both the infrastructure and the services necessary to support the advancement of innovative activities, including access to electronic medical records via health information exchange networks, telehealth consult services to underserved communities, and the education of our health sciences students.

In 1997, Methodist, IU's University Hospital, and Riley Hospital for Children combined to create Clarian Health Partners. The IU School of Medicine, other health sciences schools, and clinical practices have a deep interdependent relationship with Clarian. In pursuit of economic efficiency and to enable IU and Clarian staff to move easily among facilities and IT systems, IU and Clarian should leverage opportunities for contractual shared services that are beneficial to both organizations.

Action 59: IU and Clarian should assess and implement shared services where one can be an efficient provider to the other of network management, computation, call center, or other services that have natural integration points across both organizations.

Finally, many reports and news accounts have assessed the growing shortage of medical and healthcare professionals in the State of Indiana. Additional approaches for distance education and creative partnerships with other institutions are essential to solve this problem.

Action 60: IU should continue to develop innovative approaches to medical and life sciences education using advanced IT applications in classroom, clinical, and distance environments and through creative partnerships with Indiana institutions.

D13. Leadership in IT-Enhanced Teaching and Learning

Teaching and learning are among the core missions of Indiana University, yet there is tremendous variance in the use of IT to enhance instruction. Some faculty and instructors have employed highly effective practices in the skillful use of IT to improve learning. They have adapted teaching techniques to make use of specialized facilities and emerging social habits in the use of IT, and even developed their own software or instructional modules to aid understanding. Students have also learned to directly access a world of educational resources from institutions near and far to aid in their own study and education. With roughly 100,000 students, the opportunity for IU to adopt the time-proven techniques of great teachers and to discover new possibilities afforded by a highly connected, increasingly digital world is immense.

IU has an established record of commitment to advocating for and providing leadership in the use of IT-enabled practices that foster excellence and innovation in teaching and learning. It has long served as an agent for change through its lead role in the community source Sakai and Open Source Portfolio communities, and via faculty engagement in the Scholarship of Teaching and Learning and other valued groups such as the Faculty Colloquium for Excellence in Teaching (FACET). Collectively, these help build an international culture of outreach, innovation, and advocacy for sound pedagogical practices.

Many trends indicate an evolution from traditional classrooms and courses that are supported by Course Management Systems to more holistic approaches. Such approaches call for rethinking pedagogical practice, connecting to a growing world of educational resources, and designing physical facilities and furnishings that are attuned to learning specific topics. Examples include classrooms and informal learning spaces with tables and chairs that can be easily moved to support collaborative learning techniques as well as lecture halls and small group rooms with superb videoconferencing that enable realistic interactions across distance.

Education is one of IU's core missions, and IU's efforts must continue to broaden access to people, materials, and resources, and encourage partnerships and collaborations with learning communities within and beyond the university. IU should aggressively pursue all opportunities that can improve the quality and means of instruction and enhance student learning to further its distinction among the very best universities in the 21st century.

Recommendation 14: Indiana University should provide faculty with excellent professional development opportunities, professional support, effective digital tools, and instructional facilities that can help improve instruction and learning outcomes.

Classrooms should provide environments that promote active and collaborative learning experiences. Planning for learning spaces should take into account the continuing evolution of teaching and learning technologies, the increasing prevalence of devices, and the mobility of today's students – not

all of whom will be in the classroom or on campus. Experimental classroom environments where faculty can explore and evaluate emerging technologies and reconfigure the furniture and technology to meet a variety of pedagogical needs are needed to further insights into what works and why.

It is important that developments in IT for teaching and learning continue to be a tool in the service of the learning aspirations of all faculty, staff, and students wherever their position on IT's evolutionary curve. IU must provide services and resources that accommodate the full range of faculty skill, expertise, and interest. The design and configuration of instructional tools and physical spaces (whenever possible) must be flexible, movable, and changeable to support a variety of teaching and learning styles, preferences, and objectives.

To further these goals, IU should adopt a broad program of support for the implementation and/or development of innovative technologies that enhance teaching and learning in classrooms, in other potential learning spaces on campus (e.g., student technology centers, common areas, residence halls, etc.) and at a distance. Ideally, technology should support and work with a variety of teaching and learning approaches as appropriate to the instructor's goals, teaching style, and disciplinary requirements of the subject being taught, both on campus and via distance learning models.

