The University of Colorado at Boulder

2006 Information Technology Strategic Planning Report

FINAL REPORT

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Please let us know what you think about this report

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Bobby Schnabel, Dennis Maloney, Marin Stanek, and Deborah Keyek-Franssen

Executive Summary

Introduction

Over the past spring and summer, campus IT leaders solicited the opinions and expertise of faculty, staff and students to examine the plans and priorities for the use of information technology in support of the mission for CU-Boulder. The process involved over 200 individuals who served on committees or focus groups, authored subsections, participated in surveys, or reviewed chapters of the report.

The results of the planning efforts are a six chapter report, comprising 24 subsections. The six chapters are:

- Academic Technology
- Data and Voice Network
- Communications: Email, Web & Workflow
- Architecture and Security
- Central Services: SIS replacement project, e-commerce, printing, and software licensing
- IT Governance

Each subsection has recommendation associated with it; however several significant recommendations have emerged as the highest priority.

> *One of the greatest challenges to college and university leaders is to determine, implement, and sustain the IT infrastructure necessary for successful teaching and research in the digital age. As technology becomes more pervasive in both the academic and administrative activities of the contemporary university, the investment in IT infrastructures becomes less of a luxury and more of an absolute requirement of learning and scholarship, not to mention the operation and management of the institution.*
>
> *(Duderstadt, Atkins, and Van Houweling, 2002 Higher Education in the Digital Age. p. 99. American Council on Higher Education and Praeger Publishers)*

Recommendations of the 2006 IT Strategic Plan

1. Enhance security and efficiency by developing a unified IT architecture and set of central data services.

The campus will have greater data security if all sensitive data resides in one place that can be easily accessed by the appropriate set of people. Beyond increased data security, an added advantage of a unified IT architecture and central data service is that data would be available in real-time, rather than batch information that may be hours to weeks old. For departments, this update to our campus IT environment could be a significant increase in efficiency because personnel and IT equipment costs would be reduced by accessing one authoritative system, rather than departments creating and managing their own shadow systems.

2. Develop funding models that provide appropriate renewal and replacement funding for strategic IT infrastructure components. This includes: the data network, smart classrooms and core servers (email, web, and LMS).

- The campus needs a renewal and replacement strategy for the data network because the current model does not generate enough revenue to cover the full costs associated with it. A new model should consider various solutions, including a

usage/utility model, a "common good" model and hybrid solutions between those two options.

- The campus does not allocate enough resources to support renewal and replacement for its existing technology-enhanced instructional facilities. A comprehensive cost model for these facilities that recognizes the true cost is overdue. A new funding model for technology-enhanced instructional facilities should be developed to support: multiple pedagogical approaches, multiple levels of user sophistication, and an increasingly complex and variable technology environment.

- Many critical campus core systems do not have renewal and replacement funding to ensure continued campus support. These systems include email, web-based services and Learning Management System (e.g. WebCT). Committed, ongoing funding is essential to maintain the availability and functionality to meet campus service expectations.

3. Develop a New Data Network Funding and Usage Model

The data network is a strategic resource that faculty, students, and staff heavily rely on. The data network now includes both wired and wireless and is the virtual backbone of all electronic communication on campus. The campus must develop a model that includes a basic suite of networking services for all university members. The basic suite should include wireless access and adequate security. A small percentage of users require high levels of bandwidth and a subset of those users require even higher bandwidth for super computing. This new model should accommodate both of those users groups. Leveraging the data network directly relates to developing an appropriate funding model, which is covered in #2, above.

4. Research Computing

This is an opportune time to re-consider some degree of central support and/or coordination for research computing, especially given the potential for the NCAR/UCAR data center. A collaborative solution for high performance computing would maximize the resources of multiple departments, minimize duplication of efforts across campus, and significantly strengthen the campus' ability to respond to research opportunities for high performance computing.

5. Teaching Innovation within the Classroom

The academic technology environment on campus is characterized by a division between a subset of the campus that seeks to lead in innovative and creative uses of (especially new) technologies and a larger portion of the campus that seeks standardization, ease-of-use, and robust support for existing technologies. While the campus has historically provided adequate support and services for the second group, it has been more difficult to support and encourage the former. As it moves forward with educational technology initiatives, the campus should attend to the needs of both groups, in part through increased participation of faculty in decisions about services, support, training and programs.

The campus should investigate new technologies systematically, and disseminate the results of that investigation so that standardized and robust support for technologies

used in innovative teaching and learning methods can be developed for the entire campus. Likewise, there is a need to move some existing technologies (such as clickers and the Learning Management System—WebCT—to a more robust, supportable state to encourage widespread and cost-effective adoption.

6. Greater Email Coordination and Centralization

More email services should be centralized, decreasing the number of email servers to take advantage of economies of scale, improve security and limit reliance on departmental staff whose workload is too heavy. The need for premium service that provides email, calendaring, and mobile access should be recognized and delivered in a cost-effective manner. The decision to operate a distributed Exchange server should be made at the campus executive level in order to safeguard campus-wide service.

Other Areas of Consideration

Other areas for consideration include investigating whether the campus should: develop a **policy about recommending a laptop**, rather than desktop computer for incoming students, provide coordination and support for **campus-wide site licensing**, and **adopt a single clicker solution** with a backend infrastructure and standardized support.

Additionally, a comprehensive examination of how the campus processes documents for review, collaboration and archival in various business processes (e.g. **workflow**) is needed; however this area is at best partially an IT issue.

Finally, significant IT initiatives such as **extensive security enhancements with data security**, and library initiatives which include **institutional repositories and digital asset management** are already well underway, but need more awareness and collaboration to be fully successful.

Conclusion

Faculty, students, and staff at CU-Boulder expect an IT environment that is ubiquitous, reliable, and robust to support their academic, research, and administrative endeavors. Over the next four year this strategic plan provides a roadmap of IT initiatives the campus should undertake to support the campus mission. Information technologies are in a state of constant change, and often involve a significant investment; therefore, prudent IT strategic planning is essential to address changing campus needs and establish priorities for the use of IT on campus. IT Council, along with the office of the vice provost for academic and campus technology, and ITS will work closely with the campus to fulfill the priorities outlined in this report and report the progress to the appropriate governance boards.

Trends in Information Technology

Trends in information technology, both globally and locally, have a significant impact on the strategic priorities for CU-Boulder. At the same time, the maturity of the campus's IT infrastructure combined with pockets of cutting-edge and innovative use of technology mean that trends do not necessarily dictate the campus's strategic direction, but rather that trends can be assessed and followed as they support the academic mission of the campus.

Generally speaking, and as was the case four years ago, devices are (ever) smaller, more mobile, and more common. At the same time, expectations for IT services and support have increased across all sectors, including higher education.

Local trends that shaped CU-Boulder's IT strategic planning process include:

- Expectations on the part of students, faculty, and staff that information and services are provided to the end-user as a seamless package, even, perhaps especially, when those information and services span several campus units.
- Increasing use of the campus student portal, and concomitant increased expectations that services, including authenticated services, will be provided through the portal using a single sign-on process.
- Student computer ownership rates hovering at around 98%, with the rates of laptop and multiple computer ownership rising (to over 75% and 25% respectively). Despite high laptop ownership rates, students still rely heavily on computer kiosks (SCARPIES) around campus and rarely bring laptops with them to class. Few faculty either require or ban the use of laptops in class.
- Increasing importance of identity management for both centrally-supported systems such as email and WebCT, as well as for departmentally managed-systems such as CAPA in Physics and Moodle in Computing Sciences.
- Most courses have a web presence, but online academic environment on campus is fractured. While 80% of courses that have an online presence use the centrally-supported learning management system of WebCT, many others have websites run through products such as Blackboard, Moodle, and Sakai, or feature websites developed and hosted locally, either by faculty or their departments.

Two reports on information technology in higher education institutions, the Campus Computing Report and EDUCAUSE's Top-Ten Issues, 2006[1], indicate a shift in focus away from enterprise systems, distance education, and student portals (which were the focus four years ago), and toward issues that allow campuses to maintain the stability and integrity of their systems.

- Security concerns topped the list for both reports; respondents to the Campus Computing Survey indicated a sharp increase and high numbers of network attacks,

[1] Barbara I, Dewey, Peter B. DeBlois and the 2006 EDUCAUSE Current Issues Committee, "Top-Ten IT Issues, 2006," *EDUCAUSE Review*, Volume 41, May/June 2006, p. 58-79.

breaches involving personally identifiable information, and virus infections, as well as renewed attention to warding off such security incidents in the future.
- Closely aligned with security concerns is the issue of identity management, the process of managing identity information to appropriately provision access to online services, also of high concern to most higher education institutions.
- With the hurricane season of 2005, the necessity for disaster recovery and business continuity plans for all campuses became clear. While many are in the process of developing such plans, only a small majority of campuses actually have implemented them.
- Data from both reports indicate the continued importance of learning management systems as instructional tools at the heart of the academic endeavor. Campuses are increasingly dependent on LMSs, both as a supplement to face-to-face instruction as well as for more "traditional" distance learning courses.
- Online services are increasingly important for faculty, staff and students across higher education, with a steady increase in the numbers of campuses with a student portal, as well as in the numbers of campuses planning to implement one.

Snapshot of CU-Boulder's IT environment

- The CU Connect portal is used by 98% of students to access most student services such as registration and advising. The faculty-staff portal is used by 50% of faculty and staff, and offers such services as faculty tool kit to support course information and simple speedtype queries.

- In 1997-98 62% of the incoming freshmen class owned their own computers as compared to 95% in 2001-02 and 98% in 2005-2006. In addition, student-owned computers increasingly are mobile computers; the percentage of laptops among student-owned computers grew from a small percentage in 1998 to 40% in 2001 and now, in 2006, to more than 80%.

- 100% of faculty are served by the Faculty Computer Purchase Program; of those who placed orders for the fall 2006 semester, more than 50% purchased laptops.

- In 1997-98 13,500 campus computers were connected to the campus network as compared to 23,000 in 2001-02 and 26,000 in 2005-2006.

- Over 772 courses, supporting over 22670 students, utilize the campus' course management software, WebCT.

- In 1997-98 41% of centrally scheduled classrooms had network connectivity as compared to 58% in 2005-2006.

- Clickers are used by over 5000 students in 50 classes and 8 departments, making CU-Boulder a world leader in the use of clickers in higher education classrooms.

IT Strategic Planning Process

During the spring and summer of 2006, CU-Boulder successfully completed its third consecutive IT Strategic Planning (ITSP) process. This comprehensive, collaborative effort, which is conducted every four years, included broad participation from faculty, staff and students who participated in focus groups, on planning committees, as authors of report subsections, or as reviewers of chapters. Information Technology Services (ITS), the primary information technology service provider on campus, played a major role in participating; however, the process was led by the vice provost for academic and campus technology; overseen by the campus-wide IT governance structure, IT Council, and directed by a project manager.

The primary goal of the ITSP process was to identify significant IT strategic goals that if achieved, would lead to significant, tangible benefits which further foster academic excellence and support the mission at CU-Boulder; therefore, this plan combines those high level goals with some degree of tactical planning.

Previous ITSP efforts included focusing on IT resources and infrastructure (the 1998 ITSP), emphasizing academic and administrative IT services and the ways those services are provided and communicated to the campus community (the 2002 ITSP). The 2006 planning effort examines IT resources and infrastructure as well as IT services, and carefully identifies areas and goals that if targeted, would support academic excellence and enhance the campus community in terms of utilizing IT resources to provide better communication tools, increased collaboration efforts, and sensible security enhancements.

Initially, the core team (consisting of the vice provost for academic and campus technology, the executive director of ITS, and two staff members) along with input from IT Council, drafted a list of 24 areas to be explored. Lead author(s) were assigned to each area, which had a major question to be investigated. The author(s) organized teams to further define the issue; discuss options; and propose a recommendation. Concurrently, focus groups comprising faculty, students, and staff were conducted to provide additional insight and input for the authors to consider.

Further data was collected from campus-wide surveys conducted during the spring of 2005 through the spring of 2006. These include:

- Faculty Survey Report (sample of faculty only) spring 2005
- Student Survey Report fall 2005
- Faculty Focus Groups spring 2006
- Student Focus Groups spring 2006
- WebCT Statistics spring 2006
- IT Council Focus Group spring 2006
- FACE-IT Focus Group spring 2006

During summer 2006, the subsections of the 24 areas were compiled, and in some cases, combined, to create a IT plan. Then, the core team drafted six overarching goals to be achieved within the next four years. The subsections of the report supported the overarching goals and provided a clear blueprint for successfully proceeding forward. This entire document will be reviewed by IT Council who will then forward it on to the Chancellor's Executive Committee (CEC) during their September meeting. After the CEC is briefed on the findings, the entire report will be distributed to the campus at large, and presented to key groups on campus, including BFA, ASC, UCCS, UGGS, and others.

Chapter 1: Academic Technology

The academic technology environment at CU-Boulder experiences a tension between a subset of the campus that seeks to lead in innovative and creative uses of technologies and a larger subset of the campus that seeks standardization, ease-of-use, and robust support for existing technologies.

The sections of this chapter span the spectrum between standardization to innovation. Those sections in the standardization camp address the need for creating enterprise-wide services, and increasing the robustness of existing services. One section addresses continued funding for and increased numbers of technology-enhanced classrooms. One addresses increasing the scale and robustness of a central learning management system. And finally, one addresses the need for a centralized student response system.

Other sections of this chapter address the flow from innovation to standardization. They ask the campus to identify innovative approaches to technology which can be offered and supported more broadly for the entire campus. One of these sections addresses the need for a more robust and standardized digital asset management environment on campus. One section addresses the need for centralized coordination of research computing. And finally one section addresses the need to enable student-owned mobile computing devices to interface well with the enterprise wide technology services on campus.

Still other sections of this chapter are squarely in the innovation camp. They reflect a need to support and encourage innovations in educational technologies. One section promotes the innovative and effective use of technology-enhanced learning spaces. Another section focuses on evaluating new technologies from within the context of effective methods for teaching and learning.

A theme that cuts across all sections of this chapter is the need to have increased faculty participation in decisions about academic technology. A second cross-cutting issue is the early consideration of assistive technology in technology adoption decisions. This approach needs to be better integrated into the campus's IT environment, especially in the case of academic technologies that can enhance or obstruct students' learning.

The campus currently provides basic infrastructure to the vast majority of faculty who wish to use technology in their teaching. From classrooms to basic IT support to the existence of the Distributed Academic Technology Coordinators, the campus does a good job of meeting most of the needs of the "average" faculty user. At the same time, it has not created a systematic method of learning from innovative users of technology and then distilling from their experience how the broader campus community might benefit from their experience.

Academic technology innovation needs to be both understood and managed at CU-Boulder. Were resources much more broadly available, the campus could innovate

purely with creative uses of technologies, but that is too costly of an approach. A more affordable and sustainable approach would be to innovate on pedagogical methods, first, and then identifying appropriate and (sometimes) innovative uses of technologies that enable or enhance the innovative pedagogical methods.

Concurrently, there is a need to investigate these new technologies systematically, and to disseminate the results of that investigation so that standardized and robust support for technologies used in innovative teaching and learning methods can be developed for the entire campus. Likewise, there is a need to move some existing technologies (such as clickers and learning management systems) to a more robust, supportable state to encourage widespread and cost-effective adoption.

1.1 Classroom Technology

Major Issue: CU-Boulder needs to evolve its model of a smart classroom to support:

(a) an increasingly complex and variable technology environment,
(b) multiple levels of user sophistication with technology, and
(c) multiple pedagogical approaches,

or risk

(a) negatively impacting innovations in campus use of educational technology,
(b) decreasing interoperability of the campus educational technology environment, and
(c) general obsolescence of the "smart classroom" model (and, consequently, [d] risking considerable capital investment).

A. Background/Rationale

Instructors expect technology in their classrooms. Despite the increasing appearance of online and blended instructional delivery options, traditional classrooms will remain the primary educational space on the CU-Boulder campus for the next 5 years. Further, given the high penetration of personal laptops and presentation software, it is likely that an increasing number of instructors will expect to have the capability of using technology in their classroom teaching. In other words, the use of technology for classroom teaching, per se, will cease to be an innovation in itself.

The "smart classroom" model[2] is CU-Boulder's central method of supporting technology for classroom teaching. An excellent investment, the Smart classroom is now central to campus IT infrastructure. The best evidence of its effectiveness is that the demand by instructors for Smart classrooms continues to increase, despite a build-out to 63% of all centrally-scheduled classrooms: smart classroom functionality is now a standard expectation of instructors on our campus. At this point, the majority of faculty who request a Smart classroom are scheduled in one. However, most classes are accommodated in a technology-enhanced facility, this accommodation often requires a compromise in the class meeting time or the location. Increasing the number of technology-enhanced facilities would alleviate these constraints, particularly for the most popular class times. The campus should pursue steps to protect, strengthen, and evolve the Smart classroom model so that it continues to be highly effective and responsive to instructional needs.

The effectiveness of CU-Boulder's model of a "Smart classroom" as a standard suite of tools is achieved primarily when 3 conditions are present.

[2] Smart facilities include: Projection system – projector, or LCD panel, with security mount controller for interfaces, remote monitoring system for proactive support, network/ethernet connectivity, projection screen bank lighting controls, and multi-standard DVD/VCR Ceiling speaker systems. (Large rooms contain Closed Caption decoders and Assistive Tech Listening Device Microphones/sound reinforcement.) Many rooms also include: overhead projector, cable TV, and slide projectors.

1. The Smart classroom model is most effective when there are enough tools that packaging them together is cost-effective.
2. The model is most effective when personal technologies (laptops, PDA's, cell phones) are not common in the classroom and technologies are either solely in the hands of the instructor, or are provided by the campus (e.g., when technology-intensive assignments and activities are completed primarily in computer labs rather than in classrooms).
3. In its current configuration, the Smart classroom is most effective when technology uses are extensions or variations of a "presentational" pedagogy, which emphasizes central display of content (e.g., video, overhead transparencies, PowerPoint slides, other blackboard replacements).

The conditions that make Smart classrooms effective are changing. In the past 5 years, the user base for classroom technology has changed considerably. Each of the conditions that make the Smart classroom so effective are now undergoing rapid change and need to be re-considered as the Smart classroom evolves.

1. The technology environment is increasingly complex and variable. There are simply a far greater number of tools and devices available for educational use. It is time to re-examine whether the suite of technologies that met classroom needs 5 years ago best meet the needs of today's classrooms. Indeed, students and instructors now possess so many portable personal technologies that the Smart classroom is as much about providing an *interface* with campus infrastructure as it is about providing the technology itself. For example, to what extent should the Smart classroom support the use of different kinds of devices that are provided by individual users? As another example, to what extent do the functions of the current set of tools need to evolve, such as ensuring wireless connectivity, or wireless projectors capable of receiving input from multiple digital devices.
2. Users vary in their sophistication with technology. Five years ago, the user base was very flat, with a large number of highly inexperienced users and a very small number of highly experienced users. The shape of the user base is now more like a pyramid, with a base of inexperienced users but a larger group of somewhat experienced users and a smaller but still sizable group of highly experienced users (many of whom are the students themselves).
   As the use base changes, the campus should consider the following questions:
   a. To what extent should the campus support *innovative* uses of technology for teaching and learning in the *classroom*? In this new environment, innovation is highly likely. "Innovation" here is from the point of view of the instructor *and* the student. Instructors' use of the technology increasingly will be driven by instructional goals, rather than by basic technological affordances. They may be less likely to use presentational or lecture-based pedagogy and they will want their technology to support other approaches.
   b. To what extent should the campus support or constrain student use of technology in the *classroom*? Student uses of the technology increasingly will more likely be driven by their learning needs (or, in a negative view, their desire to accomplish other personal goals during class time). In other words, we are now seeing a context in which substantial innovation is not necessarily predictable, and, in some cases, not necessarily desirable. For example, technology may make students able to engage in activities not related to the classroom (such as text

messaging, web browsing, game playing) or that are academic violations (such as taking digital photos of tests).

3. Users expect technology to support multiple pedagogical approaches. Instructors are recognizing that lectures are not the only type of pedagogy enriched by technology, and the Smart classroom model could be examined for how well it supports different modes of teaching. Discussion, small group interaction, and in-class activities are other pedagogies that can be supported. This has implications for the *physical* elements of the Smart classroom model, such as desktop size (sufficient space for a laptop?), movable desks, or electrical outlets. It also has implications for equipment elements, such as whether to include printers, wireless access points, or wireless-enabled projectors.

B. Accomplishments to date – (These items respond to the specific items proposed in ITSP2002)

1. *Improved Access to Technology-Enhanced Instructional Facilities*
The last ITSP called for improvements in scheduling process effectiveness. A review was conducted in 2003, which resulted in the introduction of a new form for requesting a Smart classroom. This form allows Academic Scheduling to capture more complete information regarding technology needs and improves their ability to make optimal room assignments. Information about the scheduling process and use of this form are communicated through training sessions and is available on the web. At this point, the process appears to be well-understood and effective as evidenced by the high success rate in granting faculty requests for Smart classrooms. Remaining problems appear to be a function of demand for rooms outpacing supply.

