2002 Information Technology Strategic Planning Report

Final Report

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Please let us know what you think about this report

Email comments to Bobby Schnabel, Associate Vice Chancellor for Academic & Campus Technology, Robert.Schnabel@Colorado.EDU or Dennis Maloney, ITS Executive Director, Dennis.Maloney@colorado.edu
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Thank you.
Executive Summary

The What and Why of CU-Boulder’s IT Strategic Planning

The IT Strategic Planning process examines plans and priorities for the use and support of information technology in support of the mission of the University of Colorado at Boulder. Like its predecessor, the campus’s 2002 IT Strategic Plan combines high level strategic planning with some degree of tactical planning. The campus has undertaken this strategic planning process for several reasons:

- To establish plans and priorities for the use of IT on campus.
- To create greater cross-campus understanding of and involvement in IT issues.
- To fulfill requirements established by the Colorado Commission on Higher Education.

The campus last engaged in an IT strategic planning process in 1998. The resulting plan led directly to action and significant changes to the campus's IT environment, including the establishment of:

- A four-tier model for campus IT support and the Distributed Academic and Campus Technology Coordinators (DACTCs);
- The Faculty Computer Purchase Program and a student computer recommendation;
- The Network Task Force and the ResNet project;
- The position of CIO (Chief Information Officer, as part of the Associate Vice Chancellor for Academic and Campus Technology position) and of the IT Council.

Since that time, the campus’s IT infrastructure has matured greatly, and the campus’s needs have also changed, which is reflected in the two plans:

| 1998: | emphasis on IT resources and infrastructure |
| 2002: | emphasis on academic and administrative IT services |

Recommendations of the 2002 IT Strategic Plan

The ITSP process is notable for considerable information gathering, including interviews, focus groups, and surveys of a wide range of faculty, staff, students, and campus leaders; and for work completed by 25 committees composed of over 100 IT staff, faculty, and other campus representatives. This process has defined the focal points of the plan:

- Developing and enhancing programs and support for educational technology, including hardware, software and staff support, technology-enhanced facilities, and information and information technology literacy programs for students;

- Improving and greatly expanding web-based student services;

- Maintaining and further developing the middleware layer of the campus’s infrastructure, including security, access and authorization, and directory services;
• Improving **coordination, communication, and governance** of campus IT resources.

Of the specific recommendations presented in the plan, several were deemed to be of highest priority. They are listed here in unranked order.

**Educational Technology**

• Establish a well-communicated and coordinated **educational technology support model** for instructional design and advanced technological and pedagogical innovation, as well as for course content and course management and organization.

• Establish campus-wide goals and programs for **information and information technology (I/IT) literacy** for students, and facilitate the creation of goals for discipline-specific I/IT fluency.

• Provide coordinated and broad support and services for **digital media** and videoconferencing as well as develop a **digital asset management** strategy for storing and accessing campus-generated research and learning materials.

• Develop an effective scheduling process for, improve support to, and upgrade existing **technology-enhanced instructional facilities**.

• Develop a robust, unified, and supportable web-based **learning management system** infrastructure capable of supporting every course at CU-Boulder.

**Web-based Student Services**

• Provide excellent, unified **web-based student services** that are tailored to individuals based on their affiliation with CU-Boulder, in short, a **campus student portal**.

**Support and Services**

• Continue to develop the **Enterprise Directory** and Directory Services, and create the underlying campus-wide **IT service provisioning infrastructure** to address account maintenance processes, naming protocols, identity, authentication and authorization.

• Address **IT security issues** including network and data integrity and reliability, and proactive IT security management.

• Provide enhanced and new **email services** to all faculty, staff, and students.

**Coordination and Communication**

• **Centrally coordinate** specific aspects of IT to achieve efficiency and decrease duplication (e.g., wireless, security); **centrally manage** other aspects to achieve reliability and stability of the campus IT infrastructure (e.g., Enterprise Directory, software licensing); continue to **distribute responsibility** for some departmental-specific IT services (e.g., desktop support, departmental-specific applications).

• **Communicate** IT resources availability, policies and guidelines, and the roles and responsibilities of the Office of the Associate Vice Chancellor for Academic and Campus Technology and of IT advisory bodies to the entire campus.

**Governance Structures**

• **Re-configure the existing IT leadership and advisory body** (IT Council) to reflect the complexity of the campus’s IT environment, and the need for increased participation by and communication with a wide array of campus constituents by establishing faculty, administrative, and student advisory committees for IT.

Some other important recommendations include: expanding wireless access on campus, continuing to develop the four-tier IT support model, improving access to assistive technologies, developing a campus-level file systems solution, and providing web-based faculty and staff services.
Evaluating the Impact of the Strategic Plan

An integral element of the implementation of the IT Strategic Plan will be the evaluation of its impact on the campus and its IT infrastructure. The intended impact of each of the recommendations listed above is articulated in the plan's evaluation section, as are the methods that will be used to assess each of the intended outcomes.

The total cost of all the priorities listed in this executive summary almost certainly will exceed what the campus will be able to invest in new IT initiatives over the upcoming four year period. Therefore, campus discussion will be needed to prioritize the initiatives further. This discussion will necessarily include the consideration of which initiatives are essential to fulfilling the campus mission at an acceptable level of quality, and which could be deferred even though this may entail a reduced, or unimproved, level of service. This campus discussion also will consider multiple funding sources that are possible for these initiatives, including campus general fund support, support from fees, and departmental contributions in cases where services currently provided by departments are shifted to being provided centrally. The campus may need to realign priorities in the event of mandates—funded or unfunded—from the System, State, or federal government.
IT Strategic Planning Process

The IT Strategic Planning (ITSP) process was initiated by associate vice chancellor for academic and campus technology, Bobby Schnabel, in December 2001. The process was overseen by the campus's IT Council, and directed by a core team consisting of the associate vice chancellor, two of his staff members, and the executive director of ITS.

The overall goal of the ITSP process was to develop a comprehensive plan that combines high level strategic planning with some degree of tactical planning to lead to action in five significant areas: educational technology, online services, network and middleware, central services, and IT management and leadership. That action will ensure state-of-the art IT resources and services in support of the campus’s mission. Previous IT planning efforts, most notably the 1998 ITSP and the 2001 educational technology strategic planning process, provided the foundation for the 2002 strategic plan. In contrast to the 1998 ITSP, which focused on IT resources, this current strategic plan emphasizes academic and administrative IT services, reflecting the increased maturity of the campus’s infrastructure, and a need to redirect primary attention from IT resources to IT services and the ways those services are provided and communicated to the campus community.

Broad participation, significant collaborative work, and extensive campus input are the hallmarks of the 2002 ITSP process. In all, over 100 faculty, staff, and students participated in focus groups, on planning committees, or as reviewers of the planning document.

A visioning process in early 2002 focused attention on the most pressing IT issues facing the campus. Phillip Long, Chief Information Officer (CIO) of Yale University, who served as a consultant for the IT strategic plan, conducted interviews and focus groups with the following high level administrators and administrative bodies as part of the visioning process:

- Chancellor Byyny
- The Chancellor’s Executive Committee
- The Vice Chancellors Group
- The Council of Deans
- Jim Williams, Dean of Libraries
- Faculty representatives from the Boulder Faculty Assembly

Subsequent focus groups helped refine the plan’s vision, and were held with the following:

- Representatives from Staff Council and staff members at large
- Representatives from the Arts and Sciences Council
- Members of the Instructional Computing Working Group (which manages the student technology fee)
- IT Providers from ITS and across campus
- Representatives from the Libraries
- Student Representatives from the Legislative Council

Further data was gleaned from a variety of sources, including surveys and interviews in support of the 2000-2001 educational technology strategic planning process. Data collection efforts that were undertaken specifically for the 2002 process include:

Faculty survey (fall 2001)
Chairs survey (spring 2002)
Tier 2 survey (departmental IT liaisons—spring 2002)
Tier 4 survey (IT core experts—spring 2002)
IT Council survey (spring 2002)
Peer institution survey (spring 2002)

The heart of the planning process was the work of twenty-five committees, the members of which were faculty, staff, and students drawn from across the entire campus. The sections of the IT strategic plan roughly correspond to those committees:

Chapter One: Educational Technology
1.1 Educational Technology Support
1.2 Instructional Facilities
1.3 I/IT Literacy/Fluency
1.4 Learning Management Systems
1.5 Research Computing
1.6 Digital Content & Collaboration
1.7 Libraries

Chapter Two: Online Services
2.1 Online Student Services
2.2 Faculty/Staff Online Services

Chapter Three: Network and Middleware
3.1 Network
3.2 Enterprise Directory Services
3.3 IT Service Provisioning Infrastructure
3.4 Telephony

Chapter Four: Central Services
4.1 Email
4.2 Security
4.3 E-Payments
4.4 Software & Software Licensing
4.5 Prep for Next Gen of SIS & PeopleSoft
4.6 Campus Web-Based Services Infrastructure Strategy
4.7 Assistive Technology
4.8 File Systems
4.9 Application Standards & Best Practices
4.10 IT Four-Tier Support Model

Chapter Five: Management & Governance
5.1 Centralized IT Authority
5.2 CIO/ITC Structures

In spring 2002, a few committees conducted their own surveys and focus groups:

- Assistive technology survey
- Four-Tier support model focus group
- Web-based student services survey

During summer 2002, the committees’ sections of the plans were compiled, and then reviewed by IT Council members. Upon its completion, the report will be approved by IT Council, distributed to the campus at large, and presented to key groups on campus, including the Chancellor’s Executive Committee, BFA, ASC, UCSU, UGGS, and others.
2002 IT Strategic Vision

Introduction

The University of Colorado at Boulder’s mission is to lead in the discovery, dissemination, and application of knowledge through instruction, research, and service to the public. CU-Boulder’s computer and network resources support that mission by providing state-of-the-art IT resources, innovative educational technologies, and an array of IT services and support. The CU-Boulder campus has engaged in comprehensive strategic planning processes that are the keystone of the development of the campus’s IT environment. CU-Boulder’s 1998 IT strategic planning process provided the blueprint for building out a solid, accessible IT infrastructure. The hallmark of this current strategic plan is its emphasis on academic and administrative IT services.

2002 IT Strategic Vision

Over the past several years, technology has been developing at ever-increasing rates; concurrently, faculty, student, and staff expectations of the campus’s IT environment, resources, and their support structures have risen, and will continue to do so. Faculty increasingly rely on robust and effective educational technology tools to enhance teaching and research. Students expect mobility, flexibility, and customization in their use of IT for classes, and in their electronic administrative interactions with the university. Staff desire specific, timely, and accurate information to support their work. Even with the improvements to the campus’s IT environment over the past four years, including increased levels of support, faster networks, and greater access to educational technology, campus users expect ever greater performance from the campus’s computing and network resources. CU-Boulder is responding to these varied expectations by articulating an IT vision that focuses on:

- Educational technology¹ use and support; and student information and IT literacy and fluency²;
- Providing integrated web-based IT services to faculty, students, and staff;
- Moving IT support closer to end users;
- Improving the coordination of critical elements of the campus’s IT environment; and
- Improving communication about IT resources to the campus community.

Integrating the components of this vision into CU-Boulder’s academic and administrative IT landscapes will help meet growing expectations of faculty, students, and staff, and will contribute to the “Culture of Excellence” called for in CU President Elizabeth Hoffmann’s Vision 2010.

Key Area #1 – Educational Technology

The IT strategic planning process has made it apparent that each school, college, and department has significant educational technology needs and uses, many of which are increasingly discipline-specific, but concurrently reliant on centrally-managed resources. A robust, centrally-managed technology and support infrastructure—well-coordinated with unit-

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¹ Educational technology is the use of existing and emerging media and information technologies to enhance teaching, learning, and research.
² CU-Boulder defines information literacy as a student’s ability to recognize what information is needed independent of its format, to know where to find it, and to be able to evaluate it and then use it critically and creatively. Fluency comprises those more advanced abilities that may be specific to particular disciplines or groups of disciplines or to higher levels of learning.
specific support structures—can provide faculty and students with critical IT resources they need, such as:

- Advanced instructional facilities;
- Academic digital content;
- A robust learning management system;
- Comprehensive educational technology support, including desktop and facilities support, production assistance, and instructional design support; and
- High performance research computing.

Additionally, initiatives such as Information and Information Technology (I/IT) literacy for students will provide a foundation for discipline-specific I/IT fluency goals. The campus must facilitate departmental level planning to better meet both unit-specific educational technology needs and I/IT fluency goals.

**Key Area #2 - Integrated Web-Based Services**

The web is increasingly the virtual space for the campus community to access information and do its work. Students rely on web-based student services and course content, staff use web-based applications to complete a wide range of business and work transactions, and faculty access online information and digital content in support of their teaching, research, and creative work. The campus must provide web-based services that fulfill a wide range of needs and that are technically, administratively, and culturally integrated. The campus must strengthen and strategically expand current web-based services for students, faculty, and staff. In addition to being able to access financial aid and registration services, for example, students should be able to access personal calendaring, online course materials, and other services through a single, interactive website. These services, and corollary web-based services for faculty and staff require collaborative efforts by several units across campus, including ITS, University Communications’ Office of Web Communications, Enrollment Management Services, and many other units that provide student, faculty, and staff services.

**Key Area #3 - Effective IT Support and Services**

Cross-campus collaboration within a centralized/departmentally-based hybrid IT support model should be a hallmark of the campus’s continued provision of effective IT support. Providing coordinated, targeted support close to the user is the means by which the campus must facilitate effectiveness across areas as diverse as educational technology, facilities, central IT and web-based services, and desktop support. For instance, the campus should continue to develop partnerships between ITS, academic service units, and departmental IT staff to provide faculty with a wide-range of educational technology support—from assistance with course web page design to the creation and management of digital media for teaching and research. In addition to providing effective IT support, the campus should continue to provide excellent central IT services and to expand and enhance those services wherever feasible. The campus must continue to provide a suite of central infrastructure services on which the day-to-day operations of the campus increasingly depends, including, for example, email, security, an enterprise directory, and reliable network and telephony services.

**Key Area #4 - Effective Coordination of IT Resources**

Technological advances and the increasing criticality of security necessitate cross-campus participation and cooperation to ensure reliability of information and effective provision of both central and departmental services. To ensure that all IT resources—including the network, email systems, telephony, and support—are robust, accessible, and reliable, the campus must provide better coordination of critical services, including security, authentication and authorization, directory services, and educational technology support. The campus must centrally manage
some services (such as Enterprise Directory Services, server registration, an incident response system, and software licensing) and coordinate others centrally (such as wireless deployment, antivirus protection, and email filtering). At the same time, the campus must continue to work toward a distributed model of IT support, in which, for example, desktop support is provided locally and tailored to departmental needs, but with the full resources of ITS available centrally.

**Key Area #5 - Effective Communication about IT Resources**

Effective communication is critical for IT resources to be broadly accessible, used appropriately and to the fullest, and supported effectively. Communication from both ITS and the Office of the Associate Vice Chancellor for Academic and Campus Technology (AVC ACT) must be targeted and frequent. A comprehensive communication plan ensures that faculty, staff, and students know what IT resources, services, and support are available to them, and where they can access them; that the campus is aware of the appropriate use of academic and administrative IT resources; and that end-users know and understand pertinent information about policies, guidelines, and processes. Effective communication processes using IT resources as a conduit also ensures that pertinent information about critical incidents reaches all end-users.

**Key Area #6 - Effective and Inclusive Leadership for IT**

The Office of the Associate Vice Chancellor for Academic and Campus Technology and the IT Council work with ITS and other IT providers on campus to provide strategic direction for campus-wide IT initiatives. The campus must make this strategic leadership more inclusive by establishing a faculty committee for IT and an administrative IT committee, both of which would address both strategic and tactical issues. These two committees and IT Council must establish stronger communication and working ties with other leadership and advisory bodies on campus, including the Boulder Faculty Assembly (BFA), the Student Union (UCSU), the United Government of Graduate Students (UGGS), and Staff Council.
Current Situation (Trends)

Introduction

Leading global, higher education, and campus technology trends helped shape the 2002 IT strategic planning processes. These IT trends contributed to discussions regarding the role technology could play in almost every aspect of the CU-Boulder campus, whether in the classroom, residence hall, or research lab.

General technology trends

- **Ubiquitous web presence**—technology increasingly provides access from almost anywhere to the Internet, creating a virtual conduit for the individual to connect to a wide range of information as well as to different communities. Additionally, individuals expect access to high-quality, just-in-time information from expert sources.

- **Rapid connectivity**—high-speed networks, remote access, and wireless increasingly provide seamless access.

- **Increasing freedom with mobile devices**—increasingly, people are choosing portable, small, and wireless devices for their computing needs, which helps them realize unprecedented mobility in information and network access. Additionally, these devices provide more capacity and functionality in a single device.

- **24/7 Service Expectations**—individuals anticipate service and support assistance to be 24 hours a day, seven days a week.

- **Electronic Commerce**—consumers expect the convenience of numerous products and services to be available via secure online purchase and transaction systems.

- **Sophisticated applications**—greater use of more mature, common-platform applications, and easier-to-use multimedia tools, has a great impact on educational technology in areas including course management systems and video editing software.

Specific higher education IT concerns

In 2002, the third annual Educause survey identified current IT issues affecting higher education. Participants of the survey were asked four key questions: 1) What is the most important IT issue to resolve for the institution’s strategic success; 2) What IT issue has the potential to become more significant; 3) What IT issue do IT leaders spend their time on; and 4) What IT issue represents the biggest expenditure of institutional resources?

The top IT concerns of higher education institutions, especially large, public universities, taken across all four questions, include:

- Security management

- Faculty development, support, and training

- Administrative Systems/Enterprise Resource Planning (ERP)
• Online Student Services/Enterprise Portals
• Maintaining network infrastructure
• Distance Education
• IT funding strategies

**Specific CU-Boulder Trends**

CU-Boulder continues to have an explosive growth in demands on computing and network resources. Specific data, which reinforces this growth, includes:

• PLUS is now used by 99% of CU-Boulder undergraduate students and has the highest use and satisfaction rating of any student service on campus. During the first week in the fall semester of 2002, with approximately 26,000 students, PLUS was accessed over 180,000 times.

• In 1997-98 62% of the incoming freshmen class owned their own computers as compared to 95% in 2001-02. 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 2002, a majority of students prefer and purchase laptops over desktops.

• From 1997 to 2002, Internet traffic on campus has increased four-fold. Additionally, Internet2, which support academic research, has become available for CU-Boulder faculty and researchers.

• In 1997-98 13,500 campus computers were connected to the campus network as compared to 23,000 in 2001-02

• In 1997-98 very few academic courses had any web-presence. Now, in 2002 virtually all classes do. Also, in 1997-98 a central course management system did not exist. Now, in 2002, over 300 courses, supporting over 15,000 students, utilize the campus’ course management software, WebCT.

• The Libraries are increasingly relying on adding digital materials via a subscription service rather than owning the hardcopy periodical and/or journal.

• In 1997-98 72% of students had CU-Boulder email accounts as compared to 100% in 2001-02.

• In 1997-98 41% of centrally scheduled classrooms had network connectivity as compared to 58% in 2001-02.
Chapter 1: Educational Technology

Innovative uses of technology in support of learning and teaching can be found across the entire CU-Boulder campus. From the creation of web-based teaching modules to in-class technology use, faculty are using technology judiciously and effectively to improve both instruction and student learning.

Even as the use of technology in learning and teaching increases, support of it remains fragmented, and largely uncommunicated to the faculty who would benefit from it. This chapter provides recommendations for a broad array of educational technology support and services, and recommendations for better coordinating and communicating them.

Data from 2000 and 2001, as well as from focus groups and spring 2002 data collection efforts associated with this strategic plan indicate that there are several discrete (but overlapping) facets to educational technology. Understanding these facets is prerequisite to providing the most effective constellation of support and services for the use of technology in instruction and research. Our conception of educational technology on the CU-Boulder campus includes the following components.

1. **Course Content**: Although course content is not a facet of educational technology per se, it is the crucial component. All aspects of educational technology support and services must link back to it.

2. **Primary Purpose of Educational Technology Use**:
   a. Most faculty members use technology to improve or facilitate *course organization and management*, by putting syllabi on a course website, or by projecting Power Point slides instead of using an overhead projector and transparencies. In this type of use, there are few or no changes in teaching practices, which are merely translated to new media, often with increased efficiencies. Several types of support are available to faculty using technology in this way: *production and design* support for basic website development, *facilities and equipment* support in the classroom. *Learning Management Systems* support also facilitates this use of educational technology.

   b. Some faculty members use technology in ways that require *instructional design* support. That is, they change their teaching practices in response to possibilities offered by current and emerging technologies. For example, a faculty member might create an interactive, 3-D java applet to demonstrate a scientific principle that earlier could have been visualized only statically or two-dimensionally. Some refer to this as accommodative use—faculty enhance their teaching by making changes, sometimes radical, to their teaching practices as they exploit the full potential of new and existing technologies. *Production and design* support also can play a role in this type of use if digital media is a component of this type of educational technology use.

   c. Any use of educational technology requires thoughtful integration of content, pedagogy, and technology to be effective, which necessitates a close working relationship between units and programs that provide educational technology support, and those that provide faculty and graduate student development.

3. **Equipment, Facilities, and Faculty Skills**: This “nuts-and-bolts” facet of educational technology also requires support, and training. Faculty, and all instructors, need a

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4 Recommendations about commercial digital resources, the acquisition of which may be more cost-effective than a full-array of on-campus support and production, can be found in section 1.6, Digital Content and Collaboration.
minimum skill set to bring technology into their teaching: they need to have at least some skill in using hardware and software, as well as the equipment in technology-enhanced instructional facilities. Beyond the minimum, faculty either need a full array of support (such as production and design, instructional design, and facilities and equipment mentioned above) or a full array of skills, which often take an unacceptable amount of time, money, and effort to acquire (time, money, and effort that further detract from other professional activities that are rewarded in tenure and promotion processes, as use of technology in teaching is not).

The types of support that should be provided at CU-Boulder for effective and broad use of educational technology include:

1. Instructional Design
2. Media Production
3. Learning Management Systems
4. Facilities and Equipment

Support can come in many forms: traditional help-desk or desktop support, short- or long-term consulting, and training. Currently, many units on campus provide one or more types of support with little understanding among them of which unit does what, for whom, and with what effectiveness. All support and training for educational technology must be closely integrated with existing faculty and teaching assistant development programs. The campus should also continue to provide educational technology services, for cases in which a faculty member or a department prefers to have a service unit complete work in support of teaching or research endeavors, for the production of media, for example.

The theme of this chapter is the need for coordination to provide effective, efficient, and broad services and support for all educational technology uses. Several sections of the chapter are clearly related to this theme:

- Educational Technology Support
- Technology-Enhanced Instructional Facilities
- Learning Management Systems
- Digital Content and Collaboration
- Libraries

Two other sections fall into this chapter by virtue of their academic status (I/IT Literacy and Fluency), or of their reliance on similar services and support structures (Research Computing).

In addition to reflecting on the recommendations put forth in this chapter, the campus also must consider the possibility of incentives for faculty use of educational technology in teaching and research. This includes examining how educational technology use fits into salary, promotion, and tenure reviews, and what resources the campus makes available to help people incorporate educational technology.
1.1 Educational Technology Support

Recommendation: The campus should establish a well-communicated and well-coordinated model to provide both high-level support for instructional design and advanced technological and pedagogical innovation, as well as basic-level support for the use of educational technology in course content and/or course management and organization.

The campus also should establish a centralized, online source of information for faculty and a process of communication with faculty, instructors, and student users about educational technology and the resources available for its support.

Discussion of the Recommendation

Current Situation
Support and training for the use of educational technology is provided by several units on campus: ITS, through its Distributed Academic and Campus Technology Coordinators (DACTCs), Bug Busters, and Media Services units; the Libraries; the Faculty Teaching Excellence Program (FTEP); the Graduate Teacher Program (GTP); and the Program for Writing and Rhetoric (PWR). Although there is some overlap in the services each of the units provides, there is little knowledge among the units of respective services offered, and less knowledge among faculty and student users of how the support pieces fit together. In addition, little attention has been paid to fully integrating support and training for educational technology with faculty and graduate student development in the areas of instruction and pedagogy.

In fall 2001, CU- Boulder continued a series of steps to determine its academic goals, priorities, and needs in the broad area of educational technology. A committee of faculty and staff convened to establish a vision for the campus’s use of educational technology. That committee recommended that the campus establish a coordinated support model to provide both high-level support for instructional design and advanced technological and pedagogical innovation, and basic-level support for the use of educational technology in course content and/or course management and organization. The committee’s visioning document can be found at http://www.colorado.edu/Committees/itc/etsp/usesvision.html. This section is a continuation of that visioning work.

Rationale
Across higher education, there is an increase in the use of educational technology in teaching and learning. From course websites to the use of digital media, instructors are using technology as a tool to streamline course management and to produce innovations in learning and teaching. With this increase in the use of educational technology comes a responsibility on the part of institutions to provide adequate support for an increasing number and variety of users.

The campus’s educational technology support model must be coordinated better and communicated better to provide the current and future support needed by faculty, instructors, and students. All three groups need easy access to information about the resources available for educational technology, the infrastructure within which they can use these resources, the projects

See http://www.colorado.edu/Committees/itc/etsp.html for information about ongoing educational technology strategic planning.
their colleagues are pursuing, and the support staff who can help them make the most of these opportunities.

Specific Recommendations Include

- Continue to coordinate support for the undergraduate student use of educational technologies through the existing Libraries-ITS-PWR partnership. Train staff in Libraries and PWR labs to handle simple, common IT issues and to be familiar enough with the 4-Tier ITS support model to be able to make the appropriate referrals for other technical questions.

- Coordinate, and possibly co-locate, ITS and Libraries media services units.

- Assess the DACTC-FTEP faculty liaison model, and improve communication between DACTCs and FTEP to strengthen DACTC-faculty/department relationships.

- Assess possibilities for increased DACTC-GTP collaboration.

- Assess and formalize DACTC roles as new memoranda of understandings (MOUs) are written between ITS and the campus’s schools and colleges. Take steps to ensure that the distinction between DACTC and desktop support, classroom/lab support, and server support personnel roles and responsibilities are clear and respected. MOUs will formalize, but not standardize, DACTC roles, and will continue to provide local control and local tailoring of DACTC roles and responsibilities.

- Continue the trend of moving support services (e.g., desktop support, classroom/lab support) closer to faculty users, and possibly add desktop support and/or classroom/lab support representative(s) to existing DACTC-graduate student teams.

- Develop a communication plan and centralized source of information to improve faculty, instructor, and student understanding of educational technology resources and support available on campus.

Steps

Implementation

- Convene a small group of Libraries, ITS, and PWR representatives to create an IT training model for staff in Libraries and PWR labs, and to develop an integrated model to provide both lab-specific and general IT assistance to students using those labs.

- Convene a small group of Libraries and ITS staff to investigate the roles of ITS and Libraries media services units and to recommend a model for the consolidation and/or coordination of those units.

- Facilitate ITS and FTEP discussions to strengthen DACTC and faculty/department relationships.

- Facilitate ITS and GTP discussions to understand possibilities for DACTC-GTP collaboration, and to understand graduate student teaching assistant support and training needs.

Required Involvement

Governance & Authority

The Office of Academic and Campus Technology will provide coordinating authority for the support of educational technology.

Required Departmental Involvement & Responsibilities
Campus-wide involvement is needed for effective support of educational technology. Service units that provide support will be responsible for sharing information and coordinating their services as necessary.

Libraries, ITS, and PWR will work closely to create and implement an integrated IT training model for Libraries and PWR labs staff. Libraries and ITS will work together toward efficient and effective media services. ITS and FTEP will work toward strengthening the DACTC program. ITS and GTP will work toward understanding graduate student teaching assistant needs and roles. The Anderson Language Technology Center (ALTEC) should be included in discussions specific to the needs of foreign language faculty, instructors, and students.

**Expected Costs**

**Annual IT Infrastructure Investment**
None.

**Operating and Maintenance**
None.

**Personnel**
If any, reallocation of existing staff to provide increased levels of desktop support and classroom/lab support. For desktop support specifically, there is the possibility of an addition of 6-10 desktop support personnel to work on DACTC teams. The composition of those teams, which may include instructional design and production support provided by DACT Coordinators and others, will be determined by the MOUs with schools and colleges.

**Funding**
Desktop support and classroom/lab support funding would come from ITS general funds, with additional departmental and/or campus funding as necessary, and, in the case of departmental funding, viable.

**Timing**
- Finalize departmental-ITS MOUs to formalize DACTC roles in schools and colleges by fall 2002.
- Develop a model for IT support in Libraries and PWR labs by spring 2003.
- Determine consolidation and/or coordination of ITS and Libraries media services units by spring 2003.
- Begin ITS and FTEP discussions about DACTCs fall 2002.
- Begin ITS and GTP discussions fall 2002.
1.2 Instructional Facilities

Recommendation: The campus should make effective use of its existing technology-enhanced instructional facilities through more effective scheduling. The campus should designate some ITS-supported computer labs as part-time teaching facilities, and formalize the process for scheduling instructional activities in these specific labs.