Action 61: IU should provide resources and support for experimentation with and implementation of a range of creative and innovative approaches to teaching and learning, including state-of-the-art instructional technology in conventional classrooms, IT-equipped informal learning spaces, spaces specially designed to accommodate varying instructional approaches.

Technology applications are needed that support student learning outside the classroom and recognize that learning frequently involves groups, not just individuals working alone; and that learning can take place at any time. As IU designs and creates innovative learning spaces, information technology professionals should work with facilities planners to design collaboration and communication tools (both hardware and software) to support and enhance the effectiveness of such spaces.

Action 62: IU should explicitly include consideration of IT-enabled teaching and learning innovations – such as informal learning spaces – that extend beyond replicating conventional classrooms and laboratories in the design of new and remodeled physical facilities that will likely include student uses on all IU campuses.

Software and support programs are needed that will enable and encourage faculty to produce rich (interactive, integrated, customizable, multimedia, etc.) teaching materials more efficiently and more effectively and that are easier to use. Support should range from instructional consultation to complete end-to-end development. The IU Libraries will also play an essential role in connecting instructors to a world of licensed and freely available digital content for their courses. Funding decisions for instructional development activities should consider such criteria as appropriateness of the materials for the educational goals of the course and discipline, the potential number of students who could benefit, the likelihood of broader adoption across instructors and campuses, and the creativity and innovativeness of the concept.

Action 63: IU should provide faculty with the resources, support, and appropriate incentives to produce innovative digital instructional materials, educational resources, simulations, and educational games for use by students working alone or in teams, and for resident-based, and distance learning situations. Systematic processes should be developed for identifying ideas, designing experimental applications, disseminating results, and implementing new IT solutions to support instruction.

Teaching and learning are becoming increasingly collaborative. Distributed learning communities; collaborations of students across campuses or countries; devices that capture, record, and transmit; and ubiquitous network connectivity are combining to "blast out the walls of the classroom." The result is movement toward an unbounded network of teachers and learners, linked by technology that is fully integrated and easy to use. In developing distance education capabilities, priorities should be given to quality of the learning environments provided, flexibility (enabling instructors to use a variety of techniques and media), ease of use, and integration with existing instructional resources.

Action 64: IU should increase support for distributed education environments that enable IU faculty to effectively and efficiently conduct classes using distance technologies with ease of use for integrating instructional resources, flexibility, and support for a variety of pedagogical approaches.

Assessment of student learning outcomes in higher education is becoming an increasingly scrutinized area of broad concern. IT has the potential to collect, filter, analyze, and store information for individual and institutional assessments. Ongoing assessment can provide critical guidance for individual student learning progress across an entire educational experience, organize feedback for coherence over time, and enable timely student choices for mid-course corrections. Assessment and feedback systems should be convenient for both faculty and students and should enable near-term (e.g., while a student is enrolled in course) and longer-term (e.g., comprehensive assessments of progress and accomplishments). The systems must enhance and fit with the objectives of a major, degree program, or learning experience and not place an additive, undue burden on faculty or students to reap the benefits of their use.

IU has an opportunity to build on the growing interest in assessing learning outcomes. The university should continue development of its student electronic portfolio system and other means to ensure that IU can steer efficacious paths to reasonable goals for accountability.

Action 65: IU should provide technology applications as part of an integrated learning environment with instructional support services available to manage both near-term and long-term term feedback to students on their performance in courses and programs. The systems should have suitable protections for individual privacy and also enable institutional metrics for obtaining evidence of progress.

Finally, immediate feedback can also be a useful tool during classroom or instructional events taught at a distance. At present, a disparate array of "clickers" and classroom feedback devices attempt to fill this need, but many students already carry devices that might be used for this purpose. Likewise, some learning environments incorporate real-time feedback mechanisms in the physical space for resident-based courses. The devices should provide access to schedules, alerting and information, messaging, content creation facilities and the Internet. They should have services and capabilities

that would encourage and facilitate active learning in the classroom through a high level of participation from students in real time (e.g., through voting and submitting questions or comments).

Action 66: IU should evaluate, implement, and support appropriate compact, portable devices that connect students and instructors in ways that enable lean or rich communication, collaboration, and interaction using voice, audio, text, and video.