2. *Improved User Support of Technology-Enhanced Instructional Facilities*
ITS began working with schools and colleges prior to the 2002 IT strategic plan to determine the most effective model for providing support for technology-enhanced instructional facilities. The Educational Technology Facilities Support (ETFS) function was launched in the fall of 2002. This ITS program provides both reactive and proactive support the technology installed or delivered to these facilities and to the faculty using them.

3. *Improved Equipment Support in Technology-Enhanced Instructional Facilities*
Significant strides have been made in standardizing the equipment in technology-enhanced instructional facilities and improving the user interface. These improvements make the technology more user-friendly and minimize the occurrence of user errors. The technology itself is also more reliable due to improvements in monitoring and the electronics. Systems are monitored remotely by engineers for problems and serviced proactively to reduce failures at inopportune times. Theft of data projectors has been reduced by employing security mounts and alarms. Losses due to data projector theft were among the highest on campus and are now negligible. Taken together, these changes have reduced the time and resources required to maintain hardware assets, thereby improving the return on investment.

4. *Development of Renewal and Replacement Schedules and Realistic Cost Models.* ITS developed comprehensive renewal and replacement schedules for technology-enhanced instructional facilities and a cost model that recognizes the

true costs associated with providing and maintaining computer labs that are used for teaching. This information drives current funding requests. For example, in spring 2006, an additional $129,000 was allocated by the campus (Chancellor, Provost) to provide renewal and replacement for the currently installed base of Technology-Enhanced Facilities. Future cost models will include realignment and increase of technical resources in support of Smart technology.

5. *Confirmed High Demand for Technology-Enhanced Instructional Facilities.* To build on the work of the 2002 ITSP, efforts were made to determine the demand for Smart classrooms. Results of that effort reveal sufficient demand to warrant increasing the number of centrally scheduled Smart rooms to 80% of the central pool. This budget request was drafted by ITS, and approved in principle by the Faculty Advisory Committee for IT (FACE-IT) and the Chancellor's office. Funding has not yet been allocated, but this request is considered a top priority for the campus.

6. *Increased the number of Technology-Enhanced Instructional Facilities*

    a. *Approval of the use of Student Computer Labs for Instructional Purposes* The use of student fee-funded computer labs as instructional facilities was approved as a recognized practice, rather than an exception. Guidelines were established in 2003 to formalize this use and to ensure that it is equitable and sustainable. These guidelines limit the number of class meeting times per week in order to preserve student access to these resources. Facilities scheduling is done through ITS, providing oversight to improve compliance with these guidelines.

    b. *Addition of buildings with technology-enhanced instructional facilities*. Three new buildings have been added to the campus: ATLAS, Law, and Business. The principle applied to new construction of central classrooms was 100% Smart technology. This is appropriate due to the nature of the facilities. Overall the addition of the new building rooms (44) along with the original proposal of 80% coverage (136) gives 84% coverage of central rooms. Scheduling issues should decrease as the number of Smart classrooms increases.

C. Specific Recommendations

Generally, future efforts must protect the current investment while ensuring evolution and growth. As strategic planning recommendations, this list is intended as a mandate for tactical planning and implementation. (Items 1 and 2 are of equally high priority. Both should be considered necessary. Items 3 and 4 are ranked in order of funding priority.)

1. *Develop and commit to funding model that will sustain any Smart Classroom build-out*. The campus must make it a priority to protect this investment. This recommendation does not imply privileging the current Smart Classroom model in the build-out, as the model may change as a result of the use study. Timely renewal and replacement of the equipment in technology-enhanced spaces is critical to the success of this strategy. This equipment must be refreshed on a regular basis to ensure that it functions reliably; is supportable and maintainable; remains compatible with other technologies; remains

uniform across sites; and ensures ease-of-use. The model should also provide funds for regular assessment (measurement) of user satisfaction (with both equipment and staff support).

2. *Assess the current "Smart classroom" model, to determine if the model should be revised or adjusted*. The assessment should include systematic review and analysis (preferably a commissioned research study) of **actual classroom use of technology** by instructors and students in **multiple disciplines**, using **multiple pedagogical approaches**. Does a single configuration remain preferable, or should there be multiple configurations? If a single configuration, what should that include? If additional configurations are needed, under what conditions would each be used? The assessment should pay particular attention to any equipment currently used by instructors in an ad hoc manner, such as clickers, document cameras, RF devices, etc. The assessment should specify the decision criteria used to justify changes in configuration (possible examples are ease of use, standardization, reliability, innovation). The assessment should evaluate both positive *and negative* uses of technology in the classroom. The assessment should revisit and reconsider the decision to commit to a single Smart classroom configuration, versus alternatives such as multiple configurations, a "layered" configuration, or an adaptable configuration. Any revised model must have plans for sustainability and scalability.

3. *Develop resources (services, consultation, and guidelines) to advise academic departments that control non-centrally-scheduled technology enhanced facilities. Better leverage the resources of these facilities for improving campus use of educational technology.* Revise current policy and procedures to acknowledge the existence and demand for departmental controlled Smart facilities. Provide resources useful to departments that would help them improve their planning, administration, support, and renewal of these facilities. Establish appropriate guidelines for Facilities Management to follow in creation of these spaces. Establish guidelines establishing what would constitute adequate support and renewal & replacement funding for all Smart facilities built on campus. View department facilities as spaces likely to support distinct instances of instructional innovations (i.e., as innovation incubators), and systematically gather information on such innovations to inform campus IT planning (particularly for those stakeholders seeking to support effective use of educational technology).

4. *Add 30 new Smart classrooms.* Increase the number of existing centrally scheduled spaces to Smart classrooms from 106 (63%) to 136 (80%). Target buildings that have a disproportionately small number of Smart facilities today (e.g. Engineering, Duane, Education, Hale and Hellems). Ensure that 100% of the classrooms and lecture halls in newly constructed or renovated buildings are technology-enhanced to follow current established practice.

D. Resource Allocation (These refer to the estimated cost of the recommendations. They do not imply priority.)

Recommendations 1 & 4: High. There is a considerable cost associated with maintaining Smart classrooms. Costs include hardware replacement and maintenance,

support staff, and engineering functions. Continuing funding for existing Smart facilities exists, and a plan for the increase to 80% has been defined but is not yet funded. Changes to the Smart Classroom model that may result from the use study may necessitate additional ongoing funding (there is a chance the recommendations could reduce cost, but this is less likely). It is critical to note that costs for sustaining technology-enhanced facilities in the new buildings do not have a funding source. Without funding, these investments are at risk.

Recommendations 2 & 3: Low. These are costs of commissioning a study, developing materials and guidelines, and implementing procedures for campus units to follow.

E. Action Plan (short-term: 12 months; long term: 12-36 months)

Short Term:

1. Continue operation of existing Smart classroom R&R procedures (e.g., replace technology in existing spaces that are currently due).
2. Develop cost models, per Recommendation #1. Revise cost estimates to increase the existing number of Smart classrooms to 136, or 80% over the next 5 years, and integrate the newly constructed buildings into this plan. Revise cost estimates for technology renewal and replacement based on the revised number of Smart facilities.
3. Initiate a study to examine classroom use of technology to determine how the current model should evolve. Evaluate recommendations for changing the model.
4. Develop and implement methods to assess effectiveness of staff support of Smart facilities and alert ITS of problems (similar to system developed for continuous monitoring of equipment).
5. Begin to establish appropriate specifications with Facilities Management, and with Departments (when appropriate), to guide the creation of new instructional spaces, including the installation of technology. Finalize plans with Facilities Management to ensure adequate support for any Smart facilities they install for departments.
6. Begin to develop and provide resources for supporting departments with technology-enhanced facilities.
7. Work with Facilities to establish site priorities and develop a maintenance schedule.

Long Term:

8. Continue processes from Short-Term, as relevant or appropriate.
9. Implement changes recommended by study completed above (short term plans, point 3)
10. Secure funding to cover the difference between today's funding and what is needed to sustain a larger number of Smart facilities.
11. Build out 12 additional Smart classrooms per year to reach target of 80% within 5 years (contingent on funding approval). Establish appropriate specifications for the creation of new instructional spaces, including the installation of technology. Standardize support and renewal & replacement funding requirements.

Primary Person Responsible for Action

Bobby Schnabel, Vice Provost for Academic & Campus Technology

Evaluation of Achievement

1. More smart classrooms exist. Those built in 2007+ clearly and sufficiently reflect the revised smart classroom model.

2. Budgets and records of expenses to indicate effectiveness of cost models and sustainability of initiative.

3. Analysis of recorded number of scheduling conflicts, number of times courses could not be accommodated in preferred times, and number of times instructor was denied classroom with appropriate resources

4. Surveys of users in Smart facilities, assessing (a) satisfaction, (b) actual use, and (c) effect on teaching and learning.

5. Surveys of users of Department technology-enhanced facilities, assessing (a) satisfaction with campus support of facility (e.g., Facilities Management, ITS), (b) satisfaction with facility itself.

6. Database (or other easily accessible record) of classroom use of technology. Analysis of how often these records are used, and how well the information integrates into objectives of other ITSP initiatives.

1.2 New Technologies in Support of Learning

Major Issue: CU Boulder should develop a model for identifying, critically evaluating, and strategically supporting emerging web-based learning tools. This model should be adopted by faculty and support personnel as they consider technologies to employ in their teaching, research, and service work. A campus-wide committee should be formed to identify promising educational technologies, assessing their potential for adoption, and communicating their findings to the campus.

A. Background/Rationale

Educational technologies should be evaluated with a critical and creative eye, and they should be adopted if there is a reasonable expectation that they could support the university's core mission of promoting excellence in teaching, research, and service. A glance at *The Chronicle's* Information Technology section will give a reader a sense of how broadly higher education has adopted these technologies. Though many of these technologies are in use on our campus, too many of them do not benefit from a critical analysis of how they could be used to improve learning. Too many of these technologies follow the arc of fads and become hot topics for a brief time only to be discarded soon after.

While some technologies do become fads, there are information technologies that offer promise for adoption. Promising technologies are those that provide simulations of processes or ideas that might otherwise be difficult to envision; those that create collaborative spaces designed to build understanding and knowledge, and facilitate collaborative quantitative reasoning; and those that provide a means of basic productivity in communication and artifact exchange over time and over great distances. Many of these technologies have a presence on the Internet. By definition, then, these technologies often require widely available Internet access, server space, software, and computers at end-user's sites.

While the University has helped students and faculty members gain access to Internet technologies, more work remains. For example, we are currently witnessing a trend toward mobile and miniature computing devices (such as cell phones, blackberry devices, iPods, and very small computers) but it is not clear whether the university is ready to facilitate students and faculty members interacting with these devices.

Rogers (1995) descriptive model that defines five populations of technology adopters/users provides a helpful framework to identify faculty and their technology support needs. Rogers outlines the following spectrum: innovators, early adopters, early majority users, late majority users, and laggards. We are aware of the negative connotations associated with the term, "laggards," but include it as it is used widely in the field.

B. Accomplishments to Date

The campus has made much progress in building the infrastructure to support widespread use of web-based learning tools during classroom-based instruction. With recent funding from the Chancellor's office, 65% of the campus' generally-funded

classrooms will be equipped and renewed every three years with “smart” technology. This technology makes it possible to connect a laptop computer to a projector, and to play VHS-, DVD-, and CD ROM-media. It also allows cable TV to be displayed in the classroom. By the time this report is released, the campus will be well on its way to providing 100 Megabyte per second data connections in classrooms and faculty offices; and wireless network coverage over 80% of the generally-funded buildings. Also, the ATLAS building will be open and serving the general campus population with access to a variety of educational technologies. The ATLAS Center could become the educational technology “hub” of the campus where key organizations dealing with education and technology (Graduate Teacher Program, Faculty Teaching Excellence Program, ITS, and ATLAS) are all in the same space and thus more likely to collaborate.

The Distributed Academic Technology Coordinator (DATC) program is also a key agent of change in the adoption of educational technologies. The DATC program was created as a result of the 1998 IT Strategic Plan. It consists of 8 coordinators, one in each school and college. DATCs work alongside faculty one-on-one to help them learn to integrate technologies into their teaching, research, and creative works. DATCs tend to work with faculty who would be in the early adopter and early majority adopter populations.

The campus has made important strides in the maturity of the four-tier support model. This model now provides a scalable, efficient, and effective method of supporting desktop and laptop computers, classroom and computer lab technologies, and servers. However, more work needs to be done to increase the effectiveness and reach of this model. For example, not all classrooms have smart technology in them and not all classrooms are supported by an education technology facilities support (ETFS) person. A key area for investment in the future is in the enhancement of this support model.

The campus has matured in its support of learning management systems (see section 1.3 of this document). Currently the campus supports WebCT, Campus Edition, as its enterprise Learning Management System. The DATCs and other members of the four-tier support model are all available to assist faculty and students as they use this system to enhance their learning. Shortly after this report is released, the campus will have WebCT Campus Edition 6 available, which has an improved interface and enhanced features in the tools it offers. It is also a robust system that will allow the campus to expand the adoption of an LMS.

Other web-based learning tools are in use on campus today and several seem to hold promise for future adoption. For example faculty members currently create web sites with rich media content such as sound files, images, videos, and VR images. Faculty members also use web-based tools like ArtStor and Luna/Insight to let their students explore images. There is interest among the faculty today in exploring web-based technologies such as wikis, blogs, vlogs, pod casting, and e-portfolios. Some of these technologies are in use on campus already, but they have not yet been adopted in a widespread manner.

C. Specific Recommendations

Become a national leader in the assessment of emerging technology’s ability to shape student learning.
The campus should become a national leader in assessing emerging technologies, and particularly their ability to foster students’ learning. Given the ubiquity with which

information technologies proliferate on campus, and given the rapid change in function and scale of these technologies; the campus should not, over the next four years, set its sights on any particular technology, or even on categories of technologies. It should, however, develop a descriptive model that helps us understand how different populations of technology users could effectively use educational technologies. By using this model when considering technologies to support, the campus will more likely adopt technologies that will be effective in facilitating learning and that can be scaled to support faculty members and students across campus. This model could build upon Rogers' (1995) model for describing various populations of technology adopters, and it would benefit from an assumption that not all technologies will or should be adopted by all people.

Commission a campus-wide learning technology advisory group (a subcommittee of FACE-IT).
A campus-wide group should to be commissioned to build this model. This campus-wide group should consist of representatives from across the campus and it should include students and technology support staff. Such a group should identify emerging, new, and promising educational technologies, define them, identify and assess their potential to enhance student learning, and identify salient aspects of support. This group should also disseminate information about these technologies to IT support and academic units, and make recommendations for how IT staff and campus administrators can encourage faculty members to adopt these technologies. The committee should also make recommendations based on best practices, research, and studies of technology use on this campus. The committee should reach out to other educational technology organizations on campus such as FTEP, GTP, and Disability Services. And, in turn, each academic department should develop mechanisms to ensure communication with the proposed emerging technologies working group.

Address the chasm between early adopters and early majority populations.
It is important for this group to acknowledge that a chasm exists between technology users who would be categorized as early adopters and those characterized in the early majority (Moore, 2002). The current IT support model on campus appears to be focused mainly on the early majority and late majority adopter populations. While this is helpful, it is also important for that support model to also reach out to technology users at both ends of the adopter population distribution to better understand how to support them and the early and late majorities (Rogers, 1995). It is important for the campus to acknowledge the barriers to adoption in its IT support model—including barriers of accessibility to the technology infrastructure as well as resistance to change—that make it difficult for an innovation to be adopted by those in the early and late majorities.

Develop incentives and continue to invest in supports that enable faculty to integrate emerging technology into their teaching, research, and service endeavors.
The campus should **develop incentives** to reward faculty who take a critical, research-based approach to integrating educational technology. It should also **continue to invest** in the Graduate Teacher Program (GTP) to help it prepare graduate students, the next generation of the professoriate, to learn and teach with web-based technologies.

The campus administration should **leverage the Distributed Academic Technology Coordinators** (DATCs) to identify innovators, early-adopters, and those who do not adopt web-based learning tools. The DATCs should share their findings with the IT

support staff, so that the campus can benefit from the experience of people at either end of Rogers' adopter population model (Rogers 1995) and identify possible barriers to their adoption (e.g., issues of access and/or diversity). Because the DATCs are important agents of change, the two Arts and Sciences DATC positions that were lost in 2003 should be restored by the campus. That way each faculty member will have access to a DATC.

In order to **provide a stable environment and infrastructure for using web-based learning tools**, the campus must ensure campus-level funds are committed to make 80% of all classrooms "smart" and to provide 80% wireless coverage by 2008. In addition, the support for desktop computers (Desktop Support), classroom technology (ETFS), and servers (Managed Services) must be increased proportionally. The campus should also leverage the Libraries' ability to manage digital repositories related to some of these web-based tools used by faculty members.

D. Resource Allocation $150,000

Because ITS has already put forth a request to the Chancellor for funding to increase the number of campus smart classrooms from 65% to 80%, that budget item won't be included in this area. Section 1.2 also addresses learning spaces on campus.

- $7,500 per year to support the campus-wide committee in its efforts to travel to other campuses and conferences; to purchase hardware, software, and web-hosting services needed to support investigate technologies; and to provide incentives and rewards for faculty who adopt promising technologies.
- $142,160 to restore two DATC positions to Arts and Sciences. This would be $112,000 for salaries plus $30,160 for benefits.

E. Action Plan

Short Term (one to two years):
The emerging technology advisory group should be commissioned and begin meeting January, 2007. The group develops a model and assessment criteria by June 2007.

Long Term (two to four years):
The advisory group develops its first dissemination in the form of a report to the campus by June, 2008. This report should describe how the group has fulfilled its charge. The advisory group should create and disseminate a robust framework for judging the value of educational technology and its impact on the mission of the university.

Support structures for desktop support, ETFS, and server support are adjusted to fit the expansion of smart classrooms and associated technologies on campus.

Training and incentives for faculty to use emerging technologies should be included in the campus' annual budget.

<u>Specific Steps</u>

1. The emerging technologies working group is formed with representation from across the campus. Representatives should be from academic units, IT support, and units interested in educational technologies. This group would be a sub-group of FACE-IT.

2. The group convenes and begins to work on a model for analyzing promising educational technologies, articulating the usefulness of those technologies, and identifying how they could best be supported on campus. Part of this effort involves becoming aware of research in this area.
3. At its outset, the group should consider the following promising technologies, but it should not be bound by this list, and in fact it should try to avoid riding the cycles of technology fads. This list appears to have some promise: for adoption in teaching and learning contexts: wikis, podcasts/vodcasts, 'blogs/'vlogs, virtual meetings, screen casting, grid computing, instant messaging, e-folios, augmented reality, clickers, social bookmarking, technologies that allow for collaborative quantitative reasoning, and technologies that facilitate the use of numerical techniques and modeling.
4. The group defines each of these technologies, posits how they may be useful in facilitating learning, and plans for assessing their use in pilots across campus.
5. The group evaluates the first round of pilots and puts together recommendations for support and for how the technologies could be used by faculty members across campus.
6. The group publishes a report on the first round of its work. This report includes a framework for describing how different faculty members and students on campus could adopt technologies and how those technologies could facilitate learning. The group also submits proposals for conference papers or articles based on their findings.
7. The group shares its findings with educational technology organizations such as ATLAS, ITS, FTEP, GTP, and Disability Services.
8. The group continues another cycle of research, identification of new technologies, analysis of technologies, piloting of technologies, assessment, and dissemination of findings.

Timeline

- 2006—Group is identified and commissioned
- 2007—Group meets and begins to develop a model and assessment criteria
- 2008—Group disseminates the first round of its finding to the campus and through conferences and articles. 2009—Group begins another round of research, identification of technologies, pilot testing of technologies, assessment, and dissemination of findings.

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic and Campus Technology

Evaluation of Achievement

The campus will know if we have been successful in this area if we see through existing faculty surveys of technology use, and through reports from DATCs, that the faculty are aware of the group's framework, that some faculty have piloted of emerging technologies, and that the potential impact of disseminating those technologies is documented. The campus will also conduct an exit survey of graduating seniors to find out what needs to be changed about educational technology support on campus. The campus will also know it has been successful if the group examines whether currently

supported technologies are facilitating learning. For example, have clickers made a measurable impact on learning?

The work of the group should be grounded in the literature on research on educational technology and it should be informed by best practices in place at our peer institutions and institutions we strive to imitate.

F. Sources

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1.2.1 Campus Use of Technology-Enhanced Spaces

Major Issue: CU-Boulder should foster a culture of innovative and effective uses of technology-enhanced learning spaces. To do so, the campus should develop and implement a model of support, training, and shared governance for fostering that culture; leverage the success of and interest of faculty in departments and programs such as Communication, Science Education, and the ATLAS Institute; leverage the skills and networks of ITS' Distributed Academic Technology Coordinators; increase faculty participation in decisions about technology-enhanced learning spaces and faculty training in their use; provide tools to assist faculty in the assessment of their uses of educational technology spaces; and develop a sustainable model for support, renewal, and replacement of those spaces.