To provide reliable, widely available technologies that can be adapted to a variety of teaching and learning situations, the campus should enhance support for technology-enhanced facilities by locating support in proximity to the facilities, and by tailoring the support to the needs of faculty users. The campus also should continue its efforts to identify, plan for, and fund the renewal and replacement needs of technology-enhanced instructional facilities.

Discussion of the Recommendation

Current Situation
The campus has approximately 150 centrally-scheduled classrooms that have some level of technology enhancements. There are several dozen more such instructional facilities that are “owned” and maintained by departments. The recommendations in this section concern centrally-scheduled classrooms only.

Demand for technology-enhanced teaching facilities is growing, and little funding exists to convert traditional classrooms into “smart” classrooms (that is, technology-enhanced instructional facilities that have Internet connections, projection, and other media capabilities). Maintenance and support for smart classrooms are funded with one-time budget requests and from ITS’ classroom renovation account.

The campus also has over 60 ITS-operated computer labs that are funded, in large part, through student technology fees. Although there is a high level of student computer ownership (now approximately 95% for incoming first year students), the need for these labs may remain constant in the coming years. Student computer labs are used because of their convenience and specialized software; some are used on an ad hoc basis as instructional facilities. The campus has not increased the number of student labs in the past several years, and there are no plans to do so in the coming years.

Support for computer labs and computer classrooms is mainly provided by ITS through the Microsystems Group (MSG). Support for centrally-scheduled smart classrooms is mainly provided by ITS through the Classroom Support group. In a limited number of instances, that support is provided by ITS staff located in proximity to the facilities (e.g., in the Humanities Building); otherwise, little support is provided in proximity to technology-enhanced facilities. Training for faculty to learn to use smart classrooms, labs, and computer classrooms is provided formally only in the Humanities Building. Other training for these purposes is ad hoc.

Last year, the campus undertook its first comprehensive inventory of all—central and departmental—classrooms to determine which facilities had technology enhancements. The Office of the Associate Vice Chancellor for Academic and Campus Technology spearheaded the effort, with significant work completed by ITS and the Instructional Computing Working Group (ICWG). In addition to that comprehensive inventory, ITS has completed a more detailed
analysis of the facilities it maintains, and has begun to assess renewal and replacement needs and costs for them.

The campus’s continued funding for the renewal and replacement of technology-enhanced instructional facilities is inadequate, and there is no reliable, ongoing source of support for this need. While renewal and replacement for labs is funded from student technology fees, that of classrooms is not. Faculty are generally not involved with strategic decisions about the technologies that are needed in instructional facilities, or about moveable technologies that might enhance the capabilities of bare-bones classrooms (those with no technology enhancements).

**Rationale**

The demand for technology-enhanced instructional facilities is growing and will likely continue to grow. Faculty at CU-Boulder increasingly rely on laptops, projection and sound systems, VHS and DVD players, and other technologies to bring media content into the classroom. A smaller and growing group of faculty are teaching classes in computer labs or classrooms and devoting class time to individual student or group work at computer workstations. Anecdotal evidence and some survey data suggest that, while technology-enhanced teaching facilities are in high demand, campus use of them is not efficient. Faculty who need the technology in instructional facilities have no priority over those who do not; therefore, the technology in such facilities is seldom used to its full potential. Furthermore, faculty who need the technology for only a small percentage of their class meeting times must reserve a technology-enhanced facility for the entire semester.

Some faculty members use student computer labs for teaching purposes. However, this use is not formalized, and the standard configuration of the labs does not lend itself to instructional purposes.

Anecdotal evidence and survey data likewise indicate that support for technology-enhanced instructional facilities needs to be physically proximate to the location of the facilities for ease of maintenance and technical stability and reliability. This is currently the case in only a few instructional facilities.

To ensure that there is a close fit between technologies needed and technologies provided, faculty must be involved with strategic decisions about what technologies will be included in which instructional facilities, and about what moveable technologies the campus should invest in.

The campus’s continued funding for the renewal and replacement of technology-enhanced instructional facilities is inadequate, and there is no reliable, ongoing source of support for this need.

**Specific Recommendations Include**

**Effective Scheduling of Technology-Enhanced Instructional Facilities**

The Office of the AVCACT, the AVC for Undergraduate Affairs, ITS, and the Registrar will collaborate to establish a thoughtful, effective, and equitable scheduling process for technology-enhanced and computer classrooms, in part by adding the need for technology enhancements to the Registrar’s list of priorities for classroom scheduling.

**Use of Student Computer Labs for Instructional Purposes**

ITS and the Office of AVCACT will work with appropriate student groups and student fee committees to develop guidelines and procedures for the instructional use of student computer labs that are equitable and sustainable, recognizing both faculty and student needs and expectations. These guidelines will formalize the use of some computer labs as instructional facilities for a limited number of class meeting times per week.
Effective Support of Technology-Enhanced Instructional Facilities
ITS will work with schools and colleges to determine the most effective model for providing support for technology-enhanced instructional facilities. This model will locate support in proximity to the instructional facility wherever feasible.

Renewal and Replacement of Technology-Enhanced Instructional Facilities
ITS will continue its work on the renewal and replacement of centrally-scheduled, technology-enhanced instructional facilities and will continue to search for ongoing funding for the maintenance, renewal, and replacement of those facilities.

Steps

Implementation

Effective Scheduling of Technology-Enhanced Instructional Facilities
- The Office of the AVC ACT, the AVC for Undergraduate Affairs, ITS, and the Registrar will add technology-enhancements to the scheduling prioritization formula. Representatives from the three units and from the Faculty Advisory Committee for IT (FACE-IT, a faculty committee that plays an advisory role with respect to campus IT issues in general, and educational technology specifically) will consider other changes to the scheduling process, including the possibility of setting aside technology-enhanced facilities for faculty who need the technologies for limited class meetings. The Office of the AVC ACT also will communicate to faculty the existence and capabilities of technology-enhanced instructional facilities.
- The Office of the AVC ACT and the AVC for Undergraduate Affairs will develop a communication plan for informing faculty about the existence and capabilities of technology-enhanced instructional facilities. ITS will establish a modest training program for faculty on how to use the smart classrooms, labs, and computer classrooms.

Use of Student Computer Labs for Instructional Purposes
- ITS and the Office of AVC ACT will work with the UCSU and the student fee committee to develop guidelines and procedures for the instructional use of student computer labs and to gain formal approval for the use of student computer labs as instructional facilities.
- ITS and the Office of the AVC ACT will develop a process for scheduling designated student computer labs for instruction.

Effective Support of Technology-Enhanced Instructional Facilities
- ITS will work with schools and colleges to determine the most effective model for providing support for technology-enhanced instructional facilities.

Renewal and Replacement of Technology-Enhanced Instructional Facilities
- ITS and the Office of the AVC ACT will work with FACE-IT to evaluate the nature, quantity, and quality of campus instructional facilities and the emerging technologies installed in them. Moveable technologies (e.g., laptop carts and portable projectors) will be considered at this time.
- ITS will complete its renewal and replacement schedule for technology-enhanced instructional facilities and develop a cost model that recognizes the true costs associated with providing and maintaining computer labs that are used for teaching.
- ITS will continue to fund staff to support basic instructional use of smart classrooms, labs, and computer classrooms.

Communication

Effective Scheduling of Technology-Enhanced Instructional Facilities
- The Office of the AVC ACT and the AVC of Undergraduate Affairs will develop a communication plan for informing faculty about the existence, capabilities, and scheduling of technology-enhanced instructional facilities.
Use of Student Computer Labs for Instructional Purposes

- The Office of the AVC ACT and the AVC of Undergraduate Affairs will develop a communication plan for informing faculty about policy for and scheduling of student computer labs for instructional uses.

Effective Support of Technology-Enhanced Instructional Facilities

- ITS will develop a communication plan for informing faculty, schools, and colleges about the support available for technology-enhanced instructional facilities.

Policy & Standards
Guidelines will be developed to clarify new classroom scheduling processes and the use of student computer labs as instructional facilities.

Required Involvement

Governance & Authority

- The Office of the Associate Vice Chancellor for Academic and Campus Technology, in consultation with ITS and University of Colorado Student Union (UCSU).
- UCSU has authority over Student Computing Fee funds.
- Decisions about technology-enhanced teaching facilities will be made with input from FACE-IT.

Required Departmental Involvement & Responsibilities

- Associate Vice Chancellor for Academic and Campus Technology
- ITS Management and Departments, specifically
  - MSG
  - Media Services
  - Support Services
- Representatives from the faculty
- Registrar and departmental scheduling liaisons
- Deans of the schools and colleges
- UCSU student representatives.
- UGGS (United Government of Graduate Students) representatives.
- Instructional Computing Working Group to provide guidance and programmatic direction.

Expected Costs

Annual IT Infrastructure Investment

- To be determined after analysis of facilities and cost of support.
- Current renewal and replacement for classroom facilities is $500,000 over the next four years.

Operating and Maintenance
To be determined after analysis of facilities and support costs.

Personnel
To be determined after analysis of facilities and support costs.

Funding
The campus should think strategically about diverse funding sources, including central general fund accounts, student technology fees, schools and colleges, the state legislature, and corporate funding for the renewal and replacement of technology-enhanced instructional facilities. Funding for support should continue to come from ITS general funds.
Timing
Work on scheduling processes will begin by fall 2002.
Work on formalizing instructional use of student computer labs should begin fall 2002.
Work on new support models for technology-enhanced instructional facilities should begin fall 2002.
Work on renewal, replacement, and funding for technology-enhanced instructional facilities should begin summer 2002.
1.3 Information and Information Technology (I/IT) Literacy and Fluency

Recommendation: The CU-Boulder campus should establish specific goals for information and information technology (I/IT) literacy, and should facilitate the creation of discipline-specific goals for I/IT fluency for students. The literacy goals should be the responsibility of the campus as a whole; the fluency goals should be formulated and implemented by particular disciplines and departments.

Discussion of the Recommendation

Current Situation

Universities have long worked to ensure that their students are knowledgeable and educated-able to identify the need for information, to know where to find it, to evaluate critically what they find, and to use it effectively and creatively. That is, universities have always taught what we call information literacy. Today, rapid technological change and an explosion of information resources create a plethora of new technology tools, applications, and resources. This current complex information technology environment has led universities to re-evaluate the ways in which they are educating their students in information technology literacy as well as in information literacy.

During the fall of 2001 an I/IT Literacy/Fluency task force was convened as part of the Educational Technology Strategic Planning Process. The basic charges of the task force were to: develop a draft of the elements of campus-wide I/IT literacy standards, and develop an I/IT fluency process for disciplines and departments to use to create specific I/IT fluency goals. The task force, which primarily consisted of faculty from a variety of disciplines, recognized that the Program for Writing and Rhetoric has developed modules that fulfill the foundational information literacy needs of students. Therefore, the task force focused on developing a set of recommendations, primarily on IT literacy, while recognizing the inextricable link between information literacy and information technology literacy. A summary of the task force’s report can be found at: [www.colorado.edu/committees/itc/etsp/literacydraftreport2.htm](http://www.colorado.edu/committees/itc/etsp/literacydraftreport2.htm).

The task force did not suggest any changes to the curriculum. It recommended that the campus adopt a set of I/IT literacy goals that outline where a student should be in order to succeed with each stage of his or her CU-Boulder education. While the recommendations did not ask departments to design new courses or to redesign old ones, it was the hope of the task force that the faculty as a whole, if it adopts a set of I/IT literacy goals, would understand that it is the responsibility of the faculty to help students achieve the level of I/IT literacy necessary for success in upper level courses.

The task force also reviewed two different I/IT fluency processes that could be adopted and utilized by all departments. Most notably, the task force reviewed the Planning Across the Curriculum for Technology (PACT) pilot project (the other was developed by the Libraries). The PACT project is a process that identifies the advanced IT skills and concepts that are tailored and

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CU-Boulder defines information literacy as a student’s ability to recognize what information is needed independent of its format, to know where to find it, and to be able to evaluate it and then use it critically and creatively. It defines information technology literacy as a student’s ability to become proficient in new technology applications as they become available for learning and the production of knowledge. Fluency comprises those more advanced abilities that may be specific to particular disciplines or groups of disciplines or to higher levels of learning. Literacy goals need to be common across the campus; fluency goals need to be designed specifically to meet the particular needs of students following particular paths of study and need to be forward-thinking in the sense that they supply students with the requisite skills, concepts, and capabilities for at least the entry-level of their chosen career paths.
specific to students in their discipline. The departments of Fine Arts, Applied Mathematics, Communication, and Astrophysical and Planetary Sciences have participated in the PACT pilot project.

Rationale
In order to best prepare our students in an increasingly technological age, a need exists to revisit our standards for information literacy, promulgate goals for information technology literacy, and encourage departments to develop I/IT fluency goals, which are pertinent to their specific discipline. These goals are linked abilities: on the one hand, to be information literate today, one must be able to access and utilize IT appropriately; on the other, there is little point in being able to access and utilize IT unless one can use it critically and creatively.

Specific Recommendations Include

• CU-Boulder students, by the time they complete their first-year at the University, will be I/IT literate, or have the ability to be proficient in new technology applications as they become available for learning and the production of knowledge. These abilities are needed across disciplines, and make up part of the education of any well-rounded CU-Boulder student. The I/IT literacy goals should be uniform and common across the CU-Boulder campus.

CU-Boulder students, by the time of graduation, will be I/IT fluent, or have those more advanced abilities that may be specific to particular disciplines or groups of disciplines, or to higher levels of learning. The I/IT fluency goals should be designed specifically to meet the particular needs of students following particular paths of study, and should be forward-looking in the sense that they supply students with the requisite skills, concepts, and capabilities for at least the entry-level of their chosen careers. These I/IT definitions are nested in so far as the literacy goals provide a foundation that the fluency goals then build upon.

Steps

Implementation
The faculty will be the primary developers and decision-makers regarding I/IT literacy and fluency goals.

Continued development of the information literacy curriculum is occurring through the Program for Writing and Rhetoric and is integrated into the first-year PWR course that eventually will be taken by almost all first-year students.

The next steps for IT literacy are to refine the goals, and to determine the extent to which they may be met by the end of a student’s first-year. This will be achieved by determining the IT abilities that students have upon enrollment at CU-Boulder; by understanding what IT skills, concepts, and capabilities are taught in commonly taken first-year courses or can be obtained in non-credit IT instruction offered by ITS; and by identifying what IT abilities students must master in order to succeed in their first-year courses.

Next steps include:

• Work with the A&S Dean’s Office and advisors during fall 2002 to determine how the commonly taken first-year courses map to the IT literacy goals.

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7 See appendix at the end of the report for the suggested information literacy curriculum.
8 The School of Business and the College of Engineering require that their students take a foundational course within their school or college that has similar information technology literacy goals as the PWR course.
• Survey a random sample of incoming first-year students in fall 2002 to assess their IT literacy.
• Convene a faculty group in fall 2002 to review, revise, and adopt I/IT literacy goals, and determine the ability of the campus to enable all first-year students to achieve these I/IT goals through existing courses (this includes focused advising on which core courses will result in students attaining mastery of I/IT literacy goals in which they are not already proficient) and support offerings from ITS, the libraries, and other appropriate areas.

The I/IT fluency initiative will be more fully explored after the IT literacy steps taken above are completed. It is anticipated that this will include a review of the PACT pilot project, which was conducted during academic year 2001-02, as well as a consideration whether, and how to continue this project.

**Required Involvement**

**Governance & Authority**
The Office of Academic and Campus Technology will provide coordinating authority for information and information technology literacy and fluency. The Office of the Provost will provide overall authority for this program. However, the faculty will be the primary developers and decision-makers regarding the IT literacy and fluency goals.

**Required Departmental Involvement & Responsibilities**
Campus-wide involvement is needed for successful implementation of I/IT literacy and fluency goals; however the College of A&S will be heavily involved.

**Expected Costs**

**Annual IT Infrastructure Investment**
For information literacy, the Program for Writing and Rhetoric has outlined an anticipated IT infrastructure investment. For information technology literacy, the expected IT infrastructure costs if any, are unknown until the recommendations from the faculty constituency group are developed and implemented. For the I/IT fluency project, expected costs can be projected: a full-time FTE working closely with departments.

**Operating and Maintenance**
A potential need for additional IT resources and support may arise depending on the IT literacy goals defined by the faculty group. Additional resources might be needed for evaluation and assessment of this initiative.

**Personnel**
Not enough information at this time to determine personnel needs for the IT literacy goals. For the PACT pilot project a half-time FTE was utilized.

**Funding**
Funding options might be available through the student technology fee and/or Office of the Provost.

**Timing**
During summer 2002, the Office of Academic and Campus Technology will work with the A&S Dean’s Office to determine how commonly taken first-year courses map to the draft IT literacy goals. During the summer or fall of 2002, incoming first-year students will be randomly sampled to assess their level of mastery of the draft IT literacy goals. Additionally, in the fall of 2002, a faculty group will be convened to review, revise, and adopt IT literacy goals. This faculty group
will also determine the ability of the campus to enable first-year students to achieve these IT goals through existing courses, services, and resources. This group’s conclusions will be communicated to the campus, in order to reach a decision on how the campus should proceed with IT literacy. The I/IT fluency initiative will be further explored after the IT literacy steps are completed.
1.4 Learning Management Systems (LMS)

Recommendation: Develop a robust web-based learning infrastructure capable of supporting every course at CU Boulder, and one that adheres to the following principles:

- Enhances the learning experience for students
- Presents a consistent and branded resource for both students and faculty that integrates with centralized web-based student services

Discussion of the Recommendation

Current Situation
ITS currently supports a single course management system, WebCT (Standard Edition). WebCT has been used on the Boulder campus since fall 1997. Usage has grown dramatically during the last 3 years to approximately 250 courses, supporting roughly 15,000 unique students during the fall of 2001.

WebCT usage is constrained by the hardware and human resources available to support it. ITS currently allocates approximately 2.75 FTE which is sufficient at current usage levels to support the application from a systems administrative perspective. Support for faculty usage of WebCT is insufficient.

Strengths of the current approach include:

- Cost effective—the cost per seat is relatively low.
- Good support from WebCT—the vendor provides good support for the product.
- Stable infrastructure—aside from SIS interface issues, the product is stable and reliable.

Weaknesses of the current approach include:

- Database technology does not provide efficiency of operations or the robustness required for large-scale deployment.
- A lack of SIS integration means that maintaining course rosters of student information is a labor-intensive process and is inefficient.
- No integration with the Enterprise Directory Service or campus authentication: students must maintain a separate login ID and password.
- No integration with current campus email systems: students must maintain an official campus email account and a separate WebCT email account.
- WebCT has expressed a serious concern that we are overworking the version that we are using.
- The current license for WebCT allows the campus to run it on a single server only. The capability to provide truly redundant fail-over service will continue to be lacking in the absence of a significant software and hardware upgrade.
- WebCT is not easy for all faculty members to use effectively. While the interface is simple, it is not efficient. While many of the tools provided with WebCT (assignments, quiz and discussions, e.g.) allow a great deal of flexibility in how the course is presented to students, they are difficult for many faculty to use, and therefore create barriers to the course design process. In addition, WebCT does not support foreign-language diacritics, which limits its use in support of foreign-language teaching.
As a result of these known weaknesses, ITS has limited the deployment of WebCT and has not actively promoted it to the campus. Because of this, many of the campus faculty members create and deploy their own course web sites and may choose to continue to do so, regardless of the campus solution. Support for these sites is varied. In some cases, departmental staffs provide a high level of support for the department’s web presence, as well as system administration for departmental web servers. In other cases, support is minimal or not available. Concerns about these sites include the lack of available professional support, and the lack of adequate security.

**Specific Recommendations Include**

- For academic year 2002/03 maintain the current support for WebCT.
- Engage in a system requirements definition process relying upon faculty and student input to delineate functional needs. The end result will be a set of functional specifications that can be used to determine future direction.
- Utilize the newly formed faculty IT advisory group (FACE-IT) to provide counsel and advice for future strategic directions. Include BFA academic technology committee and the Arts and Sciences Council in discussions.
- Continue to actively research the various CMS/LMS initiatives, such as the Open Knowledge Initiative (OKI), to understand capabilities and determine the appropriate strategic direction for the campus.

**Steps**

Articulate campus vision for LMS that melds with our web services for students, and web infrastructure strategic plans, with the goal of a unified web presence for every course offered. At a minimum, every course should have the capability of providing a course syllabus through the unified student web service.

Plan an LMS architecture that supports the teaching and learning objectives of the campus. In addition, the vision for LMS should be effectively communicated to manage expectations of availability, capacity, and reliability.

Finally, select a LMS direction for the Boulder campus that will take the campus to the desired destination of student web services that enhance learning.

**Implementation**

- For AY 02-03 and 03-04 the campus should continue supporting the standard edition of WebCT.
- Complete full system analysis of the LMS alternatives and determine appropriate campus direction for AY 04-05.

**Policy and Standards**

- Develop a policy regarding the centralizing support of LMS.
- Develop best practices and guidelines for publishing course content through campus supported resources.

**Required Involvement**

**Governance & Authority**

Office of the Provost.
Office of the Associate Vice Chancellor for Academic and Campus Technology.

**Required Departmental Involvement & Responsibilities**

- ITS to provide faculty support for use of the LMS. In addition, ITS will provide the application support.
• Faculty committee and Associate Deans to serve in an advisory capacity for the strategic and operational directions for LMS use.
• UMS, to provide support for integration with the SIS.

**Expected Costs**
Expected costs cannot be determined until the in-depth analysis is conducted.

**Annual IT Infrastructure Investment**
Hardware renewal and replacement and software licensing will be determined after a more detailed analysis is conducted.

**Operating and Maintenance**
Yearly maintenance for the hardware is $25,000.
Yearly application costs are currently $7,000. The vendor will not offer this particular level of support next year. Next year’s cost will be approximately $75,000 for the Enterprise version of the application.

**Personnel**
3 FTE for faculty training; currently 1 FTE is funded.
2 FTE for back-end support and SIS information integration; currently 1 FTE is funded.

**Funding**
Current ITS funding for personnel needs to be augmented by campus resources such as the General Fund.

**Timing**
The current version of WebCT and the staff resources are being utilized at maximum capacity. Changes to this program will be reliant upon additional resources and further program analysis slated for next academic year.
1.5 Research Computing

Recommendation: Facilitate distributed research computing through the provision of the following services to interested research groups:

- Centralized space and for-fee operational management for departmentally-controlled high performance computing clusters;
- High capacity networking access enabling connectivity to national supercomputing sites; and
- Centralized support for high performance computing clusters located in research facilities.

Discussion of the Recommendation

Current Situation
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 such as the Pittsburgh Supercomputer Center or Los Alamos for their high performance computing needs; that access is often in conjunction with specific grants. Other units, such as Physics, have built clusters of up to a few dozen processors each. The use of these clusters is frequently restricted to the individual researchers who developed them.

Many departments recognize unmet needs for better researcher access to both national high performance computing sites and for departmentally-based high performance computing clusters, and for graduate student access to high performance computing resources for instructional purposes. At present, there is insufficient knowledge of the extent of high performance computing on campus, and no consideration has been given to whether there might be benefits through the coordination of equipment, space, or support.

Rationale
Through judicious use of grant money, several departments and institutes on campus are meeting their high performance computing needs by developing departmentally-based and controlled high performance computing clusters. Although units feel strongly that the control of high performance computing clusters should be local, there may be a need for at least two centrally-provided, for-fee support services: shared central space and centrally-provided operational support, including data back-up and hardware/software support. There is typically little space in departments to expand existing clusters or to build new clusters; space used for clusters means less space for offices and for more broadly accessible classrooms and labs. Where there is space, cooling and wiring are obstacles to optimal design and use of clusters. Additionally, units and researchers find it difficult to back-up and store high performance computing data effectively. They recognize that providing this service centrally might result in efficiencies and quality of service that are not feasible at the departmental level.

Specific Recommendations
- Consider the provision of centralized space for departmental high performance computing clusters.
- Consider the provision of central, for-fee operational support (e.g., data back-up and hardware/software support) for departmental high performance computing clusters.
- Provide, on a for-fee basis, a higher capacity networking connectivity than the campus norm (at least 10 Gb by 2003) for CU-Boulder researchers who require this capacity.
• Provide centralized support for distributed on-campus supercomputing clusters on a fee for service basis.

Steps

Implementation

• Assess the current high performance computing environment, as well as the near-term need for departmental and institute high performance computing clusters. During this assessment process, the campus should determine the optimal model, including fees, for centrally-provided operational support of high performance computing. It also should identify the departments that would be most likely to relocate their clusters to a central space and/or use centrally-provided support for research clusters, and work with them throughout the remainder of the implementation process.

• If there is interest in housing some research clusters centrally, secure adequate and accessible space for the relocation of some of the campus’s departmentally-based high performance computing clusters, and ensure adequate bandwidth to and from sites remote from researchers. A model for remote and on-site access and use of the cluster space should be developed concurrently.

• If there is interest in supporting some research clusters centrally, develop a for-fee operational support model for centrally and departmentally located high performance computing clusters. Address bandwidth, storage space, and operational support processes during this stage.

• Integrate the support of any central physical space for high performance computing, and of any operational support such as data back-up and/or hardware and software support into the 4-Tier IT support model of ITS.

• Work with the Office of Contracts and Grants (OCG) to address any overhead/infrastructure issues that may arise vis-à-vis grants and central high performance computing service fees.

• Assess campus need for higher capacity network connection, and develop strategy to interconnect to the TeraGrid (http://www.teragrid.org/) to provide high capacity networking access.

Required Involvement

Governance & Authority
The Office of the Associate Vice Chancellor for Academic and Campus Technology.

Required Departmental Involvement & Responsibilities

• ITS will work with interested units to develop models for the provision of centralized high performance computing space, and operational support.

• Departments and institutes interested in utilizing central high performance computing operational support will work with ITS to develop, modify, and contract for services.

• Office of Contracts and Grants will provide expertise about the allocation of grant monies to central high performance computing services.

• ITS will work with representative faculty from research groups to develop high-capacity networking strategy and to provide on-going network management support.

Expected Costs

Annual IT Infrastructure Investment

• Dedicated space: TBD
• Bandwidth to and from remote site: TBD
• Server(s) for data back-up and storage: TBD
• Network Service: TBD

**Personnel**
• Scheduling and maintenance of centralized space: TBD
• Management of operational support: TBD

**Funding**
Funding will flow from grants directly to ITS in the form of fees for operational support.

**Timing**
The assessment of the campus’s high performance computing environment should take place spring 2003, with the possibility of a pilot program for centrally-located high performance computing cluster space by fall 2003.
1.6 Digital Content and Collaboration

Recommendation: The campus should continue to provide excellent, coordinated, and broad support and services for digital media and videoconferencing. It also should develop support and services for digital asset management and collaboration tools for both instructional and research purposes.

Discussion of the Recommendation

Current Situation
The campus currently provides several types of support and services for faculty who use digital content in their teaching and research. ITS' digital media lab in the Stadium provides walk-in service as well as on-site consulting where people can produce, store, and disseminate digital video, images, and audio. The facilities at this site include advanced multimedia development hardware and software, as well as media servers.

The Distributed Academic and Campus Technology Coordinators (DACTCs) provide some support in the form of training and consultation, and in the coordination of multimedia projects. The ITS Courseware Support Coordinator provides assistance for faculty who would like to design course content to be distributed over the Internet. The Technology Experimentation Center provides a site where faculty can create digital media content with the assistance of a DACTC. The Libraries also provide some media services (see sections 1.1 and 1.7). Currently there are limited central services for digital asset management; and only one video server is available to faculty.

ITS videoconferencing facilities in the Stadium allow people to host videoconferences for up to 10 sites simultaneously. The Humanities building has portable videoconferencing capabilities. There are no other centrally-provided (by ITS) videoconferencing services or support.

The campus does not yet provide centralized services or support for collaboration tools for teaching and research purposes. The Electronic Collaboratorium—a virtual Internet space with whiteboard-type capabilities currently in development—will allow small teams of people to collaborate using shared multimedia artifacts.

Rationale
Digital multimedia content is rapidly becoming a means by which higher educational institutions communicate ideas. Web sites supporting courses and research projects have become quite common. The use of digital video (including animations) in demonstrating concepts and theories is also on the rise. This increased use of digital media content needs to be addressed with increased support for designing, creating, and disseminating digital media. Key elements of that effort include providing a facility where faculty and students can access state-of-the-art technologies for producing digital content, and providing support for how best to design, produce,
and deliver that content. While it is not economical to provide these technologies on each users’ desktop, it is possible to provide a centralized location where advanced multimedia content can be produced.

In addition, videoconferencing and collaboration tools are increasingly viable options for facilitating instruction and research.