D14. Accelerating IT-Intensive Research and Scholarship

Many of the core values of knowledge creation, discovery, and advancing human insight remain unchanged as part of the research and creative process. The means and tools for achieving them, however, are becoming more IT-intensive across many disciplines. The effects of IT on scholarship among disciplines are uneven due to variations in specific needs, applicability of IT tools, and skill readiness of researchers; these variations often exist even within a particular discipline. Per the president's charge to "develop the pervasive use of IT to help build excellence in teaching and research in all disciplines…" and the actions outlined in previous parts of this plan, IU will continue to advance efficacious uses of IT among all scholarly disciplines as opportunities arise.

Beyond that good pace among the myriad of scholarly disciplines at IU lie a few, specific opportunities where focused investment from IU could help accelerate existing strengths to more quickly advance them than through natural evolution. The focus of this opportunity is combining IU's strengths in IT and advanced cyberinfrastructure with the exceptional disciplinary strengths of some nationally recognized disciplines. If done well, the outcome could further advance IU's existing leadership in these areas – especially in a few areas that are part of the State of Indiana's overall strategy around the life and health sciences.

Existing collaborative efforts between IU schools, clinical partners, and the private sector may provide a sound basis for choosing promising areas of investment. Likewise, research centers that connect large parts of IU to achieve valuable outcomes, such as the Clinical and Translational Sciences Institute (CTSI) with its $25M funding from the NIH and existing alliances with Purdue University, Clarian, and multiple IU campuses may also point to promising opportunities. The targeted areas should be subject to truly advancing IU excellence and accelerating a path of greater returns, i.e., research success can lead to even greater external funding success to ignite a path a discovery and resource growth to pursue it. Tools, processes, and lessons from strategic IT investments in a few areas of focus may provide insights that are equally applicable to many disciplines.

Recommendation 15: While Indiana University should advance IT-enabled research across all disciplines, it should also focus on a few highly promising opportunities for which it has a skills, knowledge, and reputational advantage to push the frontiers of IT-enabled research and scholarship.

Action 67: IU should purposefully select areas of great and timely promise for strategic development of IT-enabled research, scholarship, and/or creative activity.

Advanced research and creativity with pioneering new uses of IT calls for advanced technologies to support complex, distributed organizations and collaborations. IU's current cyberinfrastructure is world class, but focused areas for IT investment and support will require additional resources with a plan for sustained success. Achieving true national and international excellence in promising areas will require coordination of efforts among academic leaders, deans, and administrative support areas.

Action 68: IU should identify a base of resources to provide both initial and sustained investments in selected areas for IT-enabled research, scholarship, and/or creative activity. This may include reallocating current resources and developing new ones, including endowments, grants, and/or additional fees.

The drive to achieve research distinction requires human resources beyond the community of information technology professionals. As some disciplines move their research to more advanced models of simulation, mathematical modeling, visualization, grids and gateways to vast resources, and other tools, there is a clear need for computational scientists and other deep skills to participate in some research and creative endeavors. While some of these skills may come from staff or other consulting personnel, dramatic advances in some disciplines may be tied to embedding computational scientists in the discipline itself.

Once the university has identified the strategic focus areas for of IT-facilitated scholarship, it should develop a program to provide incentives for hiring faculty, researchers, scholars, clinicians, engineers, artists, performers, and technologists with the expertise and interests to effectively lead and participate in those programs. Schools and departments that participate in this focused program of excellence should be provided with incentives and resources needed to attract and retain faculty who will use technology adeptly in their scholarly endeavors, who will drive future opportunities (through both vision and collaboration), and who will attract other like-minded scholars.

Action 69: IU should carefully assess new skills that are necessary to advance promising opportunities as research becomes more IT-intensive. Consultations with campus, school, and departmental leaders should help target some strategic hiring to supply or augment expertise for advanced, IT-enabled research and creative activity.

Section E. Appendices

E1. Charge from the President

In May of 1998 IU's IT Strategic Plan was presented to then IU President Myles Brand. In December of that year, it was approved for implementation.

By any standard IU's ITSP has been an enormous success. The awards and recognition that IU has received in just about every area of IT services and infrastructure confirm in aggregate, IU's national and international leadership in IT. It also played a major role in helping create the environment that lead to the establishment of IU's School of Informatics.

However, ten years have elapsed since this plan was developed. While the plan's ten general recommendations remain remarkably relevant, I believe the time has come to develop a new plan that will guide the future directions for the development of IT at IU for the next 5 to 10 years.

IU has developed IT services and infrastructure second to none over the last 10 years, and the impressive impacts of these have been seen in education and research in many disciplines. But this impact has been uneven. As well, new waves of technology innovation are continuously building.