A. Background/Rationale

Recent surveys of faculty and instructors at the University of Colorado at Boulder indicate that a majority use in-class technologies:

- Approximately 75% of faculty use in-class technologies to project lecture notes or as a replacement for overheads.
- Approximately 70% use them for "beyond chalk" uses that include projection of websites, images, and simulations.[3]
- Graduate student teaching assistants use such technologies at only a slightly lower rate than faculty (63% for overhead replacement, 53% for "beyond chalk" uses).

These rates are significantly higher than in 2001.[4]

Current uses, and the concurrent demand for the technology-enhanced spaces that enable them, are expected to expand and increase even further. The campus is responding by increasing the number of centrally-scheduled "smart" classrooms that include a media cabinet, VCR/DVD players, projectors, and Internet connections:

- There are currently 38 such classrooms smaller than 50 seats, with plans to increase to 83 total,
- 23 classrooms with between 50 and 149 seats (with plans to increase to 34 total), and
- 15 classrooms with 150 or more seats (with plans to increase to 19 total).[5]

Even with increased use, with some understanding of types of use across disciplines, and with localized success, innovation, and discussion about the use of technology-enhanced spaces, there is little understanding of how to foster effective use in a systemic and strategic manner. To do so, the campus should:

- Leverage the expertise and enthusiasm of departments and programs, including ITS' Distributed Academic Technology Coordinators, already engaged in innovation in and discussion about educational technologies to gain a better understanding of current and potential uses;

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[3] See http://www.colorado.edu/vpact/itsp/data/faculty2005.htm for full report.

[4] Fifty-four percent of the faculty respondents to a 2001 survey used computer technology in class lectures and presentations. Of this group,

- 64% used PowerPoint
- 66% displayed web sites
- 19% presented using other software (often course- or discipline-specific)
- 18% projected digital video.

[5] See Section 1.2 for a fuller discussion of the campus's strategic direction for the number of and technology in these "smart" classrooms.

- Concurrently address several aspects of the use of technology-enhanced spaces: tools, uses (included training and support), and assessment; and
- Increase faculty participation in discussion and shared governance of technology-enhanced spaces.

The following table conceptualizes those aspects and potential methods for seeing change and improvement in the uses of technology-enhanced spaces:

Aspects of Use of Technology-Enhanced Spaces	Methods for Progress
"Tools," including • hardware • software • furniture configurations	A new FACE-IT sub-committee to increase shared governance in decisions about spaces
"Use" of in-class technologies • integrating technology, pedagogy, and discipline • considering social and cultural impacts • training and support	Lecture series Master classes & "open lab" times Leveraged use of DATCs FACE-IT sub-committee or other technology committee
"Assessment" of use • reflection (FRPA) • do-it-yourself outcomes assessment	FACE-IT sub-committee to consider integration with FRPA Development and dissemination of assessment "toolkits"

B. Accomplishments to Date

The campus is already a leader in the area of use of technology enhanced spaces. It has:

- Longitudinal data about faculty use of in-class technologies;
- A cadre of Distributed Academic Technology Coordinators already supporting faculty use of in-class technologies and engaged in thoughtful exploration of continued innovation and study in this area; and
- Several departments such as the ATLAS Institute, Communication, and Science Education (Physics) actively and explicitly engaged in discussions and pilots that address both innovative uses of in-class technologies as well as disciplinary pedagogical issues.

C. Specific Recommendations

- Establish a sub-committee of FACE-IT to address issues of numbers of technology-enhanced classrooms (see "tools," above)
- Establish a sub-committee of FACE-IT to integrate personal and outcomes assessment into FRPA (see "use," above)
- Develop lecture series and master classes to establish and foster community of practice around the use of technology-enhanced spaces
- Develop toolkit for faculty for do-it-yourself outcomes assessment
- Develop strategic communication plan
  implement master classes series and/or open-houses to showcase innovative "classes in action"

D. Resource Allocation: $10,000 (GRA and funding for master classes & lecture series

a. Staff in the Office of Academic and Campus Technology will be responsible for establishing FACE-IT sub-committees, working with departments and programs to inventory and communicate efforts, developing a strategic communication plan for technology-enhanced spaces, and establishing lecture series and master classes in the ATLAS Building.
b. Some funding ($10,000) will be necessary for the lecture series, master classes (food and modest honorarium only) and assessment toolkits (graduate student research assistant)

E. Action Plan

Short Term (fall semester 2006)):
- Commission a new sub-committee of FACE-IT to consider model of shared governance for technology-enhanced spaces.
- Commission a new sub-committee of FACE-IT to consider ways to integrate assessment of educational technology use into FRPA. This sub-committee could be the same as the one investigating shared governance models.
- Pilot lecture series, plan master classes
- Undertake research for development of self-assessment toolkits

Long Term (spring semester 2007):
- Pilot master classes
- Pilot self-assessment toolkits

Primary Person Responsible: Deborah Keyek-Franssen, Office of Academic and Campus Technology

Evaluation of Achievement
- Faculty attendance at lecture series increases over time in number and breadth of disciplines, departments, and programs represented
- Evaluation of lecture series and master classes
- Evaluation of self-assessment toolkits

1.2.2 Clickers in Classrooms

Major Issue: The use of "clickers" (electronic student feedback in lecture) at CU-Boulder is widespread and growing; the use of multiple clicker types and lack of centralized organization and support are leading to a chaotic and costly situation; the campus needs to adopt a single clicker type which is fully supported by ITS.

A. Background/Rationale

The use of electronic student feedback systems in lecture (clickers) began in the Physics and Astronomy Departments in the spring of 2002. Since then, use of this popular teaching tool has grown steadily: currently, at least 5000 students in 50 classes and 8 departments at CU-Boulder use clickers each semester.

Clickers are here to stay. The effectiveness of clickers as a learning tool, especially in large freshmen classes, has been well-established by studies at CU-Boulder and elsewhere. When used properly, clickers provide essential feedback both to the instructor and to the student, and they can transform the student from a passive and anonymous scribe into a visible and actively-engaged learner. The number of faculty wishing to use clickers has increased every semester for the last 4 years.

The use of clickers is currently limited by classroom availability and cost issues. The most-widely used clicker system at CU, made by HITT Inc., requires expensive installation and maintenance, with an initial department investment of about $15 to $50 per seat for the room wiring. The HITT system was originally chosen because it was the least expensive *for the student*, with student-purchased clickers costing about $35 each. At present, individual departments shoulder the cost of installation and maintenance. There is no centralized organization or support. Some departments, such as Music and Humanities, want to use clickers but are currently stopped by the cost.

These cost issues are driving some departments to adopt different clicker types. A new wireless clicker technology, using radio-frequency (RF), has recently been developed, and this new RF technology requires ***no*** permanent room wiring. The installation costs of the RF system are so low that some departments have already adopted their use. The use of multiple clicker types on campus has led to a chaotic situation that is very costly to students. Currently, some students have to buy 3 different clicker types – an extremely unpopular and potentially explosive state of affairs.

Alternatives to clickers are not attractive as a campus-wide solution. Possible alternatives are web-based feedback systems using existing student-owned hardware, such as cell phones, PDAs, or laptops. A recent study (Lowry, 2005) shows that these systems are significantly more expensive than clickers and are likely to be unworkable due to the diverse nature of student-owned devices.

Clickers are a tool. Like any tool, clickers can be used badly or well, and they certainly require extra work on the part of faculty. The purpose of this document is not to promote or recommend the use of clickers, but rather to recognize and support the already large and growing demand for this technology at CU Boulder.

Our long-term expectation is that clicker use, if properly supported, will greatly expand and eventually will include most students at CU-Boulder. Thus, it is essential that a centralized support and organizational structure be created to assist faculty who wish to use this important technology.

B. Accomplishments to Date

CU-Boulder is among the nation's leaders in the use of this innovative and effective classroom technology. There are only 1 or 2 other campuses *in the world* (U.Mass. Amherst and Purdue) where clickers are more widely used. There is considerable local expertise among the CU faculty in the proper use of this new learning tool. The popularity and visibility among students and faculty of this technology are already well-established. There is no need for consensus building on this issue: there is overwhelming faculty consensus on the need for standardization of and support for clicker use.

The CU faculty who have carefully studied the impact of clicker use include:

- Michele Jackson and April Trees, of the Dept of Communication, used carefully-designed student surveys to assess clicker use in many departments (http://comm.colorado.edu/mjackson/clickerreport.htm).
- Douglas Duncan of the Astronomy Dept. wrote an instructor's manual "Clickers in the Classroom", Addison-Wesley(2005).
- Carl Wieman (who has recently started the Science Education Project) and Kathy Perkins, both from Physics, are in the midst of a long-term study of the effect of classroom reform on student attitudes about learning and science.

Specific Recommendation

The campus should standardize to a single clicker type. This standard clicker system will be one of the new RF types, will be fully supported by ITS, and will be made available in all centrally-scheduled smart classrooms on campus. (Other clicker types cannot be forbidden, but they will receive no institutional support.)

The final choice for standard clicker type will be based on

- reliability, ease-of-use, PC & Mac compatibility
- cost to students and to CU
- architectural compatibility with existing campus infrastructure
- congruence with CU Bookstore process, procedures, and policies

C. Resource Allocation

Cost of project: Medium.

- Hardware components: currently, these costs should be relatively low due to aggressive promotional opportunities by the companies supplying the receivers. Although it is unknown what the longer term pricing structure for clicker systems will be, market competition is expected to keep hardware prices low.
- Startup costs: Development for Portal additional $20k. There are no ongoing operational costs as it would be incorporated into existing services. There are potential redevelopment costs as technology changes.

- Resource allocation: no infrastructure changes will need to be done in the current Smart rooms to accommodate use of the system. In particular, the previously-anticipated need for a second LCD projector is no longer required.
- Support and Training: this cost is the largest factor. There are approximately 136 Smart Classrooms that will use clickers, with the potential for more. Clickers could potentially be used in non Smart Classrooms as well, which would have another set of support concerns.

D. Action Plan

Short Term: Choose a single clicker system.
Long Term: Develop the support and training for faculty to ensure relatively painless clicker use, and the develop the software for centralized registration.

Specific Steps

- A faculty committee will choose the clicker type, based on classroom experience, and in close cooperation with ITS.
- ITS will be commissioned and funded to provide support and repair of the standard clicker system through the Helpdesk, the DATCs, and on-site support.
- ITS will also be commissioned to provide frequent "use of hardware" training sessions for faculty and staff.
- Other units on campus, such as FTEP and the new Science Education Project, will be commissioned to provide regular training sessions in the *pedagogical* use of clickers.
- There should be a single, centralized clicker registration function in CUConnect, with the clicker ID integrated into student identity and available to applications and instructors. This will enormously simplify clicker registration logistics from the faculty standpoint and will likely accelerate adoption. It will also discourage clicker theft and ensure return of lost clickers to their owners.
- Once clickers are standardized, it is likely that they will become so widely-used that virtually all students need them. In that event, there should be universal clicker distribution to all incoming freshmen, with costs covered by a technology fee. This will help contain costs, and ease faculty concerns about the financial-burden to their students.

Timeline

- Fall 2006 and Spring 2007, large-scale classroom testing of candidate clicker types
- Fall 2007, full campus deployment of clicker hardware and support

Primary Person Responsible

ITS Architecture Group for program oversight. Clicker committee for review and consultation.

Evaluation of Achievement

The final measure of success will be whether use of clickers continues to grow among the faculty and whether student response is positive. Clicker-use will expand only if

faculty observe a positive impact in the classroom and only if clickers are easy-to-use and relatively trouble-free.

End-of-semester surveys will be used to monitor student attitudes toward clicker use, while interviews of instructors will assess ease-of-use issues among faculty.

Carl Wieman's Science Education Project is supporting ongoing studies to evaluate the success of clicker use in several science departments.

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1.3 Learning Management Systems

Major Issue: A Learning Management System is an important tool that can leverage information technology to improve the teaching and learning mission of the campus. Therefore, the campus should provide a feature-rich Learning Management System, and support it in a robust way so that it can be used to implement innovative pedagogical methods in an online environment. If the campus does not provide such a system, it will miss an opportunity to improve learning within and beyond the traditional boundaries of the classroom experience.

A. Background/Rationale

Learning Management Systems (LMSes) have been widely accepted by universities and supported at the enterprise level by universities around the world. One rationale for their use is they provide a means of extending occasions for learning into an online space. This opens the possibility for learning to occur at a distance and outside the time normally devoted for classroom interaction. A typical LMS will include web-accessible tools for allowing students and faculty members to exchange artifacts, facilitate interaction, and assess student progress.

There are a variety of commercial LMS options available to universities. Examples include WebCT/Blackboard, eCollege, Desire2Learn, Angel, Elluminate, as well as open source options such as Sakai and Moodle. CU Boulder has a centrally-supported LMS (WebCT) as well as other LMSes hosted by vendors or individual departments. For example, the School of Law uses The West Education Network (TWEN), which is hosted by WestLaw Corporation and integrated with the Lexis-Nexis database; one faculty member in the College of Engineering hosts Moodle, an open-source LMS, on his server; and the Center for Advanced Engineering and Technology Education (CAETE) program has arrangements with eCollege to host some of their courses. The College of Architecture and Planning has a presence on both the CU Boulder and Denver campuses, and so their faculty use both WebCT and BlackBoard. Blackboard has recently acquired WebCT, and they intend to merge both LMSes into a single LMS probably after the period covered by this strategic plan.

B. Accomplishments to date

CU Boulder has had a centrally-supported commercial LMS (WebCT) since the late 1990s. The first LMS was a home-grown suite of web tools for announcements and quizzes called Course Builder. In 1999 WebCT became the centrally-supported system and began with 71 courses. By 2006 it had grown to 772 courses. The campus has examined other LMS systems as well. For example, the campus joined the Sakai community source LMS project and ITS held a pilot of Sakai in the fall of 2005. As a result of that pilot, ITS decided to not adopt Sakai in the near term, but instead to look at Sakai later if it becomes a more mature product.

C. Specific Recommendations

1. The campus should select a centrally-supported LMS through an investigative and deliberative process including the input of major stakeholders

CU-Boulder should commission a group of LMS stakeholders (students, faculty, and IT support staff) to carefully analyze the teaching and learning activities faculty members would like to engage in online, and to examine how well available LMSes can support these activities. This group would be a subgroup of the existing Faculty Advisory CommitteE to IT (FACE-IT). This group should gather input from representative groups of students, and from various campus governance groups, such as the Boulder Faculty Assembly and the Council of Assistant and Associate Deans. This group would recommend to the campus Chief Information Officer an LMS that meets the needs of constituents' surveyed, that is quickly comprehensible and easy to use, and that can be centrally-managed and supported. This LMS should be sufficient to meet the needs of roughly 80% of the classes offered through LMSes on campus. Funds should be budgeted for an enterprise-wide LMS that is robust enough to support this many classes.

Because there are a variety of LMSes available (some of which are customized to specific disciplines) and because there are a variety of requirements for LMSes across campus, it is difficult for the campus to meet the demands of the roughly 20% of remaining courses. For example, in the Law School, Lexis/Nexis so tightly integrates its proprietary database with its TWEN LMS that Law faculty members are convinced that adopting another LMS would be a step backwards for them in usability and effectiveness. Therefore, CU Boulder should devote central resources to support one LMS that is available to everyone, and allow other LMSes to be used so long as they don't compete for central resources.

2. The centrally-supported LMS should be integrated with other enterprise systems and with third-party tools that enhance the LMS.

The LMS should be integrated with other enterprise systems (such as the student information system), Libraries' systems, and other systems that hold digital learning assets. The entire cost of ownership, training, and support of the LMS should be considered in recommending a system to adopt.

Many LMSes provide means for passing information between an LMS and other third-party products such as electronic portfolios, plagiarism checkers, quiz creation tools, and tools for creating simulations. ITS employees and faculty members should watch for the third-party tools that become commercially available and that can "plug into" the LMS. They should then work with faculty members and students who use the LMS to ensure the appropriate third-party tools are considered for adoption and support on campus. The campus should provide resources to purchase, test, and evaluate these tools. This will allow the functions provided by the LMS to be expanded.

3. The centrally-supported LMS should facilitate both the delivery of traditional (SIS-listed) courses as well as non-traditional interactions such as research collaborations, trainings, and non-semester-based classes.

The central LMS should support the delivery of year-long courses as well as semester-based courses. The LMS should have a consistent look and feel across the various types of courses taught on it. The LMS should allow for traditional courses (i.e. those listed in the SIS) but also for less-traditional uses such as non-course instruction and research collaborations. The system should allow for collaborations within the LMS that

are not semester-based. For this non-SIS use, faculty should apply to a review panel of faculty members and IT staff proposing how they would like to use the LMS.

4. Faculty support for the centrally-supported LMS should be improved

ITS should increase its efforts to gather faculty input on the LMS. Communication to faculty about changes in the LMS could be improved. For example, a 'blog might be a useful mechanism. Additionally informational e-mails sent to all instructional faculty members would be a good tool. While one-on-one help for faculty is currently available through the Distributed Academic Technology Coordinators (DATCs), this form of assistance should be expanded and strengthened. DATC support for the Social Sciences and Natural Science divisions of Arts and Sciences should be restored. The DATCs should help faculty learn methods of instructional design, how to teach effectively through the LMS, and on how to manage a class online. Support for the faculty should be managed by keeping in mind that the needs of the faculty vary. Some element of faculty support should include a faculty-helping-faculty and faculty mentoring model like the Faculty Teaching Excellence Program uses. The campus should provide incentives in the form of monetary rewards for faculty members who are using the LMS in innovative ways

Online support materials for the LMS should be improved. Some ideas the committee had were to provide provide support for users on the LMS login page. Also a best-practices web site could be created by the DATCs and faculty members where discipline-based LMS course templates from other institutions and from CU Boulder could be made available. This site could include a series of online courses so that faculty members could review those courses to get ideas for teaching online. This site could also contain tips from the DATCs and faculty on best practices for teaching online. The campus should establish an online forum to allow faculty members to exchange messages and conduct web conferences with one another to facilitate cross-disciplinary interaction.

Training for faculty members could be improved to include a module where experienced faculty members give workshops to other faculty members (especially new faculty members) on how to use the LMS. This would be similar to the model used by the FTEP summer institute.

A campus-wide forum should be established to help faculty members exchange ideas for using the LMS. This would be similar to the Teaching with Technology conference, but focused on the campus level.

5. Student support for the centrally-managed LMS should be improved

Support for students using WebCT should be increased. Online materials should be developed, including a student guide that shows students how to use the LMS.

D. Resource Allocation: Low = $12,500; High = $562,500

Low would include first two items. High would include all seven items.

- Funds for testing and evaluating third party tools: $2,500 per year
- Campus-wide forum for exchanging ideas: $10,000 per year.
- Monetary rewards for innovative teaching through the LMS: $10,000 per year

- Funds for faculty-training-faculty in the form of course releases: $20,000 per year
- Funds for two additional DATC positions (included in the budget of section 1.2)
- Funds for acquiring a new LMS including server, operating system, storage, and personnel to test and integrate it into the campus enterprise support system: $300,000. This figure is based roughly on the amount spent to adopt WebCT CE 6.
- Ongoing funds for an enterprise-wide LMS license: $220,000. This would include $170,000 for the license (for comparison's sake, WebCT would charge $170,000 for a license for their enterprise LMS). This would also include funds for an add-on electronic portfolio ($50,000). For comparison, WebCT currently charges $51,000 for their add-on electronic portfolio. An electronic portfolio is a mode of allowing students and faculty members to keep track of their work across their time at CU Boulder. It allows them to provide self-reflective descriptions of their work, peer reviews of their work, and instructor reviews.

E. Action Plan

Short Term: The campus commissions a committee to investigate a centrally-managed LMS. The LMS is integrated closely with other campus systems. Support for Non-SIS use of the LMS is created. Faculty support is improved.

Long Term: The LMS is integrated with the four-campus SIS. Adoption of the LMS is widespread among faculty and is used in a variety of ways to improve learning. This includes using the LMS to facilitate online interactions among research groups and other learning communities.

Specific Steps

1. The campus commissions a committee (possibly a subgroup of FACE-IT) to investigate and deliberate on a centrally-managed LMS. The committee reviews the field of LMSes available and gathers user requirements.
2. A faculty communication plan for the centrally-managed LMS is created and implemented.
3. Faculty support is improved through
    - Communication technologies like an LMS 'blog
    - Best practices data from peer institutions
    - An increase in peer-to-peer faculty mentoring and teaching
    - Online support improved including documentation and an online forum for exchanging ideas.
4. Student documentation for the centrally-managed LMS is improved.
5. Non-SIS courses are hosted on the centrally-managed LMS. This includes courses that aren't bound to a traditional semester, courses that are taught for no credit, and research collaborations.
6. The campus restores two DATC positions to support the Social Sciences and Natural Sciences divisions of Arts and Sciences
7. The committee recommends to the CIO an LMS to be centrally-supported by the chancellor's office. Funds are set aside to license and run the LMS.
8. Funds are set aside to evaluate third-party tools. The most promising tools are selected by DATCs and faculty, and are made available to individual faculty members to use with the centrally-managed LMS

9. An annual campus-wide faculty forum is established like the Teaching with Technology conference.
10. The centrally-managed LMS becomes integrated with Libraries' and digital asset management systems. The LMS also continues to be integrated with SIS, except for the non-SIS uses of the LMS.