**Specific Recommendations Include**

- Continue to provide digital media services and support centrally through ITS’ digital media lab, and coordinate them with those offered by other educational technology support units in ITS and the Libraries.
- Assess the feasibility of continuing to fund the Technology Experimentation Center (TEC) and expanding it to develop centers specific to schools and colleges.
- Develop a model for effective, centrally-provided digital asset management (see Section 1.7 Libraries).
- Determine the need for centrally-provided video- and audio-conferencing facilities; investigate the viability of centrally-supported desktop videoconferencing capabilities.
- Provide support for Computer Support for Cooperative Work (CSCW) (collaborative) tools.

**Steps**

**Implementation**

- Coordinate digital media support with other educational technology support on campus.
- Support the ongoing use of digital multimedia in teaching at CU-Boulder. Continue the RFP process already used to solicit digital multimedia projects to be disseminated on one of the three ITS media servers (capra, kubrick, and hitchcock) as well as through CDs and DVDs.
- Create a digital media streaming, hosting, and archiving framework that can scale to support the needs of campus users for instruction, reporting, and demonstration using digital media content.
- Establish digital content management policies and procedures to guide the storage, maintenance, and dissemination of digital media.
- Work with the DACTCs, FTEP, and GTP to make faculty, instructors, and staff aware of CSCW tools currently or potentially available on campus.

**Communication**

- Prepare a communication plan to bring about awareness of:
  - The existence of and services available at the Technology Experimentation Center (TEC) and the digital media lab.
  - The services available on existing media servers.
  - The capabilities of existing CSCW tools.
- Prepare a communication plan to disseminate the results of the RFP for digital media projects.
- Prepare a communication plan to disseminate digital content management policies and procedures.

**Policy & Standards**

To be determined.
Required Involvement

Governance & Authority

- The Associate Vice Chancellor for Academic and Campus Technology for final authority.
- FACE-IT will play an advisory role in the further development of digital media services.

Required Departmental Involvement & Responsibilities

ITS is responsible for implementing most of the recommendations suggested in this section. Adequate faculty involvement will be solicited for all planning and decisions.

Expected Costs

Annual IT Infrastructure Investment

2003 Hardware replacement for servers/workstations = $41,000 (new)
2004 Centralized server = $100,000 (new)
Software Investment upgrades and licensing = $16,400 (new)
Operating and Maintenance = $5,000 per year central server maintenance

Personnel

Initially Media Production, Engineering, Classroom Design and the Media Collection staff. All positions currently funded

Affiliated staff (listed above) to be determined

Funding

Staff funding will come from existing General Fund positions associated with Media Production, Engineering, Classroom Design and the Media Collection. Funds for additional staff, to be identified, would need new funding or reallocation of resources. Analysis of the relationship with other identified affiliates to be determined.

Timing

1.7 Libraries

Recommendation: Promote a Libraries/IT partnership by focusing on four areas of strategic importance:

- The development of a campus-wide Digital Asset Management plan through joint efforts from the Libraries, the Office of the Associate Vice Chancellor for Academic and Campus Technology, and ITS;
- The enhancement of digital media assets through the consolidation of ITS and Libraries media services;
- An increase in network access to digital information by:
  - Utilizing federated authenticated network access;
  - Upgrading wired network access within the Library facilities; and
  - Deploying wireless network access in all open, common areas within the Libraries.
- The support of campus-wide I/IT student literacy through the continued development of the Program for Writing and Rhetoric as well as through course-integrated library instruction.

Discussion of the Recommendation

Current Situation and Rationale
In January 2002, the CU-Boulder Libraries concluded their yearlong strategic planning process. The plan identified the need to “create strategic service and support partnerships with other campus units, especially ITS, to raise the standard of support the Libraries offer to its users.” The Libraries strategic planning process noted three specific areas as feasible and of high priority: coordinated management of digital media assets; further development of wireless connectivity in the Libraries; and continued support for I/IT literacy for all first-year CU-Boulder students. Data from ITSP interviews and focus groups indicated that digital asset management is a fourth area of strategic importance.

Digital Asset Management
The campus faces a challenge in managing a rapidly growing body of “digital assets” that constitutes significant additions to the campus collections. Digital asset management is best defined as the systematic management of educational digital data, such as text, image, audio, and video files, so that they can be accessed for reuse or re-purposing. Efficient and effective storage and retrieval can maximize the value of these assets. Protection of these assets is essential.

Digital Media Services
A variety of digital media services are offered by ITS and provide access to educational content and electronic collaboration tools (e.g., tape replication and videoconferencing). In at least a few cases, the Libraries and ITS duplicate services (e.g., both units maintain large inventories of videotapes). The Libraries and ITS need to evaluate these types of services to determine if faculty and students can be better served by alternative, combined, and more efficient delivery processes.
Network Access
Network access to Libraries materials has grown in importance as demand for online materials has increased. Also, many access points have changed from in-library access points to in-home, in-office, and in-the-field access. Many of the materials require authenticated access to meet contractual agreements. These challenges can be met by upgrading networking services within the Libraries, including upgraded wire-based connections and wireless access. Authenticated access based upon the campus Enterprise Directory will be essential to enable remote access.

Information and Information Technology (I/IT) Literacy
Both the Libraries and ITS have collaborated with the Program for Writing and Rhetoric (PWR) to support first-year student I/IT literacy. Libraries staff have worked directly with curriculum developers for the PWR writing course to include appropriate information literacy subject matter. In addition, Libraries’ faculty currently teach classes to enhance students’ skills in finding, assessing, and using information. ITS also teaches basic IT skills to students in non-credit Quick Computing classes that cover the Microsoft Office Suite and basic web development.

Rationale
Forming a Libraries/ITS partnership allows for a better utilization of resources in four areas. First, the development of a digital asset management plan can address the growing amount of digital materials that need to be available online. Second, digital media services can be co-managed to avoid duplication while giving the greatest accessibility to students and faculty. Third, network services need to be increased and enhanced to support access to digital materials. Finally, the intertwined relationship of information and IT literacy necessitates a close-knit partnership between the Libraries and ITS. Working together, the Libraries, ITS, and the Program for Writing and Rhetoric can continue to develop an appropriate curriculum that teaches first-year CU-Boulder students how to access, evaluate, and use information in a technological age.

Specific Recommendations
- **Digital Asset Management:** The Libraries will partner with the Office of the Associate Vice Chancellor of Academic and Campus Technology and ITS to develop a Digital Asset Management plan that addresses institutional repository requirements, data storage requirements, data persistence, cataloging, interoperability with other digital libraries, and security. This plan will also include recommendations for centrally organizing and storing content that academic departments currently manage. Finally, this plan will address the complex issues associated with scalability and authentication.
- **Access to Digital Media Assets:** The Libraries will partner with ITS to build and/or co-locate a Digital Media Assets Center that provides a resource for students and faculty to obtain, explore, and apply innovative multimedia technologies that support teaching, learning, and research, with emphasis on incorporating content into each one of these broad areas. This center will provide a continuous Libraries/ITS service presence through virtual and physical help desks.
- **Network Access to Library Materials:** Increase network access to digital information by:
  - Developing federated authenticated network access.
  - Updating the cabling and wiring infrastructure within the Libraries. The current cabling and wiring is based upon older technology that provides basic network access. Unfortunately, this infrastructure is not sufficient to support multimedia access.
  - Increasing wireless connectivity for public areas in all libraries (i.e., wireless for patrons who have their own laptop and/or PDA’s). The Libraries will follow the ITS model with wireless cards for end-users (as used in the Law Library).
- **I/IT Literacy:** The Libraries, ITS, and the Program for Writing and Rhetoric will build and/or co-locate a shared-space, I/IT literacy lab that also will function as a writing center. This lab would be conjointly operated by the College of A&S, the Libraries, and ITS and would function as an academic center for the campus, providing students with a course-
integrated introduction to university-level writing that addresses deficiencies in writing skills, while preparing students to write and research successfully in a technological age.

**Steps**

**Implementation**

- **Digital Asset Management**: The Libraries, the Office of the Associate Vice Chancellor for Academic and Campus Technology, and ITS will begin meeting in spring 2003 to formulate a project plan and a comprehensive strategy to identify issues, requirements, and program needs to develop a digital access management initiative. Some important areas of focus are:
  - Selection of IT hardware and software to match the expected and intended service levels for access to materials, and long-term commitment to renewal and replacement.
  - Data persistence to ensure that the digital assets are accessible in the future, regardless of the file structure or application, and to make certain that the means of data storage is based on open standards to ensure long-term access to materials.
  - Development of a sophisticated storage and retrieval system for academic departments to use for non-published materials (could include such things as course syllabi, lab activities, writing workshop materials, etc.).
  - Cataloging digital materials introduces a new complexity that must recognize the need to include the structural description of the information, e.g., book, journal, MS Word file, database format, image file, video clip, audio clip, or application information.
  - Interoperability of digital libraries is essential to providing widespread access to materials. This includes access between all campus organizations that create systems to store digital materials. It also includes access to off-campus Libraries and providers of digital materials. While the development of extensible and interoperable architectures is early in the stages of development it is essential to include in the planning processes.
  - Control and security of digital materials is a significant challenge given the reasonable expectations of the campus community to have access to digital materials “whenever” and “wherever”. Limiting access to particular groups based upon a definition of “right to access” can be complicated, but relates quite well to the use of the campus Enterprise Directory for identity verification, and as the basis for authentication and authorization. Extending access to related entities, such as other institutions of higher education, requires a trusted relationship that accepts assertions of identity.

- **Access to Digital Media Assets**: The Libraries and ITS will begin discussions to build and/or co-locate a Digital Media Assets Center in the Library during 2002-03 academic year.

- **Network Access to Library Materials**: The Libraries and ITS will begin planning to implement:
  - Federated authenticated network access for digital materials. This will include discussions with current providers regarding contractual agreements and restructuring future access methods.
  - An assessment of the wiring infrastructure within the Libraries, which will be completed jointly by the Libraries and ITS to develop a plan for remediation in areas that require high performance networking.
  - The Libraries and ITS will continue to identify areas where wireless connectivity would provide enhanced network access within the Libraries.

- **I/IT Literacy**: The Libraries, ITS, and the Program for Writing and Rhetoric will build and/or co-locate a shared-space I/IT literacy lab which also functions as a writing center. Work with the Office of the Associate Vice Chancellor of Academic and Campus
Technology, PWR, ITS, and the Libraries to coordinate how I/IT literacy can be integrated into the PWR course.

**Required Involvement**

**Governance & Authority**
The Office of Academic and Campus Technology will provide coordinating authority between the Libraries, ITS, and PWR (when necessary). The Dean of the Libraries, the Dean of Arts and Sciences, and the Executive Director of ITS will have primary responsibility for initiating these recommendations.

**Required Departmental Involvement & Responsibilities**
The Libraries, AVCACT, and ITS have primary responsibility for the recommendations in this document.

The AVCACT, the Libraries, ITS, and PWR will integrate I/IT literacy goals into an appropriate curriculum which might include the PWR classes, ITS classes, and library-sponsored classes.

**Expected Costs**

**Annual IT Infrastructure Investment**
Please refer to Section 1.6, Digital Content and Collaboration, Section 3.1, Network (Wireless), and Section 1.3, I/IT Literacy, for the annual IT infrastructure investment.

**Operating and Maintenance**
See above.

**Personnel**
See above.

**Funding**
See the funding sections for Digital Content & Collaboration, Networking (Wireless), and I/IT Literacy/Fluency for funding suggestions.

**Timing**
Decisions for consolidating ITS and Library media services and forming the Digital Media Assets Center will occur during the spring of 2003. Wireless deployment is continuing throughout the summer and fall of 2002. I/IT literacy development will also occur during the fall of 2002.
Chapter 2: Web-based Services

CU-Boulder is in the position to take full advantage of new and emerging web technologies to provide a virtual, one-stop shop for university services, from registration and online ticketing, to calendaring and procurement.

Data from focus groups and surveys indicate that the campus should move toward a portal\textsuperscript{11} strategy that will facilitate student, faculty, and staff access to the academic content and the academic and administrative services they need.

The primary challenges of providing web-based services for the campus are less technical in nature than cultural. Although there is broad conceptual support for creating a cohesive interface for accessing discrete services provided by dozens of units, the campus will need to provide leadership and support to facilitate cooperation by units that have worked independently in the past.

Security, privacy, and a reliance on the campus’s Enterprise Directory compose the technical basis necessary for successful web-based services initiatives. Recommendations for web-based services that are common to both sections of this chapter include:

- Academic, student, and administrative services should be accessible through the web and tailored to users.
- To accomplish this, a standard portal framework should be implemented.
- Steering committees should provide strategic direction and tactical buy-in for web-based services.

Due to demand, the campus should implement a student portal first, followed by a faculty and staff portal as resources permit. Strong collaborative leadership from the Vice Chancellor for Student Affairs and from the Associate Vice Chancellor for Academic and Campus Technology will be required for a successful implementation of both.

\textsuperscript{11} A portal can be defined as unified, web-based student services that are tailored to individuals based on their affiliation with CU-Boulder.
2.1 Web-Based Student Services

Recommendation: Provide excellent, unified web-based student services that are tailored to individuals based on their affiliation with CU-Boulder; in summary, a campus student portal.

To achieve this recommendation, four components are required: cross department collaboration, student involvement, selection of appropriate technology, and allocation of sufficient funding.

Discussion of the Recommendation

Rationale
Personal Look-Up Services (PLUS)\(^\text{12}\) is now used by 99% of CU-Boulder undergraduate students on a regular basis. It has the highest use and highest satisfaction rating of any student service on campus. Student responses on a recent questionnaire indicate a desire for more unification of campus web services, and fewer logins. (See Appendices for details) While PLUS as a student service is highly successful, it is based on outdated technology, proprietary programming language, and it can no longer be expanded to include the new services that students want and need. In addition, the campus must develop better security, reliability, and scalability through new software for its web-based services.

Student services have been splintered across multiple, independent structures: hosted locally on PLUS, hosted on the mainframe in SIS, hosted by a third party distinct from the University, or provided through a combination of mainframe and locally-supported databases. These services are difficult to create, hard to maintain, and present a fractured view of administrative services to our students. The current situation has also encouraged duplication of effort in developing sites.

In the future, when a new service is proposed, all departments that are critical to the success of the service delivery must be involved and able to participate in the effort.

PLUS and web-based services provide convenience by providing answers to routine and simple student service questions. While a web-based environment augments and enhances the student service experience, it does not take the place of meaningful, in-depth interactions between faculty and students, and staff and students. Developing a robust, unified, online student portal would allow more time for substantive interactions between students and the university. Ideally, a web-based student service infrastructure would be matched by an actual physical, centrally-located service center.

Current funding of the campus’s centralized student web services is inadequate. Although there is a modest general fund allocation for web-based student services, no current student fees are specifically earmarked for critical development and maintenance of PLUS. There may be opportunities through consolidation of multiple services to create a financially efficient service model.

Specific Recommendations Include
1. Build on the success of PLUS by strengthening and strategically expanding the services available on a single, student-centered web site.

\(^{12}\) PLUS, or Personal Look-Up Service, allows students to take care of 26 transactions from various administrative offices such as the Bursar, Registrar, Financial Aid, and Wardenburg, and provides important academic information to students.
PLUS currently allows 26 separate transactions from the Bursar, Financial Aid, the Registrar, Wardenburg Student Health Center, and ITS. Other services from departments such as Housing, Orientation, Libraries and Advising are vital to student success at CU and should be considered for the new, unified service site as it is developed. New services requested by students, including personal calendaring, online ticket purchases, announcements and academic alerts, would be appropriate additions to a portal. Other services, important to smaller populations, should be expected to meet campus-wide programming standards in order to be available to students on the central site. These other services might include Parking Management permit purchases, Student Academic Services Center workshops or tutoring information, study abroad applications or information, and telecommunications checkout processes.

2. The campus also needs to keep in mind that some faculty and staff need to be able to see the same view of academic and financial records that the student sees. As new student web services are developed, the campus should keep faculty/advisor access to information in the student portal as a goal. To support the development of this next generation of PLUS, a collaborative, interdepartmental structure is required to set policies, identify criteria and develop processes, priorities, and designate responsibilities by which services are added to and maintained in this new web site. This structure must work with other systems and system owners to ensure success.

Web development of services requires input from many different sectors: content providers, both service and academic departments, technology specialists from ITS and UMS, and web specialists and designers. These offices are in different divisions, yet need to work together closely to create the best service for students.

3. Develop a standard portal framework and infrastructure utilizing open, non-proprietary, component-based, reusable standard modules to support unified student services on the web.

4. Review and reassess the current levels and distribution of student fees and general and auxiliary funds in support of campus and university technology to assure adequate funding of all aspects of the development and maintenance of web-based student services.

Steps

Implementation

• Web-based student services are only a part of the overall IT strategic plan addressing the development of unified, integrated service delivery. The campus needs to set overall priorities and direction for the web, which include student services as a critical component.

• A cross-departmental team(s) with student representation, and a policy-setting group should be appointed by the chancellor or vice chancellor to
  o develop policies, criteria, processes, and priorities;
  o designate responsibilities; and
  o recommend a structure by which web-based student services can be expanded and improved.

• ITS should appoint a team to focus on selecting or developing appropriate technology to support web-based services for students and eventually, faculty and staff (see Section 2.2 Faculty/Staff Web-based Services).
Communication
A plan for a campus-wide discussion of these recommendations and their implications is important to the long-term success of web-based student services. This would be a long-term effort. Ultimately, a comprehensive communication plan for the marketing and promotion of the portal to students, staff and faculty would be essential.

Required Involvement

Governance & Authority
A campus web strategy group convened in 2000 noted that there was no campus-wide or system-wide management of web development and use, and that Institutional Relations (IR), now University Communications, and ITS both were managing web development. The group noted a need to clearly define campus-wide accountability, especially between ITS, IR, and individual departments. This representation of the campus’s web environment is still true in May of 2002. In the case of student web services, it is particularly important to understand the role and scope of the Division of Student Affairs and UMS, as well as ITS and University Communications. Project management, budgets, and final approvals are all critical issues for an expanded student services website.

Leadership and guidance need to be provided by the appropriate authority, specifically in the Office of the Vice Chancellor of Student Affairs, in the Office of the Associate Vice Chancellor for Academic and Campus Technology and the Office of the Executive Director of University Communications. Their leadership would acknowledge and encompass student services and communications provided by all departments on campus, not just those in student affairs.

Required Departmental Involvement & Responsibilities
A shared commitment to a unified student web services site by all service providers is required. The collaborative effort between student information providers, ITS, and Web Communications must be led by the designated campus champion of student web services.

The following is a partial list of departments, divisions, and existing committees, which have interest in, or control over, some aspect of student services on the web:

- Student Affairs, Enrollment Management and the departments within this division
- Academic Affairs, College and School Dean’s offices, advising, and libraries
- Administration, particularly Parking Management
- Budget and Finance, particularly the Bursar’s Office
- Continuing Education
- UCSU
- ITS
- UMS and System Administration
- University Communications, particularly Web Communications
- Boulder Campus SIS Working Group
- Committee on Electronic Communication
- IT Council
- Student Fee Advisory Board
- Web-based Student Services Committee
**Expected Costs**

**Annual IT Infrastructure Investment**
Hardware infrastructure needs to be robust, redundant, fault-tolerant, and capable of supporting the entire Boulder campus student population during the heaviest usage period of fall enrollment. The hardware should be on a three-year replacement cycle.

A recent Gartner study states, “Although many enterprises think that the major costs of the portal go into the product acquisition and initial release, those that have done their homework recognize that the long-term TCO of the portal is driven more by the subsequent customization work.”

$236,000 hardware outlay  
$10,000 IDE (Integrated Development Environment)

**Operating and Maintenance**
Hardware maintenance: $30,000 per year for 24 by 7 support

**Personnel**
Commitment to open, platform-neutral, standards-based computing helps lessen the up-front costs, but increases the campus’s reliance and dependency on well trained IT professionals who understand leading-edge technologies. In addition to technological upkeep, web sites need updating, revising, and retirement in the same way as paper publications. The positions listed below would not all be rostered in ITS.

Training: $7,000 per FTE per year (new or reallocated)  
$30,000 for service site maintenance of content (new or reallocated)  
1 FTE for portal technical administration  
2 FTE for presentation programming,  
1 FTE for content continuance, project management, and planning (portal manager)  
$250,000 per year would include new or reallocated salaries, benefits, and operating expenses.

**Funding**
Creating a central, unified area for services to the campus requires a stable source of centralized funding. This funding should be allocated from a number of areas.

Current general funds in involved and responsible departments should be reviewed for appropriate allocation toward the goal of unified web services. Funding for web-based student services has not kept pace with volume of student usage and the number of student services that have been shifted to the web. If a web process replaces an in-person or paper process the funding should be reallocated to support the web process costs.

The distribution of SIS and student technology fees should be reassessed to assure adequate funding of the development and maintenance of web-based student services. The campus should investigate the need for an increase in student fees to support web-based student services. A questionnaire with more than 500 student responses indicated a willingness to increase student fees for better and expanded web-based services.

**Timing**
Enhancements to PLUS including the financial aid award acceptance and several bursar transactions have already begun and should be completed by summer of 2002. ITS and Web Communications should continue to support PLUS, but consider only critically vital additions or improvements to PLUS after summer 2002.
ITS should dedicate resources to the development of a portal software framework for campus-wide use with special consideration for web-based student services. Production of the portal technology should be a goal for spring 2003.
2.2 Faculty/Staff Online Services

Recommendation: Provide unified, web-based information services for faculty and staff utilizing a standard portal framework.

The campus should design and implement a campus-wide Information Portal to support the delivery of personalized web-based services to faculty and staff. A single intuitive gateway should be developed to integrate web-based information and applications, and provide a personalized interface to information resources in a secure, consistent and customizable manner.

Discussion of the Recommendation

Current Situation
Campus web-based services are delivered primarily through static web pages and a wide range of unconnected general web applications that are not directly oriented toward a person’s role within the University or toward specific customer communities. Content, data and applications cannot be delivered in ways tailored to a user’s needs. Authentication and authorization methods for accessing campus web services are inconsistent and present security risks, requiring users to enter separate, (and often unprotected) login names and passwords for each web application accessed.

In the simplest definition, a portal is an aggregation point of information, applications, views, and services brought together into a single view, and often customized for the viewer based on a user’s profile or preference. Portals streamline access to content and applications by becoming a one-stop interface for the user providing web services relevant to the user’s needs. Information consumers only care that services are accessible and delivered efficiently. This assumption has led other universities to orient their portals to offer services according to “user intentions” or campus role.

Rationale
CU-Boulder must develop enterprise-wide thinking that leads to easy, seamless information access for faculty and staff regardless of where the data resides. The campus should consider developing multiple portal services oriented toward faculty and staff roles within the University community, based upon a standard portal framework and infrastructure that utilizes open, non-proprietary component-based, reusable standard modules. These infrastructure components will allow the portal services to provide a consistent interface to a disparate set of back-ends including PeopleSoft, mainframe systems, and numerous departmental legacy systems. By leveraging a common portal framework and underlying infrastructure, the campus can create true end-to-end systems for any community of interest, personalized to deliver a full range of academic and administrative services, campus intranet offerings, student/faculty communication, distance learning resources, community tools and Internet content from a single login and fulfill the need for online communities.

Specific Recommendations
- Determine functional requirements for Faculty/Staff portal services including security, privacy and access needs, transactional services, data and information requirements, priorities and goals for portal development and implementation.
- Create and fund a portal infrastructure implementation plan.
- Fund and implement a centralized, highly scaleable platform for hosting the portal, portal infrastructure and applications.
• Fund software development for portal integration, portal operations and software maintenance activities.

Implementation
• Design and develop a test/prototype portal for use of a limited number of faculty/staff.
• Create core technical teams and representative faculty/staff portal steering groups and processes for defining project scope, determining core portal services, prioritizing business requirements, formulating policies and standards for the appropriate development and use of the portal.
• Analyze and evaluate alternative approaches for meeting portal infrastructure requirements, select acquire and implement infrastructure framework components.
• Develop training programs, development standards and best practices for campus software development staff to adhere to portal infrastructure integration requirements.
• Design, develop and implement a full production faculty/staff portal.

Communication
Create and fund a plan to communicate to the campus regarding portal design goals and objectives, portal implementation schedules and solicit input to focus groups. Provide a feedback mechanism.

Policy and Standards
• Create a policy to resolve issues related to accessing campus departmental data sources and information through a campus-wide portal framework.
• Create policy and technical standards for web-based content and applications to ensure adherence to campus infrastructure requirements.

Required Involvement

Governance and Authority
Office of the Associate Vice Chancellor of Academic and Campus Technology.

Required Departmental Involvement and Responsibilities
• IT Council to provide guidance and programmatic direction.
• ITS to provide project management, systems analysis and design, software development, training, technical standards, operation and maintenance of portal initiatives.
• University Communications to provide web content consulting and collaboration.
• University Management Systems (UMS) to provide Human Resource, Financial and Student information resources.
• Staff and faculty representative groups to provide overall portal design guidance and prioritization of requirements.
• Campus departments as web service providers to consult and collaborate on portal integration issues.

Estimated Costs

Annual IT Infrastructure Investment
Implementation of an infrastructure to support portal development and deployment is a necessary foundation for multiple portal efforts. As such, the infrastructure costs should be considered separate from individual portal development and deployment efforts. Infrastructure costs include web portal software, web server hardware and software, web application hardware and software, database hardware and software and network connectivity. These costs will range from $200,000 to $400,000, based upon the alternative approach selected.
Operating and Maintenance
Depending upon alternative selected, hardware and software infrastructure maintenance costs will average between $40,000 to $80,000 per year.

Personnel
Personnel for development and implementation of a faculty staff portal needs to be increased by approximately 2.5 full-time employees (FTE), over a period of 1 year, which will cost approximately $235,000 (including salaries, benefits, training, travel etc).

Personnel for maintenance and support of a faculty staff portal software application needs to be increased by .5 full-time employee (FTE) which will cost approximately $45,000 per year.

Funding
Funding will likely include a combination of charge-back fees for specific portal web-based services and institutional funding for campus-wide core portal services.

Timing
A faculty and staff portal development initiative can commence in fiscal year 2002-2003.
Chapter 3: Network and Middleware

The campus’s ITS unit provides the campus with much of its underlying IT resources, including the network, and telephony services. With advances in the area of middleware, the common software layer between the network and applications, the campus needs to expand its central provisioning of IT resources to include Enterprise Directory Services and an “IT services provisioning infrastructure” (which in turn provides the framework to allow standardized and reliable account, access, authentication and authorization, and identity management). These services provide the infrastructure necessary, for example, for a single sign-on from anywhere to specific campus applications and resources.

All network and middleware services must be designed and delivered to ensure reliability, stability, and scalability. Furthermore, in the case of middleware services, they must integrate with UMS and campus applications and data seamlessly. In the implementation and expansion of network and middleware services, the campus must strike a delicate balance between:

- Central authority, coordination, policy, and guidelines;
- Cross-campus collaboration;
- Flexibility to meet needs of campus units and users; and
- Anticipating changes in technology.

Specific recommendations in this chapter include:

- Continue the development of the Enterprise Directory and establish it as the authoritative source for information about faculty, staff, and student identity and roles;
- Develop the infrastructure necessary for central coordination of identity management, authentication and authorization, and single sign-on;
- Expand network bandwidth;
- Expand wireless access to meet demands for mobile access to campus and Internet resources; and
- Prepare for the next generation telephony solution, Voice over IP (voice services over the data network).
3.1 Networking – General (Section I of II)

Recommendation: 1) Increase the bandwidth available to the campus; 2) strengthen the availability and reliability of the network; 3) expand remote access to campus, networked resources.

Discussion of the Recommendation

Current Situation
The previous IT Strategic Plan and the Network Task Force called for a major upgrade to the campus network. Within the last two years, and with substantial one time Total Learning Environment funding from the Chancellor, the campus network was upgraded from an aging and completely shared 10 Mbps Ethernet to a modern, supportable, switched 10 Mbps and 100 Mbps network. The campus core network currently supports 1 Gbps links throughout the backbone connections, all the way out to the switches that connect customer systems. These switches support 10 Mbps and 100 Mbps switched Ethernet connections to customer systems, but fewer than 10% of the connections on campus can run faster than 10 Mbps because existing, old wiring in building structures prevents higher speeds. In approximately half of the buildings on campus, new wiring can be installed on a case-by-case basis to allow individual connections to run at 100 Mbps. In some situations, and certainly within the timeframe of this plan, fiber connections could be made to support 1 Gbps to specific customer systems, but the implications of such increased load for the core network must be carefully considered.

Bandwidth to Internet2 is currently 155 Mbps via a 155 Mbps link that is also shared with the four-campus video network along with access to the global Internet. Near term plans call for upgrading the shared line to 622 Mbps, but there is already pressure from the NSF to provide 1 Gbps access to Internet2 by the year 2004.