Hence the next IU IT Strategic Plan should be a plan to develop the pervasive use of IT to help build excellence in education and research in all disciplines, in administration, in IU's engagement in the life of the State, across all campuses, and in collaboration with IU's key partners such as Clarian Health and institutions of higher education in the State. The plan should sustain IU's leadership in services and infrastructure, while maximizing how these are leveraged to build excellence in education and research. And the plan should attempt to take into account the impact of the new waves of technology innovation in education and research based on the best predictions and analysis that can be developed.

In developing this plan a key guideline needs to be kept firmly in mind. IT at IU must continue to be seen as a university-level service provided at both the IU Bloomington campus and the IUPUI campus by University Information Technology Services (UITS) under the Office of the Vice President for Information Technology (OVPIT). OVPIT should also continue to provide guidance and oversight to the IT units on all the regional campuses.

The aim of this is to continue to ensure that IU maximizes the collective leverage of IU's total investments in IT in a way that is efficient, effective and financially responsible. However OVPIT must also continue to be responsive to the IT needs of the individual campuses and schools, but in a way that is consistent with the forgoing principles.

This means for example, that university and campus administrators should ensure that "shadow" IT administrative systems, infrastructure or services are not developed or acquired that provide duplicate or similar IT systems, services or infrastructure to those provided by UITS, unless these are compelling and exceptional reasons for doing so and with the approval of OVPIT. University administrators should instead work with UITS to either provide these IT systems, infrastructure or services, or to modify existing IT systems, infrastructure or services. Where university or campus administrators require completely new IT systems, services or infrastructure, discussions should first be held with UITS about the provision of these and to ensure that security and economic efficiency considerations are taken fully into account.

You will be responsible for the development of the new IU IT Strategic Plan. I would like to receive it on 1 October 2008. Please insure that in developing the plan, there are substantial opportunities for involvement and input from faculty, staff, students, administrators and IU's many external constituencies.

Michael McRobbie
President
Indiana University

E2. IT Accomplishments at IU, 1997-2007

Human curiosity and intellect, augmented by information technology (IT), can escalate the development of human knowledge at a pace that once would have been unimaginable. Digital networks, combined with knowing what to ask and how to ask it, widen the reach of investigation and research. New applications for IT, and new levels of engagement among their users, bring a new convergence of evolution and opportunity. The route for the evolution and development of IT at IU was mapped out in 1998 by an information technology strategic plan. It set a course for the development of IT in support of teaching, learning, research, and lifelong learning and built an information technology foundation that has continued to serve IU for years beyond the timeframe of the plan.

Enduring infrastructure

The enduring foundation began at ground level, establishing a steady state of desktop computing and network connectivity across the university, backed by base funding. Preparing a level ground of standard IT tools was among the first of a progression of logical steps. Working with IU Purchasing and commercial vendors of IT hardware and software, and leveraging the buying power of the university, UITS provided desktop computers, operating systems, and common software applications for all campuses and all 110 IU Schools and service units. Agreements with Microsoft, Macromedia, Symantec, Oracle, Corel, SPSS, Dell, and others consistently supplied the campuses with hardware and low- or no-cost software, at an annual savings of $16-million. These agreements began long-term partnerships with vendors that today continue to help sustain a reliable foundation of current desktop technology.

A comprehensive, base-funded IT plan renovated classrooms to accommodate new modes of instruction, and equipped them with a standard installed package of IT hardware and software that mirrors the build in student IT labs. The percentage of installed technology classrooms reaches nearly 100% on the core campuses. UITS extended the foundation of standard IT hardware and software when it and Residential Programs and Services (RPS) agreed that UITS would take over responsibility for RPS IT labs and support at IUB. Currently UITS owns and operates 2,400 workstations and provides the software build to more than 800 workstations in 18 schools and departments, including all Classroom Technology Services (CTS) stations in classrooms across both campuses. The number of seats serving students exceeds 3,200.

Teaching and Learning

To support faculty innovation with IT, the plan established or expanded on all campuses centers for teaching and learning. These provide a working environment and contact area for faculty, instructors, and instructional technology providers interested in any aspect of developing, implementing, or assessing teaching and learning materials.