Timeline

- AY 2006-2007: Steps 1 and 2
- AY 2007-2008: Steps 3, 4, 5, 6, and 7
- AY 2008-2009: Steps 8, 9, and 10
- AY 2009-2010: Evaluation of steps 1 to 10.

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology

Evaluation of Achievement

We will know we have been successful if in four years:

- Faculty members report that they have a centrally-managed LMS that meets their needs and that they had a say in selecting it.
- Faculty members are able to quickly locate online materials telling them about best practices for teaching online and providing them with online templates and course examples.
- The centrally-supported LMS is integrated with other enterprise systems and it allows plug-ins from third parties.
- There is an increase in non-SIS use of the centrally-supported LMS.
- Two additional DATCs are in place; one to support the Social Sciences division, and one to support the Natural Sciences division of Arts and Sciences.
- An annual faculty forum for exchanging best practices has been implemented.
- We are able to demonstrate an improvement in students' learning experiences online.

These elements could be measured through faculty surveys, verifications of the above items, and through incorporating an assessment mechanism in some courses taught online.

1.4 Research Computing

Major Issue: CU-Boulder should facilitate local research computing in research institutes and academic research departments; investigate and provide collaborative initiatives where appropriate; minimize the effort needed to discover and implement operational solutions; and improve communications with researchers to increase awareness of the potential research opportunities of using National Lambda Rail and I2 network capabilities.

A. Background/Rationale

CU-Boulder features world-renowned research departments and institutes, many of which rely on high performance computing for intensive data analysis and simulations. Several units and individual researchers rely on access to national supercomputing sites; others have built clusters of processors to meet their high performance computing needs. Currently, there are no communication channels between the Office of the CIO/ITS and directors, chairs, IT system administrators, or individual researchers about the opportunities afforded by initiatives such as the National Lambda Rail or I2, or about the operational solutions that could be realized by collaborative partnerships between campus units with similar computing needs. In addition, a lack of coordinate between IT system administrators in research departments and institutes means that IT support staff often implement multiple instances of local solutions to common problems, unnecessarily "reinventing the wheel."

B. Accomplishments to Date

Establishing a culture of collaboration around the issues of high performance computing has already begun through the establishment of regular meetings between ITS directors and the IT system administrators and directors in research institutes and departments.

C. Specific Recommendations

- Support and facilitate research computing that is locally-supported in institutes and academic research departments, in part through the creation of a forum for research computing that includes department chairs, institute and research group directors.
- Provide opportunities for collaborative solutions for high performance computing needs to maximize the effectiveness of solutions for multiple departments and minimize duplication of efforts across campus.
- Leverage the knowledge and connections of the Office of the CIO and the Vice Chancellor for Research to investigate opportunities for collaborative research computing across departments, programs, and institutes.
- Establish a culture of collaboration between ITS and multiple partners, as well as process and support structures, to minimize the effort needed by any one department to implement operational solutions by increasing awareness of and replication of existing solutions on campus or elsewhere, and to influence the direction and effectiveness of department or institute IT architecture and security.
- Research and investigate the potential of developing a pilot for a High-Throughput Computing (HTC) facility, possibly based upon the Condor Project model (see http://www.cs.wisc.edu/condor/ for more details).
- Research and investigate the possibility of developing an institutional resource for high-volume research data storage and access.

D. Resource Allocation: $50,000

.5 FTE for additional ITS staff to develop a pilot service based upon HTC architecture in collaboration with a small number of researchers from academic units. Goals of the pilot are to understand the value of developing a HTC facility by prototyping a model service that could potentially be scaled to meet broader campus academic research demands. Ideally the campus would commit to a two year pilot to allow adequate time for a solid assessment of the service.

E. Action Plan

Short Term (one to two years):

- Continue discussions between ITS and institute and research department IT staff.
- Develop and implement strategic communication plan for raising awareness of directors, chairs, IT staff, and researchers and encouraging campus collaborations in the area of high performance research computing.
- Conduct research about campus and other solutions, local and national opportunities.
- Prototype a HTC resource, possibly based upon the Condor project model. This includes development of the resource as well as assessing the research potential of such a resource with an academic research partner, such as Chemistry or Physics.

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic and Campus Technology

Evaluation of Achievement

- Surveys of directors, chairs, IT staff, and researchers of institutes and departments to show increased awareness of campus and other operational solutions for research computing needs, of opportunities for collaborative solutions on campus, of local and national research computing resources.
- Tracking of research computing collaborations to show an increase in number per year and in total over the next four years.

1.5 Digital Asset Management Systems and Institutional Repositories

Major Issues: CU-Boulder should develop a model and process for the acquisition, storage, access, and management of digital assets, including images, audio, video, data, learning objects, and the intellectual output of the CU community; the campus should continue with its current digital asset management systems (DAMS), including the campus-wide use and support of the Luna Insight and ARTstor databases; the campus should take steps to create an institutional repository (IR) to store, manage, preserve, and provide access to the intellectual output of the CU community.

A. Overall Background/Rationale

Faculty and students are showing an increased demand for the access to, storage, and management of a wide range of digital assets, including images, audio, video, data, learning objects, and the intellectual output of the CU community. The campus is at risk for replicating the compartmentalization and limited access to existing analog collections as they become digitized, and as new digital assets are created or acquired. CU-Boulder needs to coordinate efforts across asset-type for this and several other reasons: to avoid duplication of efforts by academic departments and other stakeholders; to realize economies of scale with hardware and software acquisition, as well as data entry; to standardize authentication and authorization processes and metadata across different digital asset projects; and to integrate present and future digital asset management systems and collections.

By modeling a portfolio of digital asset projects, the campus will position itself to reduce the compartmentalization of collections, and increase the probability of seamless access to digital assets, be they image, audio, video, or other digital objects. As the campus develops a broad model of digital asset management, it must also foster a broad culture about, and an awareness of, the existence and effective use of institutional repositories and their digital objects, and to recognize and anticipate pedagogical uses that would access multiple resources.

A holistic view of a range digital asset projects will allow multiple stakeholders to view how individual collections relate to one another across several spectra, including:

- The need for digital rights management (restricted and copyrighted assets versus open and/or campus-owned);
- The site of creation (outside the University versus inside);
- The process for cataloguing and display (by collection managers versus collaboratively by users throughout the CU community).

Developing a holistic model also will enable the campus to work toward an end-user experience that is seamless, even if the assets are stored and managed in a distributed manner across campus.

Two digital asset projects on campus, of two distinct types and described in separate sections below, are either underway or have enough momentum to begin. DAMS and IRs are similar in that they are both software platforms that provide a means to access, manage, and store a variety of digital media and data files. The primary difference between DAMS and IRs is that digital asset management systems are intended to

manage assets ***owned*** by the university that are generally purchased or acquired from sources ***outside*** of the university, whereas institutional repositories are a ***set of services*** that manage the acquisition and access to the intellectual output (i.e., research papers, theses, dissertations, etc.) created by members ***inside*** the university. While DAMS can contain digital assets that may also reside in an IR, an IR would never contain assets that were purchased or created outside of the home institution. Another significant difference is that DAMS are generally dependent on professional staff to acquire, catalog, and enter the digital assets into the system, whereas the digital content contained in institutional repositories is directly input by the content's creator, generally a faculty member or student. The majority of DAMS include a suite of presentation tools for use in classroom instruction (which function similar to PowerPoint), while most IRs do not include classroom presentation tools. It should be noted that, at this time, no single software platform has emerged that will accommodate all of the services and functionality requirements of both digital asset management and institutional repository projects.

As these two projects continue, representatives from each, along with faculty and with staff from ITS and the CIO's office will begin development of a broader model for implementation of future projects that will leverage the successes of the two underway.

B. Accomplishments to date

Significant work has been completed on the campus's digital asset management project; the institutional repository project is poised to begin.

C. Specific Recommendation

In addition to continuing (DAMS) and beginning (IR) current projects, the campus will develop a holistic model for implementing and integrating future digital asset and repository projects.

D. Resource Allocation

Cost of the project: little or no impact for development of model; costs for DAMS and IR included in their respective sections below.

E. Action Plan

Short Term: Develop and create model; secure stakeholder buy-in
Long Term: Monitor effectiveness of new model

Specific Steps:

- Establish working group with representation from current DAMS and IR projects, ITS, and the Vice Provost for Academic & Campus Technology Office
- Conduct focus groups to determine current and potential need for digital collections
- Research peer institutions to determine if effective practices for integrating wide varieties of digital and institutional assets exist
- Develop model

Timeline:

- Fall 2006: establish working group, peer institution research
- Spring 2007: focus groups
- Summer 2007: develop model

Primary Persons Responsible:

Bobby Schnabel, Vice Provost for Academic & Campus Technology

Evaluation of Achievement:

Review of model during the Fall of 2007 conducted by DAM and IR project leads and FACE-IT.

1.5.1 Digital Repositories: Digital Asset Management Systems (DAMS)

Major Issues: As implementations of multiple digital collections in Luna Insight software proceed at CU-Boulder, several related projects are underway. These include establishing the means of authentication and authorization for controlled access to collections; the formulation of standards for digitization, metadata, and preservation; and the creation of the University of Colorado Digital Library web site. Future issues include examining the culture and costs of long-term technical support for digital archives; identifying digital collections across the university, as well as their IT infrastructure and support needs; and determining the feasibility of federated searches across collections in different software platforms.

A. Background/Rationale

Prior to 2004, multiple digital collection silos had been created in CU colleges, departments, museums, and libraries, utilizing different databases that did not interoperate nor provide the ability to perform cross-collection searches. To address the problem, the Boulder campus took the lead in establishing a CU system-wide Digital Asset Management committee in May 2004.

With a focus on digital images, the committee investigated digital content. To address the immediate need for a critical mass of copyright-compliant digital images, the committee recommended system-wide subscriptions to ARTstor, an online database containing nearly 500,000 digital images of art, architecture, and other visual and material culture of interest to a broad range of disciplines in the humanities and social sciences. Because no single resource, including ARTstor, can meet all of the digital content needs required for teaching and scholarship, the committee recommended Luna Insight as the common software platform that units may purchase as they are ready to create, migrate, or publish the local digital collections (image, audio, video) that meet their missions and curricular needs.

Because CU's departments, libraries, and museums have differing missions, budgets, workflows, and IT support models, a single, centralized software implementation was not suitable to meet the unique needs of each of these units in a timely fashion. The committee selected Luna Insight in part for its flexible architecture that allows distributed

server implementations while simultaneously providing cross-collection search capabilities. This preserves autonomy among units, but the end-user experiences a single search interface.

B. Accomplishments to date

In October 2005, the President's Initiative Fund provided the archive capital fee for ARTstor at each CU campus. The libraries pay the annual access fees. The ARTstor rollout occurred in the spring 2006 semester, with publicity, library instruction, and departmental training workshops happening on all three campuses.

Two implementations of Luna Insight entered beta phase in February 2006. One resides in the UCB University Libraries, administered by their systems department. The other is a collaboration of three academic units on the Boulder and Denver campuses, with the shared server administered by the Managed Services and Consulting group of the Boulder ITS department. Digital Asset Management subcommittees are creating a University of Colorado Digital Library web site containing links to collections in Luna Insight, guidelines for creating digital collections, and links to ARTstor and other system-wide digital resources.

C. Specific Recommendation

The Digital Asset Management Committee will continue its work in the current implementations of Luna Insight and the creation of the University of Colorado Digital Library web site. Existing or new task groups should be assigned to address the issues of authentication and authorization; the culture, critical issues, and costs of long-term technical support and archival storage for academic units; identifying current and future digital collections across the university, as well as their IT infrastructure and support needs; and the possibility and feasibility for future federated searches across software platforms.

D. Resource Allocation

Cost of the project: there is little or no impact in the investigation stages. Departments and libraries currently shoulder the costs of Luna Insight and other software implementations and associated hardware expenses. Costs and responsibility for long-term archival storage of data from grant-funded projects are undetermined.

E. Action Plan

Short Term: Completion of current projects of the Digital Asset Management subcommittees, as listed in numbers 1 and 2 in the "Specific Steps" section below.

Long Term: Investigations by existing or new task groups of projects listed in numbers 3 through 6 in the "Specific Steps" section below.

Specific Steps:

1) Complete the current projects of the Digital Asset Management subcommittees that are assigned to address components of the CU Digital Library and its web site, including

digitization and metadata standards, copyright guidelines, preservation best practices, and information about how to create collections in Luna Insight;
2) Determine and implement methods of authentication and authorization to control access to current and future digital collections, with system-wide coordination for digital resources that span all campuses;
3) Examine the culture and costs of long term technical support as technology evolves and new systems are adopted, which includes identifying the unit(s) that will take charge of issues surrounding sustainability, migration, and the long-term storage of digital archives;
4) Through focus groups and surveys, identify existing and potential digital collections across the university as well as their IT infrastructure and support needs;
5) Assess the growing need for federated searches across a variety of software platforms, such as digital asset management systems and institutional repositories, and develop a strategy for future adoption.

Timeline:

Summer 2006
- Design and completion of University of Colorado Digital Library web site
- Methods of authentication and authorization for Luna Insight collections established and operational

Fall 2006
- University of Colorado Digital Library web site launched
- Rollout of current digital collections in Luna Insight; includes publicity, training, and instruction

Spring 2007
- Digitization and metadata standards completed

Spring 2007 to Fall 2009
- Identify the culture, critical issues, and costs of long-term technical support of digital archives
- Surveys and focus groups identify existing and potential digital collections appropriate for Luna Insight software, and the software needs of specialized collections requiring unique functionality
- Study feasibility of federated searches

Primary Person Responsible:

For libraries: James F. Williams, II, Dean of University Libraries
For academic units: Bobby Schnabel, Vice Provost for Academic and Campus Technology

Evaluation of Achievement:

The first part of the Digital Asset Management project will be successful if all items listed in 1 and 2 of the “Specific Steps” section are completed by May 2007. These include the launch of the University of Colorado Digital Library, with authentication and authorization methods in place for Luna Insight collections. Evaluation of the achievement of the remaining tasks listed in items 3 through 6 in the “Specific Steps” section will occur in the 2010 IT Strategic Plan.

1.5.2 Digital Repositories: Institutional Repositories (IR)

Major Issue: CU-Boulder needs to create an institutional repository (IR) to store, manage, preserve, and provide access to the intellectual output of the CU community.

A. Background/Rationale:

Escalating journal subscription costs, the slow dissemination of print-based research, and the pressing need for preservation of born digital research are all contributing to a crisis in scholarly communication. Universities around the country are responding to this crisis by creating institutional repositories, digital archives of the intellectual output (e.g. peer-reviewed articles, conference proceedings, data sets, research papers, electronic theses and dissertations) of an academic institution. In "Institutional Repositories: Essential Infrastructure for Scholarship in the Digital Age" (http://www.arl.org/newsltr/226/ir.html), Clifford Lynch describes the role of an IR:

> "... [A] university-based institutional repository is a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the institution and its community members. It is most essentially an organizational commitment to the stewardship of these digital materials, including long-term preservation where appropriate, as well as organization and access or distribution. ... [A] mature and fully realized institutional repository will contain the intellectual works of faculty and students--both research and teaching materials--and also documentation of the activities of the institution itself in the form of records of events and performance and of the ongoing intellectual life of the institution. It will also house experimental and observational data captured by members of the institution that support their scholarly activities."

Institutional repositories benefit the academic community by providing broader access to research in a timely manner, raising scholars' visibility, and showcasing an institution's intellectual assets. IRs also serve a critical preservation function: safeguarding an institution's digital research output, including ancillary materials such as data sets.

Establishing an institutional repository requires a new paradigm. Traditionally, professional advancement is tied to publishing models in which authors relinquish copyrights. The academic community must advocate for the right to self-archive, encourage publishers to support open access initiatives (http://www.soros.org/openaccess/read.shtml), and consider alternate publication models when evaluating scholarly merit. At the local level, the university must establish the services, policies and architecture necessary to support self-archiving of research materials. Advocating for new publishing models and establishing the needed infrastructure will require the support and participation of the teaching faculty, librarians, and administrators.

B. Accomplishments to date

Building on its traditional role as the repository for print scholarship, University Libraries has taken the lead in laying the foundation for an institutional repository. The Dean of University Libraries is working with the Boulder Faculty Assembly to pass an Open Access Resolution which explicitly recommends the establishment of an institutional repository called CU Scholarship.

University Libraries is also working with other members of the Colorado Alliance of Research Libraries to evaluate IR software and investigate infrastructure issues. The Alliance's implementation team is close to completing a document with recommended directions and specific technical solutions.

C. Specific Recommendation

The campus will establish an institutional repository—CU Scholarship—to manage, provide access, and preserve the university's scholarly output. In partnership with the faculty, ITS, and administration, University Libraries will take the lead role in providing the necessary services and managing CU Scholarship.

D. Resource Allocation

Discussions about resource allocation and funding models are in the initial stages. However, the Alliance IR study suggests a medium impact (*20k-80k, as defined in the ITS-SP template*) on resource allocation. The business model will require start-up funds and on-going maintenance costs, no matter which platform is selected.

E. Action Plan

Short Term: Implement an institutional repository at the University of Colorado, Boulder.
Long Term: Promote scholarly contributions to the IR; Assess the effectiveness of the IR's services, architecture, and policies, as well as its overall impact.

<u>Specific Steps</u>

- University Libraries is currently:
  - Investigating IR software and developing an implementation plan
  - Identifying needs for supporting architecture
- Establish a committee to:
  - Develop policies regarding the submission, management, and preservation of IR content
  - Work with faculty to raise awareness, address potential concerns, identify IR content, and establish simple and effective models for contributing scholarly materials to the IR

<u>Timeline:</u>

- 2007 Propose IR model to campus
- 2007-2008 Implement IR

Primary Person Responsible

James Williams, Dean of University Libraries

Evaluation of Achievement

Perform an assessment in 2009 to determine the effectiveness of CU Scholarship's services, architecture, and policies, as well as its overall impact.

1.6 Student Mobile Computing

Major Issue: CU-Boulder needs to determine if a student laptop requirement or recommendation will enhance learning opportunities inside and outside of the classroom, and will be in the best interest of students; the campus must also determine what impact such a requirement or recommendation would have on teaching, faculty and student support, classroom facilities, and policy.

A. Background/Rationale

Upon the recommendation of the 1998 IT Strategic Plan, CU-Boulder commissioned a group of students, faculty, and staff to determine if the campus should have a computer ownership requirement or recommendation or neither for students. That group determined that it was in the best interest of students and the campus to strongly recommend that students bring a personal computer to campus with them, if this is financially feasible. At that time, student computer ownership was approximately 75%. Students could and still can increase the amount of their financial aid packages (primarily through loans) to cover the cost of a computer.

Beginning in 1997, the annual Resident Hall Advisor Survey has included questions about student computer ownership and use of campus computing and networking resources. Respondents to the survey are primarily freshmen. Longitudinal analysis of these and other student survey data shows a significant change in computer ownership over the past several years. Overall ownership rate has held steady at around 95-98%, while the percentage of students who own laptop computers has steadily increased to its current level of 75%. Few students, however, bring their laptops with them to class.

With laptop ownership already high, and with financial constraints restricting the funds that the campus could invest in laptop carts for in-class use, it is time for the campus to decide whether to leverage student computer ownership through a laptop requirement or recommendation.

B. Accomplishments to Date

In early summer 2006, orientation directors (primarily juniors and seniors) met to discuss the possibility of a laptop recommendation or requirement or neither for students. The group was decidedly against a requirement, because of the additional burden that could place on low-income students, but reached no firm conclusions about the benefits or disadvantages of a laptop recommendation.

ITS publishes a set of computer purchase recommendations for students, which could be used as purchase guidelines in the case of a laptop requirement or recommendation (see http://www.colorado.edu/its/recommendations/machinesr.html).

C. Specific Recommendations

- Establish a working group of students, faculty, and staff to determine if the campus should institute a laptop requirement or recommendation or neither; background research should include an evaluation of the benefits and disadvantages of laptops and other wireless mobile devices with respect to teaching and learning.

- Work with FACE-IT (and Legal Counsel, if necessary) to develop and communicate necessary policies or guidelines for students and faculty, including those to provide guidance about requiring laptops or restricting their use in classrooms, either with a requirement or recommendation in place, or in their absence (in the instance of locally requiring or restricting laptop use in classrooms).
- Work with ITS to determine impact of any requirement or recommendation on facilities and support.
- Track student computer ownership, as well as use of laptops in teaching and learning (both formal and informal learning, working with Directors in Student Affairs for evaluation of laptop use in informal learning).