The Boulder campus currently subscribes to 60 Mbps of commodity Internet access via the Front Range GigaPOP (FRGP), though a more realistic number would probably be 70 Mbps. A large part of the growing use of the Internet is related to file sharing of music and other entertainment applications. Currently, ITS limits much of the entertainment uses of the Internet so that academic uses are not overwhelmed.

The campus network core currently has sufficient redundancy to be able to function in the event of many single point failures in the core campus backbone. However, the campus is entirely dependent upon the FRGP for its access to Internet2 and the global, commodity Internet.

Using student technology fee funds, ITS currently supports dial-in modem service on 869 v.92 modems. Although we have seen as many as 844 simultaneous modem users, the users of those modems do not get busy signals, even in peak usage times. Also, ITS supports nearly 900 students, faculty, and staff who connect from their homes using Qwest's Digital Subscriber Line (DSL) service.

Rationale
Popular discussion suggests that the demand for global Internet access doubles every 18 to 24 months for the Boulder campus. Thus, in five years, the expected commodity Internet bandwidth demands will be about 500 Mbps and the Internet2 requirements will be about 1 Gbps.

More and more functions of the university in general, and the Boulder campus in particular, depend upon the reliable operation of the network, not just across campus, but also to the global Internet.
Essential network services (such as the Domain Naming System (DNS), the Dynamic Host Configuration Protocol (DHCP), and authentication and authorization services such as RADIUS and Kerberos/IdentiKey) all need to be available at all times.

Growth in modem usage is approximately 50 concurrent connections per year. Growth in DSL customers is less than half of that, presumably because neither Qwest nor ITS have promoted the service.

As the campus expands its firewall capabilities at the campus border, the demand for more complete and authenticated access from the global Internet will grow. Such a demand is usually met with a Virtual Private Network (VPN) service. ITS is currently testing a VPN service that it expects to rollout to the campus within the next few months. That service will grow as more people use their own ISP for access to the Internet and to campus networked resources.

**Specific Recommendations Include**

- Continue to provide incremental increases in commodity Internet and Internet2 bandwidth to accommodate demand.
- Given that sufficient bandwidth may not be affordable for all uses, continue to limit the effects of entertainment uses of the Internet and explore options for providing Quality of Service guarantees to certain uses of the Internet such as video conferencing.
- Continue to offer services in support of advanced networking applications such as those offered across Internet2 including multicast and IPv6.
- When the funds become available from the State to rewire the campus, examine the options for installing more optical fiber between buildings as more uses for that fiber develop.
- Once the campus is able to support 100 Mbps to any desktop, the campus backbone, currently using 1 Gbps links, will need to be upgraded to 10 Gbps.
- The campus must place more emphasis and support on the reliability of its network access and services.
- The campus should have at least two separate connections to the commodity Internet, with service coming into the campus at two different locations.
- The campus should invest in more reliable power (i.e., electrical generators) for key locations on campus where essential networking services are provided.
- Continue to provide modem and DSL services to the campus customers. Expand these services as the demand grows.
- Build the Virtual Private Network (VPN) service as demand requires.
- Provide support for mobile computing environments, particularly with respect to wireless and mobility issues, by providing network related training for Tiers 2 and 3 and by providing more networking documentation for Tiers 1, 2, and 3.
- Network security is an important issue and it is addressed in the Security section, 4.2.

**Steps**

**Implementation**

- Continue to monitor the bandwidth demands made by the campus and make incremental upgrades to the campus core and to add bandwidth to support increased use of Internet2 and the commodity Internet.
- Task ITS with ensuring that entertainment uses of the Internet do not negatively impact the academic and administrative uses.
- Task ITS with providing at least two separate connections to the commodity Internet, with service coming into the campus at two different locations.
As part of its disaster recovery and business continuity planning, the campus should determine where additional electrical generators should be provided to insure reliable network services in the face of extended electrical outages.

Several departments already implement VPN services to provide their clients with authenticated, secure access to networked resources on campus. ITS is about to offer such a service for the campus in general.

Communication
- Access to the campus network via DSL is cost effective, and the campus should encourage its constituents to use that service when appropriate.
- The campus should develop a set of best practices with respect to uses of the campus network.

Policy & Standards
Recommend a policy that clarifies that entertainment uses of the Internet must not interfere with the academic uses of the network and charge ITS to enforce that policy.

Required Involvement

Governance & Authority
Network services for the campus fall under the authority of the Office of the Associate Vice-Chancellor for Campus and Academic Technology (AVCACT) with the advice of the IT Council. Pockets of semi-independent subnetworks on campus are managed by individual departments to meet their own programmatic needs. These subnetworks are termed "Alliance Networks" to reflect that they still rely upon many of the essential network services provided by ITS.

Required Departmental Involvement & Responsibilities
ITS networking will need to continue to manage and maintain the campus network and its connections to Internet2 and the global Internet. Campus departments maintaining alliance networks will coordinate with ITS.

Expected Costs

Annual IT Infrastructure Investment
A second ISP connection of 60 Mbps will cost approximately $15,000 per month or $180,000 annually. Electrical generators at the Engineering Center and at the Computing Center would cost approximately $300,000 one-time plus $10,000 per year maintenance.

Operating and Maintenance
No new operating or maintenance costs are proposed other than for a second ISP.

Personnel
No new personnel are suggested in this section of the plan.

Funding
The funding for these activities will come from existing general fund support for networking and from recharges for network services including the "Alliance Network" fees and the normal charges for 10 and 100 Mbps network connections. That funding still leaves a substantial funding gap that manifests itself in an overly long equipment replacement cycle, insufficient staffing, less Internet bandwidth than is required to meet the growing demands, a lack of redundancy in access to the global Internet, and less reliability in the face of long power outages.
Timing

Continuing funding for a second ISP should be sought as soon as possible.
3.1 Networking – Wireless (Section II of II)

Recommendation: Expand and coordinate wireless LAN access across campus in order to meet increasing demands for more mobile access to campus and Internet resources.

Discussion of the Recommendation

Current Situation
The currently supported standard for wireless network access is the IEEE 802.11b standard. This supports 10 Mbps wireless Ethernet service over distances generally limited to 150 feet indoors and up to 1000 feet clear line of sight outside. Devices that support this standard have dropped dramatically in price over the past year and are readily available from most computer/network outlets. This has made these devices increasingly popular. The campus has instituted a policy that requires that departments coordinate their wireless access point installations with ITS.

There are approximately 25 wireless networks on campus using an estimated 60 access points in 20 buildings. There is complete, or nearly complete, coverage in three buildings: Business, Regent Hall, and the Computing Center. In the Engineering Center, for example, there is complete wireless coverage in the classroom wing, the main lobby, and the Real McCoy grill, but there is no official coverage in the departmental laboratory wings. In a classroom in Education, one professor finds that it is much easier and more flexible to use wireless laptops than to try to use wired desktop computers.

Rationale
Wireless network access is particularly attractive in facilitating mobility for the campus community. It is often ideal for common areas such as classrooms, conference rooms, teams rooms, and libraries. Wireless is not generally an acceptable alternative to wired connectivity in an office, due to the slower speed, shared media, and less secure service than wired.

Over the timeframe of this plan, we expect that Personal Digital Assistants (PDA) will begin to replace laptops as the more prevalent choice for mobile computing and that many of them will use wireless network access to stay connected to the Internet.

Customers often need more than the usual technical support when installing wireless access cards and access points. Wireless network access technology is evolving, and easily within the timeframe of this plan, the campus will see substantial changes in the technology as it moves to higher speeds and more restricted coverage. In addition, the campus must work toward offering suitable security that is easy to use.

Specific Recommendations Include
- Continue to implement wireless network access capability across campus, both in public, common places and in dedicated departmental spaces in a coordinated fashion in order to insure that the service is secure and reliable.
- Enforce the wireless policy to ensure that departments that wish to implement network access capability should do so only after consulting with ITS.
Steps

Implementation

• The campus, with technical support from ITS, is already deploying wireless network access in common areas across campus on a limited basis as funds become available.
• ITS already is working with departments to coordinate and even manage their private wireless network access installations.

Communication

• The campus wireless policies must be communicated broadly to the campus through town meetings, website updates, and campus bulletins.
• Implementation plans and schedule must be communicated to the campus through regular website updates, campus bulletins on major milestones, and Tier 2 support community updates for communication to departments.

Policy & Standards

IT Council has established policy that requires any 802.11 wireless network installation be coordinated by ITS to insure non-interfering use of the available frequency spectrum and to be sure that departmental wireless activities do not compromise broader campus uses of wireless. This policy can be found at: http://www.colorado.edu/its/policies.html

Required Involvement

Governance & Authority

Wireless access implementations on campus fall under the authority of the Office of the Associate Vice-Chancellor for Campus and Academic Technology (AVCACT) with the approval of the IT Council. This responsibility and authority has been delegated to ITS for implementing the policy.

Required Departmental Involvement & Responsibilities

• The AVCACT and IT Council will continue to provide guidance and direction.
• Campus departments must coordinate wireless installations with ITS.
• ITS must develop frameworks for Memorandums of Understanding for departmental partnerships.
• Partner departments will provide funding and input on the developing demands for wireless network access.

Expected Costs

Annual IT Infrastructure Investment

Broad campus coverage would require at least $300,000 initial outlay for installation of 150 access points. Less than one third of that amount is equipment costs with most of the balance devoted to construction. The Information Technology Infrastructure Improvement Plan (ITIIP) includes a budget of $200,000 for wireless network access.

The campus should expect to replace or add 45 access points at $1000 each for each year over the next five years. This requires budgeting $45,000 per year for equipment.

Operating and Maintenance

The above annual costs include maintenance.
Personnel
It is expected that continuing support for 150 wireless access points distributed across campus would cost about $80,000 including salary, benefits, training, and operating expenses.

Funding
Funding for an initial, broad wireless deployment is included in the IT Infrastructure Improvement Plan (ITIIP), but funding for that plan is currently delayed by State fiscal problems. Some additional, earlier, and even continuing funding may be available through the use of student technology fees.

Timing
The timing of this deployment is largely tied to the ITIIP, although ITS is attempting to make some small, initial improvements prior to the availability of that funding.

Phase One of the ITS deployment plan, which includes public areas in the Norlin Library, the Engineering Center complex, and public areas of the University Memorial Center, will be nearing completion in fall 2002. This initial phase will be completed as funding is developed.

Phase Two of the ITS deployment plan includes large classrooms and auditoriums across the campus. This phase will begin once funding is established. Expected start: spring 2003.

Phase Three of the ITS deployment plan includes departmental installations and administrative offices across campus. Campus departments have been prioritizing themselves in the deployment by providing funding for hardware and network access charges, which will continue to be an option throughout the deployment process. Expected start: winter 2003/spring 2004.
3.2 Enterprise Directory Services

Recommendation: Provide a framework of policy, data, tools and processes for Directory Services for CU-Boulder within the context of the University-wide environment.

The Enterprise Directory must become a trusted and authoritative data source for CU Boulder resources. The Directory Service – scalable, flexible and robust – must be usable by a variety of authorized, independent applications and services, supporting security mechanisms, enabling relationships, and resolving discrepancies in information between communities, systems and services.

Discussion of the Recommendation

Current Situation
The CU-Boulder Enterprise Directory was implemented November 5, 2001. Since that time, the Directory Services continues to mature as its production environment is strengthened, policy is reviewed and established by the Directory Governance Board (DGB) and requests for usage are addressed. Based upon the first few months of the Directory’s life, it is apparent that a continuous stream of requests for enhancements and usage must be prepared for and effectively handled.

Rationale
An Enterprise Directory is a critical component of any institution's middleware infrastructure. It is the glue that holds together the applications our institution is dependent upon and the networking and hardware upon which these applications are built. A robust Enterprise Directory Service provides the foundation that allows an institution to maximize the effectiveness of all components of its IT environment. To accomplish this, the Directory Service must offer:

- A clear direction toward enterprise-wide, general purpose Directory Services (and away from special purpose, system-specific directories).
- A trusted data source.
- Accessibility by a wide range of applications and services.
- Integration with campus-wide and application-specific security services.
- Identity management, data management and relationship management services set within a unified and consistent management model.
- A robust production environment to ensure availability and responsiveness.
- Location-independent access to directory information.
- A Directory Governance Board that ensures appropriate use of the directory, appropriately prioritizes directory-related requests, and addresses process issues highlighted by the Enterprise Directory.
- Collaboration with major initiatives such as CU-Boulder security, ITS service provisioning, University of Colorado four campus directory deployment, and Internet2 initiatives.

Specific Recommendations Include
Over the next five years, the primary goal of CU-Boulder’s Enterprise Directory Service is to become the centerpiece for middleware services for the campus. This goal plays an integral role with Section 3.3 (IT Service Provisioning Infrastructure) of this strategic plan.
• The Enterprise Directory must be positioned to support the security initiatives of CU-Boulder-ITS, particularly authentication and authorization.

• As it matures, the Enterprise Directory Service should adhere to its strengths and continue to expand upon these (i.e., manage the identity and attributes of objects stored within the directory, ensuring the integrity, accuracy and currency of these objects; supply commonly-needed data from trustworthy sources to trusted inquirers; support those applications which would benefit from directory-enablement; maintain an inquiry vs. transaction orientation.)

• An all-campus effort should be undertaken to establish the Registry as the central authority for university-wide identity management.

• The Directory Governance Board must continue its active involvement with the Enterprise Directory, reviewing pending requests for Enterprise Directory enhancements and usage, prioritizing these requests, and delivering its recommendations to ITS with the goals of maximizing the directory’s utility to the campus, adhering to directory policy and making the most effective use of directory development resources – all within the context of concurrent IT initiatives.

Steps

Implementation

• Directory support of authentication and authorization requires collaboration among the ITS Security Coordinator, IT Architect, Enterprise Directory Project Manager, and Directory Manager as well as coordination of strategic directions of Security and Directory initiatives. The Enterprise Directory must ensure a single identity and properly defined affiliation(s) for each directory entry. Specific attributes required by authorization schemes must be evaluated by the Security Coordinator and Directory Manager to determine appropriateness of inclusion within the Enterprise Directory.

• The directory must be positioned to continue to support new initiatives without compromising performance, stability or integrity. To do this:
  o The directory should be flexible enough to accept new sources of data yet adhere to robust identity reconciliation processes within the Registry.
  o The directory should be flexible enough to add new attributes while cognizant of industry best practices regarding design issues such as multiple vs. single use attributes and application-specific attributes.
  o Access to information within the directory should be available to those who demonstrate need through appropriate authentication and access control mechanisms.
  o Secure processes must be built by ITS that allow entries to be created in the directory for individuals or objects who fall outside the realm of the University’s source systems in order to provide Directory-dependent services to all affiliates who are entitled to these services.
  o Secure processes must be built by ITS that allow individuals to add and update information about themselves that is not available from systems of record in order to ensure the completeness of information for entries within the directory.
  o The directory structure must accommodate additional objects such as organizations, services, systems and groups in order to support the middleware services depended upon by these entities.

• Create an all-campus task force to address issues and craft an implementation plan for a university-wide identity management infrastructure.

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13 Registry: a university-wide database that houses information used by the Enterprise Directory. Logic applied at the database level (prior to populating the database) enforces the identity management and data reconciliation business rules upon which the Directory depends.
• Requests for directory usage and enhancements must be handled through continued communication between the Directory Project Manager, Directory Manager and Directory Governance Board coupled with monthly DGB meetings. Requests should come through the Directory Manager for an initial feasibility review and resource estimate. This review should consider: appropriate directory usage (query vs. transaction), evaluation of requests for new attributes (appropriateness for a general directory vs. an application specific database), and potential sources for new data. The initial analysis of the directory-related requests should be forwarded to the DGB for prioritization considering both directory-specific initiatives and campus-wide initiatives.

Communication
• Communication within the Directory Services development environment focuses on the Directory Services Project Manager and the Directory Manager and their collaboration with concurrent IT initiatives (i.e., Security, Account Management, email, portals, etc.) as well as with the technical staff involved with supporting the Directory. This communication will be accomplished by:
  o Meeting individually with project leads for various initiatives.
  o Building project teams for specific directory enhancement initiatives.
  o Monthly meetings with the Directory Core Team for as long as the directory initiative work warrants these meetings.
• Communication with the campus and University will be focused primarily on:
  o Monthly Directory Governance Board meetings. DGB members are responsible for bringing their constituents’ concerns to the Board and for relaying Directory-related information to their constituents.
  o Periodic updates from the Directory Services Project Manager to the IT Council.
  o Formal presentations to various university governance boards upon request.

Policy & Standards
Directory Policy, which is subject to periodic review and update. See: http://www.colorado.edu/committees/DirectoryServices/

Required Involvement

Governance & Authority
Office of the Associate Vice Chancellor for Academic and Campus Technology
Directory Governance Board, with decision-making representatives from key constituencies of the Enterprise Directory (Registrar, Human Resources, Faculty Affairs, Libraries, Housing, University Management Systems, and ITS)

Required Departmental Involvement & Responsibilities
• ITS to provide directory management, operational support and development work.
• Web Communications to provide directory development work.
• IT Council to provide guidance and programmatic direction.
• Human Resources representatives and Registrar to provide data-related expertise.

Expected Costs

Personnel
• Existing Costs: Directory management, project administration and directory infrastructure development and support costs are approximately $240,000 annually.
• New Costs: Personnel for design, development and implementation of core campus services and applications based on the Enterprise Directory is expected to require 1.5
additional full time employees (FTE), which will cost approximately $135,000 annually (including salaries, benefits, training, travel, etc.).

Operating and Maintenance
- Existing Costs: Enterprise Directory hardware maintenance and software licensing costs are approximately $10,000 annually.
- New Costs: Capital costs to upgrade hardware and ensure adequate performance for expanded use of the Enterprise Directory is expected to cost approximately $40,000 annually.

Funding
The general implementation and ongoing production/operation costs of basic directory services are currently funded by ITS. New costs associated with development of core campus applications and costs of capital upgrades to accommodate core services require general fund support. Departmental-specific enhancements and applications that require modifications to use the directory should be funded by the specific department application/system owner.

Timing
- Enhancements/Initiatives review: Directory Governance Board meets monthly and will continue to do so through the life of the Enterprise Directory or until no longer deemed necessary (as the Directory matures and demand decreases).
- Ongoing Enhancements: no drop in directory development demand is anticipated over the next five years. Sequencing of individual initiatives will occur as the initiative presents itself. Each request will be reviewed and prioritized by the Directory Governance Board, working with a three-to-six month detailed project plan. All requests will be considered in conjunction with the overall IT Strategic Plan, which includes many directory-dependent initiatives.
3.3 IT Service Provisioning Infrastructure

Recommendation: Create a campus-wide infrastructure that establishes and maintains an identity for each campus affiliate and enables the provisioning\textsuperscript{14} of access to campus resources.

The IT Service Provisioning Infrastructure (ITSPI) will address account maintenance processes, naming protocols, persistent identity, enterprise authentication, and enterprise authorization.

\textit{Discussion of the Recommendation}

\textbf{Current Situation}
Technology has advanced to the point where a rich set of on-line services can be delivered to the campus user. The consequence, however, is that administrative control over various services and resources are distributed among many entities on-campus and off. This has resulted in:

- A heterogeneous technical environment as each entity independently chooses a technology for providing and managing their specific service.
- A diverse and inconsistent set of policies and processes as each entity uniquely addresses the issues of security, privacy and managing access to entity-specific services and resources. Practices within one department may place others on campus at risk.
- A wide variety of identifiers that are potentially overlapping or inconsistent: user-based, role-based, core system-based (SIS, HR), or administrative-function-based (i.e., ID Card), etc., with little or no reconciliation between the identifiers.
- Redundancies and inefficiencies as individual campus entities develop their own processes and solutions for provisioning and managing departmental or system-specific accounts.
- A multitude of identifiers, passwords and processes creating both a fragmented user experience and an insecure environment as individuals build homegrown solutions for managing their logins and passwords.
- Inconsistent and most likely insecure mechanisms for assigning, storing and transmitting passwords.
- Potential for improvements and enhancements restricted by departmental budgets that focus, justifiably, on the department’s primary mission rather than on IT development.
- A level of responsibility that may exceed the department’s ability or desire to manage increasingly complex IT issues.

\textbf{Rationale}
Centralizing the campus IT Service Provisioning Infrastructure and providing appropriate delegated authority enables campus IT service providers to devote their energies and resources toward meeting department-specific business needs while capitalizing upon the features of a centrally-provided, readily available infrastructure. This model offers significant economies of scale by minimizing the inefficiencies inherent in redundant solutions scattered throughout the campus. At the same time, it offers a flexible suite of tools that can be used by IT managers to provide end-to-end services specific to their individual constituencies’ requirements.

Authentication and access management policies, mechanisms, and administrative interfaces will be consistent, robust, and trusted campus-wide, offering multiple benefits:

- Decreased management burden.

\textsuperscript{14} Provisioning: The act of determining who can access what services and assigning identities, roles, permissions, and criteria at the user and system level that allow for that access.
• Reduced risk throughout campus IT.
• Enhanced data and process flow capabilities and compatibilities between systems, departments and campus-wide entities.
• All campus IT services built upon the centralized infrastructure will be in auditable compliance with regulations such as FERPA and HIPAA.

Much as the campus network infrastructure is taken for granted and, consequently, has become an integral component of IT and campus life today so, too, should an IT Service Provisioning Infrastructure become a given that can be relied on to serve campus IT needs. Future applications, IT-enabled learning objectives, middleware, and other facets of IT-enhanced campus life increasingly expect various aspects of ITSPI to already be in place. If the infrastructure is not built centrally then CU-Boulder will realize significant inefficiencies and increased risks as departments attempt to build these components separately.

Specific Recommendations Include

• Build a single authoritative identity per person – across the university and its systems – with attributes that can be referenced by authentication and authorization mechanisms. Use this authoritative identity to facilitate single/same sign on and to help establish trust relationships between campus systems, between campuses and with UMS.
• Adopt the industry direction of middleware services built around a robust Enterprise Directory
• Centralize the storage and management of institutional identity data increasing the ability to manage it consistently, in compliance with regulations, and so it is auditable for compliance.
• Establish Identity and Role management policy that answers the questions of: who gets an identity, under what circumstances can or should an identity or role be established, what roles can be established for each identity, who has access to identity, who can change attributes, and what are the valid sources for identity and role creation.
• Centrally coordinate authentication and authorization policies and mechanisms, and trust relationships among data owners and specific applications. Coordination will take the form of mandates, best practices and standards.
• Design and implementation must carefully consider concurrent technological developments, the momentum of other IT architectural initiatives and Higher Education’s IT directions – balanced with the university’s capabilities for implementing technical solutions within a particular timeframe.

Our ability to muster resources will influence our ability to deploy ITSPI. Campus-wide participation requires people with appropriate skill sets and the proper prioritization of duties in order to ensure a successful deployment of the infrastructure.

Steps

Implementation

• Establish the Enterprise Directory as the single authoritative source of Identity and Roles; tie campus applications to this source.
• Build a flexible framework that accommodates application-specific directories as extensions of the Enterprise Directory.
• Increase campus-wide trust in IT direction. To do this, ITS must demonstrate its understanding of departmental issues by partnering with individual concerned departments to arrive at appropriate solutions.
• Evaluate the costs, benefits and capabilities of commercial technologies that may offer desired ITSPI component functionality.
• Implement ITSPI in a modular fashion so that components can accommodate changes in technology, enhancing the infrastructure without disrupting the infrastructure.
• Establish campus technology standards based on industry standards that allow all complying systems and applications to take advantage of campus middleware services.
• Implement authentication services as a key component of ITSPI striving for single/same sign-on.
• Use the Enterprise Directory and emerging web standards for the implementation and policy management of a centralized Provisioning and Access Management infrastructure. See the ITS working document “E-mail Address and Account Provisioning for ITS Systems.”
• Incorporate Active Directory into the IT Service Provisioning Infrastructure as an extension of the Enterprise Directory.

Policy & Standards
• Establish campus authentication policies and standards.
• Establish campus entitlement and access management policies and standards.
• Establish Active Directory policy and Service Agreement to set expectations for administrators, AD administration, and policy exceptions.
• Establish standards that the campus can follow to take advantage of middleware services.
• See also Enterprise Directory policies regarding identity and role management.

Required Involvement

Governance & Authority
• The Office of the Associate Vice Chancellor for Academic and Campus Technology.
• Directory Governance Board as the leadership board for the Enterprise Directory and its role in identity management.

Required Departmental Involvement & Responsibilities
• Individual campus departments and IT providers. ITS must know the campus well enough to understand the impact of proposals on current departmental practices, workflows, and IT management personnel as well as the issues involved with integrating existing technologies into the new infrastructure.
• IT Council to provide guidance, programmatic direction, and policy review and approval.
• Campus Tier 2 support representatives to provide insight into their specific business needs
• ITS initiative leaders for coordination amongst initiatives.
• ITS to provide core leadership in the design, maintenance, operation and management of the ITSPI
• UMS as a partner in the implementation of ITSPI.
• Campus Card program as a key player in the identity arena.

Expected Costs

Research, development and implementation

ITS-campus trust building:
Combination of new and existing resources
Initial investment: Dedicated effort to assess and understand campus business needs; six months, two people at 50% each (one existing FTE, one new FTE).
Existing resources:
Ongoing: Continuous effort at something less than half time.
Campus technology standards:
Existing resources:
- Ongoing committee (assume a highly skilled representative from each of ITS’s core services, meeting monthly plus research)

Access Management Solution:
There is a wide range of options in this area. Some packaged vendor solutions provide complete identity and access management with policy engines and application programming interfaces. On the other end of the scale are “freeware” options that provide simpler web single sign-on services, but lack administrative tools or interfaces. Either approach requires a robust hardware and network infrastructure in order to provide highly available campus services. Some example pricing:
Vendor solution (eg. Oblix, Netegrity, iPlanet):
$140,000 - $500,000 plus 3-6 person months
WebISO / Shibboleth:
- Software is free.
- Servers: $40,000; Proxy or Switch: $20,000;
- Development/install: $15,000 plus 3-6 person months.
The freeware solution is likely to be adequate initially, provided it is coupled with some provisioning mechanism (see below) for controlled services. The capabilities of the free solution, along with enhancements provided by peer institutions, may improve as our needs increase, thus keeping this a viable approach. The cost of a vendor solution is included under the assumption that we will, eventually, outgrow a free software solution. The degree to which we do outgrow it will dictate the cost.

Account Provisioning Utilities
While it is a long term objective to manage access via well established identities and roles, the reality is that many systems will continue to require system-specific accounts or provisioned access. An account provisioning system translates entitlement and access management policies into the creation of accounts on systems, using system aware agents. The DURM/Uniquid/Adduser suite, written in-house, is the current such system in place and is used widely on campus. It will need to be rewritten or replaced as a component of the new Directory driven infrastructure.
- Vendor solution (eg. Access360, Waveset, Business Layers):
  - Gross est. $500,000 plus 4-8 person months
- Rewrite DURM:
  - 4 people 10 months each
(Assume central components could share existing hardware resources).

Application-specific ITSPI requirements:
New Resource requirement: 1.5 FTE
- Note: Estimate will vary greatly by application. Assume two new application requests per month plus a multitude of existing applications that may request directory enablement (Libraries, Recreation Center, Wardenburg, Facilities Management, Housing, Bookstore, iVote, Off Campus Housing, Faculty Information System, Telecom Management system, PLUS, etc.)

Active Directory deployment:
Today: 1000 machines, budget in place for hardware requirements to support FY03 new requests if requests are not actively solicited.
Aggressive marketing estimate: 4000 new machines. Hardware budget already requested. Up to two new FTE would be needed for support.
Highest level of saturation likely would total an estimated 7,000 machines and require a minimum of 2 additional FTE.
Active Directory build from Enterprise Directory:
Existing resources:
  Two person months for development and implementation (analyst/programmer)

Cost of not implementing an IT Service Provisioning Infrastructure
Approximately 20 departments on campus are currently managing significant IT assets with their own staff. All of these departments will rely at least upon an Active Directory infrastructure for mission critical operations. Absent any central middleware services, all 20 of these departments will be required to spend some effort accommodating their future needs in this area.

There are six departments (in addition to ITS) that support vendor-supplied mission critical administrative applications with campus-wide impact. Within the next four years it is highly likely that without a campus infrastructure, all of these departments will need to implement some form of directory/middleware services to support their applications. The departments are: Libraries, Recreation Center, Wardenburg Student Health Services, Housing, Facilities Management, and the Bookstore. If each of these departments requires 1 FTE and $200,000 in one-time capital spending to develop a modest but functional departmental service, the cost to the campus is 6 FTE and $1.2M. The result is six disparate implementations, none as robust as the proposed set of central services. This cost and result would be in addition to the infrastructure that ITS will (must!) build to support campus-wide student and faculty IT-dependent services.

Funding
Funding for the development and deployment of the IT Service Provisioning Infrastructure should be handled at a campus-wide level. Consideration should be given to department-specific funding for migration to the ITSPI of department-specific applications and services.