The plan provided incentives and help services tailored to specific audiences. Through the Ameritech Fellows Program UITS awarded $1M over seven years to IU faculty to support innovation in IT-based teaching. Winning faculty Fellows showcased their projects and lessons learned in annual summer forums, establishing a group of mentors and seeding the discussion and diffusion of best practices in teaching with technology. Building partnerships with departments and schools, UITS set up the Local Support Provider (LSP) Services program, which now provides IT support and consulting to more than 650 LSPs in departments and schools on the core and regional campuses.

Continued investment in LSPs includes an online LSP community resource system (LSP Online), UITS-sponsored technical certification series, and professional development opportunities.

To support the university vision for distributed education, IU created its homegrown collaborative learning and course management system, Oncourse, and in that process partnered in founding the Sakai open source initiative. Oncourse CL (Collaboration and Learning environment), built via the Sakai initiative (*www.sakaiproject.org*), with 100 colleges and universities around the world, serves as IU's learning environment. The UITS/IU podcasting initiative provides today's mobile, digital-age students with portable learning through the Oncourse podcasting tool and iTunes U.

Research and Collaboration

IU's philosophy of advanced information technology in service of, and broadly available to, the IU community dates back to the 1950s and IU Research Computing Center led by astronomy professor Marshall Wrubel. The development of IU's high performance computing (HPC) infrastructure from 1997 to 2007 built on this tradition and accelerated innovation and service growth through leveraging grants, building partnerships, and engaging IU's HPC resources broadly across the map of IU's research initiatives.

A critical start was a $1.2 M NSF grant that enabled IU to implement one of the first SGI Origin2000 supercomputers at any US university. Targeted investment by OVPIT expanded this grant to include a room-size 3d virtual reality system - a CAVE - making IU one of the early adopters of this technology. UITS expanded IU's high performance computing hardware with Shared University Research grants from IBM. These grants set the cornerstone of a nearly decade-long and productive relationship with IBM, adding steadily to IU's supercomputer assets. In 2001, IU implemented a 1 TFLOPS IBM SP supercomputer (capable of 1 trillion mathematical operations per second), made possible in part by the Lilly Endowment's support for the INGEN initiative. IU was the first US University to have such a powerful supercomputer available as a university resource; at the time the 50th fastest unclassified supercomputer in the world. Also using a mix of INGEN and IU funding, IU established a distributed large-scale scientific data archive, ensuring the preservation of IU's critical data assets even in face of a disaster striking either the IUPUI or IUB caps.

In 2003 an NSF grant funded the AVIDD (Analysis and visualization of Instrument-Driven Data) facility, a distributed computing, storage, and visualization system. The AVIDD cluster, with components at IU Northwest, IUPUI, and IU Bloomington, became the first distributed supercomputer cluster to achieve more than 1 TFLOPS on common benchmark applications, and was the 25th fastest unclassified supercomputer in the world in 2003. In 2005, IU became the first US University to implement a BARCI Move Lite room scale Virtual Reality facility, then, and still, a VR facility providing the bet pixel density of any VR device in existence.

In 2006, IU acquired Big Red, the IBM e1350 Blade Center Cluster, then at 20 TFLOPS the fastest academic supercomputer in the western hemisphere and the 23rd fastest unclassified supercomputer in the world. It was key to IU's competitiveness for large grants from such funding sources as the National Science Foundation, National Institutes of Health, and National Endowment for the Humanities. Big Red supports research into discoveries in the life sciences, astronomy, informatics, computational physics, and the humanities. Among the beneficiaries of the acquisition was the work of the Center for Genomics and Bioinformatics in developing innovative ways to analyze gene expression patterns in model organisms.

IU's Data Capacitor, a one TeraByte high performance spinning disk storage system, offers researchers fast temporary storage, serving compute resources, visualization, archival storage, and

scientific instruments. Through IU's partnership in the NSF-funded national TeraGrid and operations role in the Open Science Grid, IU researchers can reach, from their desktops, national supercomputers, collaborations, laboratories, and scientific instruments. Serving the TeraGrid community of users locally and nationally are IU HPC staff who write and update documents for the IU-hosted TeraGrid knowledge base.

2007 brought a fundamentally new development: the Indiana Initiative for Economic Development. With the aid of IBM and the Indiana Economic Development Corporation, Big Red's capacity was doubled to 30 TFLOPS, and a 10 TFLOPS Purdue-owned system called "Gold" was also installed on the IU Bloomington campus

From 1997 to 2007, partnerships between IU faculty, UITS staff, the Pervasive Technology Labs at IU, helped bring more than $100M in external grants to IU (not counting in this total grants from the Lilly Endowment). Faculty and staff created to implement systems that achieved a number o firsts; developed software that enabled new insights, and made possible innovation and discovery across many disciplines of science, engineering, humanities, and the fine arts. Scientific publications, outreach events, and conferences such as the periodic I-Light conference held in Indiana, have helped disseminate these innovations widely.