D. Resource Allocation: none

CIO staff will conduct research and manage the process associated with determining if the campus should have a student laptop requirement or recommendation or neither and with communicating decisions to appropriate student, faculty, staff, and parent audiences.

E. Action Plan

Short Term (fall semester 2006)):
- Commission working group of students (including UCSU and RHA representatives), faculty, and staff (including ITS and Student Affairs representatives)
- Undertake background research for working group
- Determine and communicate working group decisions to students, faculty, and governance groups

Long Term (spring semester 2007):
- Work with Admissions and Housing to communicate decision to incoming freshmen
- Work with faculty group and possibly Legal Counsel to determine and implement policy or guidelines (as appropriate)
- Work with ITS to determine and prepare for impact of decision on technology-enhanced facilities and centrally-provided support

Primary Person Responsible

Marin Stanek, Office of the CIO

Evaluation of Achievement

- Initial evaluation of the benefits and disadvantages of laptop and other wireless mobile computing devices with respect to teaching and learning prior to making any recommendations.
- Continued tracking of student computer ownership to determine impact of any recommendation or requirement on ownership rates
- Implementation of additional surveys of students and faculty to gauge use and effectiveness of laptops in teaching and formal learning. Any evaluation of laptop use should be part of a broader effort to evaluate technology use in learning and teaching overall (see section 1.6).

1.7 Assistive Technology

Major Issue: CU-Boulder should ensure the accessibility of all computer-based information technology and electronic information resources on campus through the integration of accessible computer stations into campus computing labs; the continued maintenance of current "satellite" stations; improved communication, procurement, training, and collaboration about accessibility issues.

A. Background/Rationale

Assistive technologies effectively lower barriers for students with disabilities and make campus resources accessible to them. Although CU-Boulder strives to meet the requirements of Section 508 of the Rehabilitation Act, which requires all federal agencies to make their information technologies accessible to people with disabilities, the campus lacks both a champion and a culture that would move the campus toward the full accessibility of technology and information resources. Instead, attempts to ensure accessibility are often characterized by adversarial relationships, rather than cooperative, leaving little energy and resources to influence vendors directly or through consortia.

Currently, students with disabilities have access to a few computing stations in the Assistive Technology lab and a few "satellite stations" in computer labs around campus that are equipped with the text enlargement, scanning, and screen reading capabilities and headphones needed for students with visual, physical, or learning disabilities. There is no formal process in place to guide procurement of new information technology applications to ensure that they are accessible, and little communication about availability or need for accessible technologies at the departmental level or in classrooms.

B. Accomplishments to Date

The campus continues to provide a base-level of assistive technologies in the Assistive Technology (AT) lab and at three sites around campus. A fourth site will be in the ATLAS Building, scheduled to open fall 2006 and a fifth station is being discussed for the new Wolf Law Building. The AT Lab is operated and staffed by Disability Services. Assistive technology satellite stations are jointly run by Disability Services and ITS, with improved communications between the two units over the past four years. The AT Lab continues to offer guest lectures and workshops on Web accessibility to classes on campus, when requested, particularly the Web design class at the business school. Brown bag seminars on "Making Web Pages Accessible," have been discontinued because of lost staffing and increased workload at the AT Lab. However, the annual "Accessing Higher Ground," a national conference hosted by CU-Boulder, affords campus IT professionals and web developers workshops for learning about assistive technologies and making information resources and web pages accessible to people with disabilities.

The campus's Web Publishing Policy specifies that "all electronic publications, to the extent feasible, must be made accessible to people with disabilities," yet this policy is not widely known or communicated on campus.

C. Specific Recommendations

- Integrate assistive technology and physically accessible computer stations into campus computer labs, while maintaining joint management between ITS and Disability Services.
- Develop a training module for supporting AT on standard and adaptive stations and integrate this training and support for AT into the 4-Tier IT support structure so that the ITS help desk can provide basic support for these applications.
- Continue to maintain existing, higher-end assistive technology stations, while exploring ways to better support the use of personally-owned devices.
- Explore the built-in accessibility tools native to MacOS (as long as headphones are available).
- Exploring possibility of providing laptops with accessibility software to students who need them as a supplement to other accessibility strategies
- Ensure the accessibility of web and IT resources, including
    - E-Reserves
    - WebMail
    - Clickers
    - WebCT and/or other learning management systems
    - Course materials
    - Computer classrooms (especially physical access)
- Establish accessibility standards for computer labs and classrooms. Publish these standards & guidelines on the UCB Web site.
- Work with national groups such as EDUCAUSE and CIO groups to influence vendors to produce high-quality products that are also accessible to people with disabilities.

D. Resource Allocation: $35,000

.5 FTE for additional Disability Services staff for maintenance of satellite stations, development of strategic communication plan, development and implementation of evaluation plan, and joint development of procurement, testing, and training processes.

E. Action Plan

Short Term (one to two years):

- Identify a champion for assistive and accessible technologies from within the upper levels of the campus administration.
- Develop strategic communication plan to raise awareness of accessibility issues, noting the possibility that new technology adoption can have unintended and negative impacts for students with disabilities.
- Investigate models for integrating assistive technologies into or leveraging existing computer lab load sets.
- Develop evaluation plan to determine effectiveness of implementing recommendations.

Long Term (two to four years):

- Establish strong policy requiring accessibility of all information technologies and resources on campus and/or reasonable, appropriate, and adequate accommodations in cases where accessibility is unattainable.

- Galvanize national group to influence accessibility of information technologies at the vendor level.
- Consider participation in national consortiums, such as those coordinated by UIUC, to improve the accessibility of products such as WebCT. (http://www.cita.uiuc.edu/collaborate/).
- Establish a process for procurement, usability/accessibility "testing", IT professional training (including both concepts and tools).

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic and Campus Technology

Evaluation of Achievement

- Usage data from satellite stations and accessibility features of stations in computer labs.
- Surveys of students who self-identify as users of assistive technologies show increased usage of and satisfaction with assistive technologies and improved accessibility of and satisfaction with other campus information resources and educational technologies.
- Surveys of ITS staff and departmental IT professionals show increase awareness and acceptance of assistive technologies and needs for making information and educational technologies accessible. In addition, tactical plans should reflect this increased awareness.

Chapter 2: Data and Voice Networks

CU-Boulder's data and voice networks are a strategic resource for faculty, students, and staff, providing the virtual backbone for all campus communication. Maintaining and expanding these resources appropriately is an ongoing strategic effort.

The first section of this chapter outlines next steps in developing a new data network funding model that covers the annual costs of the data network and includes sufficient renewal and replacement costs associated with the network. The current date network funding model, developed in FY2000, is a pay-per-jack model, which is now outdated, considering the current high and anticipated pervasive use of wireless on campus. The findings from this subsection suggest that a campus-wide committee be formed to study and adopt a new model. The committee should consider various solutions such as a usage/utility model or a "common good" solution to provide sustained funding for the data network.

The second subsection in this chapter discusses next generation telephony and the immediate need to decide what functionality and services a new telephone service should provide. The current telephone system was purchased with a bond that will be fully repaid in 2008, making the next year an opportune time to assess what services are required on campus, and what new infrastructure is needed to deliver and support them.

2.1 Data Network Funding Model

Major Issue: The current data network funding model is inadequate to generate sufficient annual resources to cover annual network costs. In addition, the current pay-per-jack funding model does not recognize wireless connections in the cost recovery calculations. To address these issues, a Network Funding Task Force should be commissioned to investigate and propose a robust and scalable data network funding model that addresses current and future data network funding challenges.

A. Background/Rationale

The data network is an increasingly strategic service that faculty, students and staff rely on to fulfill the mission of the university; achieve coursework; conduct research, and carry out essential business for the continued operations of the university. A network that is reliable, mobile, fast, and state-of-the-art by providing ease-of-use and mobility is expected by all members, and at all levels of the university.

The current data network funding model is structured around a pay-per-jack scenario. It also includes a differential price structure (e.g. alliance fees) that allows certain entities (e.g. Housing, ITS, JILA, LASP, etc.) to obtain access to the network, while maintaining their own departmental networks. Non-alliance fees include access to, and service provided by, ITS. These users include schools, colleges, other general fund units, and auxiliary units. The pay-per-jack model was adopted in FY2000 and functioned reasonably well.

In 2002 the Chancellor invested $3M in the network remediation project that included a complete replacement of the campus network electronics. This was the first time the campus invested strategic resources in the campus network, recognizing the strategic value of ubiquitous networking for students, faculty and staff. The impact of this project was significant; resulting in markedly higher network performance, reliability and security.

Funding for network improvement, and specifically wireless, originally was approved in the FY2000 program plan from the state capital construction funding, but was retracted in FY2004 due to a state budget crisis. Students, during a historical referendum, voted to help fund the construction costs for several new buildings as well as establish a wireless network throughout the majority of the campus. Because of this one-time infusion of funds, implementation of the wireless network should be completed by December 2006. When completed, the campus will see an increase in wireless service from 29% coverage to 100% coverage of general fund buildings. In addition to this increase in coverage there will be a variety of improvements that will affect both new and existing wireless service. These security enhancements include the implementation of network access controls, authentication improvements and improved roaming in high-density environments.

Now that wireless is a viable network solution for some individuals and departments, a concern exists that those who needed minimal services will unplug their network jacks in favor of wireless, perceiving it as being “free.” If, under the current data network funding model, numerous individuals and departments eliminate their wired

connections for wireless, the revenue stream will quickly erode, jeopardizing the current level of service and reliability; therefore, it becomes clear that in this environment the current pay-per-jack funding model is not viable and an updated funding model must be developed.

B. Accomplishments to date

ITS, the provider and manager of the data network, worked to continuously improve the network by: 1.) securing the network by segregating it into network zones and providing a campus-wide firewall; 2.) increasing the wireless data access points from 400 to approximately 1100 access points (anticipated by the Fall of 2006); and 3.) upgrading data switches on campus to improve reliability, provide greater port-based controls over usage, and power over Ethernet capability.

C. Specific Recommendations

The Vice Provost for Academic and Campus Technology and Senior Vice Chancellor for Budget and Finance should commission a Network Funding Task Force that:

- reviews various data network models that peer institutions have successfully adopted;
- develops a reasonable data network model for CU-Boulder; and
- proposes it to the executive staff during the 2006-2007 school year.
- the updated network model is implemented during the 2007-2008 school year.

The model should:

- cover the complete cost of the data network (The complete cost will be clearly identified and documented by the task force.)
- be based on criteria that is reasonable and clear
- include adequate security
- offer a basic suite of data networking services for all university members (The basic suite of services will be determined by the task force.)
- include appropriate renewal and replacement costs

D. Resource Allocation

Cost of project: The cost of investigating peer institutions' funding models and developing a new model will be absorbed by existing staff time. The cost of implementing a model (e.g. changes or updates to a new billing system) is undetermined at this time. Ideally the updated model will impose a fee structure that does not materially affect negatively the budgets of current department network customers; therefore the impact will be minimal.

E. Action Plan

Short Term: Commission the Network Task Force to complete the study and forward recommendation.

Long Term: Adopt a sustainable and scalable data network funding model that provides an adequate and secure level of annual resources to cover annual network operating costs, maintenance costs, and plans for future growth and enhancements in order to

continue to raise the status of CU-Boulder as a top public research, teaching and learning institution.

Specific Steps and Timeline

1. Commission the Network Task Force – Summer 2006
2. Review peer models, collectively understand the current funding and anticipated shortfall – Summer 2006
3. Develop the updated model, test and revise – Summer 2006
4. Communicate to the affected parties, revise – Summer 2006
5. Propose model to the executive staff – Fall 2006
6. Executive staff adopts a model and communication to the vice chancellors, deans and other high-level administrators occur – Winter 2006
7. Campus-wide communication regarding the new model occurs prior to fiscal planning – Spring 2007
8. New model fully implemented – July 2007

Primary Person(s) Responsible

Bobby Schnabel, Vice Provost for Academic and Campus Technology, and Ric Porreca, Sr. Vice Chancellor and Chief Financial Officer.

Evaluation of Achievement

Data networking is an expensive investment; however, so essential to the universities day-to-day operation that it must be viewed as a strategic resource. Steps need to be made to ensure that the network is meeting the needs of faculty, students and staff. This translates into real costs that squeeze already-tight budgets. It will be important to evaluate the new model to determine the level of satisfaction the university community has regarding the network versus the trade-off of using those dollars for other equally critical budget item.

It is recommended that a review of the data network model be performed by Planning Budget and Analysis within one year of adopting the data network model to determine if the level of funding appropriately matches the service, security, and renewal/replacement needs determined by the campus and/or if additional modifications are necessary.

2.2 Next Generation Telephony

Major issue: Over the past ten years, the campus, and indeed the world, has seen a dramatic shift in the how people use the telephone, and expectations of customers are evolving toward more mobile and enhanced services. The most major change is growing interest and dependence upon mobile telephony services. Related expectations include anytime and anywhere services, customized preferences, and enhanced services such as paging and text messaging. Over the next four years the campus needs to addresses these telephony services challenge while leveraging the solid telephony infrastructure and support services currently in place.

A. Background/Rationale

For the past 20 years the campus has utilized a solid telephony system that was designed to meet campus office requirements as well as residential requirements. The fixed-line system was deployed with basic telephone features and voice mail. In addition, the system supports call centers all over campus to meet the needs of high volume telephone applications. Today, many campus customers have business cellular phones to handle their mobile communication requirements. Students in particular rely upon cellular phones as their primary communication device. The features and mobility of cellular service are important to recognize as essential requirements of any next generation telephony solution.

Thus, ITS should be commissioned to develop telephony services that incorporate the features that customers desire, are flexible so that as new features and capabilities are developed by the industry, they can be quickly offered to our customers, and which will accommodate the strong demand for the convenience of wireless phones. This must be done in conjunction with the significant fixed-line telephony capabilities that will be required to support the business of the campus for many years to come.

The current telephone system was purchased with a bond that will be fully repaid in June, 2008. This is an opportune time to commission an analysis effort to assess what services are required on campus and what new infrastructure and skills may be required to deliver and support these services. The telephony funding model has been developed as a full recharge service center, and, any future solution should consider various funding options.

B. Accomplishments to date

As mentioned in the 2002 Strategic Plan, telephone services have held largely steady over the last 20 years. The current cost of fixed-line services compare favorably with comparable services such as Qwest's enterprise class services. There have been minor services changes over the years, such as Caller ID and E911 services. The core processors for the telephone system have been upgraded so that the system is easier to maintain, and the cost of PBX maintenance has been reduced by "in-housing" portions of the maintenance activities. The system upgrade included the capability to support Voice over the Internet Protocol (VoIP) telephones with that new system hardware. ITS has also done a very limited pilot of VoIP equipment from CISCO; the limited scope of the pilot provided exposure to the technology but was not sufficient to analyze the solution in the context of a campus the size of CU-Boulder.

C. Specific recommendations

The campus should engage in a comprehensive requirements analysis in 2007 to understand campus telephony needs, appreciating both the fixed and mobile requirements. The analysis should address departmental requirements as well as students living in the resident halls and family housing.

The analysis should also address the possibility and capability of integrating traditional telephony systems with data networks, the broad array of messaging systems, video services and application services. The potential of efficiently integrating these services is real and represents effective enhancements to support the mission of the campus. The appendix at the end of this chapter represents many areas that should be examined as part of this analysis.

D. Resource Allocation

Funding for some of these developments is already included in the existing Telecommunication Auxiliary budget.

E. Action Plan

Short term: (12 months)

- Begin requirements analysis for next generation telephony. It is anticipated this process will take 12-18 months.

Long Term: (36-48 months)

- Specific Steps: Establish an implementation project for the next generation telephony system including all integrated services
- Timeline: The system conversion should conclude no later than 2010.
- Primary Person Responsible for Action: This should start in the Architecture group of ITS.

Appendix A: Topics for further study

Integrated messaging

- Blending of voice mail with e-mail, both accessible from customer's computer or telephone.
- Elimination of the need for FAX machines.

Mobility

- Within an office or building:
    - Bluetooth headsets
    - Cordless phones
    - 802.11 Voice over wireless LAN
- Across campus and beyond:
    - Cellular service - Partner with one or more service providers

Telecommuting support

- Allow the appearance of office telephone numbers at home or on the road.

Reduce service prices, possibly including:

- Free long distance
- Bundled services, similar to many service providers

Richer set of telephone features
- Call history
- Directory access via the telephone
- Web access via the telephone
- User control of telephone configuration
- Color display
- Customizable display, either from the customer's department or from ITS

Develop new revenue producing services, yet competitively priced.
- Advertising or important information on the telephone display
- Could market space on phone to housing or athletics for example.

Philosophical change in providing more services and options to the customer.

Video conferencing
- Some phones can have cameras, just like many cellular phones.
- Customer's computer is also a likely end-point for a video conference.
- More video phones and video conferencing appliances are available.

Life/Safety issues
- There is an expectation that a telephone will always have service available, even when the power is out, and particularly when calling 911.

- There is also the expectation that the customer's location will be automatically provided to the Public Safety Answering Point. It is imperative that the next generation telephony system should support both E911 and reverse 911

- There is also a less widely held expectation that the telephone system can be used to call large numbers of geographically selected customers to deliver a recording pertinent to some emergency (aka, Reverse 911).

Chapter 3: Communications: Email, Workflow & Web

Electronic communication in various forms has become fundamental to campus faculty, staff, and student users. Use of email for communication has been commonplace for many years and typically an assumption is made that “everyone” has campus email service; however, only students are currently provisioned an email account and required to read it as part of the official email policy. A gap exists for faculty and staff who may not have campus email accounts or may use departmental systems that are not registered in the campus email directory. The first section in this chapter includes a recommendation to extend the official email policy to campus faculty and staff and ensure they are automatically provisioned campus email service and receive official communications. It also recommends further centralization of email accounts to improve security and efficiency.

The next section in this chapter addresses the increasing demand for online workflow, typically seen primarily as a means to improve business processes. Moving an existing paper-based process to online can improve speed, make tracking easier, and facilitate quick information retrieval. Online processes are not without risks; security is a major concern. Online services must be developed to ensure data integrity is maintained and the participants are properly identified. Another source of concern is data retention and access years after technology has changed and retrieval becomes difficult. This section recommends the campus work in concert with the University System to develop policies that address records retention; evaluate benefit and risk of moving workflow online; continue leveraging existing infrastructure such as the CUConnect portal to deliver online services; and pay careful attention to technologies being introduced by Microsoft that facilitate workflow and to the Student Information System replacement project which will have major impact on campus processes.

Web content management is the last section in this chapter and recognizes the mix of central and distributed responsibility for provision of information on the campus. Needs identified here include strengthening the campus server infrastructure that provides the “home page” for the campus; creating more comprehensive policies that address security and privacy, technical and graphical standards, and accessibility; and providing a broader suite of training and support for web development and management. The most striking recommendation of this section calls for implementing a web content management system. Such a system would provide standardized software tools to facilitate distributed website management and would enact change management and control. The scope of web content management as defined in this section covers official content from schools, colleges, and individuals but excludes personal content.

3.1 E-mail Policies and Efficiencies

Major Issue: Electronic communication has become essential to all academic and business activities. E-mail service is not universally available and lacks overall coordination and oversight. New technologies have emerged that should be incorporated into an overall strategy for delivering information to students, faculty, staff, and interested community members.

A. Background/Rationale

University administration and faculty can depend on using e-mail to communicate with students as a result of the designation in 2000 that e-mail is an official means of communication for students. That designation resulted in automatic provisioning of university e-mail accounts for students and delivery of e-mail to students through e-memo, buff bulletin and the faculty toolkit in CUConnect. Access for faculty and staff is uneven; central e-mail service is available upon request to all employees but accounts and e-mail addresses are not automatically provisioned. Furthermore, many units operate their own e-mail servers and e-mail address information for their users may not be reliably available to the campus electronic directory. Distributed management of Exchange servers poses a risk in that a compromise or a server failure in this environment can potentially disrupt service for every server. In terms of features, both mobility and a tight integration of e-mail and calendaring are desirable for administrative use. For students, who typically carry cell phones to campus but not laptops and are heavy users of email and text message, mobility is particularly important.

In addition to e-mail, other communications methods are used in a variety of ways but lack an overarching strategy. The portal announcement channel can be used to deliver urgent information to the entire campus but is often overlooked; instant messaging and group collaboration tools are being used in an ad-hoc manner but are not provided centrally; and departments are constructing and delivering bulk e-mail independently of campus mechanisms, sometimes straining resources or failing to reach the desired target audience. Resources are being spent in a distributed manner on campus without regard to coordination or efficiency and reliability considerations; during a crisis, such as a natural disaster or health emergency, this may disrupt the ability of campus executives to respond effectively.