Timing
The Enterprise Directory, Active Directory, ITS Account Provisioning, and WebISO components of the ITSPI are all in process - each with its own level of resources, project plan and schedule. These initiatives are interrelated and, as such, must be coordinated within the ITSPI. The future momentum of each of these initiatives is dependent upon the strength and continuity of funding streams. Also dependent upon the funding stream and its impact on these ITSPI components are the multitude of initiatives that await the build-up of the IT Service Provisioning infrastructure. Only as the ITSPI components are further developed and implemented, can new initiatives – which must necessarily be aligned with the ITSPI – be developed and implemented, assuming the necessary resources (development staff, operational staff and funding) are in place.
3.4 Telephony – Voice over IP (Section I of II)

Recommendation: Prepare the campus for the next generation of telephony services by evaluating and deploying limited integrated voice and data services over campus data network by VoIP\(^{15}\).

Discussion of the Recommendation

Current Situation
Campus telephony today is based upon traditional circuit switched technology that is distinct from the campus data network. However, these two networks ride on much of the same infrastructure, and the campus data network is expected to be the basis for the next generation of voice related services.

Rationale
The campus is one year into the planned seven-year lifecycle for the existing phone system. Voice over IP (VoIP) is expected to be the next generation telephony solution. This technology would allow the university to manage voice and data services across a single network and provide campus customers with a wider variety of services. The key to successful transition to the next generation of telephony solutions is to start exploration and small-scale deployment of this technology well in advance of the next expected upgrade.

Specific Recommendations Include
- Test VoIP solutions beginning in the summer of 2002.
- Deploy VoIP solutions as a remote service option for all new remote voice solutions beginning in 2003.
- Deploy VoIP in pockets on campus as appropriate.
- Prepare campus network for VoIP deployment.

Steps

Implementation
- Complete a VoIP test on campus using a variety of sets, customer needs and campus network locations.
- Deploy smaller VoIP solutions in remote areas not connected to campus.
- Prepare campus network to meet the needs of VoIP as the next generation phone system.

Communication
- Work with IT Council to develop a communication plan that prepares the campus for this eventual transition. This would include periodic updates on the service offerings and provide campus with an overview of this technology.
- Conduct forums as part of the ongoing Tier II community event series to discuss the VoIP deployment on campus.

Policy & Standards
- Develop a set of service guidelines that include quality of service (QoS) and other technical standards necessary to support VoIP deployment as a real alternative to circuit

\(^{15}\) VoIP, for purposes of this discussion, is applying voice service onto the data network.
switched telephony. Standards to include network viability requirements and analysis programs.

- Create a standard set of supportable voice features that transfer from the circuit switched arena to the data network with minimal impact to customers.
- Create documentation for Tiers I – III of the 4-Tiered support model.

**Required Involvement**

**Governance & Authority**
The Office of the Associate Vice Chancellor for Academic and Campus Technology.

**Required Departmental Involvement & Responsibilities**

- ITS Networking to configure and provision regions of the campus network to handle VoIP deployment.
- ITS Networking to provide the interface between the campus network and existing phone systems.
- ITS support Tiers I, II and III to be prepared to support VoIP customer.

**Expected Costs**

**Annual IT Infrastructure Investment**
Initial VoIP test already funded. During the course of the next four years, we will be doing small-scale deployments that are within existing cost recovery models. No additional annual funding expenditures are expected since the test period is well within the expected life of the campus phone system.

**Operating and Maintenance**
Ongoing costs to be recovered through service fees.

**Personnel**
No new personnel expected to support the deployment. However, some training will be required for voice service personnel to support the new technology.

**Funding**
Cost recovery models consistent with existing campus voice services delivery will be developed.

**Timing**
Program begins with FY 02-03 for the VoIP test on campus. Testing and evaluation should be completed by spring 2003. Deployment of VoIP to new remote sites will happen as appropriate while continuing to examine the technology in preparation for next generation phone system.
3.4 Telephony – Service Integration and Mobility (Section II of II)

Recommendation: Make it easier for campus customers to access voice related technologies and services.

Discussion of the Recommendation

Current Situation
Voice services on campus are limited to telephone sets physically connected to the campus PBX system. These services on the voice network do not support freedom of movement about campus. Increasingly, campus customers are using carrier-based mobility technologies such as cell phones and two-way radios. These technologies are not integrated with the set of campus voice services currently available. Customers are required to go to the technology in order to get the services they need rather than the technology coming to the customer. This situation applies to basic telephony, voice mail, as well as administrative services.

Rationale
Campus customers have noted a lack of compatible voice service offerings that support mobility and service integration. In an effort to bring technology to customers, ITS should support the voice communications tools that customers need while responding to rapidly changing technology. The campus should design such a strategy to provide improved access to all members of the university community including those with disabilities.

Specific Recommendations Include
- Cordless telephone set offerings for mobility within all campus buildings
- Mobility features support for cell phones, which will allow customers to use their cell phones to receive campus calls simultaneously with their campus telephones.
- Voice activated (hands-free) control of telephone and voice mail features.
- Desktop computer access to telephone and voice mail features.
- Investigate and deploy integrated voice mail and email on the desktop.
- Provide additional web based resources to assist customers with service changes while automating simple requests with proper authentication.

Steps

Implementation
- Develop cost effective and scalable solutions that include short- and long-range telephony options for campus customers.
- Research wireless telephony opportunities that may integrate with campus wireless LAN planning.
- Develop and provide voice-activated technologies that integrate with existing campus telephony offerings.
- Enhance the web interface for telephone service requests so that simple requests can be processed automatically.
- Explore and develop integration of desktop voice mail access with current email access.

Communication
- Develop a communication plan that includes mobility solutions as part of Tier II community events, and other customer forums, as well as disability access.
• Create a communication plan, which regularly provides campus customers with updates regarding service improvements and additional feature offerings.

Policy & Standards
• Create a plan that incorporates FCC and other regulations regarding the deployment of wireless solutions. Integrate this plan with campus spectrum management.
• Incorporate campus Environmental, Health and Safety (EH&S) guidelines regarding radio frequency emissions.

Required Involvement

Governance & Authority
The Office of the Associate Vice Chancellor for Academic and Campus Technology.

Required Departmental Involvement & Responsibilities
• ITS for installation, provisioning and maintenance of equipment on an ongoing basis that is consistent with development of wireless LAN on campus.
• ITS support Tiers I-III to be prepared to support the customer.
• ITS CAUS Group for email support and integration.
• ITS Networking Group for the development of these services.
• Environmental, Health and Safety (EH&S) for review of acceptable levels of transmission energy.

Expected Costs

Annual IT Infrastructure Investment
No annual infrastructure increase is planned other than an estimated $100,000 investment during the FY 05-06 for integration of the campus voice mail and email.

Operating and Maintenance
Costs for operating and maintenance are expected to be within normal operating funds.

Personnel
No new FTE are required to support the development or ongoing maintenance of this activity. Provide training to personnel on the safe deployment and operation of wireless equipment.

Funding
Funding for most services can be obtained through ongoing cost recovery activities with the exception of voice mail and email integration, for which institutional funding should also be pursued.

Timing
• FY 02-03: Evaluate mobility features and technologies. Deployment of web based service request form.
• FY 03-04: Development of automation services. Deployment of small-scale solutions.
• FY 04-05: Deployment of automation services and development of integration.
• FY 05-06: Deployment of integration of voice mail and email.
Chapter 4: Central Services

Central services are those that are used by or affect the campus as a whole, and often require collaboration across multiple units. Traditionally on the CU-Boulder campus, those services have been provided both by the central IT unit (ITS) and by departments. In some instances, this mix of central and departmental provision of services has resulted in greater flexibility for departments and the ability for departments to tailor IT services to local needs more effectively. In others, central and departmental services may be duplicative at best, competing at worst.

The recommendations in this chapter include a call for greater central management and/or coordination of certain services, including integration of departmental services with the Enterprise Directory, email server management, and software licensing and distribution. This does not change the fact that central provision of services will be balanced by services that are provided in a more distributed fashion. Although many of the recommendations require greater collaboration and cooperation between ITS and departmental IT operations, departmental IT personnel are the keystone in the provision of services and support that is both close to end users and tailored to their particular needs. As such, it is imperative that increased centralization and collaboration coexist with appropriate departmental autonomy and that, even as the campus implements greater centralization in critical areas such as security, it concomitantly seeks to maintain and enhance distributed services in areas such as desktop support. Chapter five discusses issues of authority and coordination more fully.

As with recommendations in other chapters, those in Chapter four have security, reliability, and cross-unit collaboration and cooperation as their foundation and top priorities. Recommendations include:

- Enhancement of existing services such as email, the four-tier IT support model, and assistive technology;
- Better management of existing services such as software licensing and application standards;
- Development of a security and of a web-based services infrastructure;
- Development of e-payment and file system solutions;
- Coordinated preparation for the next generation of SIS and PeopleSoft; and
- Development of best practices, policies, and guidelines critical to the successful implementation of these recommendations.
4.1 Email

Recommendation: Provide enhanced and new email services to all faculty, staff, students, and designated affiliates so that email is: convenient to access from on- and off-campus, easy-to-use, reliable, highly available, and secure. Centrally-managed systems must be enhanced to further combat unsolicited commercial email and viruses; the central infrastructure must be augmented to ensure high-availability and redundancy to reduce the need for distributed systems which may be expensive, proprietary, and complex; reliance on client desktop software should be reduced in favor of new web-based, feature-rich interfaces; new methods should be provided to facilitate group collaboration in both real-time and via more traditional message-based and web-based delivery. Key components, including bulk delivery, address lookup, and delivery mechanisms should be integrated with the Enterprise Directory.

Discussion of the Recommendation

Current Situation
All students are required to have CU-Boulder email accounts and are responsible for reading email sent to them. No similar policy exists for faculty and staff and access for them is uneven, with some having excellent email access through central or departmental servers while others have poor or no access. Group and bulk email communication methods are inconsistent, sometimes slow, and often unwieldy to use and manage. Unsolicited commercial email (UCE, often called “spam”) is rampant and there is no campus-wide, comprehensive effort to eliminate and prevent the spread of electronic viruses. Email is routinely used to send sensitive information yet most email is sent without any verification of sender and without content encryption. The centralized and departmental costs associated with providing email services on campus are not widely recognized or understood.

Rationale
Email has become a ubiquitous means for communication within the campus community and beyond. It is quicker and cheaper to send email than to deliver hardcopy mailings and its colloquial nature promotes a sense of community unmatched by traditional paper mailings. Email has become mission critical and the infrastructure needed to support this function must be further developed and established.

Specific Recommendations Include
- Develop and encourage the use of a reliable and redundant email infrastructure that provides all faculty, students and staff with:
  - Robust, standards-based service that uses secure authentication integrated with the Enterprise Directory; the service should include a full-featured web-based interface requiring no client software besides a campus-endorsed web browser.
  - Online access to messages with adequate storage capacity to accommodate the variety of needs and roles of campus constituents.
  - Integration with future web-based services offerings for the variety of constituent groups (e.g. faculty, students, administrators, researchers, instructors, alumni, etc.).

16 Many students have and use an alternate email provider instead of or in addition to the CU-Boulder service.
• Further develop and promote the centralized campus email gateway for use in processing all incoming and outgoing email; on this gateway perform real-time anti-virus processing and filter unsolicited commercial email.
• Develop and promote a uniform, campus-wide, scalable email addressing scheme that is integrated with the Enterprise Directory for lookups and is designed to enable graduating students and designated affiliates to keep their CU-Boulder email addresses forever, if they so choose.
• Provide role-based email identities to enable an individual and/or individuals to receive and send email from a non-personal identity that is linked to the individual(s).
• Develop and promote mechanisms for small group collaboration via easy-to-use email lists and/or threaded discussions.
• Develop and promote mechanisms to enable rapid and efficient delivery of messages to large segments of selected campus populations for both urgent and routine messages.
• Develop and promote best practices and policies governing use of email for performing transactions and sending confidential information and for appropriate retention, backup, and restoration of email.

Steps

Implementation
• Establish service level goals for the campus email infrastructure, including the central gateway and central servers, by considering requirements for:
  o Capacity and scalability.
  o Redundancy and reliability.
  o Universal availability.
  o Features, including client software, anti-virus, and content (UCE) filtering.
• Design and develop a centrally-managed infrastructure to meet the established service goals.
• Perform anti-virus and anti-UCE processing on all incoming and outgoing email by routing all email through the central campus gateway.
• Establish an efficient mechanism for delivery of urgent messages to sender-specified populations.
• Develop a web-enabled group message environment for collaboration.
• Incorporate security into the campus email infrastructure to provide non-repudiation of sender and recipient identities (to guard against forgery and spoofing), guarantee message integrity, and safeguard message content.
• Leverage the Enterprise Directory and IT service provisioning infrastructure to provide role-based email identities.
• Evaluate needs for campus-wide instant messaging systems.

Communication
ITS and appropriate campus departments and individuals will collaborate on development of policies, best practices, and service level agreements. Additional communication and input-gathering will be performed via surveying faculty, staff, and students; by talking with campus IT representatives; by offering presentations at committee meetings and other gatherings; and by communicating via traditional channels such as ememos, print media, and hardcopy mailings.

Policy & Standards
• Establish policies regarding: anti-virus and UCE filtering on servers that accept incoming email; use of email for official notification to faculty and staff; use of email for distributing sensitive or critical data; requirements for appropriate backup and retention of email.
• Establish guidelines and methodologies for administration and management of central and departmental email servers.
• As part of the service provisioning infrastructure initiative, establish campus-wide standards for email addresses.

**Required Involvement**

**Governance & Authority**
The Office of the Associate Vice Chancellor for Campus and Academic Technology.

**Required Departmental Involvement & Responsibilities**
• IT Council to provide guidance and programmatic direction.
• Legal Counsel for guidance on policies.
• Human Resources and Faculty Affairs for guidance on policies relating to faculty and staff.
• ITS to develop and promote service level goals in cooperation with campus departments.
• ITS to lead the design, development, and implementation of a centrally-managed email infrastructure in cooperation with campus departments.
• ITS to develop and promote best practices in cooperation with departmental IT and email providers.
• ITS to design, maintain, operate, and manage the campus gateway and central email servers.
• ITS security coordinator and working group to guide development of secure messaging.
• ITS, Mailing Services, and Registrar to collaborate on bulk delivery mechanisms.
• ITS to partner with campus email providers to help them leverage a centrally provided email gateway for processing incoming and outgoing email services to better meet their departmental messaging needs.
• ITS, UCSU, and student fee allocation committees to address spending of student fees.

**Expected Costs**

**Annual IT Infrastructure Investment**
Costs include hardware and software needed to deploy a fault tolerant operating environment, including the central email gateway and central email servers, backup subsystems, redundant power environment, and software.

Student fees currently support the non-personnel costs associated with the central email systems dedicated to students. Ongoing costs are approximately $180,000 per year and cover operating expenses (server software, hardware maintenance), small capital improvements, and renewal and replacement of existing systems. Fees currently do not contribute to any cost associated with the central gateway system.

• One-time cost to augment the email gateway to ensure high-availability and reduce viruses and UCE - $220,000. Ongoing costs for renewal and replacement (based on a 4-year replacement cycle), operating (10%/year), small capital improvements (10%/year) - $99,000.
• One-time cost to augment servers used by faculty/staff to provide service equivalent to that provided to students - $350,000. Ongoing costs for renewal and replacement (based on a 4-year replacement cycle), operating (10%/year), small capital improvements (10%/year) - $157,500.

Costs for providing non-repudiation and security of message delivery should be included as part of the overall campus security plan.
Personnel
Personnel exist within ITS to lead the design and development of the infrastructure enhancement as well as its operation; no new personnel are required. If campus departments choose to convert from locally-maintained email servers, particularly Microsoft Exchange-based, to centrally-provided services, existing ITS personnel up to 0.5 FTE for 6 months can be made available to assist with the migration. Enhancement and development of group collaboration will require 0.5 FTE for 2-3 months that can be found within existing ITS personnel. Personnel to provide backup subsystems also exist within ITS.

Funding
Email and electronic collaboration are essential and increasingly mission-critical for all students, faculty, and staff. A combination of institutional funding, student computing fees, and cost recovery should be used to provide campus-wide email services.

Student fee revenue, either by reallocation or additional, should be identified in the amount of $5/student (assume 26,000 students) to contribute to the one-time cost of augmenting the campus email gateway - $130,000. Student fee revenue in the amount of $2.25/student/year should be identified to contribute to the ongoing cost of the central email gateway - $58,500.

The balance of the one-time cost for augmenting the email gateway and the full cost of augmenting faculty/staff services should be identified through cost recovery. A mandatory one-time assessment of $74 per FTE (assuming 6000 FTE) should be made. Ongoing fees of $2.75/month/FTE should be assessed as part of a new basic services infrastructure fee that would provide services such as email, security infrastructure, departmental web services, and basic file services.

The campus will see cost savings if departments migrate from departmentally-provided email to a centralized service. For an average department of 40 FTE, annual savings of $7,000 – 20,000/year for system acquisition, renewal and replacement, software licensing, and operating could be realized along with reduced personnel requirements of .2 FTE. Assuming 20 such departments, the campus-wide savings will be $140,000 – 400,000 per year plus 4 FTE.

A one-time special budget allocation should be identified to explore and develop instant-messaging services for the campus. If successful, ongoing costs should be recovered as part of a basic services infrastructure fee.

Timing
Development of a robust email gateway should begin immediately to shield the campus from the risk of email viruses and reduce the personnel time wasted by attending to unwanted, unsolicited commercial email. A web-based email system should be deployed in AY 2002-03 for all faculty and staff to match the service provided to students since 1999. Email list delivery should be improved in AY2002-03 followed by evaluation and potential deployment of collaborative environments. Methods to ensure non-repudiation and message integrity should be carefully monitored and deployed when the technology supports it.
4.2 IT Security

Provide an Information Risk Management (IRM) function that establishes a secure campus Information Technology (IT) environment, employs best practices to ensure reliable and secure electronic communication, maintains a secure and robust computing and network environment, data integrity and reliability, and encourages proactive IT security management.

The IRM function includes developing security policies and procedures that address authentication, access control, non-repudiation, and authorization, plus planning and oversight for data integrity and privacy, disaster recovery, network security, intrusion detection, firewalls, and incident response.

Discussion of the Recommendation

Current Situation
The campus is well underway in the effort to develop security-related policies, best practices, and guidelines. However, much of the campus lacks awareness of and understanding of these policies and guidelines. Consequently, system administrators and users often make uninformed decisions that have a detrimental impact on the security and integrity of the campus IT infrastructure and other IT systems.

The Network Security Proposal, drafted by the ITS Security Working Group, was developed specifically to address campus network security weaknesses, and is in the process of being implemented.

CU-Boulder has recognized the need for an IT risk assessment process to ensure the security and continuity of the University’s IT resources. The results of the risk assessment process will help to mitigate vulnerabilities of campus mission critical, IT-dependent services. In addition, data collected and lessons learned from the risk assessment will provide the foundation for setting the future directions for campus IT security. The early stages of the current risk assessment cycle have shown that business continuity planning and disaster recovery is significantly lacking at CU-Boulder. Many IT units either do not have disaster recovery plans or have not tested existing plans.

Rationale
The IT resources impacted by IRM include information, services, and equipment. More to the point, the qualities of these resources that the campus seeks to secure are privacy, integrity, authenticity, and availability. Attacks, human errors, and system malfunctions threaten these qualities. Any IT resource on campus has the potential to negatively impact a wide variety of other IT resources on- and off-campus; therefore establishing an IRM strategy is a campus-wide function.

The increased reliance on IT as part of the university business and academic communications infrastructure requires technical solutions to ensure the integrity and authenticity of electronic communication. Maximum benefit from these solutions will only be achieved if they are implemented under an overall IRM strategy.

17 Current policies can be found at http://www.colorado.edu/its/security/policy.html
18 The proposal can be found at http://www.colorado.edu/ITS/security/SWG/NetworkSecurityPositionPaper.doc
The reasons to provide secure means for electronic communication are many. While there is no question that email as a delivery mechanism has proven to be easy, economical, and fast regardless of the message content, there are risks in sending sensitive or critical data via email. It is relatively easy for an attacker to capture email thus gaining access to private or sensitive information. Additionally an increasing number of attacks involve social engineering that deceives users by falsified “official” university communications. A campus-wide mechanism to protect both the privacy and integrity of the data is needed.

Finally, while desktop anti-virus scanning is still an integral part of worm, virus, and trojan-horse defense, experience has shown scanning to be less effective than necessary for a number of reasons. Foremost, the software is only as effective as the user or administrator configuring the product. All too often, software is installed and not updated, or users just do not understand the need to use such defensive software. Anti-virus software is increasingly both hard to understand and to manage.

Without the basic IT security infrastructure, it is impossible to have effective IT security.

**Specific Recommendations include establishing a campus IRM function by:**

- Continuing efforts to improve security awareness and practices through establishment, communication, and enforcement of policies, best practices, and guidelines.
- Providing campus risk assessment processes and business continuity planning guidance to mitigate vulnerabilities in critical systems and to provide data to better determine future campus security needs.
- Providing effective campus solutions for worm, virus, and trojan-horse defense.
- Implementing solutions providing integrity and verification of electronic communication and communicating secure and effective uses for electronic communication.
- Proactively improving security through campus intrusion detection and vulnerability assessment.
- Improving the campus incident response process and formalizing the ITS incident response team.

**Steps**

**Implementation**

- The ITS Security Working Group and ITS core experts will evaluate and develop IT best practices and policies and provide the campus with training opportunities.
- Continue with the existing risk assessment process.
- Provide IT business continuity & disaster recovery templates for campus departments. Provide an anti-virus licensing option or a campus site license; build supporting infrastructure; implement a campus anti-virus policy; publicize best practices; and offer training for desktop protection strategies.
- Campus infrastructure servers already support the encryption of authentication and sensitive data. This technology should be extended to other campus or departmental servers. Reconfigure or replace client-side application to utilize server security features.
- Develop and implement a secure email environment that enables non-repudiation of sender and recipient identities and guarantees integrity of electronic communication.
- Implement a network vulnerability assessment service for use by the campus Tier 2 computing support partners.
- Evaluate different intrusion detection system solutions and approaches; resolve policy and legal issues; and implement a campus intrusion detection solution.
- The ITS Security Working Group will develop and implement an incident response process.
Communication
Build on the existing security communications team to develop and implement a security communications program with the goal of increasing awareness of and adherence to security policy and guidelines.

Policy & Standards
- Develop campus Anti-Virus Policy.
- Continued best practices and standards for existing and new technologies.

Required Involvement

Governance & Authority
- The Office of the Associate Vice Chancellor for Academic and Campus Technology.
- IT Council to provide guidance and programmatic direction.

Required Departmental Involvement & Responsibilities
- Tier 2 Computing Support Advisory Team to provide input and review IT security initiatives.
- ITS to provide core leadership in the design, maintenance, operation and management of the IT security infrastructure.
- Office of the Associate Vice Chancellor for Academic and Campus Technology and ITS to provide core risk assessment core team members.
- Boulder Campus Health and Safety, and Risk Management as well as the University Internal Audit to provide input into Business Continuity and Disaster Recovery templates.
- Legal Counsel to provide clarification of liability and other legal concerns regarding aspects of IT security.

Expected Costs
All funding requests require new funding.

Annual IT Infrastructure Investment
- Ongoing $5,000 for continuing communications support.
- Campus anti-virus site license upfront costs of up to $250,000 depending on licensing and technical strategies chosen.
- Web based secure shell application $15,000.
- Hardware and software for secure electronic communication supporting infrastructure. Depending on the scope of the effort costs estimated to be between $250,000 and $2,000,000\(^\text{19}\). The campus will focus on implementing a smaller scale solution that may require more internal staff effort thus keeping costs closer to $250,000.
- $250,000 for firewall hardware\(^\text{20}\).

Operating and Maintenance
- $100,000 annual maintenance for anti-virus software licensing (exact costs dependant on licensing and technical strategies chosen). Costs for this should be recharged.
- $4,000 hardware maintenance and $1,500 administration for vulnerability assessment of systems.

\(^{19}\) The variation is based on the specific technical solution and possible broader campus objectives for enterprise authentication as addressed in the IT Provisioning Strategic Plan.

\(^{20}\) The variation based on the specific tactical solution and the current state of the technology.
$25,000 hardware maintenance and $4,500 administration for intrusion detection systems.

**Funding**

All of the above funding items above require new funding. A combination of institutional finding and cost recovery should be identified to fund IT Security initiatives. Potential cost recovery sources include network fees (e.g., network security, intrusion detection, incident response), student fees (e.g. secure electronic communication), and e-memo (e.g., secure electronic communication) funding mechanisms.

**Timing**

Specific timing will vary based on funding and tactical level decisions. The timing listed represents implementation priorities for the objectives in this plan.

- Security Awareness: in progress and an ongoing effort.
- Risk assessment process: in progress and an ongoing effort.
- Provide business continuity & disaster recovery templates for campus departments: Fall 2002.
- Anti-virus solutions: Winter 2002
- Encryption of authentication and sensitive data: Winter 2002
- Secure electronic communication: AY 2003-2004
- Network vulnerability assessment: Spring 2003
- Intrusion detection system: AY 2002-2003
- Incident response process: Fall 2002
4.3 Electronic Payments

Recommendation: Provide a trusted, robust, and secure method of accepting electronic payments\textsuperscript{21}.

Discussion of the Recommendation

Current Situation
Handling credit card payments is widely accepted on campus by auxiliary operations as an effective means of payment. However, formal policies, guidelines, and/or best practices are not established, widely disseminated or routinely followed. Though campus departments are increasingly interested in accepting e-payments, they are rarely equipped to handle the issues and the technological considerations that are part of doing business on the web. A uniform e-payment solution can resolve these issues and is one of the web-based services most frequently requested by departments.

To begin addressing the issues of accepting e-payments and doing business on the web, CU-Boulder established a review process described in the university’s Web Publishing Policy. (See: \url{http://www.colorado.edu/webcom/webpolicy/}.) The need to address issues created by the absence of a campus-wide e-payment solution was a key element in the framing of this policy.

The review process for e-business and 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).

The University Treasurer’s Office has set up robust and secure methods of e-payments 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: \url{http://www.cusys.edu/~treasury/}.

Despite the Web Publishing Policy and the Treasurer’s Office guidelines, recent survey information shows that departments have implemented a disparity of payment solutions, most of which did not go through the review process outlined above. It has been identified that approximately 40 departments on campus accept e-payments in some form, although these solutions vary greatly.

Rationale
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). E-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 e-payment, a department is assuming a

\textsuperscript{21} Electronic Payments are defined as the acceptance of payment for goods and services where the sale is negotiated over the Internet. Payments are tendered in the form of credit cards or funds transfers.
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.

Specific Recommendations Include

- Develop and communicate policies with specific statements to include that:
  - The business and technological aspects of all e-payment solutions must be approved by the Office of the Director of Budget and Finance.
  - All e-payments must be handled through the Office of the Treasurer for banking and accounting purposes.
  - All electronic transactions must be made using secure connections to secure services. On-campus servers must meet ITS requirements for security to ensure payments are accepted in a consistent, secure and controlled manner.

- Formalize CU-Boulder campus approval process by ensuring that:
  - A department contacts the Department of Budget and Finance, which will facilitate the review required by the web policy.
  - Upon approval, the department will be referred to ITS for technical support, ITS requirements, and advice.
  - Upon approval of the department’s e-payment proposal the department will be referred to the Treasurer’s Office.
  - The Treasurer’s Office will implement banking and accounting arrangements.

Steps

Implementation
To achieve this recommendation the development of four components are required: campus-wide policies; the Budget and Finance process; campus-wide, web-based authentication tools using the Enterprise Directory Service; and formal financial arrangements with the university’s financial institutions.

Communication

- Detailed communication plan to be developed after pilot deployment occurs.
- Ongoing training programs on e-payment opportunities, responsibilities and changes through Treasurer’s Office.

Policy & Standards

- Periodic update of the Web Publishing Policy (which includes the e-business review).
- Treasurer’s Office Requirements and Policies for departments accepting electronic payments (to include Visa / MasterCard, bank, and other regulatory requirements).
- Treasurer’s Office Standards for initiation of ACH\(^{22}\) debits (currently under development).
- PSC / Treasurer’s Office Standards for initiation of ACH credits (currently under development).

Required Involvement

Governance & Authority
The CU-Boulder Chancellor should issue a directive that all departments wishing to accept e-payments must adhere to campus and system-level policies. The AVCACT and the Director of Finance and Budget have joint coordinating responsibility for the program.

\(^{22}\) ACH is the Automated Clearing House Network, which is a nationwide batch-oriented electronic funds transfer system. The American Clearing House Association, Federal Reserve, Electronic Payments Network, and Visa act as ACH Operators.
Required Departmental Involvement & Responsibilities

- Budget and Finance will facilitate the process of providing consultation and guidance to departments wishing to accept e-payments.
- ITS will provide technical consultation and guidance to departments who express interest in developing e-payment applications.
- Web Communications will provide guidance, standards, and best practices for the development of web applications.
- Treasurer’s Office will set standards for e-payment acceptance and required regulatory business standards, as well as to setup and maintain banking and card system relationships.