Enterprise Information

Information is among a university's key strategic assets. In realizing the plan's recommendations, UITS made those data more manageable and accessible, contributed to online access to library data, and built the means to protect those data. In the largest system reengineering effort in IU's history, UITS created a coordinated environment that maximizes cost savings, efficiency, flexibility, scalability, and access for IU's ad-hoc-developed enterprise information systems. A new level of self-service allows students to move online through admissions, advising, enrollment, financial aid and other business and academic activities. IU's more than 35,000 faculty and staff handle hiring, payroll, benefits, and timekeeping — all through the web-based university application portal OneStart. From this systems development experience IU partnered in creating the Kuali Foundation, contributing its client-server financial system toward open source software that serves the financial system needs of Carnegie-class institutions.

Collaborations with IU Libraries technologists realized the Libraries strategic goals of integrating web-based services for the IU community. IUCAT, the Library's web-based interface, features, among other resources, patron self-service, federated search capability (searching across groups of databases and consolidating the results), and catalog database. To protect the foundational IU services and data that now rely on information technology, UITS developed a comprehensive disaster recovery plan. It ensures basic infrastructures are geographically redundant, and that service managers adequately back up data and build redundancy into their operations.

Telecommunications

In 1998 telecommunications was seen as the "cement" that interlinks the university, and that connects the university to national and international research communities. The plan's five-year goal for telecommunications called for erasing the electronic borders between home, workplace, campus, and community.

Connecting IU. On the core campuses wireless connectivity is pervasive. Videoconferencing facilities ease collaboration and discussion. Unified messaging, teleconferencing, and converged

voice, data, and video at the desktop are being rolled out. This creates a foundation for levels of collaboration across the globe. And the technologies provide substantial gains in productivity and sustainability.

Local networking. A partner in building foundational network connections among universities in the state, IU with Purdue built the I-Light regional network, which provides sufficient capacity for the next 10 years, an increase of more than 500% over previous capacity. The 2008 expansion of I-light provides public and private colleges and universities across northern Indiana greater access to very high-speed networking for collaboration, research, and education. IU was also a partner in founding the National LambdaRail, the largest optical network owned and managed by the higher education community. The Crossroads Technology Report cites I-Light as key to "innovation zones" in the Midwest. With Purdue, IU founded the IP-grid, connecting the universities to the TeraGrid in Chicago. Through IP-grid IU makes its computing, networking, and data storage facilities available to the TeraGrid.

International networking. IU was a founding partner in the TransPAC network, the first high performance network to connect US scientists with their counterparts in the Asia Pacific region. TransPAC2 connected the US to the Asia Pacific Advanced Network (APAN) and established the basis for an inter-Asia network backbone.

Managing networks. Its expertise in network management led UITS to manage engineering and operations services for major regional, national, and international high performance research and education networks at the Global Research Network Operations Center (GRNOC) at IUPUI. The GRNOC manages network operations for I-Light and for the Internet2 Network, National LambdaRail, TransPAC2, STAR TAP, MAN LAN, AmericasPATH, IP-grid, and iVDGL. It also serves as the watch desk for the REN-ISAC (Research and Education Networking Information Sharing and Analysis Center) security initiative.

IT Support

IT tools are only as useful as the mechanisms for supporting users of varying needs and abilities. Making practical use of IT in teaching, learning, and research depends on support that is pragmatic, current with IU-specific issues and audiences, and accessible.

To create a seamless help environment UITS progressively extended its IT oversight, taking on responsibility for residence hall IT sites and support, expanding Student Technology Center (STC) facilities and hours, extending help to 24/7 on participating campuses, and continuing to grow the Knowledge Base, which now holds more than 14,000 documents and averages more than 77,000 searches a day. In a services- and support-based online help environment any user connected to the Internet can get help and information and handle countless procedures and activities that once required an in-person visit to a campus help desk. UITS also assumed management responsibility for IU telephone services, which include a large and important collection of the university's central information and communication services.