B. Accomplishments to date

Central e-mail services have become more secure, reliable and robust; messages sent inbound to "@colorado.edu" are scanned for viruses and spam and all authentication to central e-mail servers is encrypted. A premium Exchange e-mail and calendaring service is provided on a cost-recovery basis to more than 500 administrative subscribers and an enhanced web-based e-mail and calendar service will be available to all campus constituents by fall 2006. A single portal interface delivers both general and role-specific news and information to all Boulder students, faculty, and staff.

C. Specific Recommendations

E-mail should be considered a utility service provided centrally by the campus to all designated affiliates. The need for premium service that provides e-mail, calendaring,

and mobile access should be recognized and delivered in a cost-effective manner. The number of e-mail servers should be minimized in order to take advantage of economies of scale and improve security and limit reliance on departmental staff whose workload is too heavy. E-mail for all high-level campus administration should reside on the same e-mail server to facilitate day-to-day and emergency communications. The decision to operate a distributed Exchange server should be made at the campus executive level in order to safeguard campus-wide service.

Bulk e-mail delivery should be enhanced to ensure the desired target audience is reached and to allow customization of format and delivery mechanism based on user preference. An overarching strategy for electronic communication should be developed that considers the variety of tools and methods available (such as CUConnect, online newsletters, and web sites) and resources should be allocated to implement and support effective communication tools. Outsourcing of basic services should be considered as providers become available and response to concerns such as FERPA privacy and Open Records Act compliance becomes known

D. Resource Allocation

Cost of the project: low-to medium overall campus cost
Cost for developing policies and standards is low; adoption of centralized e-mail will have limited overall campus impact but will affect individual unit budgets as costs are shifted.

E. Action Plan

Short Term: Develop and implement policies
Long Term: Enhance communication tools, investigate new technologies, and monitor demand and enhance services to respond to changing requirements

Specific Steps

- IT Council should oversee development of policies and standards for use of electronic communication tools and delivery mechanisms that:
    - designate of e-mail as an official means of communication for faculty and staff
    - require centralization of Exchange servers for executive staff
    - require CIO/Vice Chancellor approval for operation of distributed Exchange servers for non-executive staff
- ITS should research campus demand for new tools and technologies and incorporate them where appropriate; this will include bulk communication tools (e-memo, buff bulletin, listservs, mobile communication and calendaring)

Timeline

- Fall 2006 –development of policies (official e-mail; centralization of servers) and standards
- Spring 2007 – ITS and Mailing Services to improve bulk communication tools (e-memo and buff bulletin)
- Spring 2007 – ITS to investigate other communication and collaboration tools, such as listservs, forums, and instant messaging

- Fall 2008 – ITC and ITS to review potential for outsourcing basic e-mail services

Primary Persons Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology and
Dennis Maloney, Executive Director, ITS

Evaluation of Achievement

Conduct an annual review of the number of e-mail servers and non-central subscribers; continue to evaluate and improve security on distributed servers; annually evaluate changing technology and subscriber needs.

3.2 Technologies to Improve Workflow

Major Issue: Documents and materials are often routed electronically for review, collaboration, approval, and archival without regard for delivery accuracy and receipt; security and access control; and legal requirements for retention and destruction. With the judicious use of technology, business processes could be accomplished more effectively and more expeditiously but University policies and business practices would need to be examined and re-engineered to successfully implement a robust workflow solution.

A. Background/Rationale

Workflow may be defined as the execution of tasks in a business environment according to procedures and includes the task structure, execution, timing, interdependencies, and monitoring.
Numerous business processes currently rely on paper document processing, which can be slow as documents are routed from person-to-person for review and approval and can easily be disrupted if documents become lost on a desk or when misfiled. In addition, paper storage can become voluminous; documents in hardcopy form are difficult to search; and if the electronic original is lost, are tedious to update. Online workflow can facilitate process improvements as well, such as coalescing multiple sources of data into a single repository and allow progress tracking and automated alerts. However, many staff are used to and comfortable processing paperwork and prefer the sense of security of having something “in hand.”

E-mail is often used, at least informally, for electronic routing and approving of tasks. However, e-mail can easily be spoofed (made to appear to originate from someone else), lacks delivery assurance and tracking, and can be forwarded, retained, or destroyed at will without regard for policy requirements. Electronically signed e-mail is a technology that could leverage the widespread availability and convenience of e-mail to facilitate workflow. Doing so will require building an infrastructure that performs authentication of senders and guarantees the integrity and privacy of the message transmitted. This infrastructure would most likely rely on a Public Key Infrastructure (PKI) framework and would also require the use of suitable e-mail clients.

Campus departments often see a need to streamline workflow that was originally designed to handle paper documents. They seek the speed of electronic transmittal and the ease of searching a virtual file cabinet for a document based on characteristics such as its name, contents, creator, or creation date. A few examples of both administrative and academic forms and workflow that are potential candidates for online workflow include: time reporting, leave requests, travel vouchers, ACard reallocations, performance plans and evaluations, conflict of interest policy compliance, faculty course questionnaires (FCQs), and semester grade submittal.

Several areas must be addressed when adopting electronic workflow. Security is a major concern: signers must be authenticated; the integrity of materials that have been signed must be ensured and safeguarded from alteration and tampering (this includes both the document and signature); privacy must be assured (no one other than authorized individuals may view the document); and auditing should provide confirmation of relevant facts about the signing and who has accessed the document (for read and/or write). It should be understood that documents have varying requirements for security; materials

that lack sensitive information may warrant lighter security controls than those that contain personally identifiable or sensitive information such as social security numbers, student grades, or employee hours worked.

Another concern is archival and retention – electronic documents must be stored, must be retrievable and viewable, and authenticity and integrity must be verifiable throughout the retention period. The quick pace of technology change may make it difficult to retrieve, view and verify documents for the duration that is required by law or regulation, as storage media and devices to read the media become obsolete long before the retention period has expired

There will be pressures to implement workflow in the coming years at both campus-distributed and university-central levels. Microsoft will include embedded workflow in its new operating system and Office 12 application suite. Whatever system is chosen for the new Student Information System (SIS) will have considerable embedded workflow.

B. Accomplishments to date

A necessary precursor to electronic workflow is sound user identity verification and authentication; when someone signs a document, there must be reasonable assurance the individual is who he/she claims to be. ITS has adopted Identikey as the campus-wide authentication standard. All students are issued Identikeys and they are available to all faculty and staff. The Identikey has been strengthened to require a more secure password and plans are underway to provide a secure alternative means of verifying identity (needed to initially acquire or reset a forgotten password).

A CU-System committee has formed to examine document retention requirements, though the scope is limited to hardcopy materials. Another group at that level is working on legal, policy, and technical requirements for electronic routing and electronic signatures.

Numerous forms and workflows have been made available through CUConnect, including iVote (student voting application), Boulder Faculty Assembly voting pilot, student financial aid application, application for Housing (a redirect to a Housing-run application), student address update, Registrar workflow (drop/add and course forgiveness requests; in progress), and Faculty Report of Professional Activities (FRPA; in progress).

C. Specific Recommendations

The campus should work in coordination with CU-System efforts to address policy development regarding streamlining workflow and records retention. The campus should identify forms and workflows that could benefit from moving online; categorize them based on their security requirements, potential for efficiency improvements, and ease of implementation; and coordinate with currently proposed online workflows. The campus should examine the various methods for electronic approval and determine what infrastructure should be built to support electronic routing and signatures. ITS should pay careful attention to Microsoft product introductions because of the potential for significant adoption by administrative departments on campus. The campus should pay particular attention to business process impacts of the SIS replacement project.

D. Resource Allocation

Cost of the project: low to high overall campus cost
Cost for developing policies is low; cost to build infrastructure depends on technology chosen – within the existing CUConnect framework, the cost will be moderate and must be coordinated with other CUConnect priorities, but development of a public key infrastructure system to implement digital signatures will be very high.

E. Action Plan

Short Term: Continue developing policies; categorize forms and workflows based on security requirements and benefits of migrating from paper processes to online workflow; continue and expand efforts to implement forms with limited security risk through CUConnect and build workflow applications according to campus IT architecture and security guidelines and in recognition of existing online workflow processes
Long Term: Implement signed e-mail; convert hardcopy-based workflows to online as demand and resources permit; coordinate campus implementation of Microsoft-based workflow activities; integrate the new Student Information System into the campus environment

Specific Steps and Timeline

- Fall 2006 – IT Council to charter ITIAG with identifying and categorizing forms and workflows that are candidates for migrating to online
- Winter 2006 – IT Council to work with CU-System based groups that are defining retention requirements and specifying technology
- Ongoing – ITS to build forms and workflows into CUConnect as prioritized by CUConnect Steering Team as funding permits
- Ongoing – ITS to continue investigating signed e-mail
- Ongoing – ITS to investigate and participate in coordinated implementation of workflow-enabled systems such as Microsoft operation systems, applications suites, and SIS replacement project

Primary Persons Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology

Evaluation of Achievement

IT Council to review work performed by ITIAG and CU system groups. CUConnect team to survey campus constituents regarding processes that could be put online

3.3 Web Content Management

Major Issue: CU-Boulder needs to develop much more comprehensive web hosting and support services to provide a robust, consistent, and well coordinated web presence. The lack of a strong set of centrally provided services has led to a fragmented web infrastructure and significant inefficiencies as departments struggle to overcome this lack of centrally provided services by developing skills and building and managing infrastructure for themselves.

A. Background/Rationale

At CU-Boulder, institutional and departmental web sites serve over 100,000 sessions each day. Academic and administrative departments use the Web extensively to offer services and present marketing information to prospective students; parents; alumni and donors; students, faculty, staff, and administrators; campus visitors; news media; opinion leaders; researchers and academicians; and the general public.

Many of these web sites are highly successful. For example, the primary means of marketing to prospective students has shifted to the Web and over 80 percent of admissions applications received for 2006 were online. Services offered through CUConnect are used by 99 percent of students. Institutional, college and school, and many departmental sites follow CU-Boulder web identity standards and policies.

Over the last decade, however, CU-Boulder's web presence has experienced tremendous, largely uncoordinated, growth. This growth has come without sufficient investment in a comprehensive technical or support infrastructure to meet the web development needs of the campus community. Within the current CU-Boulder web presence, a large number of campus web-based applications and static pages are developed and hosted by individual departments on an ad hoc basis without oversight, coordination, or centrally provided support.

Web infrastructure was addressed in the 2002 IT strategic plan, but inadequate funding for a comprehensive approach and other priorities prevented much action on this plan. A comprehensive web content management, hosting, and support strategy is needed to ensure that web-based content is in compliance with campus web branding, privacy, and security policies, and to gain efficiencies by making it easy for departments to create and manage their own content without having to independently buy and manage infrastructure and develop or hire web site development expertise.

B. Accomplishments to date – if applicable (if the subject area was covered in ITSP2002)

Some infrastructure improvements were made to the central web infrastructure as a result of the 2002 plan recommendations. Specifically, it was moved to a cluster to improve failover capability and disk capacity has been added.

In addition to the recommendations in the 2002 plan, ITS' Managed Services group is offering a hosted web site service for departments who don't wish to manage their own web servers.

Web Identity Standards were approved by the Chancellor in July of 2003. The Web Identity Standards and free templates are online, free individual consultations are available, and brownbag seminars are offered.

CUConnect, the Boulder campus portal for students and employees, launched in January 2004. Departments can use CUConnect to present news and announcements to their employees and constituents.

WebCentral, a site outlining web services, resources and policies, launched in February 2005.

Several policies addressing web development, privacy and security have been developed and are awaiting legal approval.

C. Specific Recommendations

The CU-Boulder web presence is essential to its mission of teaching, research, creative work and public service and contains a complex network of institutional and departmental web sites. Further analysis is needed to fully outline an effective model for the CU-Boulder environment, but following are initial recommendations to improve the consistency and security of the CU-Boulder web presence and meet the needs of web developers:

1. Institute and enforce more comprehensive policies and guidelines for official CU-Boulder websites in relation to security, privacy, technical standards, graphical identity and content, accessibility and URL establishment.

2. Implement a new central web server infrastructure and offer a broader suite of central web hosting and web server and web application management services.

3. Develop a broader suite of centrally provided and generally funded, web development and management support services. Support service must have the capacity to provide proactive outreach to departments and provide training and some one-on-one guidance for managing campus content.

4. Implement a content management system that will increase the efficiency of managing and updating website content but is suitable for the university's highly distributed environment. After further investigation, it will be necessary to choose one of two models:

    - A set of standardized software tools and templates for developing and managing content that will be distributed to website managers.
    - A database-driven system with a suite of tools for staff to manage and maintain website content, including sharing of content across sites and change management capabilities.

    Under either model, these tools should enable following of guidelines and policies for content management. Use of the tools should be well supported through centrally provided support services and they should be provided as part of using any centrally managed web infrastructure.

This strategic plan is specifically focused on managing official campus content, including content of schools and departments. Excluded from scope are:

- Personal content including personal employee or student web pages that are not academically focused or are not related to the mission of the university.

- Personal content that *is* academically focused. This content is increasingly taking the form of blogs and e-portfolios and is covered by section 1.6 of this strategic plan.

It's possible that an implementation of this strategy can also facilitate management of these types of personal content, but doing so is not considered a requirement on the outset. It should be noted that consideration does need to be made on how central web content management services interact and interoperate with these other potential web content services.

D. Resource Allocation

High impact.

Properly implemented, this plan involves three significant investments:

- New central web server infrastructure hardware and software plus infrastructure for bootstrapping a more robust hosting and server management service for departments,
- Training and on-going staffing to provide support services,
- Web content management software site licenses for the campus.

E. Action Plan (short-term: 12 months; long term: 12-36 months)

Specific Steps

Short Term:

- Gather input from website developers on service needs.
- Draft and/or revise policies and guidelines.
- Define features and tools necessary for content management.
- Begin investigating content management solutions that fit the campus environment.
- Specify a new centrally managed infrastructure to replace the existing www.colorado.edu server. Propose short- and long-term migration plans for existing content.
- Begin development of a service plan for centralized, hosting, management and support of campus web sites.

Long Term:

- Select a content management solution.
- Develop a plan and timeline for rolling out the content management solution.

- Formalize and communicate campus content management services, policies and guidelines.
- Implement selected content management system and migration plan.
- Develop and roll-out new services: support and training services for web development and content management; central web hosting and administration services.

Timeline

- Fall/Winter 2006/2007: Gather input from website developers on service needs
- Fall/Winter 2006/2007: Policy and guideline development
- Winter 2006/2007: Research content management software. Specify new web server infrastructure.
- Spring 2007: Draft service plan for web support services
- Summer 2007: Install new infrastructure.
- Summer 2007: Make recommendation for content management campus license
- Summer 2007: Begin communicating web development and management policies and guidelines
- Summer 2007: Draft new service plan for web site hosting and administration services
- Winter 2007/2008: Purchase content management solution and develop support and management services
- Winter 2007/2008: Begin implementation of content management solution
- Summer 2008: Roll out comprehensive web support and management services

Primary Persons Responsible for Action

Dennis Maloney, Executive Director of ITS and the new Associate Vice Chancellor for Strategic Communications

Evaluation of Achievement

Customer satisfaction reviews of centrally provided web hosting, management, and support services.

Measurable increase of compliance policies and standards, including identity standards, and policies on privacy and security. An analysis of compliance would occur before and after the project.

High demand for services.

Chapter 4: Information Architecture & Security

The fundamental question that this chapter seeks to answer is “How do we create a secure IT environment that also ensures the availability of resources in an effective and efficient manner?” Any IT system must still be built with specific business and academic needs in mind. In addition to understanding business needs, it is imperative that risk must be addressed as part of the planning and deployment of any IT system. Without a consistent and unified approach to identifying risk, it will be impossible to achieve adequate safeguards. An accurate inventory which captures both the business criticality of the system and the sensitivity of the data is a prerequisite for the development of both technical and non-technical safeguards and ensure that there are not gaps in implemented controls. To provide appropriate safeguards that are cost effective to reduce risk often means centralizing services, especially if certain components such as services that handle either sensitive data or authentication are in place.

Additionally, this chapter outlines the initiative to develop a unified, IT architecture though building a central data and application service. This would mature the campus’ IT infrastructure and allow for real-time secure data to be accessed by campus departments rather than departments accessing and distributing sensitive data with few downstream controls and accountability. It would also significantly increase security by storing data centrally rather than perpetuating the need for departments to often store information locally on “shadow” systems. Duplication of both personnel and hardware/software by providing central data and application services that includes responsive support services for departments would decrease.

Another aspect to this chapter is ensuring the availability of critical assets, especially in the event of a natural or man made disaster. CU-Boulder needs to develop processes that ensure disaster recovery and business continuity plans are developed, maintained, and routinely tested. The campus must also continue to conduct risk assessment of all departments to determine our areas of greatest exposure.

4.1 Information Architecture and Security

Major Issue: CU-Boulder must develop an information architecture and accompanying set of services that provide for the need of departmental applications to access and create sensitive data, yet enforce much greater controls over how such data is stored and used. Without an enforced architecture and supporting services, there is no relief to the current practice of widely distributing sensitive data with few controls and little accountability with respect to how data is used and handled.

A. Background/Rationale

Many campus applications depend on access to electronic records which contain personally identifiable or otherwise sensitive information. Some of this data is generated and maintained locally by the application or elsewhere within the department, but most business applications on campus also require data from a University primary system, such as the Student Information System (SIS), the PeopleSoft Human Resources System (HR) or the Computer Information Warehouse (CIW). The typical use of this data involves establishing a feed from a primary system, populating "shadow" databases that are maintained locally within the department.

The need for data is genuine, as many applications that best suit a business need are rigid in how they access and manage data. Applications tend to assume an autonomous, application database that stores a mix of data specific to the application and sensitive personal or financial information derived from a source system. For the most part, departments who a data feeds from a source system and maintain data locally understand the sensitive nature of the data and take measures to secure it. In some cases, the department would gladly not own responsibility for a copy of sensitive data if there were a viable alternative. In other cases, the departments express a need for flexibility in organizing and using the data that can only come from keeping a local copy.

There are two significant security concerns in having multiple, autonomously managed stores of sensitive data on campus:

1. There is increased direct risk of a security incident that inadvertently exposes sensitive data. Without better controls, this risk increases in proportion to the number of local databases that are maintained on campus.

2. System-wide data owners establish access permissions and controls for the data that are maintained by the source systems, SIS, HR, and the CIW. When data is exported from these systems to another database, the access controls on the data are not maintained or even known. This leads to a great deal of inconsistency on data access, where it is up to many individual applications to assert their own type of access controls on the data.

In addition to the security implications of managing multiple, application-centric data stores, there are the campus inefficiencies of needing numerous robust and secure database servers distributed across campus to house the data and a large number of highly distributed, skilled staff to maintain these servers.

A new information architecture must be established with the following goals:

- Sensitive data should transmitted over the network as infrequently and as securely as possible,
- The number of copies of any data should be minimized,
- The infrastructure for housing data and the staff skilled in managing database systems should be more centralized,
- The access controls for data should be retained outside the source systems for the data. That is, Jane Doe accessing SIS sourced data through a departmental application should have the same access rights that Jane Doe would have using SIS. This should be enforced at the data access level and not necessarily by the application.

B. Accomplishments to Date

The System wide security policy initiative is establishing data classification standards and policies and procedures for managing data classified as critical or sensitive[6]. This will require that regular risk assessments be performed on systems that house or access data and will place a larger burden on those that manage these systems.

Additionally, the data itself has been "cleaned", removing unnecessary SSNs from copies of the data where it isn't explicitly needed.

C. Specific Recommendations

The recommendation is to embrace the direction of the System wide IT Security Office (ITSO) with regard to policies and procedures for data access and management. These will be supported by creating central data services that enforce the policies and procedures through a managed information architecture.

Specifically:

- The System ITSO must follow through on data classification policies and procedures and effectively communicate them to the campus,
- The System ITSO, in cooperation with the Boulder Campus IT Security Office (within ITS), must enforce policies by assigning accountability for managing data according to policy,
- The policies must include not only data owner consent to use data, but data owner specification on access roles and rules regardless of how the data is accessed,
- CU-Boulder, working with UMS, should design and document an information architecture that:
- Identifies authoritative sources of data,
- Establishes acceptable methods and conditions for exporting or otherwise making data available to applications that require it,
- Establishes methods for ensuring that access rights established in the source systems are retained even if the data resides external to the source system.

[6] Draft APS 131 requires classification of all information assets. Critical data is defined as being essential to the mission of the university or having life/safety implications, sensitive data is defined as being either protected by state or federal statute or data the university places access restrictions upon.

ITS, in cooperation with UMS, must vastly improve the data services available to CU-Boulder departments. Centrally provided data services should include:

- Support and consulting knowledgeable on the data, who owns it, what policies apply, and what options are available to accessing it,
- Development and operations of secure data services that implement the information architecture and allow for greater central management and control over sensitive data in order to mitigate security risks. Access to this data will be provided in an efficient and secure manner that supports legitimate downstream business functions.
- Continual improvements to central reporting and analytics services so that demand for raw data for these purposes is reduced (along with concern over misinterpretation of data).
- Continual improvements to real-time access of data from source systems via Web Services, SQL Queries or a service bus architecture.