Expected Costs

Annual IT Infrastructure Investment
Annual IT Infrastructure costs will be integrated into the operating budgets of ITS and UMS for the base system support.

Departments accepting any form of e-payment will be responsible for any and all incremental costs related to supporting the service.

Operating and Maintenance
Same as above.

Personnel
Same as above.

Funding
Use existing budgets for funding.

Timing
January 1, 2003 for limited campus deployment.
June 30, 2003 for full implementation of policy, including review of existing electronic payment relationships.

Existing contracts should be honored until the end of the contract periods.
4.4 Software and Software Licensing

Recommendation: 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.

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. These responsibilities should be assigned to existing units based on their established roles, competencies, and resources.

Discussion of the Recommendation

Current Situation
The campus has many computing systems and therefore, a significant need for software products. The campus acquires software products from a large number of developers/vendors who provide a wide array of products, with a wide variety of features and capabilities, technical requirements, and licensing terms.

The university faces special challenges in acquiring software products because software contracts are not like contracts involving ordinary goods. Software contracts transfer intangible assets and often provide a right to use rather than to own the product. Therefore, 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.

Rationale
The availability of software tools is critical to the business, instructional, and research 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. As well, many departments, academic units in particular, report that they are unable to afford the software tools required to do their work. Improving the processes used to identify, acquire, and manage software licenses will improve software availability while lowering ownership costs.

Specific Recommendations Include
- Develop selection criteria, such as the demand for software, the value of software, the compatibility of software with other computer systems, and the cost of software.
- Develop best practices and guidelines for managing software assets.
- Identify funding sources to acquire essential software tools for faculty.
- Improve student access to software tools, especially those used in teaching and learning.
- Identify funding sources to support activities related to the administration of software licenses, coordination of purchase programs, dissemination of information about software, and distribution of licensed software products.

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• Define computer system ownership at an appropriate level (deans, directors, department heads), considering the funding organization of the campus and delegate responsibility for ensuring license compliance accordingly.
• Identify and clearly define roles and responsibilities for:
  o Decision makers, including technical and subject matter experts, who will determine which software products will be acquired.
  o License agreement interpretation and guidance for legal compliance.
  o Procurement, distribution, asset management and related business activities.
  o Coordination of license and purchase agreement and communication regarding existence, availability, and terms and conditions of use.
• Participate in consortia with other universities to share information and possibly gain advantages through coordinated negotiations with vendors.
• Promote coordination of software selections for use across academic, business, and research areas.
• Negotiate and promote purchase agreements for the campus, focusing initially on products that are ubiquitous or essential, and based on IT and campus initiatives.

Steps

Implementation
• Survey and assess the software products that have been purchased and are in use on the CU-Boulder campus.
• Determine the cost of providing and maintaining software tools and make this information available for inclusion in budget projections.
• Perform a gap analysis to determine how well the software needs of the campus are being identified and addressed.
• Review the current software licensing processes and procedures, identifying specific opportunities for improvement.
• Assign responsibilities and establish timelines for developing selection criteria and best practices for managing software assets.
• Identify a funding source specifically for providing software for faculty.
• Identify specific roles and responsibilities in cooperation and consultation with faculty, the Tier 2 support community and IT Council.
• Create and staff two positions to support the administration of software-licensing programs.
• Develop advanced solutions for software distribution and access, including automated and remote installation and management, network licensing and license metering.
• Investigate the availability and value of software management products.
• Partner with the Office of Budget and Finance to develop improved practices and identify specific business opportunities.

Communication
• Use appropriate channels, such as the campus web site, constituent group meetings, e-memos, support community events, and print advertising to:
  o Inform the campus community of the existence of site and other broad license agreements.
  o Raise awareness about the rights and responsibilities of software ownership and use.
  o Ensure that IT support providers can provide accurate and timely information.

Policy & Standards
• Develop guidelines for selecting and acquiring software products.
• Develop standards and/or guidelines for managing assets and complying with licenses.
• Publicize position statements and policies that promote the ethical and legal use of software.

**Required Involvement**

**Governance & Authority**
The Office of the Associate Vice Chancellor for Campus and Academic Technology.

**Required Departmental Involvement & Responsibilities**
- ITS for technical expertise in advising and support.
- Office of Budget and Finance for coordination of business service activities.
- Faculty and academic technology representatives and coordinators for guidance and identification/prioritization of software tools.
- Departmental support associates for guidance and identification/prioritization of software tools.
- Procurement Services and University Legal Counsel for review and authorization of contracts.

**Expected Costs**
The following infrastructure, operating, maintenance, and personnel items represent new costs. The specific products that are cited reflect solutions that are available today and provide a basis for cost estimates. Further analysis will be required to identify the best solution and to establish the actual cost of implementation and maintenance. These newly incurred costs would be partially offset by savings in budgeted software acquisition costs and unbudgeted staffing costs.

**Annual IT Infrastructure Investment**
Costs include hardware and software needed to deploy a large-scale software management system that provides: software distribution, cost recovery system, efficient license management, and monitors demand.
- Software management and distribution systems (e.g. e-Academy License Management System (ELMS)).
  - One-time setup and integration fee - $5000.
  - Annual license fee, including updates, $1 per FTE - $31,000.
  - Primary and backup hardware systems - $10,000 (replaced every 3 years).

**Operating and Maintenance**
The campus should provide funding to acquire essential software tools for faculty, especially for products that support teaching and learning. Since software costs are ongoing and occur annually, a fixed amount should be allocated to each full-time faculty member each year. Higher software costs for years in which hardware is replaced is mitigated by the inclusion of operating systems and related software in the new system's price. The use of these funds, while limited to software expenses only, could be amassed by several individuals to support the acquisition of licenses that are desired by more than one faculty member, program or department.
- Annual software allowance per full-time permanent instructional faculty - $400\(^{24}\), which would equal $550,000 per year based on 1,375 eligible faculty members.

\(^{24}\) It was determined through faculty focus groups and individual interviews that approximately $400 would be needed on average for a full-time faculty member to acquire discipline-specific software tools to support teaching and learning activities. Many of these desired tools are unique and of interest to only a few, so economies of scale cannot apply. However, given the current fiscal environment it is not feasible to allocate $400 per faculty member. Rather, a figure of $45 is used to ensure that faculty at the very least have the full Microsoft Office suite (or subsidy of a comparable product).
Personnel
Personnel to design, develop, deploy, maintain, and enhance the license management system is estimated at 1.0 FTE or $60,000\textsuperscript{25} per year including salary, benefits, training, and operating expenses.

Personnel requirements to design, develop, deploy, maintain, and enhance the software management and distribution systems have not been established.

Personnel will be required to coordinate licensing activities; liaise with vendors; distribute software; communicate information to the campus; and provide accounting services. Leverage existing service units, such as the Procurement Service Center, Buffalo Chip, and ITS, which will minimize the personnel requirements.

Funding
Software is essential and increasingly mission-critical for all students, faculty and staff. A combination of institutional funding, student fees, and cost recovery should be identified to provide adequate software tools and to cover the associated administrative expenses. Course fees should be investigated to provide for unusual software expenses associated with specific curricula. Institutional funding would be the preferred means of covering these expenses.

Timing
An initial needs assessment and software inventory should be conducted for the campus in the fall of 2002, followed by the development of a plan to improve software licensing processes and procedures. “Quick win” opportunities should be identified at this time. An assessment of the financial impact of these recommendations should be conducted in AY 2002-03, with funding sources identified for FY 2003-04.

\textsuperscript{25} Salary $41,667/year plus benefits 26% at 100%, professional development and operating expenses $7,500/year.
4.5 Next Generation of Peoplesoft HR and SIS

Recommendation: Minimize impact of proposed Peoplesoft upgrade to the campus technical infrastructure.

An upgrade to the university’s Peoplesoft Human Resources system has been proposed for fiscal year 2003-2004 and is presently under evaluation. Depending upon implementation decisions, the campus should immediately begin consulting with members of the university’s Peoplesoft deployment team to measure possible technical impacts and implement measures to ensure a seamless transition to the new release. The impact of a possible replacement of the university’s Student Information System (SIS) is not addressed in this plan, as there is currently no plan to replace the system within the next four years.

Discussion of the Recommendation

Rationale
An upgrade of the university’s Peoplesoft Human Resource system to release 8.3 would introduce significant functional improvements by offering web-based transactional access. The campus technical infrastructure would be affected in the following areas:

- Campus network traffic – would be significantly increased due to reduced use of Citrix servers and associated data compression. (Citrix would continue to be used for the Financial System).
- Desktops – browser based access to HR system will require standard release levels of browser software. Panel navigation will require training for book-marking panel urls, etc.
- Data interfaces – some modification to campus system interfaces may be required to accommodate revised data interface formats and processes.
- Web-based authentication and authorization – the new release provides a capability for using an LDAP directory for authentication and role based authorization. Integration of these functions with the recently deployed enterprise directory service should be strongly considered.
- Portal interaction – the new release includes an optional functionality for self-update of employee information through a web interface and a portal channel interface. If selected, this option must be integrated with campus portal technical design and development planning considerations.

Specific Recommendations
- Determine technical impact and requirements for integrating Peoplesoft release 8.3 with campus technical infrastructure and planning.
- Develop and fund a Peoplesoft technical integration plan for the campus.

Implementation
- Create core technical team and process for defining project scope and requirements for integration with campus systems and processes.
- Participate in planning processes and provide consulting for Peoplesoft upgrade project.
- Analyze and evaluate alternative approaches to meet requirements for integration with campus systems and processes.
- Design and develop interfaces.
- Provide assistance and support for technical staff in campus departments.
Communication
Create a plan to communicate to the campus regarding technical impact of the new release and recommended solutions. Provide a feedback mechanism.

Policy and Standards
Develop and publish standard data formatting instructions for campus departmental technical staffs and coordinate issues related to security and common data feeds.

Required Involvement

Governance and Authority
The Office of the Associate Vice Chancellor of Academic and Campus Technology.

Required Departmental Involvement and Responsibilities
- ITS to provide project management, systems analysis and design, software development, training, technical standards, and operation and maintenance of system interfaces.
- University Management Systems (UMS) to provide interface support for these applications.
- Peoplesoft Development team to provide consulting and collaboration on technical issues.
- Campus departmental technical staffs to consult and collaborate on system interface issues.

Estimated Costs

Personnel
Personnel for technical impact analysis and design, development and implementation needs to be increased by approximately 1 full-time employee (FTE), over a period of one year, which will cost approximately $90,000 (including salaries, benefits, training, travel etc.) to be recovered through recharges.

Funding
Funding will likely include a combination of charge-back fees for auxiliary departments system interfaces and institutional funding for general fund departments and campus-wide interfaces. This funding model has been used for previous campus interface development efforts.

Timing
A Peoplesoft technical impact initiative for the campus can commence late in fiscal year 2002-2003, but depends upon timing of the upgrade project, which is not decided at this time.
4.6 Web-based Services Infrastructure Strategy

Recommendation: Provide a high-performance, centralized web infrastructure for hosting and managing campus web-based content and services.

CU-Boulder should provide a robust, highly available, fault tolerant, central infrastructure to serve present and future web-based operations and develop solutions for web content management for campus departments, students, faculty, and staff.

Discussion of the Recommendation

Current Situation
CU-Boulder’s web-based infrastructure has grown without attention to comprehensive planning and strategic goals. There is limited campus-wide coordination of development and hosting of web projects. ITS currently provides minimal hardware, software and staffing for hosting institutional, student, faculty, and staff web pages and some departmental web applications. However, a significant number of campus web-based applications and static pages are developed and hosted within individual departments on an ad hoc basis without oversight or coordination. With the proliferation of web content and web-enabled applications, the campus is facing policy-level and technology-related challenges to optimize web-based services. The campus has experienced web service outages in recent months due to limited infrastructure fail-over capability. Increased variety and complexity of content, such as animation, sound, and streaming video in addition to current text files and increasing demands for more advanced website functionality cannot be met by the current campus web infrastructure.

Rationale
A consistent, comprehensive campus web infrastructure is a prerequisite for further development and deployment of campus web-based applications. As the primary source for campus information, web services must be reliable, robust, and always available. As an institutional asset, campus web content should be managed and controlled in a manner that ensures the integrity of the content creation process. In addition to providing browser-based content administration tools, version control, and workflow capability, a good content management solution separates the development and deployment environments employing at a minimum, two physical servers – one for development where content is created and structured, and one for deployment, from which content is served. A central web infrastructure, utilizing content management and available campus-wide, would provide a secure and efficient operating environment for developing and supporting campus web-based applications. Adopting a web content management strategy and common security processes would improve consistency and currency of campus web-based information; reduce web development costs; enable the implementation of campus-wide security services utilizing the campus’ Enterprise Directory; and realize benefits from standard practices, shared costs, and increased quality of data.

Specific Recommendations Include

- Restructure the current central web-based infrastructure to improve performance, improve fail-over capability, improve manageability of content, and enhance security.
- Fund the development and maintenance of central web-based services to provide robust production level capabilities and staffing to meet necessary service levels for current and future campus needs.
• Fund and implement web content management hardware and software for a phased implementation of campus-wide access and distributed administration of central web-based content.
• Develop a program of operational excellence for supporting web-based services to meet campus departmental business needs, ensure customer satisfaction, and achieve the results required for mission-critical web sites.

Steps

Implementation
• Review and analyze components of the current web-based services infrastructure to determine approaches for rationalizing and stabilizing the current hardware and software platforms, addressing security issues and web content issues, implementing web site monitoring, adopting management tools, and developing and implementing policies and procedures.
• Develop a phased implementation plan and deploy a flexible, robust, comprehensive central web-based infrastructure, utilizing standard reference architectures, to provide web hosting for the campus. Adopt an operational excellence approach to meet the desired level of service and support.
• Develop a forecast of web-based access demand for a central infrastructure for the next three years including known and pending web application deployments, departmental web sites, opportunities for consolidation of web infrastructure, and growth in demand for higher bandwidth web services such as multi-media content.
• Analyze campus content components, investigate various content management alternatives, develop an implementation plan, and deploy a campus-wide web content management solution.

Communication
Create a plan to communicate to the campus regarding the deployment of campus-wide web-based services. Solicit feedback from campus departmental web administrators from early planning through implementation.

Policy and Standards
Establish and implement policy and technical standards for web-based services encompassing mandatory and recommended practices, technical services, and content management. Policies and standards should reflect differing business needs and privacy and security requirements presented by separate web spaces such as public, student, departmental, and intra-campus.

Required Involvement

Governance and Authority
The Office of the Associate Vice Chancellor for Academic and Campus Technology.

Required Departmental Involvement & Responsibility
• ITS to design, implement, maintain, operate, and manage the central web-based services infrastructure.
• Web Communications to collaborate on web policy, best practices, selection, and deployment of web content management software and infrastructure design issues.
• Campus departments to collaborate on design, support requirements, web site monitoring and distributed content management.
• University Management Systems (UMS) to collaborate on design and content management issues.
• Committee on Electronic Communications to provide policy oversight.
• IT Council to provide guidance and programmatic direction.

**Expected Costs**

**Annual IT infrastructure Investment**

New costs

Infrastructure costs necessary to deploy a fully fault tolerant operating environment to ensure business continuity in the event of a disaster include: web server hardware and software, application server hardware and software, database hardware and software, network hardware and software and redundant power supplies. These costs are estimated to be $200,000 with annual costs estimated to be $40,000 per year.

Infrastructure costs necessary to create a production level central web service, provide the necessary content management capability and development platform include: web content management hardware and software, content development and staging hardware, and web site monitoring tools. These costs are estimated to be $250,000 with annual costs estimated to be $50,000 per year.

**Personnel**

New costs

Personnel for deploying, maintaining and supporting a production level central web service needs to be increased by two full-time employees (FTE), which will cost approximately $180,000 (including salaries, benefits, training, travel, etc).

**Funding**

Funding for creating a fully fault tolerant operating environment should be provided by general fund with re-allocation within ITS budget as necessary. Funding for web content management and central web production services will require a combination of general fund support for core services with recharge for specific departmental services as appropriate.

**Timing**

Development and deployment of a fault tolerant, fail-over campus web infrastructure should have high priority and begin early in 2002-2003. The development and deployment of web content management and central web production services should begin late in fiscal year 2002-2003.
4.7 Assistive Technology and Accessibility

Recommendation: Continue to provide access to assistive technology facilities and technology support for individuals with disabilities. Work to ensure the accessibility of all technology and information resources on campus.

Discussion of the Recommendation

Current Situation
Currently, students access assistive technology (AT) on campus at one of five satellite stations or at the central Assistive Technology Lab on the third floor of Willard. The AT Lab is operated and staffed by Disability Services (DS). Assistive technology satellite stations are jointly run by DS and ITS. Other labs on campus are minimally accessible (e.g., adjustable tables, operating system level accessibility tools, etc.). Support for the satellite stations is neither well coordinated nor provided by on-site ITS support staff or advisors, which often results in unnecessary downtime for the stations.

Disability Services and the AT lab provide some individualized assistance to students with disabilities, including a limited laptop loan program and some “help at home,” made possible by a special fund of money.

The Web Publishing Policy specifies “all electronic publications, to the extent feasible, must be made accessible to people with disabilities.” For several years, ITS and Disability Services have offered brown bag seminars on “Making Web Pages Accessible to People with Disabilities.” In 2001, the campus developed “Creating Accessible Web Pages,” a web site with resources and guidelines for campus web developers, and offered special workshops for IT staff that work with faculty. In addition, Web Communications is currently working with UMS to improve the accessibility of web registration. The new design of the CU-Boulder web site was developed to meet accessibility standards, and templates that meet the standards are available for web developers. As the new design is implemented, the percentage of accessible pages is increasing. However, much work remains to raise awareness among campus web developers and to improve the accessibility of campus information resources for people with disabilities.

Rationale
Through implementation of the recommendations below, the campus should take the next steps of integrating the satellite stations into the ITS support system and of integrating AT software into the labs on campus. The result would be significantly greater AT access for students with disabilities; improved repair and support of assistive technology on campus; and less duplication of effort by integrating AT into the existing ITS and ITS Support Center structure.

By implementing the recommendations below, the campus will ensure equitable access to its information and IT resources.

Specific Recommendations
CU-Boulder should continue to provide assistive technology facilities and support throughout the campus for individuals with disabilities both in the AT lab, as well as at existing satellite stations around campus. The AT Lab should work with ITS to develop and monitor standards for ensuring the accessibility of all labs. The campus should improve the support available to assistive technology satellite stations. The campus should continue to provide some individualized assistance to students with disabilities (e.g., laptop loans, etc.). The campus should expand
policies and develop communication plans to ensure the accessibility of campus information resources, such as web pages and web-based services.

Continue to fund and support the AT Lab and satellite stations (Disability Services [DS])
- Continue to provide dedicated space for student assistive technology stations in the AT Lab.
- Provide dedicated space for alternate formatting (e.g., brailling), preferably removed from the student workspace.
- Maintain the existing stand-alone adaptive stations in Norlin N310 and in Muenzinger and continue to assess usage statistics to determine need for these stations. Maintain three other satellite stations (Norlin Reference, Engineering, and Law).

Ensure accessibility of all labs (DS and ITS)
- Include AT software as part of the ITS loadset for ITS labs (e.g., screenreader, screen enlargement, and OCR/reading software for learning and visual disabilities).
- Continue the practice of adding at least one adjustable station in each ITS lab as labs are renovated.

Ensure that students have access to audio capabilities in all labs, through the long-term loan of headsets or short-term checkout of headsets in ITS labs with advisors.
- DS and ITS should work together to develop a procedure for accommodating students with disabilities in instructional facilities.
- Disability Services, the AT Lab, and ITS should work together to establish and communicate best practices for making departmental labs and classrooms accessible.
- DS and ITS should determine the best way to provide distributed scanning services to students with disabilities.
- DS and ITS should investigate and implement a method for making the IdentiKey prompt more user-friendly for vision-impaired users.

Improve support to satellite stations
- Integrate support of AT satellite stations into ITS 4-Tiered IT support model by:
  - Providing training to the ITS Service Center and Bug Buster advisors so they can provide broad support for existing adaptive satellite stations.
  - Integrating assistive technology support into ITS workflow system.
  - Making the AT Lab a Tier 4, core expert partner to handle escalated assistive technology cases.

Continue individualized assistance
- Continue and enhance the AT Lab loan of laptops with adaptive software to students with disabilities as needed.
- Explore the possibility of providing “help-at-home,” and work with other campus support services such as ResNet and the ITS Service Center to coordinate student support in residence halls or other locations.

Ensure accessibility of campus information resources
- Coordinate and expand efforts to provide training and resources on creating accessible web pages.
- Include accessibility in the criteria for evaluating upgrades to online student services and academic resources, such WebCT, the campus portal, SIS, and PeopleSoft.
- Initiate the development and implementation of an expanded web accessibility policy by preparing a Briefing for the Vice Chancellor for Student Affairs (as recommended by the Office of Diversity and Equity).
- Address resource needs (staff, training, and communication) as part of the briefing.
**Steps**

**Implementation**
- Obtain, test, and pilot adaptive software and keyserver technology in ITS lab loadsets.
- Develop a model for improving audio capabilities in ITS labs.
- Establish best practices for ITS and departmental labs.
- Monitor usage of satellite stations.
- Research models for distributed scanning services for students with disabilities.
- Develop a training program for ITS Advisors and help desk and implement.
- Develop a service level agreement between ITS and the AT Lab.

**Development of the Web Accessibility Briefing**
- Research applicable laws and accessibility policies at other universities.
- Assess the accessibility of campus web-based information resources
- Prepare a proposal for the CU-Boulder that includes:
  - Issues and opportunities.
  - Special needs for online student services and academic resources.
  - Definition of standards.
  - Resource needs: staff, training, and communication.
  - Proposed model for coordination with the UMS.
  - A proposed implementation plan.
  - Timeline and priorities for implementation.

**Required Involvement**

**Governance & Authority**
Office of the Associate Vice Chancellor for Academic and Campus Technology.

**Required Departmental Involvement & Responsibilities**
- **Disability Services**
  - Provide AT training for ITS Service Center.
  - Continue to work on AT Lab, Satellite stations, laptop loan program, and “help-at-home” possibilities.
  - Work with ITS on lab accessibility best practices, program for widespread AT software in ITS labs, audio accessibility in ITS labs, exploring distributed scanning services, and developing a procedure for accessibility accommodations.
- **ITS**
  - Work with DS on lab accessibility best practices, program for widespread AT software in ITS labs, audio accessibility in ITS labs, exploring distributed scanning services, and developing a procedure for accessibility accommodations.
  - Work to integrate the AT lab into ITS workflow system as a Tier 4 Core Expert in the field of IT accessibility, including an SLA between the groups.
- **Office of Diversity and Equity**
  - Provide leadership, coordination, and possibly funding for the development and communication of guidelines, policy, and training opportunities to ensure the accessibility of information and IT resources across campus, including web-based student services and academic resources.
- **University Communications**
  - In conjunction with the Office of Diversity and Equity and the Office of the Associate Vice Chancellor for Academic and Campus Technology, develop and
communicate guidelines, policy, and training opportunities to ensure the accessibility of information and information technology resources.

- Instructional Computing Working Group (ICWG) for discussions about ITS student-fee funded labs.

**Expected Costs**

**Annual IT Infrastructure Investment**
- Establishing AT software in ITS labs program
- KeyServer software for ITS labs: $18,250 (new cost)
- KeyServer hardware: $7,000 (new cost)
- AT software (10 licenses of each): $12,000 (new cost)
- Total one time costs: $37,250

**Operating and Maintenance**
- Annual maintenance cost of KeyServer software: $3,300 (new cost)
- Annual cost of replacement cycle for satellite stations: $1,500 (existing)
- Annual cost of headphone loan program: $500 (new cost)

**Personnel**
- 0.25-0.50 FTE for integration of AT software into ITS loadsets (new cost)
- 0.10–0.20 FTE AT-Lab costs for upgrading and servicing 5 Satellite stations (existing)

**Funding**

Funding for the continued operation and the renewal and replacement of satellite labs should come from ICWG funds as in previous years. The campus needs to look into alternate sources of funding for integration of AT software into ITS labs. Possible sources include ICWG as well as Disability Services or Office of Diversity and Equity.

Funding for the distributed AT software and headphone loan programs should be obtained from ICWG due to their availability in open student facilities.

Disability Services currently funds support for Satellite Stations and should continue to provide that support.

Funding for the .25 - .50 FTE for personnel for integration of AT software possibly could be absorbed by ITS.

The Web Accessibility Briefing will investigate further funding requirements.

**Timing**

- Begin integrating greater AT support into the campus IT support system with the goal of having Tier 3 AT support provided by ITS and Tier 4 AT support provided by DS by fall 2003.
- Develop a procedure for accommodating accessibility needs in ITS facilities by spring semester 2003.
- Develop and implement campus policies regarding information and information technology accessibility by fall of 2003.
- Begin work on widespread AT software availability in ITS computing facilities with a goal of a pilot program by spring semester 2003 and widespread use by fall semester 2003.
- Develop a plan for distributed scanning services for students by fall 2003 with an implementation goal of fall 2004.
- The Web Accessibility Briefing will be developed in fall 2002.
4.8 File Systems

Recommendation: Provide a robust, highly available campus-wide file storage, access, management, backup and retrieval system.

Discussion of the Recommendation

Current Situation
A wide variety of file storage systems exist on campus. Very limited storage, typically 5 – 20 MB, is available on centrally-provided servers for student, faculty, and staff web pages. Space is also available on central systems for departmental uses, though it is constrained by available capacity. Other central servers are available for limited multimedia applications and centrally provided email.

Computing lab workstations have no persistent storage available natively. Students in particular are highly mobile, using a variety of platforms both on- and off-campus. To have access to their electronic materials from anywhere, students must rely on removable media or email, neither of which can easily accommodate large quantities of data or facilitate sharing. Complex tools are required for all constituents to move files from local desktop or lab systems to central servers. Group collaboration can be challenging, with the need to understand file ownership and permissions and often relies upon insecure sharing of a group account. Backups of central systems are performed to recover from catastrophic failure but retrieving individual files is performed in an on-demand, fee-based manner and is awkward and slow.

Many departments have private servers but must invest considerable resources in both hardware and personnel to deliver security and availability. Other departments, due to lack of financial resources or sufficient technology proficiency, have no access to even basic file sharing and fallback on email and even floppy diskette transfer to exchange data.

Rationale
Supporting coursework, creative endeavors, and collaboration requires adequate data storage, typically far in excess of what is now routinely available. Capacity that is considered modest on an inexpensive desktop computer is still considered extravagant when provided centrally. Collaborative projects among and between students and faculty demand storage availability and tools to manage ownership, permissions and file transfer and to ensure version integrity is maintained between edit cycles. The lifecycle of storage must extend beyond semester boundaries as students accumulate coursework and faculty build portfolios. Highly mobile constituents should be able to use a public access kiosk, a computing lab workstation, or their own laptop or desktop workstation to gain easy access to their files.

Departments have both similar and different needs. Individuals need adequate capacity to store administrative data, though their capacity requirements are typically less than in the academic area. Like faculty and students, they need to collaborate electronically with colleagues using tools that facilitate file transfer as well as sharing functions such as ownership and permissions. Departmental needs differ in that they may also require substantial capacity for databases and archival of scanned text or workflow processing. Security of data may be a serious consideration for departments that have responsibility for secure or critical data.

No online system is effectively maintained unless backup procedures take into consideration needs for recovering from catastrophic loss as well as more routine unintended file deletion. Data of high importance should be backed up both on-site for easy retrieval and also stored in a remote location geographically separated from the primary storage facility.
Efficiencies may be realized when needs for storage across campus are considered in a comprehensive manner. Though storage needs and uses may be different, a network accessible file system infrastructure could provide high capacity and availability for typical applications such as web pages, databases, multimedia, and administrative data. However, certain segments of the campus community, such as Libraries with their impending massive digital library collections, may be outside the scope of a widespread storage solution.

Specific Recommendations Include

- Develop and deploy an institutional file system (IFS
  26) providing significant storage space to all students, faculty, and departments
  27; space will be accessible through designated central campus servers. The IFS should be compliant with campus authentication and authorization strategies.
- Implement platform-neutral
  28 methodology to enable users on all supported campus platforms to:
  - Easily transfer files between the desktop and IFS.
  - Specify individuals and groups who should have access.
- Ultimately implement a platform-independent
  29 web-based system to:
  - Transfer and manage files and ownership.
  - Enable project collaboration by controlling versions.
- Investigate the feasibility of providing centralized, user-controlled backup and retrieval services for the IFS. Consider extending the service to departmental servers.
- Leverage the knowledge gained in developing a campus-wide storage architecture to explore solutions for large scale initiatives such as Libraries’ digital collections.