IT puts learning on a social footing, encouraging online learning communities, local and remote collaborations, and real-time video. IU's Information Commons, a joint venture of UITS and the IU Libraries in the Herman B Wells Library, expresses social learning with collaboration areas and space for faculty and students to gather. In its converging of services from multiple university units — the IU Writing Tutorial Center, Adaptive Technology Center, IU Libraries reference services, and IT consulting — it is emblematic of the intertwined nature of IT and other aspects of learning and expression. It is a hub of student activity and productivity.

Digital Libraries

Academic research today depends on access to digital information and the scholarly record. The IU Digital Library Program is a collaborative effort of the Indiana University Libraries, the Office of the Vice President for Information Technology, and IU research faculty, with leadership from the School of Library and Information Science and the School of Informatics. The program has served as a focal point for multidisciplinary partnerships, which have created resources like CLIOH — an initiative to preserve endangered archaeological sites, and the Digital Library of the Commons, a gateway for literature on the commons. It hosts collections that reflect notable IU strengths, via such collections as the Victorian Women Writers Project and the Swinburne Project. Its photography holdings represent the heyday of the steel industry in Indiana, the life and work of Hoagy Carmichael, and regional images of Indiana's rural past, its dimensionality promoting understanding of Indiana past and present for the farthest Internet-connected viewer.

IT Security

Fundamental to academic discourse is the free exchange of information, which can thrive only in a secure context, where personal privacy and intellectual property rights are protected. In 1998 the OVPIT assumed responsibility for leading IU in developing policies and procedures that protect IU's IT resources and institutional data, safeguard personal privacy and intellectual property, and promote access to information and freedom of discussion. IU's security and policy offices became leaders in higher education in determining and applying effective security to complex campus environments.

IU partners with the Indiana Office of Technology to protect state data by providing backup data center space and network connectivity to the state through the data center at IU Bloomington and the I-Light high-speed network. The partnership provides critical redundancy, saves money for the state, and serves as a basis for further partnership and collaboration between IU and the state.

In the national arena, IU was among the leaders in the national strategy to secure cyberspace, through the EDUCAUSE/Internet2 Computer and Network Security Task Force. IU developed the first higher education-based Research and Education Networking Information Sharing and Analysis Center (REN-ISAC), benefitting US higher education. IU's Center for Applied Cybersecurity Research (CACR) combines leading university thinkers and strategists in IT, law, policy, security, computer science, business, and informatics. Research focuses on current problems — phishing, identity theft, and terrorism; its scholars and practitioners advise industry, Congress, government agencies, and academe, and fill leadership roles in professional associations. IU's partnership with the SANS (SysAdmin, Audit, Network, Security) Institute provides advanced security training and benefits state law enforcement, education, and non-profit agencies.

Assuring IU's Technical Assets

In 1998 UITS staff at IUPUI were housed in multiple buildings. In fall 2004, the Informatics and Communications Technology Complex (ICTC) opened its doors to UITS staff, providing state-of-the-art, secure housing for IU cyberinfrastructure and the hub for telecommunications and I-Light at IUPUI. In 2007, IU broke ground for a long-anticipated Data Center at IUB. The 82,700-square-foot berm structure will contain and protect IU's supercomputing resources, ever-expanding IT infrastructure, and mission-critical systems from electrical damage, power outages, natural disasters and malicious harm. IU Trustees have approved plans for a Cyber Infrastructure Building (CIB), sister to the Data Center to house Bloomington IT scientists, strategists, technologists, and support staff.

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2141 # Endnotes and References

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[17] p. 4, Laura Brown, Rebecca Griffiths, and Matthew Rascoff, University Publishing In A Digital Age. Ithaka, July 26, 2007. Available at: Hhttp://www.ithaka.org/strategic-services/Ithaka%20University%20Publishing%20Report.pdfH, accessed 10/10/2008. [17] Ithaka, p. 4

[18] Across institutions, Portico, a division of Ithaka with Mellon Foundation and subscription funding, has agreements with many publishers to keep a dark archive of electronic journals (i.e., an archive that normally does not allow access to the stored material but preserves it in case of future calamity).

In the event that the journal or the publisher goes out of business, there are "trigger events" that allow Portico to makes the back copies available. Similarly, LOCKSS (Lots Of Copies Keep Stuff Safe), another Mellon-funded entity, has a similar mission but uses a different technology and a different set of agreements with publishers to create a dark archive. Additionally, a number of national libraries in Europe have agreements with publishers that allow them to keep dark archives.