A critical success factor is that an inventory of current consumers of data must be taken and we must understand the business processes that result in a need for the data. This is necessary input for the design of the information architecture.

D. Resource Allocation

The resource allocation requirement of the proposed plan is **high**.

The policy and procedure recommendations are underway and require no additional investment.

Developing an information architecture is a significant undertaking that can be done with existing personnel, but only with prioritization that will certainly impact other important campus and system-wide initiatives. It is imperative that UMS assume a leadership role in establishing a scaleable information architecture.

Implementing the architecture through centrally provided data services will require a substantial investment in both infrastructure and skilled personnel.

There will be efficiencies realized by the campus in being able to consolidate database infrastructure and personnel.

It may be that certain tailored data services should be provided under a cost-recovery model.

E. Action Plan (short-term: 12 months; long term: 12-36 months)

Short Term:

- Work with System ITSO to ensure policies and procedures adequately address accountability for data managers and compliance with source system access policies,
- Inventory “shadow” data stores and understand the business need behind them,
- ITS deploy secure managed data services per ITSP section 4.8

Long Term:

- Design, document, and communicate an information architecture,
- Develop a comprehensive set of central data services that incorporates ITS managed data services

Timeline

Summer 2006 – Work with system office on policy and procedure recommendations
Fall/Winter 2006 – Inventory campus data stores
Early 2007 – Design information architecture
Summer/Fall 2007 – Communicate and refine information architecture and implications for central data services.
Summer/Fall 2007 – Specification of central data services
2008 – Development and deployment of central data services
2009 - 2010 – Redesign and update services as necessary for new SIS deployment architecture

On-going – Refinement and update of the information architecture to account for new technologies and changing application needs. Subsequent modifications to central data services.

Primary Person Responsible for Action

Dennis Maloney, Executive Director for ITS

Evaluation of Achievement

Periodic inventory of data usage by campus applications and audit against University policies and procedures and adherence to the information architecture.

Annual audit/assessment of central data services for adherence to policy and architecture.

Customer satisfaction reviews of central data services.

4.1.1 IT Infrastructures for New Applications

Major Issue: Departmental application systems are currently developed and operated in an ad hoc manner, using a variety of technologies and development environments. Students, faculty, staff, and other end users are confronted with a variety of interfaces and differing authentication requirements. Functional, performance, and security testing are typically not part of the software development lifecycle.

A. Background/Rationale

Numerous campus departments, schools and colleges operate applications for use by their staff, faculty, students, and affiliates. These applications are purchased commercially or developed in-house. Typically these applications rely on system data, such as that from SIS and HR, that is stored local to the application. This data is delivered through periodic batch updates to the departmental system which then provides an interface to the user that gives the impression of being “real-time”, though the data may be one to several days old. The interfaces are developed independently and often have no common look-and-feel that would serve to reassure the end user that he/she is accessing a University rather than a departmental service. In addition, the method used to authenticate may differ from that used by central campus applications such as CUConnect, further leading to feeling of an uncoordinated set of online services.

Behind the scenes, the development tools and methods used vary from department to department as do the choice of server platform and the operating environment. Few departments use a structured methodology, using code review along with functional, performance, and security testing to ensure integrity before launching a service. Many put thought and funds into server redundancy but do not provide a secure data center environment protected by uninterruptible power supply and generator. A significant risk to continued operations in such a distributed environment comes from reliance on a single key individual who provides all layers of support necessary to sustain the application.

B. Accomplishments to Date

CUConnect, the portal for students, faculty, and staff, uses a single interface to deliver a variety of applications based on the role of the user. Identity data for CUConnect is retrieved from SIS, HR, and other authoritative sources and blended to create a single, unique identity for an individual; roles for the individual are assigned based on the individual’s affiliation(s). The standard for authenticating to CUConnect is the Identikey, which is issued automatically to all students and is available to all faculty, staff, and authorized affiliates. CUAccess provides a unifying authentication service behind the scenes that grants access to web-based applications based on the individual’s affiliation and role. ITS is redefining its data architecture and will move to eliminate batch datafeeds as soon as the source SIS and HR systems are capable of a service oriented architecture that will deliver on-demand, real-time data. The ITS development methodology includes attention to quality assurance, such as functional, performance, and security testing throughout the development cycle.

C. Specific Recommendations

The campus should provide access to campus-wide applications through an ITS-managed portal environment. ITS would have the responsibility to:

- develop and promote an enterprise architecture that specifies how data is stored and delivered and facilitates gaining permission for use of the data
- assess the suitability and supportability of selected applications
- serve the application through a common portal interface that grants access based on affiliation which is compliant with campus operating and security standards
- develop applications using common toolsets
- adopt testing methodologies to ensure systems meet functional, performance, and security requirements
- perform regular risk assessments to ensure data integrity and security

Departments that have applications that are specific to their unit and that serve a small number of users should be encouraged to investigate delivering access through the campus portal environment in order to benefit from the common means of authentication and authorization.

As the System office replaces & upgrades the SIS and HR systems, the current batch method of data transfer should be modernized to an on-demand, real-time delivery system using a Service Oriented Architecture (SOA) that can trigger downstream activities.

D. Resource Allocation

Cost of the project: low-to medium overall campus cost; the CUAccess infrastructure is in place and an enterprise architecture is under development. Requests for delivering applications through CUConnect should be evaluated and prioritized based on anticipated utilization and benefit. Additional developer resources may be needed if additional requests are received and/or current backlog continues.

E. Action Plan

Short Term: continue and expand usage of CUConnect and CUAccess
Medium to Long Term: continue campus participation in SIS replacement project; engage with central administration on data delivery enhancements to HR

Timeline:

- Summer 2006 – ITS to update its data, directory, and database architecture
- Ongoing – ITS to continue deployment of CUAccess for common authentication and authorization to web-based applications
- Ongoing – ITS to continue expanding usage of CUConnect by soliciting campus participation and evaluating feasibility for delivering access through CUConnect
- Summer to Fall 2006 – campus to participate in needs assessment for SIS replacement
- 2006-2007 – System office to develop service oriented architecture for Boulder campus that interacts with other data sources including central administration

Primary Persons Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology;
Dennis Maloney, Executive Director, ITS; Steve McNally, Associate Vice President

Evaluation of Achievement

Annual review of CUConnect usage; annual survey of students, faculty, and staff regarding desired features.

Annual review by IT Council to determine the most significant, campus-critical applications leading to risk assessment by the IT Security Office.

4.1.2 Central Storage & Services for Sensitive Data

Major Issue: CU-Boulder needs to provide services which allow for the secure storage and provisioning of sensitive data. The availability of this data is critical to second tier business systems and functions. Data must be made available to support secondary business uses, ensure the data is used appropriately, and that the data remains secure at all times. While improving the security of sensitive data is the primary driver, providing centralized services can also result in improved overall efficiency.

A. Background/Rationale

Many departments on campus depend on access to electronic records which contain personally identifiable or otherwise sensitive information in order to provide services to their customers. This data may be generated and maintained locally or it may be pulled from a University primary system, such as SIS or the CIW. In some cases, this data is used to populate shadow databases that are maintained locally within the department, thereby creating additional instances and increasing security risk. Furthermore, at times the original data owner may not be aware of who is using their data or for what purpose, leading to a loss of control.

Departments depend on downstream feeds from SIS, CIW and other sources in order to support critical business functions. Without this data, their ability to provide services to their customers would be greatly impeded. The departments interviewed for this plan had a good understanding of the risk and responsibility that goes with managing sensitive data and were aware of the various policies pertaining to it. In general, they didn't store sensitive information locally unless it was absolutely necessary, and efforts were made to secure the systems on which it resides. Furthermore, most departments recognized that they are accountable for this information and that keeping it secure increased their costs. But since this information is critical to their operations, in the absence of an alternative solution, they had little choice but to maintain it locally.

To reiterate, the majority of the data being considered here is drawn from SIS and the CIW. While most discussion centers on the needs of downstream data users, it is also appropriate to consider the point of view of the data owners. Data owners, such as UMS, put significant effort into maintaining the security and integrity of data in core systems. Yet, they are often not aware or able to control how this data is used.

B. Accomplishments to Date

The SSN remediation project has reduced or eliminated the presence of social security numbers in student and personnel records. The ongoing security awareness campaigns have increased awareness of security concerns and the requirements for protecting personally identifiable information. Security audits initiated by the ITSO or Internal Audit have further raised awareness of the need to protect sensitive data and have exposed vulnerabilities so that they can be addressed.

C. Specific Recommendation

i. Develop secure data services that allow for greater central management and control over sensitive data in order to mitigate security risks. Provide access to this data in an efficient and secure manner that supports legitimate downstream business functions. Analysis would be performed by the ITS Architecture group so that business data requirements are understood and appropriate services defined. Service would be maintained by ITS Operations.
ii. Encourage the use of centralized services (database hosting) in order to reduce the occurrence of sensitive data on distributed systems and improve overall security policy compliance.
iii. Involve data owners in decisions regarding downstream feeds where their data is concerned. Doing so allows for greater involvement and control over how the data is used.
iv. Address specific business-driven data needs at the source system or as close to it as possible to improve overall data management effectiveness, reduce risk, and improve efficiency.
v. Enforce standards and best practices for the storage and use of sensitive data in cases where it will be managed locally.

D. Resource Allocation

Cost of the project: The cost of this project would likely be high (in excess of $80K). This is in effect developing a database hosting service, which requires analysis, development and some investment in hardware and software.

E. Action Plan

Short Term: Formalize the process for requesting and approving of the use of sensitive data to support second tier business functions and ensure ongoing oversight. Develop a service model that improves the campus' ability to secure and control access to sensitive data, while improving the efficiency of its provisioning for appropriate business functions.
Long Term: Develop central database hosting service to provide storage for and access to sensitive data to support the University's business needs. To do this effectively will also require performing outreach and offering some form of business analysis service. Establish the funding requirements and determine if service will be supported through the GF or on a cost recovery basis.

Specific Steps:

- Draft a charter for a new service model that satisfies requirements of both downstream data users and the data owners.
- Develop central services to provide access to sensitive data.
- Formalize process for requesting and justifying the need to store or use data that contain personally identifiable or otherwise sensitive data.
- Determine appropriate level at which access/use will be authorized and define process for securing authorization.
    - Authorizations should be for a finite period of time and require renewed justification and authorization beyond that time.

Timeline:

- Spring 2007: draft charter and develop service definitions; define processes for justifying and authorizing access to data feeds.
- Fall 2007: develop services, such as database hosting.

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology, for the enforcement of standards, best practices and policy compliance.
Dennis Maloney, Executive Director of Information Technology Services, for developing and maintaining secure data services.

Evaluation of Achievement

Review effectiveness of justification and authorization processes. Determine if the number of instances of sensitive data has been reduced and also if access for legitimate business needs has been preserved or enhanced. Evaluate adoption rate of centralized services and level of satisfaction of downstream data users and data owners. Gauge compliance with policies governing the use and storage of sensitive data as a result of centralizing services.

4.2 Information Technology Disaster Recovery and Business Continuity Planning

Major Issue: CU-Boulder needs consistent and pervasive disaster recovery and business continuity plans for Information Technology (IT) services. Additionally, IT services need to be prepared to facilitate campus-wide business continuity plans.

A. Background/Rationale

With the pervasiveness of information technology on campus, disaster recovery planning (DRP) and business continuity planning (BCP) for IT resources become critical to maintaining overall campus business functions during a disaster. Additionally, recent large-scale disasters at multiple institutions have underscored the role IT can play in enabling campus business continuity.

The UC Boulder campus has strengths in campus-wide disaster planning and business continuity planning for key IT services, but weaknesses in IT infrastructures designed to facilitate business continuity and the pervasiveness of department level disaster planning. The campus requires additional, and more consistent, IT disaster recovery and business continuity planning, and processes to properly handle moderate or major disasters.

B. Accomplishments to date

The UC Boulder campus has significant disaster planning and business continuity efforts headed by the Environment Health and Safety (EHS) department that bring together a number of campus constituents. This includes a standing emergency management operations group (EMOG), campus-wide disaster planning efforts on specific scenarios including large-scale floods and pandemic illness, and campus-wide table-top exercises for specific scenarios. Additionally, EHS provides BCP tools for campus departments.

For core campus IT services, ITS both participates in campus-wide planning efforts and internal planning for disaster recovery and business continuity. This internal work includes business continuity plans for services and annual table-top disaster exercises.

Individual departments have a variety of levels of disaster recovery and business continuity plans. Currently, there is a system-wide draft policy that would require each department to maintain business continuity plans.

C. Specific Recommendations

1. The campus will develop and utilize self assessment tools, both internally for ITS and for distribution to departments, including standardized checklists and templates to produce a clear map and census of critical systems, processes, and roles across campus. Plans will be stored both locally and in a central campus repository. Campus leadership will need to express that completing business continuity plans are of import and mandatory.
2. The campus will identify external dependencies and contact these entities to clarify expectations and procedures in a disaster or crisis situation.

3. The campus will identify additional technical resources which are available as for use during outages or disasters such as central storage services or potential partner institutions who may have usable facilities and services in the event that a CU Boulder building, office, or program is affected.
4. The campus will study ways to increase online availability of instructional resources such as classes, library materials, and instructor contact.
5. The campus will provide instructional material concerning standards and best practices for hardware, software, connectivity, and security to assist the setup and support of remote access. (telecommuting, distance learning). It is important to note that Telecommuting access must move with services (i.e., if a data store is moved to an offsite location during crisis accommodations must be made for remote access).
6. The campus will identify and test means to maintain communication in a crisis situation. Departments will be required to test plans in addition to the existing campus wide disaster planning exercises.

D. Resource Allocation

Recommendation	Existing Staff	New Staff	HW/SW	Vendor/3d Party
1 & 2 Assessment tools, determine external dependency	Training, Deployment, Local Staff (Tier 2)	Trainer	LBL Contingency Planner software, templates, and web site	No
3 Identify technical resources such as centralized storage or identify partner institutions.	Management support, with authority to enter into contractual relationships		HW/Software(?)	Explore third party contractors
4. Increase online instructional resources	Faculty time to plan and transition	Faculty assistance and training	Capacity - By 2007, individual departmental systems may not have backup	Explore vendor hosted services
5. Telecommuting support	Develop best practices	Support	Instructions VPN etc.	ISP
6. Crisis Communication	Website, info, email for parents, news releases, call center in ARC			Consider offsite/third party redundancies for onsite resources, esp. call center.

Cost of the project: TBD

E. Action Plan

Short Term (12 months):

- EH&S and the campus IT Security Office will determine specific tools, forms, guidance, and processes to be used by campus departments
- EH&S and the campus IT Security Office will develop communications and training
- Vice Provost for Academic and Campus Technology (VPACT) and/or Chancellor will encourage departments to evaluate third party services
- VPACT sponsors the effort to inventory critical IT resources which would need backup systems in the event of either an IT or physical disaster. The ITSO will provide assistance in this endeavor.
- ITS evaluates campus level resources and contracts
- VPACT beings discussions with other possible partner institutions to determine feasibility of solution
- VPACT documents departmental LMS systems which includes BC/DR posture
- ITS completes projects to increase capacity of WebCT
- VPACT forms committee to develop policies for Telecommuting and ITS providing supporting technical standards as appropriate.
- ITS develops campus-wide mechanisms for individuals to self-subscribe to crisis communication tools

Long Term (12 to 36 months):

- ITS and EH&S to determine mechanism and requirements for campus BCP/DRP archive
- ITSO utilize BCP/DRP data as part of campus risk assessment activities
- EMOG monitor BCP/DRP efforts and assist in BCP/DRP process review.
- ITS implements backup solutions at partner institution or other third party
- Deans encourage faculty to develop on-line class materials
- ITS improves campus VPN services and evaluate VOIP to facilitate telecommuting
- Recognizing that providing IT support to the home is not feasible VPACT and Department Heads reinforce the need for individual accountability and improved technical knowledge for employees who telecommute. Individual campus departments provide more detailed documentation and coaching for employees to facilitate user independence.
- EMOG continue to evaluate campus level crisis communication mechanisms and tools.

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology

Evaluation of Achievement

ITSO will prepare an annual evaluation report which will be presented to the VPACT, ITS Executive Director, EMOG, and IT Council. Success will be demonstrated by campus units competing business continuity plans.

4.3 Asset Management & Control for Data & Network

Major Issue: Security strategies must be appropriate to the type of asset to be protected. A "one size fits all" approach will result in security strategies which are either weak or too costly. A prerequisite for the development of both technical and non-technical controls must then be an accurate inventory which captures both the business criticality of the system and the sensitivity of the data.

A. Background/Rationale

Campus Information technology (IT) resources are valuable assets that the Campus has responsibility to manage, secure, protect, and control. IT resources are integral to teaching, research, and public service and must be provided and used efficiently and effectively to support those missions. Sensitive data or personally identifiable information is processed daily on a wide variety of systems by a wide variety of individuals. This means that security solutions will require both address system level controls and procedural controls. The University has established that it will establish a risk based approach as a foundation for security programs.

It is important to note that this section addresses asset management from a security and risk management perspective. Asset management has a broader technical context which is not addressed by this strategy.

B. Accomplishments to date

Campus has established minimum security standards both for networked devices and sensitive data systems since 2004. The data breaches from 2005 highlighted that implementation and enforcement of polices is a fundamental problem however.

Significant work has been completed at the system level, with a high level of involvement by the Campus, on development of a comprehensive suite of security policies based on ISO 17799. It is anticipated that the policies will be approved by Spring 2007.

ITS has completed a framework for completing risk assessments on campus and will be initially deployed with a small number of critical departments during the summer and fall of 2006.

C. Specific Recommendation

- Campus departments will inventory information and IT resources which catalogues the, location, and owner, criticality, and sensitivity of information assets. The process will follow guidelines established by the Campus IT Security Office (ITSO).
- The ITSO, working with the CU-System Information Security Officer, will establish campus specific processes and implementation guidelines for implementing security controls based on CU system-wide IT Security Policies.

D. Resource Allocation

There will be implications for ITSO staff currently charged with oversight of campus information risk management processes. There will also be significant implications for departments who may not currently have asset inventories and will need to reallocate staff time to compete inventories.

E. Action Plan

Short Term (12 months):

- The ITSO will develop and implement a training program to communicate requirements for asset inventories.
- The ITSO will work with the CU-System Information Security Officer to identify high priority process and implementation guides which need to be developed.
- Campus departments will complete initial inventory of information and IT resources.
- Long Term (12 to 36 months):
- The ITSO, though the risk assessment process, will work with campus departments to determine appropriate controls based on the criticality of the information or IT resource. Departmental level IT asset inventories will form the basis of this effort.
- The ITSO will evaluate options for providing a secure central repository for IT asset inventories.
- Working with the System Information Security Officer ITS will deploy training programs to communicate requirements, process, and guidelines for implementing security controls.

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology

Evaluation of Achievement

ITSO will prepare an annual evaluation report which will be presented to the VPACT, ITS Executive Director, EMOG, and IT Council. Success will be demonstrated ability to complete asset inventories, ability to complete risk assessments, and policy compliance.

Chapter 5: Central Services: SIS Replacement Project, E-Commerce, Printing, and Software Licensing

Central services are a collection of IT services that affect a wide range of campus constituents and can effectively and efficiently be provided and/or coordinated centrally. Central provision may come from the University System through the department of University Management Systems (UMS) as well from Information Technology Services (ITS), the Boulder Campus central IT unit. When determining whether to provide services centrally or more locally at the school, college, or department level, considerations such as access to sensitive data, duplication of effort, and degree of customization must be made. Regardless of service provider, the most effective services will be provided when all stakeholders collaborate on their needs and coordinate their efforts.

This chapter calls for substantial and ongoing Boulder Campus participation in the replacement project for the University System-provided Student Information System (SIS). This project will unfold over the next several years and will have widespread impact on campus departments, faculty, staff, and students. The implementation should be consistent with the campus IT architecture and integrate effectively with related services including the campus learning management system. Recommendations from other sections in this chapter call for developing an electronic payment policy and a process for approving the acceptance of credit cards; and developing and implementing an efficient and cost-effective solution for student printing. The last section recommends further coordinating the purchase of software tools, aggregating software licensing, and improving communication about software availability in order to reduce inefficiencies in software purchasing.

5.1 SIS Replacement Project

Major Issue: The current Student Information System (SIS) was installed in 1988 and a combination of factors, including the end of vendor support and a desire for new technologies, is driving a replacement. The new system promises to deliver real-time data in a flexible manner that enhances services for students, faculty, and staff across all three campuses. The implementation will have long-lasting functional, organization, and technical impacts that demand strong participation from the campus.

A. Background/Rationale

The Boulder campus has a long history of providing students with access to academic and other information, starting with CULine in the 1980s, PLUS in the 1990s and since 2003, CUConnect. Students now expect 24/7 access to schedules, grades, bills, financial aid information, address update, and much more, but because of the underlying architecture and legacy system, that data is often hours or days out of date, though it may appear to students as being "live." Advisors and support staff continue to access data through a mainframe interface to SIS which may present data that is out of synch with that available in CUConnect, creating a source of confusion.