Steps

Implementation

- Determine requirements for adequate storage space and features for students, faculty, and departments; requirements may be discipline- or departmental-specific.
- Acquire appropriate storage system and server infrastructure, including backup subsystems, to provide storage access to campus-supported platforms
  30 using campus standards-based authentication integrated with the Enterprise Directory.
- Further investigate web-based storage management tools to enable platform-independent shared access to files.
- Investigate solutions for institutional backup and retrieval systems that integrate with an institutional file system. Evaluate the feasibility of providing such services beyond the central IFS.
- Investigate web-based solutions to enable platform-independent versioning and content management.

Communication

- Partner with campus IT providers and support personnel to help them leverage a centrally provided IFS to better meet their constituents’ needs.
- Use appropriate channels such as campus web presence, constituent group meetings, ememos, and print advertising to communicate availability of services.

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26 IFS – Institutional File System.
27 Fee-based for departments.
28 Platform-neutral: same basic feature set available from supported computing platforms, though interface and advanced features may vary slightly from one to another.
29 Platform-independent: same user interface on any of the supported computing platforms.
30 Campus-supported platforms currently include Windows 98, NT, 2000; Macintosh OS 9 and X; Solaris; and soon will include FreeBSD and redhat linux.
Policy & Standards

- Develop guidelines and best practices for efficient and effective storage and sharing of files.
- Develop best practices for the management and backup of campus file servers.

Required Involvement

Governance & Authority
The Office of the Associate Vice Chancellor for Campus and Academic Technology.

Required Departmental Involvement & Responsibilities

- IT Council to provide guidance and programmatic direction.
- ITS to develop and promote best practices in cooperation with departmental file server providers.
- ITS to design, maintain, operate and manage the central IFS.
- ITS to partner with faculty and academic technology representatives and coordinators to develop tools and methods for file sharing.
- ITS and Student leadership to assess needs and develop training and usage strategies.

Expected Costs

Annual IT Infrastructure Investment

Costs include hardware and software needed to deploy a fault tolerant operating environment, including the central IFS, basic backup subsystems, redundant power environment, and software. Additional costs will be incurred to provide redundancy of file arrays, network switches, network file server; and further costs will be incurred for an automated backup/retrieval system.

One-time costs:

- Implement the basic infrastructure of storage arrays and platform-neutral file servers to create a central IFS. Include a basic backup subsystem and configure with capacity to provide disk capacity of 100 MB/individual for students (assume 26,000 FTE) and 100 MB/individual for faculty/instructors (assume 2000 FTE) - $330,000 plus $100,000 for basic backup capability.
- Provide disk capacity for departmental use with costs fully recovered through fee for service - $100,000 for 1,000 GB (1 TB).
- Expand disk capacity as demand warrants - $100,000 for 1,000 GB (1 TB).
- Enhance infrastructure by adding additional redundancy of fiber switches and network file servers - $300,000.
- Develop and implement a web-based file access solution with versioning and content management – costs cannot be estimated at this time.

Operating and Maintenance

On-going costs:
Renewal and replacement should be budgeted at 25%/year (4 year replacement cycle). Hardware/software maintenance is budgeted at 10%/year and small capital improvements are budgeted at 10%/year.

- Disk capacity for departments (costs recovered through fees) - $45,000/year.
Cost savings:
Departments that choose to use centralized file systems instead of providing their own server could realize annual savings of $7,000 – 20,000/year currently expended on hardware and software acquisition, renewal and replacement, and maintenance. Personnel savings of 0.2 FTE per server could also be realized.

Personnel
- Design and implementation of basic infrastructure – 0.5 FTE for two months. Existing within ITS.
- Design and implementation of automated backup and retrieval system – 0.5 FTE for four months. Existing within ITS.
- Investigation of web-based versioning and content management systems – 0.5 FTE for two months. Existing within ITS.

Funding
Basic infrastructure:
- Use a one-time reallocation of student computing fee to pay for the basic infrastructure serving students and faculty - $16.50/student (assume 26,000 students).
- Continuing reallocation of student fee to fund on-going costs - $3.75/semester/student.

Departmental file services:
- Perform cost analysis, provide on at-cost basis. Expect fees of approximately $120/year/200 MB.

Timing
A basic institutional file system with 100 MB of storage for all students should be deployed for spring Semester 2003. Capacity for faculty early adopters should be part of the initial deployment for spring Semester 2003. As usage grows, additional capacity for faculty and student use and collaboration should be added along with enhanced redundancy. A pilot service to provide file services for departments should be implemented in CY 2003 and expanded in scope as the service is developed. Web versioning and content management should be explored in AY 2002-2003 with target implementation of fall Semester 2003.
4.9 Application Standards and Best Practices

Recommendation: Provide application development guidelines, best practices, and technical review process for campus administrative systems initiatives.

Develop baseline campus technical standards for the purchase and/or “in-house” development of administrative computer applications. Develop, publish, and keep current “best practices” for the purchase and/or development and integration of campus applications with core campus technical architecture and maintenance and support of deployed applications. Establish a centralized review process to ensure adherence of campus application initiatives with campus best practices and technical guidelines. Create a web-based application certification process for publishing and hosting web applications through the campus’ institutional web sites.

Discussion of the Recommendation

Current Situation
The development and implementation of campus administrative systems and web-based applications is being done in an uncoordinated, inconsistent manner without benefit of technical oversight to ensure compliance with the campus technical infrastructure or well established best practices for software development. Because there is no unifying technical development oversight and coordination, campus departments may not utilize a systems development methodology to define and understand requirements before acquiring or developing applications. Departments may rely solely on advice from software vendors for purchasing software or departmental staff for in-house development to address complex technical issues without campus assistance. Without guidelines, issues such as integration with central and campus systems, authentication and authorization, directory services integration, database requirements, data conversion, software licensing, privacy, and legal liability may not be adequately addressed. Software applications developed and implemented in this environment cost more to implement, maintain, and support than software that has been developed using standard development methodology and completed systems often fail to meet campus’ technical requirements.

Rationale
Campus application developers and technical staff can benefit from the use of common standardized technical approaches, guidelines, and best practices for application development. Development costs can be reduced, applications can better interoperate and integrate with the campus infrastructure, data quality, and security can be improved and common development techniques can be shared across campus. Implementation, presently underway by the campus, of an Enterprise Directory services infrastructure and recent campus security initiatives provide an important technical foundation that should be leveraged to unify future campus application development efforts. The deployment of a web-based portal infrastructure is under consideration and if implemented will require that standard development techniques be used to certify that web-application or content to be presented or published, through the portal, meet technical requirements.
Specific Recommendations Include

- Develop and publish a set of technical guidelines, best practices, and policies to ensure that adequate systems development methodologies are employed in the acquisition or development of campus administrative applications.
- Develop and publish a set of technical guidelines, best practices and policies for the utilization of campus-wide directory services, authentication and authorization, database standards and data administration to ensure that campus technical development and integration requirements can be met by departmental administrative applications.
- Develop and implement a technical review process to encourage compliance with guidelines, best practices and policies for administrative application acquisition and/or development.

Steps

Implementation

- Create a campus-wide core technical team and process for defining and maintaining an administrative application development methodology, technical guidelines, best practices and policy recommendations.
- Create and fund a plan for the implementation of application development platform and tool standards.
- Create and fund an application integration position within ITS to provide campus-wide integration and coordination between departmental applications and campus technical infrastructure.
- Establish and fund a campus-wide administrative application review process.

Communication

Create and fund a plan to communicate to the campus regarding technical guidelines, best practices, policies and processes.

Policy and Standards

- Create a policy to ensure that administrative systems and applications acquired or developed meet departmental functional requirements and comply with campus technical infrastructure requirements.
- Establish technical standards for application development and integration.

Required Involvement

Governance and Authority

The Office of the Associate Vice Chancellor for Academic and Campus Technology and the IT Council. Policies and standards will be brought before the IT Council and the voting members will be responsible for reviewing proposed standards.

Required Departmental Involvement and Responsibility

- Campus departments as IT providers to provide technical collaboration and consulting in defining and developing guidelines and to adopt resulting guidelines, processes and standards.
- ITS to provide technical leadership, collaboration and consulting in the development and maintenance of guidelines, policies, processes and standards.
**Expected Costs**

**Annual IT Infrastructure Investment (new)**
Infrastructure costs include acquisition and deployment of campus-wide standard application development platforms and tools. These costs are estimated to be $120,000 with annual costs estimated to be $20,000.

**Personnel (new)**

Personnel for project management, departmental liaison, application review process administration and application platform administration needs to increase by 1 full-time employee (FTE), which will cost approximately $90,000 annually.

**Funding**
This should be provided as a core campus service funded by institutional funding for acquiring, deploying, and supporting standard application platforms and tools, and creating and administering applications standards and a review process.

**Timing**
The initiative should begin early in fiscal year 2002-2003.
4.10 Four-Tier Support Model

Recommendation: Provide best-in-class IT support to the campus community through the Four-Tier Support Model.

The Four Tier Support Model is an effective model for providing IT support to the CU-Boulder campus and in the next four years we should continue to 1) move support even closer to the customer and 2) strengthen the internal infrastructure within the Four Tier Support Model.

Discussion of the Recommendation

Current Situation
The elements of the Four-Tier Support Model: communication, training, self help, distributed, centralized, and core experts, are deployed and have been adopted by the campus at large as the appropriate structure through which IT Support is delivered. The distributed or second tier of the Four-Tier Support Model comprises in-house IT support staff in each campus department and provides a vital mechanism for communication and service integration between ITS and all units on campus. Although deployed, the quality and quantity of IT support delivered through the elements of the model can be improved through refinement of communication and by moving the delivery of support as close as is practical to the customer.

Rationale
As the campus grows and becomes increasingly dependent upon IT resources, so also grows the demand for fast, efficient and robust IT support. In order to meet this demand with best-in-class IT support, the delivery of that support must be easy to find, easy to use, and must leverage the entire support community of ITS and departmental staff.

Specific Recommendations for Item 1) Include
- Develop Educational Technology Facilities Support (ETFS) for classrooms, labs, team rooms and assistive technology stations.
- Leverage the success of the Tier 2 program by further developing liaison relationships within departments for educational technology facilities and web resources.
- Continue to move support closer to the end-user by dedicating Desktop Support resources to the schools and colleges.
- Develop IT support teams within the schools and colleges consisting of Distributed Academic Technology Coordinators, Desktop Support Technicians, and Educational Technology Facility Support Technicians. These teams will work alongside the existing Tier 2 resources in each area.
- Expand and improve Tier 1 self help to be a more effective resource for ITS and our customers through a dedicated Tier 1 web support position, a natural language searchable knowledgebase, Frequently Asked Questions for all products and services, and the addition of a dedicated knowledge management position.
- Establish a fee-based Server Administration Service for non-UNIX (Windows and Apple) platforms.
- Increase and improve communication both internal and external to the support model.
Specific Recommendations for Item 2) Include

- Review Clarify as a workflow tool, ensure renewal and replacement costs for a workflow tool, and manage the expectations of what any workflow tool can provide to customers both internal and external to ITS.
- Improve reporting and trend analysis on data collected through the support model.
- Advertise and promote training that already exists and new training opportunities as they are developed. This includes creating a Faculty/Staff Trainer position within ITS to provide a delivery mechanism to the faculty and staff, to improve existing training materials, and to develop new training curriculums.

Steps

Implementation

- Recommendation 1) will require: Combine the resources of the existing Classroom Support, Site Support and Lab Advising programs and redistribute these resources into the schools and colleges to provide Educational Technology Facilities Support. Continue to build relationships with departments by establishing Tier 2 entities for educational technology facilities, web resources and hiring a Telecommunications Liaison Coordinator. Fund, hire and/or purchase a Tier 1 web resources manager, a web content management tool, a knowledgebase manager, and a natural language searchable knowledgebase. Establish an auxiliary or add to an existing auxiliary to provide server administration services on a self-funded basis.
- Recommendation 2) will require: Establish funding for the renewal and replacement of the workflow tool and then reevaluate the workflow products available and the option of writing a custom application. Improve data collection opportunities, provide trend analysis, and distribute this information throughout the support community. Fund and hire a faculty and staff trainer and more heavily promote new and existing training opportunities. Fund and hire a position to support the use of database applications by the faculty in their research and in their curriculums.

Required Involvement

Governance & Authority

ITS is the owner for both recommendations in this initiative.

Required Departmental Involvement & Responsibilities

- ITS to provide leadership, direction, and communication for all elements of the Four-Tier Support Model.
- Schools, Colleges, and Departments to provide guidance on their IT support needs, input to the IT support teams serving their customers, supervision of Tier 2 personnel, funding as a partner on appropriate initiatives, and feedback on the support process to ensure that Four-Tier Support Model is achieving the greatest efficiency possible.

Expected Costs

Annual IT Infrastructure Investment

- Workflow tool replacement (existing) - $350,000
- Natural language searchable knowledgebase (new) - $75,000
- Web Content Management tool (new) - $35,000

Operating and Maintenance

- Workflow tool renewal (existing) - $70,000
- Natural language searchable knowledgebase (new) - $15,000
• Web Content Management (new) - $7,000
  Operating and Training funds for five new personnel (new) - $30,000

**Personnel**

• Web Resources Manager (new) – Programmer Analyst I - $52,000
• Faculty and Staff Trainer (new) – IT Professional I - $52,000
• Database Application Support (new) – IT Professional III - $62,000
• Knowledgebase Manager (new) – IT Professional I - $52,000
• Communications Liaison Coordinator (new) – General Professional III - $48,000

**Funding**

Funding will include a combination of 1) the redistribution of existing ITS resources; 2) contributions on a one-to-one ratio by schools/colleges and ITS to the deployment of the Desktop Support Technicians; 3) development of for fee services such as server administration support; 4) an internal ITS recharge mechanism for establishing a fund for the renewal and replacement costs of the workflow tool; and 5) requesting continuing funds for purchasing a knowledgebase, purchasing a web content management tool and for staff positions that are not reallocated from existing resources.

**Timing**

Enhancements to the Four-Tier Support Model are in progress and will continue to be pursued through the life of the IT Strategic Plan.
Chapter 5: Leadership, Coordination, and Governance of IT

CU-Boulder’s IT environment is characterized by complex layers of central and distributed services, support, and leadership. This chapter includes recommendations for clarifying central and departmental roles in the provision of services and support, and for clarifying and increasing participation in IT leadership and governance.

To the end of increased reliability and stability of IT resources, recommendations in this chapter call for greater centralized authority for certain aspects of the campus’s IT environment (including security and cross-campus use of the Enterprise Directory). To the end of increased efficiency and decreased duplication of services, other recommendations call for greater centralized coordination in areas such as wireless deployments and e-payment solutions. Concurrent with the implementation of these recommendations, the campus needs to ensure the autonomy of departments and their ability to customize services to meet their specific needs. Continuing to develop a model of distributed desktop support is one way to achieve this.

This balance between cross-campus concerns and departmental autonomy is possible only in a culture that supports effective, broad collaboration and cooperation. To promote such a culture, recommendations call for broader and deeper input and increased participation, particularly by faculty, in strategic and tactical oversight of IT initiatives and management of the campus’s IT environment. Recommendations also call for increased communication, which is crucial to the development of a collaborative culture, and which also facilitates successful implementation of cross-campus IT initiatives and the continued provision of a comprehensive suite of IT resources.
5.1 Centralized Coordination and Management of IT

Recommendation: Specific aspects of IT on the CU-Boulder campus should be coordinated centrally to best achieve efficiency and to decrease duplication. These aspects include wireless deployment, a security infrastructure, and maintenance of DNS/DHCP servers. Other aspects of IT, such as the Enterprise Directory, server hardware registration, and software compliance, should be managed centrally to ensure that campus-wide standards are maintained for reliability and stability of the campus IT infrastructure. To achieve this, the campus should determine, prioritize, communicate, and enforce which areas need centralized coordination and which need to be managed centrally.

Discussion of the Recommendation

Current Situation
As in many higher education institutions, the computing and network resources at CU-Boulder have evolved into a complex, layered, and in some cases, duplicated IT environment. Several units on campus (such as Financial Aid, the University Memorial Center, Housing, JILA, LASP, CIRES, CLIPR, Computer Science, Physics, and Aerospace Engineering) maintain their own IT staff and services. Now, with increasing costs and concerns for security, the campus is clarifying what IT services need to be centrally coordinated, as well as what aspects of academic and campus computing need centralized oversight to maintain the reliability and stability of the campus IT infrastructure.

Rationale
While customization and autonomy of many aspects of IT in particular departments continues to be desirable, three forces are motivating a campus-wide discussion regarding coordination and/or centralization of a basic set of IT services: 1) the need for efficiency, given the current fiscal constraints; 2) the increasing interconnectedness between IT resources, which create potential vulnerabilities for the entire campus; and 3) the need for compliance in the areas of software licensing and library subscription services.

Due to increasing IT costs (and decreasing support from the State), a strong need exists to have efficient utilization of IT resources. For example, an opportunity for this exists with file storage systems. A wide variety of file storage systems are available on campus but their use is often constrained by available capacity, financial limitations, and technical proficiency. Faculty, students and staff are increasingly mobile, requiring tools to easily move files from a local desktop or lab systems to central servers. A centralized, campus-wide solution would provide a needed file sharing service to faculty, students, and staff.

Another opportunity exists with credit card payments, which are widely accepted on campus as a means of payment. Formal policies, guidelines, and/or best practices are not established, widely disseminated, and/or not routinely followed. Coordinating this initiative would provide stability and consistency across campus.

Increasingly, any IT resource on campus has the potential to negatively impact a wide variety of other IT resources on- and off-campus; therefore security is another salient area on campus potentially needing increased coordination and centralization. Because an increased reliance on IT as part of the university’s business and academic communications infrastructure continues to
grow, a security infrastructure should be developed to ensure the integrity and stability of the IT infrastructure.

A final area where increasing coordination and centralization might be needed is with software compliance. External vendors are demanding that higher education institutions better track their computing and software licenses. As external vendors continue to develop better tools to track their licenses, the CU-Boulder campus will need to respond with increasing vigilance over their software agreements and licenses.

**Specific Recommendations Include**

Authority for the following areas should be centralized or be centrally coordinated. The items are categorized into three areas: efficient utilization of resources, security, and compliance.

**Efficient Utilization of Resources**

What should be centralized:

1. Continued development of the **Enterprise Directory** and an IT Service Provisioning Infrastructure. ITS, along with a campus-wide Directories Steering Committee currently has centralized authority over the Enterprise Directory. The IT Service Provisioning Infrastructure is being developed by ITS; however, no clear understanding exists of who has governance over this infrastructure.

2. **Centralized server (hardware) registration**. Currently there is no centralized server registration on campus. Centrally coordinating server hardware registration is necessary to maintain and track what services specific servers are providing. This is an important step in developing a campus-wide network security plan. Also, the server hardware registration ties an identity to a specific hardware address, which enables troubleshooting relating to continued operations and security.

3. **Networking Services**. Voice and Backbone networking services must continue to be centralized to ensure economies of scale and manageability. These critical campus services are most efficiently provided centrally, by ITS.

What should be coordinated:

4. **Wireless deployment**. In 2002, a IT policy was approved by IT Council to grant authority to ITS to coordinate and regulate wireless deployment on campus. Wireless access allows campus spaces including common areas, classrooms facilities, and labs to be “smart.” Coordination is critical because wireless networks are being installed at an ever-increasing rate. If this process isn’t managed, competing signals will degrade the overall performance of the wireless network, jeopardizing wireless signals for everyone. Recognition of ITS’s centralized authority to coordinate wireless would ensure stability and reliability of the campus wireless environment.

5. **Setting minimum standards for servers**. Currently this is not happening on campus. Providing and coordinating a minimum standard for all campus servers by ITS would ensure

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31 The Enterprise Directory is a general-purpose service, usable by a variety of campus constituencies; however, for it to be a trusted, reliable source of information, a single unit on campus must have ownership and responsibility of it. The primary advantage of the Enterprise Directory is to tie together independent applications (such as SIS, HR, PeopleSoft) and enable relationships as well as resolve discrepancies between these applications. Other advantages include the ability to enable campus-wide calendaring, authentication & authorization, identity management, access management, and account management. To manage privileges granted to individuals, the campus computer and network infrastructure needs to identify who individuals are when they login (identity management), verify that individuals are who they say they are (authentication), and grant individuals access to the privileges they need (access management/authorization). See section 3.2, Enterprise Directory Services.
that all servers will have a certain amount of security built into them, and allows for more efficient central support management.

6. Coordination of Domain Name Servers (DNS) and Dynamic Host Configuring Protocol (DHCP). Currently this is not happening on campus. Centrally coordinating IP addresses would significantly decrease individual manual work done by local administration support; decrease duplication of IP addresses; and ensure a www.colorado.edu scalable mapping scheme. Providing centralized authority for DNS and DHCP would provide greater efficiency by freeing local administrators from this administrative task to provide more specialized local support.

7. Coordination of e-payments. While e-payments are an accepted means of payment on campus, formal policies, guidelines, and/or best practices do not uniformly exist. Coordination of e-payments would provide stability and consistency across campus.

8. Development and coordination of a campus-wide file storage system. Currently, this is not happening on campus. While a wide variety of departmentally owned file storage systems exist on campus, there is not a centralized, coordinated repository for electronic data. Faculty, students and staff are increasingly mobile, requiring tools to easily move files from a local desktop or lab systems to central servers. A centralized, campus-wide solution would provide a needed file sharing service to faculty, students, and staff.

**Security**

What should be centralized:

1. Develop and coordinate an IT communication infrastructure that responds to specific IT related issues. Currently an IT incident response system does not exist on campus. For example, if a computer virus or trojan worm successfully infiltrates the campus, a campus-wide plan on how to best communicate the problem and the anticipated resolution to the campus does not exist. An incident response system would give the campus a reliable conduit to communicate in the event of an emergency or in a situation that specifically and significantly jeopardizes the campus computer and networking infrastructure.

2. Mandate email filtering. Currently this is not uniformly happening on campus and poses a significant security risk. Email filtering prevents “worms” from infiltrating an email system, wiping out email, data, and spreading to other user’s computers. Similar to antivirus protection, email filtering is particularly important because of an increased proliferation of worms, which presents a higher risk to the campus.

What should be coordinated:

3. Maintain and provide antivirus protection. This is happening on campus in a varied and inconsistent way. Centrally coordinating antivirus protection on campus minimizes successful attacks on campus that could lead to loss of data and disruption of computing and network resources. Coordinating antivirus protection is important because of a large increase in number of viruses attacking the campus. Individual academic or research departments would be less likely to be protected against virus threats if no centralized coordination continues.
Compliance

What should be centralized:

1. Ensure compliance with **software licensing**. Currently ITS is only able to track software licenses within ITS. External vendors, such as Microsoft, are demanding that higher education institutions better track their computing and software licenses. These external vendors have better tools to track computing and software licenses than existed in the past. Negligence on the part of the campus could translate into litigation for the university. A centralized authority could provide effective oversight rather than relying on individual departments to track and manage their license agreements.

2. **Compliance Review of campus-wide IT policies.** The Office of the Associate Vice Chancellor for Academic and Campus Technology (AVCAST) was established in 1998 and has enforcement authority over IT policies. The AVCAST Office has implemented policies but historically has not played an authoritative role. Now, the complexity and the interdependence of the campus computing and network infrastructure increasingly ties together everyone on campus and necessitates compliance with accepted campus-wide IT policies, guidelines, and processes. In the near future, the AVCAST Office might need to play a more active role in the enforcement of campus-wide policies, practices, and standards that have been developed by campus-wide constituencies in order to maintain the security and reliability of CU-Boulder’s computing and network resources.

Steps

Implementation

- Research, develop, and implement tools and processes to allow for DNS, DHCP coordination; wireless registration; and minimum standards for servers (see specific recommendation in section 3.1, Wireless).
- Continue working on the Enterprise Directory and IT Service Provisioning Infrastructure and solidify the steering committee and governance infrastructure for the IT Service Provisioning Infrastructure (see specific recommendation in sections 3.2, Enterprise Directory and 3.3, IT Service Provisioning Infrastructure).
- Support security initiatives on campus to develop an antivirus protection solution and email filtering. Develop an incident response system to communicate to the campus in the event of an IT-related emergency (see specific recommendation in section 4.2, Security).
- Develop, communicate, and enforce a server (hardware) registration process as well as a campus-wide software licensing policy.
- Continue to develop appropriate campus-wide IT policies as needed. Explore strategies for communication, acceptance, and enforcement of such policies.

Communication

A comprehensive communication plan will be developed to outline the suggested changes and solicit campus-wide involvement.

Policy & Standards

- Development of campus-wide antivirus and email filtering policies.
- Outline standards for minimum server requirements.
- Develop standards for centralized server (hardware) registration.
- Develop a campus-wide policy for software licensing.
**Required Involvement**

**Governance & Authority**
ITS will have operational responsibility for these initiatives with oversight provided by The Office of Academic and Campus Technology.

**Required Departmental Involvement & Responsibilities**
- AVCACT for policy development and oversight.
- ITS for centralized operations support.

**Expected Costs**
No additional costs are expected from these recommendations, but rather significant campus coordination.

**Annual IT Infrastructure Investment**
See specific infrastructure investment sections in other areas of this report (e.g. Enterprise Services, ITSPI, Security, and Wireless.)

**Operating and Maintenance**
Not applicable.

**Personnel**
Not applicable.

**Funding**
See specific funding sections in other areas of this report (e.g. Enterprise Services, ITSPI, Security, and Wireless.)

**Timing**
Immediately – fall 2002.
5.2 Management, Leadership, and Advisory Structures for IT

Recommendation: The CU-Boulder campus should re-configure the existing IT leadership and advisory body (IT Council) to reflect the complexity of the campus’s IT environment, and the need for increased participation by and communication with a wide array of campus constituents. The campus also should assess the roles, responsibilities, overlap, and effectiveness of the wide range of other committees addressing IT issues. The roles and responsibilities of the Office of the Associate Vice Chancellor for Academic and Campus Technology with respect to campus IT management and leadership should be clarified and communicated to the entire campus.

Discussion of the Recommendation

Current Situation
The complexity of CU-Boulder’s IT environment is evident in the diversity and number of units and staff providing IT services and support across campus. That environment can be characterized as one that supports cross-campus collaboration on many IT issues, but also as one that needs improved coordination and communication. Successful collaboration by multiple units on campus-wide initiatives such as the Enterprise Directory, for example, stands in sharp contrast to instances in which multiple units provide similar or even duplicated services—such as educational technology support—with little communication among each other, and no coordinated communication to the constituents who use their services. It is an environment that increasingly needs effective, well-coordinated management, leadership, and advisory structures that are broadly representative, and engaged in providing both strategic and tactical direction for the entire campus. A description of the current structures follows.

- The Office of the Associate Vice Chancellor for Academic and Campus Technology (AVCAct) oversees campus-wide IT initiatives—including both academic and administrative initiatives. Staff in this office work closely with ITS on policy development, planning, and communication, and also function as support staff for ATLAS (the Alliance for Teaching, Learning, and Society) and other academic IT initiatives.

- The Executive Director of ITS reports to the AVCAct. Because it provides a broad array of services to the entire campus, ITS also implicitly and explicitly provides direction for IT on the CU-Boulder campus.

- CU-Boulder's IT Council, which is managed by the Office of the AVC of Academic and Campus Technology, comprises representatives from central units on campus, as well as faculty, student, and staff representatives. The Council meets roughly twice a month to fulfill its charge to:
  - provide strategic leadership, coordination and guidance concerning campus-wide IT initiatives and vision;
  - provide high-level management—policy, budgetary, and organizational—recommendations related to campus-wide IT issues; and to
  - provide communication and advocacy for IT initiatives.

- In addition to IT Council, the campus also has many other committees that address IT issues. Membership within and across these committees is varied in level; topics addressed by these committees are likewise a mix of strategic and tactical issues. In
addition to these more strategically-oriented groups (such as the Committee on Electronic Communication), there are committees focused on specific, ongoing issues (e.g., the ICWG [Instructional Computing Working Group], which oversees student computer fee funded labs), and ad hoc committees focused on short-term initiatives (such as Educational Technology Strategic Planning committees). There is some membership and some topic overlap between campus IT committees.

Overall Recommendation:

Based on feedback from campus focus groups, a survey of IT Council members, and discussions at IT Council, the campus should consider re-configuring its IT oversight structure to provide broader, and deeper input into decisions about the campus’s IT environment and its development, and about IT communication and policy enforcement issues. There is a need for greater faculty participation in strategic IT work, and, to the end of better communication and broader campus involvement, a need to have cross-representation on IT advisory and leadership structures with other existing groups on campus, such as the BFA, ASC (Arts and Sciences Council), UCSU, and UGGS. There needs to be a distinction between advisory and oversight bodies that provide strategic oversight and those that provide tactical oversight.

Based on feedback from campus focus groups, the Office of the AVC ACT needs to continue to provide strategic direction of IT on campus and oversight of IT initiatives. It also should take on a coordinating function in the area of educational technology.