The replacement of SIS provides an opportunity to further direct access to data through an information portal and meet the demand for unified and "nearly continuous and real-time access to information"[i] through a service-oriented architecture. The relationship with other tools, such as learning management systems, which depend heavily on course, student, and faculty information, must be considered as part of SIS system implementation. Outlying services, such as electronic communication will also be affected by a new SIS.

A student information system is the most complicated enterprise system used in higher education. Each of its thousands of feature will impact one or many campus business processes and touch departments ranging from student services to academic and administrative support. The frontrunners in this space are all powerful systems but it is the years-long implementation that will define the way campus constituents make use of the system. During that period, participation from both campus functional experts and IT/data experts will be needed to shape the service around a coherent architecture.

B. Accomplishments to date

Preliminary research for a replacement SIS began in 2003-04, followed by a project charter in 2005. A pre-RFP phase began in October 2005 to identify processes and requirements. The current timeline calls for release of an RFP in summer 2006, selection of a vendor and contract negotiations in fall/winter 2006-07, with initiation of implementation in July 2007 and roll-out by 2010.

C. Specific Recommendation

The campus must work closely with UMS during the RFP phase to identify functional and technical requirements for the new system. The campus must develop an enterprise architecture that describes how data will be accessed, delivered, and integrated in a

manner that is cohesive and tailored to the needs of the many constituent groups. Upon selection of a vendor, IT resources should be dedicated to the implementation project to ensure the resultant services are delivered according to the campus enterprise architecture and integrate effectively with related services, such as learning management systems and e-portfolios.

D. Resource Allocation

Cost of the project: moderate to high; minimum of 2 FTE; the campus should immediately fund and assign a campus representative to the replacement project to act as a campus liaison, drawing upon campus resources to provide input to the replacement team and to bring information back to the campus; after vendor selection, the campus should fund and assign at least one dedicated IT professional rostered in ITS to act as a technical liaison with the implementation team; additional academic and functional unit representation will be required during the implementation phase as well.

E. Action Plan

Short Term:

- ITS to develop an enterprise data architecture and strategy for integrated and unified delivery of services
- Campus liaison to be funded and assigned to represent UCB during remainder of selection process and through implementation
- SIS replacement project team to select a solution that supports a service-oriented architecture

Long Term:

- ITC to require campus departments to use service-oriented architecture for access to enterprise data (as it becomes available through replacement and upgrade efforts by CU-System)
- ITS to participate in the implementation team and integrate campus applications and services with the new SIS

Timeline:

- Summer 2006 –RFP finished
- Fall 2006 – ITS to develop enterprise architecture
- 2006-2007 – System office to develop service oriented architecture for Boulder campus that interacts with other data sources including central administration
- Summer 2007-2010 – campus to participate in system implementation; campus departments to migrate data exchange to service-oriented architecture

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology and Steve McNally, Associate Vice President

Evaluation of Achievement

Quarterly review by IT Council of SIS replacement project status through vendor selection phase; monthly review during implementation phase; annual survey by CIO's

office to determine how campus departments acquire and use enterprise data, with results to be reviewed by ITC and subsequent follow-up by IT Security Office in cases where shadow systems or batch data transfers remain in use.

[1] SIS replacement project charter; strategic business drivers

5.2 E-Commerce (Standards & Policies for Credit Cards, E-Checks, etc.)

Major Issue: CU-Boulder needs to develop and adopt a new framework of policies, standards and enforcement designed to ensure a secure e-commerce environment.

A. Background/Rationale

Handling credit card payments is widely accepted on campus as an effective means of receiving payments from customers. Electronic commerce, in the form of credit cards or fund transfers, are defined as the acceptance of payment where the transaction is negotiated over campus networks and/or the internet, and is generally referred to as e-commerce. However, formal policies, guidelines, and/or best practices are not established, widely disseminated or routinely followed. Since departments are increasingly accepting electronic commerce (primarily credit cards), they must be equipped to handle the issues and the technological considerations that are part of doing business on the web. Recent departmental security breaches highlight the increased risk and level of exposure the campus faces.

The establishment of control measures for e-commerce transactions is necessary to maintain proper security over credit cardholder information. The review process for e-commerce activities is meant to ensure compliance and appropriateness in the following areas:

- Alignment with the campus academic mission.
- Consideration of and attention to business/financial/licensing issues.
- Marketing/communications.
- Legal review, contractual arrangements, etc.
- Technology/infrastructure integration (most importantly related to security).
- Protection of sensitive data, such as SSNs and credit card numbers.

There is significant customer demand for electronic payment for campus products and services (e.g. tickets for the Artist Series and other theater events, athletics tickets, and tuition and fee payments). Electronic payment clearly provides a competitive position for many services. The financial and technical aspects of the campus solution should be developed based upon generally accepted business practices, adopted by the appropriate campus constituencies, and enforced by a designated authority. In accepting any form of electronic payment, a department is assuming a significant responsibility. In the event that a department does not meet its responsibilities to the sponsoring merchant bank, the credit card system, the customer and the university as a card accepting merchant, not only is the department potentially liable, but also the university as a whole may face significant financial risks.

Despite ongoing efforts such as a Web Publishing Policy and Treasurer's Office guidelines, departments have implemented a disparity of payment solutions, most of which did not go through formal business and technical review processes. It has been identified that approximately 60 departments on campus accept electronic commerce in some form, which makes it critical to develop e-commerce policies and procedures.

B. Accomplishments to date

To address the issues of accepting electronic commerce and doing business on the web, CU-Boulder established a review process described in the university's Web Publishing Policy (see http://www.colorado.edu/policies/webpolicy.html). The need to address issues created by the absence of a campus-wide electronic payment solution was a key element in the framing of this policy.

The University Treasurer's Office has set up robust and secure methods of electronic commerce and has negotiated financial arrangements and very competitive rates to handle e-commerce transactions. In addition, the office publishes information and best practice guidelines that are meant to ensure that good business processes are in place before a department accepts cards for payments. Most of the requirements in the Treasurer's Office documents are either mandated by law or are dictated by prudent business practices. See http://www.cu.edu/treasury/policies/CardMerchant.html for the Card Merchant Policy.

C. Specific Recommendations

- Develop a process to centrally approve the acceptance of credit cards throughout the campus.
- Develop an Electronic Payment Policy with specific statements to include:
  - Departments must use the UCB 3rd party transaction processing vendor, or obtain prior approval if special circumstances require a different process.
  - The business and technological aspects of all e-payment solutions must have appropriate prior approvals as defined by the policy.
- Policies must be formally communicated to campus departments.
- Compliance with stated policies and procedures must be periodically reviewed.
  - Sanctions for non-compliance will result in suspension of e-payment capability and potentially, fines imposed by credit card companies

D. Resource Allocation

Cost of the project: no or little impact. The cost of implementing electronic payment capabilities will be assumed by the merchant department. There will be implications for staff charged with the approval, monitoring and enforcement processes but the incremental costs should be small.

E. Action Plan

Specific Steps:

Short Term (0-12 months):

- Develop and implement an Electronic Payment Policy which guides future merchant activities.
- Identify and contract with a 3rd party transaction processing vendor

Long Term (12-36 months):

- Monitor effectiveness of 3rd party processing model to improve security of electronic commerce
- Ensure compliance by departments with policies

Timeline:

- Fall of 2006 – develop policies; start process of selecting vendor
- Spring 2007 – contract with 3rd party vendor and implement policies

Primary Person Responsible

Ric Porreca, Senior Vice Chancellor and Chief Financial Officer

Evaluation of Achievement

All merchant departments are in compliance with Electronic Payment Policy and card association rules.

5.3 Student Printing

Major Issue: The current printing solution for students on campus (known as CPI) is not financially sustainable and cannot be funded beyond the existing contract with Xerox. CU-Boulder must develop a model for printing that provides a high quality service for students at a reasonable price, and is financially viable over time.

A. Background/Rationale

The current CPI solution was driven by the following concerns:

- Printing costs were increasing rapidly, due mostly to increasing volume and use of consumables.
- The "free" printing service resulted in undesirable waste (there was no disincentive to needless and wasteful printing).
- Printing costs were not being born equitably: heavy users paid the same computing fee as light users, and students were subsidizing administrative use of printing.

The current solution with Xerox did accomplish the objectives of curbing the rapidly increasing volume of printing, reducing wasteful printing, and shifting the costs to those who print the most. However, printing was reduced so much that the fixed costs of the solution greatly exceed the revenue, making the current CPI service unsustainable.

The students have strongly expressed that the base printing quota of the current program is much too low. There has also been some feedback that the print-station card swipe is cumbersome, given that in most cases the print job is being submitted by an authenticated user in a lab. It's unclear, though, from printing statistics and observed behavior whether this is an opinion shared by a majority of students.

The current CPI solution is scoped broadly so that it may be implemented within the residence halls and campus departments who wish to use it as a cost recovery mechanism for departmental printing. The residence halls have since discontinued use of the service and adoption within departments has been minimal. This suggests that the scope for a central solution with strategic value is limited to printing in labs or other public areas that support computing, and should be focused at students and library patrons.

The contract with Xerox expires October 31, 2006, with an option to extend it up to two years. CU-Boulder can renegotiate the details of the contract before opting to extend it.

B. Accomplishments to date

It has been established as a matter of principle that printing is a *necessary and fundamental* campus IT infrastructure service. Reliable, easy-to-use, high quality printing in for students in labs and other key public locations furthers the academic mission of the campus and is of strategic value. Being able to easily produce high-quality output in convenient locations on campus – and particularly in the student labs – is an *expectation* of our students and contributes to CU-Boulder's nationally ranked stature as a "wired"

campus. The students have validated this by clearly stating the value they place on convenient printing and have voted with their pocketbooks by allocating a substantial portion of their student fees toward printing in general and maximizing base quota allocations in particular.

The conclusion that printing is an essential IT infrastructure service, and that the primary customers are students, implies that it should be an ITS provided and supported service. Library patrons wishing to print from public access workstations are also key customers and ITS should work with the Libraries to ensure the solution is suitable for library patrons.

ITS has already begun the process of specifying requirements for a campus printing service. ITS has also begun negotiating with Xerox to determine if the Xerox solution can fit the requirements, including significant restructuring of the financial terms.

C. Specific Recommendation

ITS should continue to develop and implement a new campus printing solution with a target of Spring term 2007 for having it in production.

ITS should negotiate with Xerox to determine if a favorable partnership can be established for providing a sustainable solution. If not, ITS should extend the current Xerox contract through December of 2006 while a new solution is developed.

ITS should evaluate the Imaging Services costs of managing the program and understand how those costs apply to an ITS managed and supported program.

ITS should have three main objectives in developing the new solution:

- The solution must be financially sound and sustainable, meaning that the current student fees, plus any printing revenues, plus any library patron printing fees must fully pay for the program.
- The solution should strive to be a user-friendly system, focused on students. Use of the system in multiple scenarios (printing from labs, printing from a personal laptop over wireless, etc.) should be as simple and logical as possible.
- The solution should seek to maximize the annual base printing quota for students.

D. Resource Allocation

Cost of the project: no or little impact (the expectation is that a new printing solution will use existing funding sources for CPI, primarily student fees and cost recovery).

E. Action Plan

Specific Steps:

- Revisit the initial tenets and requirements for printing established for the Xerox RFP; establish their on-going validity in light of our experience with the existing solution.
- Establish a service strategy and reference model for campus printing that is independent of any particular vendor (or in-house) solution.
- Establish any new specific business, functional, and technical requirements for campus printing solution.
- Negotiate new business terms with Xerox
- Make go/no-go decision with Xerox
- Either work with Xerox to implement their solution, or develop a solution in-house
- Transfer responsibility for program management from Imaging Service to ITS

Timeline:

- June 2006: Complete new requirements specification and reference model
- June 2006: Determine whether a Xerox solution can be developed that meets the requirements and fits the business model
- June 2006: If Xerox is not an acceptable long term solution, negotiate a contract extension with Xerox through December 2006
- August 2006: New solution selected and designed
- December 2006: New solution implemented

Primary Person Responsible:

Dennis Maloney, Executive Director of ITS

Evaluation of Achievement:

Careful review of program during Spring 2007 to ensure it is on target financially and that it is meeting functional requirements. Quarterly review of program finances to ensure the program is solvent. Annual review of overall program, with student input, for effectiveness and applicability as a campus IT infrastructure service.

5.4 Aggregated Licensing

Major Issue: The CU-Boulder campus spends huge amounts of money and effort purchasing software licenses in a largely unorganized fashion. The CU-Boulder campus must develop selection criteria for software tools; investigate and identify appropriate products; negotiate advantageous purchase programs; communicate information and best practices to campus users; and provide resources to improve the management of software assets or risk serious over expenditures and major inefficiencies where software is concerned.

A. Background/Rationale

The campus has many computing systems and therefore, a significant need for software products. The campus acquires software products from a large number of manufacturers/developers/vendors who provide a wide array of products, with a wide variety of features and capabilities, technical requirements, and licensing terms. People involved with software licensing on campus must take time not only to identify appropriate products but also to understand complex licensing and purchasing terms, both of which change frequently.

The availability of software tools is critical to the instructional, scholarly, creative, research and business activities of the university. However, many in the campus community are seemingly unaware of existing campus-wide licenses or purchase programs; information about our current programs has not been effectively communicated, advertised or promoted. Improving the processes used to identify, acquire, and manage software licenses will improve software availability while lowering ownership costs.

B. Accomplishments to date

There exists a site license for CUantivirus product which has been widely advertised and installed across the Boulder campus. Further, both the CU Bookstore and ITS have improved the process of advertising and acquiring software tools via bulk purchase agreements. For example, purchasing software from the bookstore, via the CUConnect portal, is easier and more efficient than ever.

C. Specific Recommendations

Improve the processes used to identify, acquire, and manage software licenses, making software tools available to the CU Boulder campus community at the lowest possible cost. Further, increase the communications, advertising and marketing of existing software purchase programs.

D. Resource Allocation

Cost of the project: The cost of creating and maintaining a centrally managed software management office alone along with the actual purchase of appropriate software related to the mission of the campus is expected to be high – over $80,000.00. The return on investment of such an undertaking could be substantial given the current practices

associated with software purchasing. Further, some of the cost of this program may already be allocated to individual departments spending monies in a distributed manner.

E. Action Plan

Short Term:

- Creation of an advisory board for software management.
- Increase communication, advertising and marketing of existing software programs.

Long Term:

- Staff the software management office
- Develop selection criteria for software purchases; purchase specific software relating to the mission of campus.

Specific Steps

- Creation of a software management advisory board for software licensing, purchase, and management. Participation should include relevant student, staff, and faculty governance committees and would report to the IT Infrastructure Advisory Group (ITIAG). Participation may include representatives from other campuses and/or the Procurement Service Center.
- Creation of a software management office in ITS which would spearhead the promotion, procurement and tracking of software in use on the Boulder campus. In addition the office would promote coordination of software and disseminate information about software selections for use across academic, business, and research areas.
- Create a central information system, probably via a CU web page, where administrators, faculty, staff, and students can examine available software licenses and software purchase options.
- Increase communications, advertising and marketing of existing software site licenses and bulk purchase agreements.
- Develop selection criteria for new software site licenses/bulk purchase agreements.
- Purchase specific software that related directly to the teaching/learning mission of the campus (e.g. plagiarism software, essay grading software, etc.)
- Participate in consortia with other universities to share information and possibly gain advantages through coordinated negotiations with vendors.

Timeline:

- Fall of 2006 advisory board created and increased communication concerning existing software purchase programs begins.
- Spring 2007 creation and staffing of software management office
- Summer 2007 selection criteria for software purchases established; recommendations for software purchases presented for budget approval (to include those software products related to the mission of the campus).

Primary Person Responsible

Bobby Schnabel, Vice Provost for Academic & Campus Technology

Evaluation of Achievement

Review of newly created software management office and advisory board during the 2007-08 academic year. The review of the software management office would be conducted by the advisory board, the review of the advisory board should be conducted by IT Council, and results would be reported to both ITS management and ITIAG for further recommendations and improvement.

Chapter 6: IT Governance and Authority

The campus' IT environment is characterized by complex levels of central and distributed services and support. IT governance structures continue to mature and provide valuable leadership, communication, and coordination.

Currently, IT strategy and policy decisions are made by at IT Council, which comprises faculty and high level administration from across campus. IT Council is supported by two advisory groups: ITIAG (IT Infrastructure Advisory Group) and FACE-IT (Faculty Advisory Committee for IT). One proposal from this chapter is to incorporate the ECC (Electronic Communications Committee) into the IT governance structure as a third advisory committee to IT Council.

This chapter also recommends that the consistency and frequency of communications among and between the subcommittees and ITC be improved by producing and archiving minutes for all committee and subcommittee meetings, communicating them to audiences such as CEC, CVC, BFA, A&S, etc. The mission, roles, and relationships of and between the IT governance groups also should be formalized. Finally, the chapter recommends that the CIO should participate regularly in chancellor/vice chancellor governance meetings to communicate strategic decisions and advocate for IT at the highest levels of the campus administration.

6.1 IT Governance & Authority

CU-Boulder should build upon and improve its existing IT governance structure by formalizing the roles of and relationships between existing governance bodies; by proposing incorporating ECC (Electronic Communications Committee) into the IT governance structure as a standing sub-committee of IT Council; by improving the consistency and frequency of communications between the governance bodies; and by increasing the visibility of IT at the highest levels of campus administration.

A. Background/Rationale

The current IT governance structure on the CU-Boulder campus has its roots in the establishment of the IT Council (ITC) in 1998. Since then, in 2002, the campus has added two additional groups that play an advisory role to the ITC: ITIAG (IT Infrastructure Advisory Group) and FACE-IT (Faculty Advisory Committee for IT). Both committees meet regularly and there is continued interest in participation, indicators that these newer committees are valuable elements of campus IT governance. In practice, ITIAG's advisory role has been more to ITS and less to IT Council and FACE-IT has struggled with uneven attendance, but both groups have expressed a strong desire to continue meeting.

An additional committee on campus, the Electronic Communications Committee (ECC), was established by University Communications and the Chancellor's Office over ten years ago. Throughout its tenure, though, ECC has had only occasional interaction with IT Council, FACE-IT, or ITIAG. With the increased importance of IT infrastructure, decisions, and policy to electronic communications, there seems to be a natural fit between ITC and ECC, and opportunities for increased and increasingly necessary collaboration and communications about the issues and policies that are the focus of the ECC.

During the past four years, the current IT governance bodies, although linked in concept, have worked largely in isolation from one another. Minutes that do exist for committees (occasional only for ITC and ITIAG, none for FACE-IT) are not shared; there are few formal communications between the groups; and even less frequent and consistent communications between ITC and other governance bodies on campus such as the Chancellor's Executive Committee and Boulder Faculty Assembly.

Because there is an increased recognition that IT decisions have far-reaching and sometimes unforeseen impacts, there is an increased need for high-level administration involvement in strategic decision involving IT.

B. Accomplishments to date

- The establishment of ITIAG and FACE-IT upon the recommendation of ITSP 2002.
- All three governance bodies have met regularly over the past four years and have broaden discussion and decision making to include units and constituents campus wide. All three have provided significant input into the

current IT strategic plan and process; ITIAG in particular has provided valuable direction for ITS.
- ITC has played a significant role in setting campus IT priorities and increased awareness about departmental IT priorities and initiatives.
- The formation of architecture, security, and site licensing subcommittees of ITIAG.

C. Specific Recommendations

- Evaluate, rewrite as necessary, and post mission and roles documents for all IT governance bodies.
- Continue with current membership structure of IT governance bodies, including maintaining close ties with UMS through *ex officio* membership on ITC and including a new UMS representative on ITIAG.
- Begin evaluation and tracking of decisions and actions of all IT governance bodies.
- Propose incorporating the ECC (Electronic Communications Committee) into the IT governance structure as a subcommittee of ITC.
- Improve and evaluate communications between and among ITC and the other IT governance bodies, in part by formalizing communication role of cross-representatives.
- Be diligent about producing and archiving consistent minutes for all committee and sub-committee meetings, communicating them to appropriate audiences such as CEC, CVC, BFA, A&S, Staff Council, Tri-Execs, Tier 2.
- Recommend to campus administration that the CIO participate regularly in chancellor/vice chancellor meetings
- Consideration of blogs and communication thereof to all IT folks, faculty, staff, and students on campus to increase opportunities for campus to participate in and react to IT decisions.

D. Resource Allocation

Recommendations will be implemented using existing staff in the CIO office.

E. Action Plan (short-term: 12 months; long term: 12-36 months)

Specific Steps & Timeline

Implement all recommendations in the 2006-2007 academic year.

Primary Person Responsible for Action

Bobby Schnabel, CIO

Evaluation of Achievement

- Implement tracking of decisions and actions of IT governance bodies
- Implement 360° review of IT governance bodies and the CIO office through surveys and interviews with appropriate campus constituents and governance bodies.