Specific Recommendations Include:

- Streamline the membership of IT Council, and supplement the Council with (FACE-IT: Faculty Advisory Committee for IT), administrative, and student IT advisory bodies. IT Council would retain faculty, student, and staff representation. Structure the four committees to include standing ex officio members who act as technical experts. Delineate between the strategic oversight of the IT Council, and the strategic/tactical oversight of the other three committees. The faculty advisory group will likely focus on educational technology issues—including support, facilities, and I/IT Literacy and Fluency; the administrative advisory group will likely focus on business process re-engineering and other administrative IT issues; and the student group on both undergraduate and graduate student issues related to IT. Nonetheless, there will be overlap between the topics that the groups might address, because each will be concerned with infrastructure issues that impact both academic and administrative functions on campus. To foster the effectiveness of the committees, there will be cross-representation on all.

- Assess the roles, responsibilities, overlap, and effectiveness of committees addressing IT issues.

- Clarify and communicate the roles and responsibilities of the Office of the AVC ACT.

Steps

Implementation

All aspects of the implementation assume broad campus participation, input, and communication.

- Develop plans for establishing FACE-IT and administrative advisory body; and for the reconfiguration of the IT Council.

- Clarify functions of AVC ACT office, make staffing recommendations, and complete both AVC ACT website and communication plan.
• Develop primer for IT on campus that clarifies roles of ITC, FACE-IT, administrative IT body, student IT body, and the Office of the AVCACT. Online and hard copy should be distributed to new (and existing) administrators as part of communication plan. Develop orientation for new (and existing) members of all IT advisory bodies.

Required Involvement

Governance & Authority
The Office of the AVC for Academic and Campus Technology and the Office of the Provost will provide oversight of the Office of the AVCACT.

Required Departmental Involvement & Responsibilities
Campus-wide involvement is needed for successful implementation of changes in IT leadership and advisory bodies, and in Office of the AVCACT.

Expected Costs

IT Leadership Bodies
Current operating expenses for IT Council ($7500 per year) are enough for IT Council and any new IT leadership and advisory bodies.

AVCACT
A potential need exists for additional staffing to expand the role of the AVCACT office to include greater coordination with other campuses and system office, and to include a larger role in educational technology. The coordination of educational technology will necessitate at least a .5 FTE faculty associate.

Funding
Funding would come from the AVCACT GF budget.

Timing
• Fall 2002: develop plans for reconfiguring ITC and the Office of the AVCACT; develop communication plans and website.
• Fall 2002: solicit input about plans from current ITC and campus groups such as UCSU, BFA, Staff Council, CEC, Council of Deans.
• Fall 2002: Initial meetings of FACE-IT.
• Spring 2003: Newly configured ITC begins meeting; administrative IT and student IT advisory bodies begin meeting.
## Evaluation Matrix

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<tr>
<th>Intended Impact</th>
<th>Possible Performance Measures &amp; Methods</th>
<th>Assessment Timeline</th>
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<td><strong>Establish a well-communicated and coordinated educational technology support model</strong> for instructional design and advanced technological and pedagogical innovation, as well as for course content and course management and organization.</td>
<td>Faculty will have high quality educational technology support when and where they need it.</td>
<td>Survey faculty and students regarding the effectiveness of the support model; conduct focus groups with the DACTS; and benchmark with comparable schools.</td>
</tr>
<tr>
<td><strong>Establish campus-wide goals and programs for information and information technology (I/IT) literacy</strong> for students, and facilitate the creation of goals for discipline-specific I/IT fluency.</td>
<td>Students will possess appropriate competencies in I/IT literacy and fluency.</td>
<td>Survey faculty &amp; students regarding learning impact; survey alumni regarding the usefulness of the I/IT initiative after graduating; evaluate overall impact; and benchmark w/comparable schools.</td>
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<td><strong>Provide well-coordinated and broad support and services for digital media and videoconferencing.</strong></td>
<td>Uses of and services for digital media and videoconferencing will effectively support the academic mission.</td>
<td>Survey faculty and staff regarding quality and usefulness of services and benchmark w/comparable schools.</td>
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<td><strong>Develop an effective scheduling process for, improve support to, and upgrade existing technology-enhanced instructional facilities.</strong></td>
<td>Instructional facilities will be scheduled, equipped, and supported effectively to support faculty use of educational technology in the classroom.</td>
<td>Survey faculty and students regarding effective use of technology classrooms; gather performance measures regarding scheduling; and benchmark w/comparable schools.</td>
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<td><strong>Develop a robust, unified, and supportable web-based learning management system infrastructure capable of supporting every course at CU-Boulder.</strong></td>
<td>Use of LMS tools will enhance the teaching/learning experience.</td>
<td>Survey faculty and students regarding how the LMS has affected the learning experience.</td>
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Provide excellent, unified **web-based student services** that are tailored to individuals based on their affiliation with CU-Boulder, in short, a **campus student portal**.

Continue to develop the **Enterprise Directory** and Directory Services, and create the underlying campus-wide **IT service provisioning infrastructure** to address account maintenance processes, naming protocols, identity, authentication and authorization.

Address **IT security issues**, including network and data integrity and reliability, and proactive IT security management.

Provide enhanced and new **email services** to all faculty, staff, and students.

**Centrally coordinate** specific aspects of IT to achieve efficiency and decrease duplication (e.g., wireless, security); **establish centralized authority** for other aspects to achieve reliability and stability of the campus IT infrastructure (e.g., Enterprise Directory, software licensing); continue to **distribute responsibility** for some departmental-specific IT services (e.g., desktop support, departmental-specific applications).

**Communicate** IT resources availability, policies and guidelines, and the roles and responsibilities of the Office of the Associate Vice Chancellor for Academic and Campus Technology and of IT advisory bodies to the entire campus.

| **Students will have easy access to a wide range of student academic and transaction-based services.** | **Survey students regarding performance and usability of a portal and conduct student focus groups.** | Review in May 2003 & 05 |
| **The campus will have a trusted source of directory data to build a provisioning infrastructure that enables campus users to facilitate a variety of technology interactions.** | **Survey all campus affiliates and gather benchmarks regarding the ease-of-use and effectiveness of an Enterprise Directory and IT Service Provisioning Infrastructure.** | Review in May 2003 & 05 |
| **Network and computing resources will be protected by appropriate security practices and policies.** | **Assess security effectiveness through the use of incident reports and other appropriate measures. Survey faculty, staff, and students regarding the balance of security with the ease-of-use of campus computing and network resources.** | Review yearly |
| **Email services will support effective and efficient campus communications.** | **Survey faculty and staff regarding email performance and user expectations.** | Review in fall 2003 |
| **Collective IT resources will be appropriately balanced between a combination of distributed and central services.** | **Survey faculty, students, and staff specifically on the effectiveness of key initiatives to determine effectiveness of centralization or decentralization.** | Review yearly |
| **IT leadership will communicate IT policies, guidelines, and initiatives effectively to the entire campus.** | **Survey faculty, staff, and students about knowledge and understanding of IT issues and evaluate the website.** | Review yearly |
**Re-configure the existing IT leadership and advisory body (IT Council) to reflect the complexity of the campus’s IT environment, and the need for increased participation by and communication with a wide array of campus constituents by establishing faculty, administrative, and student advisory committees for IT.**

**Effective and well-balanced governance and advisory bodies will guide campus IT decisions.**

**Conduct self-evaluations by the groups at an intermediate stage (2003) and evaluate during the next ITSP process for effectiveness.**

Spring 2005
### Financials – Top Recommendations

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<th>FY 2004-05 year 3</th>
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Assumptions

- Inflation rate yr 3: 4%
- Inflation rate yr 4: 4%
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**Assumptions**

1 FTE = 65k unless given specific numbers
"Current budget" is only the current budget for the specific new initiative, not the entire current budget
Orange text = new initiative
Inflation rate yr 3 4%
Inflation rate yr 4 4%
Appendices

Appendix A (to section 1.4)

PLUS-WebCT Satisfaction Questionnaire
April 19, 2002

During the IT Strategic planning process, the On-Line Student Services planning committee invited students to fill out a brief survey about on-line services. The survey was available to anyone who logged on to PLUS from Friday evening, April 12th through Wednesday morning, April 17th. 544 responses were recorded, from all class levels. Approximately 60% of the respondents were WebCT users. Fewer than 25 graduate students completed the survey, and 6 non-current students responded. The undergraduate student respondents were distributed evenly among the four class levels.

When asked how WebCT was to use 233 students thought WebCT was somewhat easy to very easy to use and 26 students responded very difficult to somewhat difficult. 59 students or 19% were neutral.

Students were asked to select all statements that applied with regards to the effectiveness of WebCT. 178 students felt WebCT saved them time with class work. 102 students responded that WebCT did not contribute to their learning experience. 13 of 303 respondents indicated WebCT did indeed save time, but did not contribute to their learning experience.

39% of responding students thought WebCT should be used more often and 18% felt WebCT should be used for all their classes.

In the comments section of WebCT 73 students wrote additional remarks. In their comments,

33 believed the best part of WebCT was the ability to view course and test grades throughout the course of a semester.

A few students did not feel as though their instructor understood all the functionality of the tool nor used the tool effectively.

Several comments (5) shared concern about the reliability and availability of the WebCT resource. Also the speed in which the pages loaded was a source of frustration.

“Unified” was a theme of many of the comments even when this exact word was not used:
“Allowed me to get to course website without memorizing its address”
“Good to have a uniform site for all my classes”
“I think every course or teacher should have a website that is on a common template for all CU websites. That way all sites are similar and easy to use for students. That would be perfect.”
Appendix B.1 (to section 2.1)

PLUS Satisfaction Questionnaire
April 19, 2002

During the IT Strategic planning process, the Web-Based Student Services planning committee invited students to fill out a brief survey about web-based services. The survey was available to anyone who logged on to PLUS from Friday evening, April 12 through Wednesday morning, April 17th. 544 responses were recorded, from all class levels. Fewer than 25 graduate students completed the survey, and 6 non-students responded. The undergraduate student respondents were distributed evenly among the four class levels.

Students indicated that the following services on PLUS were most useful:
Registration  523
Grades  481
Schedule Planner 477
Transcripts  358
Bills and Payment  350
Textbook lookup  281
Financial Aid 266
Degree audit  257
Computer Account Management  249
Address Change  244
Health Insurance  223
PIN change  189

When given a selection of possible additional services, students chose
Campus ticket sales  376
News and announcements  246
More on-line courses  228
Personal calendaring  214
Personal bookmarks  64

In the comments section, more than 300 students wrote additional remarks and offered suggestions. In their comments,

More than 100 students indicated they thought PLUS was ok, wonderful, all-inclusive or awesome. “PLUS is excellent.”
64 students asked for more detailed financial information, such as back records, or the ability to pay their bills online, or pay with a credit card. Of these, 6 students asked for access to their Credit Union account information.
35 students requested either a degree audit, or improved degree audit capabilities.
29 students wanted personal calendaring, an events calendar, and/or a calendar which could automatically show important university dates such as deadlines and exams.
19 students asked for earlier information about textbooks or easy access to on-line purchase.
17 students asked for better access to their advisors, either directory information, or the ability to make an appointment, or to combine the A&S system with PLUS.
10 students asked for mid-term grades and test scores like those available on WebCT.

When asked if they would be willing to pay more for improved services, 54% of the respondents said yes.

75 respondents said they were undecided
174 said no
235 said yes, from $1 to $5 a semester, and
59 were willing to pay $6 to $10 more a semester.
Questions about WebCT were also included in this questionnaire. The results are reported in the educational technology chapter of the planning report.

Appendix B.2 (to section 2.1)

Personal Look-up Services (PLUS)

Current Functionality Available in PLUS

• Profile Page (displays information on student’s major and minor, year in school, residency, advising flags or stops, and rotating information based on the time of year)
• Grades
• Schedules (with required books based on schedule)
• Degree Audit
• Unofficial Transcript
• Transcript Request
• Address Change
• PIN Number Change
• Health Insurance Waiver
• E-mail and Passwords—Getting Started, Account Activation and Passwords, Change Outgoing E-mail Address, E-mail Delivery, and Specialty Accounts
• University billing detail
• University bill balance due
• Tuition Recalculation
• Financial Aid Application Status
• Financial Aid Award Status
• Financial Aid Estimated Expenses
• Math Modules (access to grades)
• Telecommunication Services current bill
• Link to Registration
• Link to Scholarship Application
• One-time payment (link to third-party service)
• E-bill (link to third-party service)
• Troubleshooting application
• Frequently Asked Questions

Historical Timeline

1993
University financial information (all charges and credits available) and schedules and grades for students was first posted to CUline in 1993 by ITS (CNS at the time).

Summer 1995
PLUS went from CUline to the Web

PLUS as of December 1997

• Schedules/Grades for three semesters
• Degree audit (from flatfile)
• Current semester’s running balance
• Display required textbooks based on a student’s schedule
• Address on file
(Above information was all updated in batch nightly or weekly)
Printing to a choice of network printers
E-mail page to self

ITS and Web Communications (then SACS) started planning the next version of PLUS working with UMS and the Registrar’s Office.
Fall 1998
PLUS received a major upgrade to access SIS in real-time (back to 1986), the navigation was improved, capability to print from browser was added, and a bulletin board for important dates was created.

Transactions
• Grades
• Address change
• PIN change
• Bursar's information (in batch)
• Schedules (with required books based on schedule)
• Degree audit (in batch)
• Invitation to Register
• Math Modules (access to weekly grades)
• Telecommunication Services current bill

Spring-Summer 1999
Transactions Added
• Link to Registration Pilot
• What-if degree audits
• Unofficial transcripts
• Modified profile page to include most timely information (e.g. schedules at beginning of a semester).
• Health Insurance Waiver
• Tuition Recalculation

Fall 1999
Transactions Added
• Registration time assignment
• Stops on profile page

Summer-Fall 2000
PLUS was redesigned and a troubleshooting application and Frequently Asked Questions were added.

Transactions Added
• Financial Aid-Application Status
• Financial Aid-Award Status
• Financial Aid-Estimated Expenses
• Adjusted the account balance module to work with the new BRS

Spring-Summer-Fall 2001
Transactions Added
• Billing Address
• Advising flags to profile page
• Student e-mail account administration—5 different transactions
• Bookstore query enhancement
• WebCT-PLUS integration
• Unofficial transcript enhancement
• Insurance waiver for spring semester

Spring 2002
Transactions Added
• Link to Scholarship Application
• One-time payment (link to third-party vendor)
• E-bills (pass authentication to third-party vendor)
• Transcript request
• Financial Aid Award Accept (in progress)
• Two-payment plan (in progress)
Appendix B.3 (to section 2.1)

<table>
<thead>
<tr>
<th>Monday</th>
<th>Year</th>
<th>Profile page</th>
<th>%&gt;Prior yr</th>
<th>Since 98</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-Aug</td>
<td>1998</td>
<td>21,582</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-Aug</td>
<td>1999</td>
<td>49,378</td>
<td>56%</td>
<td></td>
</tr>
<tr>
<td>28-Aug</td>
<td>2000</td>
<td>59,400</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>27-Aug</td>
<td>2001</td>
<td>75,077</td>
<td>21%</td>
<td>71%</td>
</tr>
<tr>
<td>Projected</td>
<td>2002</td>
<td>90,092</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix B.4 (to section 2.1)
Pros and Cons for Boulder Campus unified student web services

Pros
- One stop shopping
- Consistent presentation; no ‘web shanty town’ and less fractured services
- Adherence to security standards
- Resources of the leading IT provider for the Boulder Campus brought to bear on development and support
- Professional development experience
- System monitoring and support from one place
- Brand recognition
- Redundant and high availability hardware infrastructure
- Straightforward integration with core IT services (email, course tools, etc.)
- Student centric; access to resources without requiring an understanding of the administrative structure of the University

Cons
- Inflexible
- Too many restrictions
- Development cycle too long
- Inability to control priority
- Central support services not responsive
- Unable to establish separate, unique web ‘brand’
- Another layer of complexity and bureaucracy
- Not all the information available from a department’s web site can be incorporated in a unified service; students will still need to come to our site.
- Diseconomy of scale – why can’t we use MS Word, MS Access and an insecure web server?

Appendix C (to section 4.7): Usage Data from Assistive Technology Satellite Stations

Number of Visually and Mobility Impaired Students:

About 35/40 visually and mobility impaired students are listed in the DS database.
About 13 of these students use the services of the lab and satellite stations.

Assistive Technology Satellite Stations

1. Norlin Reference Section: Room E130
2. Norlin Mac Computer Lab: Room N310
3. Engineering Center: ECCR 225A
4. Muenzinger Psychology: Room E311
5. Hale Science: Room 347, 3rd floor. Graduate Student Research Lab. NOT AVAILABLE FOR GENERAL AT USE.
6. Law Library: Room 029
7. Duane Physics - Lester Math/Physics Library: Portable CCTV only.
## Use of stations & AT Lab: Fall 2001

<table>
<thead>
<tr>
<th>Fall 2001</th>
<th>Uses</th>
<th>Students</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MacLab - 3rd Floor, Norlin 1 Adaptive PC station (based on student survey)</td>
<td>8</td>
<td>1</td>
<td>1 other student who used station graduated in Spring 2001</td>
</tr>
<tr>
<td>Ref. Station - 1st Floor, Norlin 1 Adaptive PC station (based on student survey)</td>
<td>70</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Public use station with ZoomText</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Engineering 1 Adaptive PC station (based on student survey)</td>
<td>2</td>
<td>1</td>
<td>student who used it often last semester now has a laptop</td>
</tr>
<tr>
<td>Hale Science Room 347, 3rd floor. Graduate Student Research Lab 1 station with Zoomtext screen enlarger only.</td>
<td>40</td>
<td>1</td>
<td>Restricted to graduate students</td>
</tr>
<tr>
<td>Muenzinger</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Law</td>
<td>0</td>
<td>0</td>
<td>See focus group feedback below.</td>
</tr>
<tr>
<td>AT-Lab</td>
<td>15</td>
<td>40 - 50</td>
<td></td>
</tr>
</tbody>
</table>

## Use of stations & AT Lab: Spring 2001

<table>
<thead>
<tr>
<th>Spring 2001</th>
<th>Uses</th>
<th>Students</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MacLab - 3rd Floor, Norlin 1 Adaptive PC station (based on student survey)</td>
<td>45</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Ref. Station - 1st Floor, Norlin 1 Adaptive PC station (based on student survey)</td>
<td>N/A</td>
<td>N/A</td>
<td>Not in place until end of spring semester.</td>
</tr>
<tr>
<td>1 Public use station with ZoomText</td>
<td>N/A</td>
<td>N/A</td>
<td>Not tallied.</td>
</tr>
<tr>
<td>Engineering 1 Adaptive PC station (based on student survey)</td>
<td>60</td>
<td>1</td>
<td>student who used it often last semester now has a laptop</td>
</tr>
<tr>
<td>Hale Science Room 347, 3rd floor. Graduate Student Research Lab 1 station with Zoomtext screen enlarger only.</td>
<td>23</td>
<td>1</td>
<td>Restricted to graduate students</td>
</tr>
<tr>
<td>Muenzinger</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Law</td>
<td>?</td>
<td>?</td>
<td>See focus group feedback below.</td>
</tr>
<tr>
<td>AT-Lab</td>
<td>15</td>
<td>40 - 50</td>
<td></td>
</tr>
</tbody>
</table>

### Focus Group Feedback

**General (N = 2)**

- Preference for being able to choose her own screenreader - on Integrated stations, students will have to use the selected screenreader.
- Even if not used extensively, it is comforting to know that the satellite station at Engineering is available in the event of their own equipment breaking down. Satellite station was crucial before student obtained her own laptop.
- Preference indicated for keeping at least some “disability-dedicated” satellite stations. Concern expressed that students will use adjustable tables in standard labs even if signs are posted.
• Student in wheelchair indicated sometimes has problem accessing “Scarpies” because of height of workstation.
• Noise was indicated as a problem at the Engineering satellite station because of close vicinity of advisors.
• Issue of scanning server - would be important to have assistance for visually impaired students - otherwise, they wouldn’t know if items had scanned clearly until after they accessed files from their computer. This could cause a lot of frustration.
• Campus should set up login so that system is customized (font size, other AT) based on person’s disability/saved profile.
• Plus seems to be the main online system that visually impaired students have difficulty with - mainly because of the “time out.”

Feedback about Law School station (N = 3)

• Two students who used to use the satellite station have stopped using it primarily because they have been able to use their own equipment instead. One student had the adaptive software she needed installed on her own computer and because wireless networking has been set-up at the law school, another student has been able to print from her own laptop, which has needed adaptive software.
• Location of current adaptive station at law school is a problem - it’s a quiet area and hence, voice recognition cannot be used. Sometimes equipment disappears, such as the mouse.
• One student did not know anything about the adaptive stations - indicated it would have been nice to have a point of contact. Services aren’t very well advertised.
• Table mounted magnifying lenses and slant boards at law school would be helpful for reading fine print.
• No clear person around to provide support - currently they generally go to ITS help desk.
## Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A&amp;S</td>
<td>Arts and Science</td>
</tr>
<tr>
<td>Access Management</td>
<td>Access Management consists of two complementary functions: A person determining who can access what services and assigning roles, permissions, and criteria at the user and system level that allow for that access. An application, service or resource using previously assigned roles, permissions, and criteria to determine whether or not to fulfill a request or present an option. The first function is a provisioning function and may be all that's required to provision access.</td>
</tr>
<tr>
<td>Account</td>
<td>An Account is a local identity required by a system or application for authentication (see below). An example is an /etc/passwd entry on a Unix system. A person might be able to access some system or application without an account, and a single account may entitle a user access to numerous services or resources.</td>
</tr>
<tr>
<td>Active Directory</td>
<td>Microsoft's LDAP directory implementation. Windows 2000 in a networked environment relies on Active Directory for all user and privilege information.</td>
</tr>
<tr>
<td>ALTEC</td>
<td>Anderson Technology Language Technology Center</td>
</tr>
<tr>
<td>Anti-virus</td>
<td>A software program designed to identify and remove a known or potential computer virus.</td>
</tr>
<tr>
<td>Apple (Mac OS)</td>
<td>Apple Computer, Inc.’s proprietary operating system for their Macintosh family of personal computers.</td>
</tr>
<tr>
<td>ASC</td>
<td>Arts and Sciences Council</td>
</tr>
<tr>
<td>AT</td>
<td>Assistive Technology</td>
</tr>
<tr>
<td>Authentication</td>
<td>The act of establishing that you are who you say you are.</td>
</tr>
<tr>
<td>Authenticity</td>
<td>A resource is correctly identified. For email and documents, this might require electronic signatures to prove that the content originated from a specific person or source. For web servers, this includes authentication of the server, as with server identification certificates.</td>
</tr>
<tr>
<td>Authorization</td>
<td>is the act of granting access to a resource or function. Access can be granted based on Identity, some Identity attribute combination (Role), or some pre-requisite behavior. There is a very strong industry leaning toward Role based authorization.</td>
</tr>
<tr>
<td>Availability</td>
<td>A resource is accessible when needed and usable as intended.</td>
</tr>
<tr>
<td>AVC</td>
<td>Associate Vice Chancellor</td>
</tr>
<tr>
<td>AVCACT</td>
<td>Associate Vice-Chancellor for Academic and Campus Technology</td>
</tr>
<tr>
<td>AY</td>
<td>Annual Year</td>
</tr>
<tr>
<td>Backbone</td>
<td>The top level in a hierarchical network.</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>The amount of data that can be passed along a communications channel in a given period of time.</td>
</tr>
<tr>
<td>BFA</td>
<td>Boulder Faculty Assembly</td>
</tr>
<tr>
<td>Bits</td>
<td>A fundamental unit of information having just two possible values, as either of the binary digits 0 or 1.</td>
</tr>
<tr>
<td>Byte</td>
<td>A sequence of adjacent bits, usually eight, operated on as a unit by a computer.</td>
</tr>
<tr>
<td>CIO</td>
<td>Chief Information Officer</td>
</tr>
<tr>
<td>CIRES</td>
<td>Cooperative Institute for Research in Environmental Sciences</td>
</tr>
<tr>
<td>CLIPR</td>
<td>Computer Laboratory for Instruction in Psychological Research</td>
</tr>
<tr>
<td>CMS</td>
<td>Call Management System</td>
</tr>
<tr>
<td>CSCW</td>
<td>Computer Support for Cooperative Work</td>
</tr>
<tr>
<td>DACTCs</td>
<td>Distributed Academic and Campus Technology Coordinators</td>
</tr>
<tr>
<td>Desktop</td>
<td>Small enough to fit conveniently in an individual workspace (i.e. Desktop Computer).</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>DGB</td>
<td>Directory Governance Board</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Configuration Protocol</td>
</tr>
<tr>
<td>Digital Asset Management</td>
<td>Comprises the collection and repository of digital educational materials used at CU-Boulder, as well as the collective mechanisms and processes that provide effective access to those materials.</td>
</tr>
<tr>
<td>DNS</td>
<td>Domain Naming System</td>
</tr>
<tr>
<td>DS</td>
<td>Disability Services</td>
</tr>
<tr>
<td>DSL</td>
<td>Digital Subscriber Line</td>
</tr>
<tr>
<td>DVD</td>
<td>Digital Versatile Disk</td>
</tr>
<tr>
<td>EH&amp;S</td>
<td>Environmental, Health and Safety</td>
</tr>
<tr>
<td>Electronic Payments</td>
<td>The acceptance of payment for goods and services where the sale is negotiated over the Internet. Payments are tendered in the form of credit cards or funds transfers.</td>
</tr>
<tr>
<td>ELMS</td>
<td>e-Academy License Management System</td>
</tr>
<tr>
<td>Encryption</td>
<td>To alter (a file, for example) using a secret code so as to be unintelligible to unauthorized parties.</td>
</tr>
<tr>
<td>Enterprise Directory</td>
<td>A general-purpose service, usable by a variety of campus constituencies; however, for it to be a trusted, reliable source of information, a single unit on campus must have ownership and responsibility of it. The primary advantage of the Enterprise Directory is to tie together independent applications (such as SIS, HR, PeopleSoft) and enable relationships as well as resolve discrepancies between these applications. Other advantages include the ability to enable campus-wide calendaring, authentication &amp; authorization, identity management, access management, and account management. To manage privileges granted to individuals, the campus computer and network infrastructure needs to identify who individuals are when they login (identity management), verify that individuals are who they say they are (authentication), and grant individuals access to the privileges they need (access management/authorization).</td>
</tr>
<tr>
<td>ETFS</td>
<td>Educational Technology Facilities Support</td>
</tr>
<tr>
<td>Ethernet</td>
<td>Type of networking technology for local area networks.</td>
</tr>
<tr>
<td>FACE-IT</td>
<td>Faculty Advisory Committee for IT</td>
</tr>
<tr>
<td>FERPA</td>
<td>Family Educational Rights and Privacy Act</td>
</tr>
<tr>
<td>Firewall</td>
<td>Any of a number of security schemes that prevent unauthorized users from gaining access to a computer network or that monitor transfers of information to and from the network.</td>
</tr>
<tr>
<td>FRGP</td>
<td>Front Range GigaPOP</td>
</tr>
<tr>
<td>FTE</td>
<td>Full-Time Employee</td>
</tr>
<tr>
<td>FTEP</td>
<td>Faculty Teaching Excellence Program</td>
</tr>
<tr>
<td>FY</td>
<td>Fiscal Year</td>
</tr>
<tr>
<td>Gateway</td>
<td>Software or hardware that enables communication between computer networks that use different communications protocols.</td>
</tr>
<tr>
<td>Gbps</td>
<td>Gigabits Per Second (1 gb = 1,073,741,824 bits)</td>
</tr>
<tr>
<td>Gigabyte</td>
<td>A unit of computer memory or data storage capacity equal to 1,024 megabytes.</td>
</tr>
<tr>
<td>GTP</td>
<td>Graduate Teacher Program</td>
</tr>
<tr>
<td>HIPAA</td>
<td>Health Insurance Portability and Accountability Act of 1996</td>
</tr>
<tr>
<td>HR</td>
<td>Human Resources</td>
</tr>
<tr>
<td>I/IT</td>
<td>Information and Information Technology</td>
</tr>
<tr>
<td>ICWG</td>
<td>Instructional Computing Working Group</td>
</tr>
<tr>
<td>IDE</td>
<td>Integrated Development Environment</td>
</tr>
<tr>
<td>IdentiKey</td>
<td>An IdentiKey consists of a login name and password that are maintained in a central server. The Boulder campus IdentiKey is based on kerberos and is used to allow the same username and password for Identikey enabled services. However, now all uses of Identikey require kerberos.</td>
</tr>
</tbody>
</table>
Identity
A representation of a human (or other identifiable entity) within a directory or other system. Typically this representation will be in the form of a unique identifier and some associated attribute/value pairs: (E.g. ID: 999881111, Name= John Doe, Address=314 Meadowlark Lane).

IFS
Institutional File System

Information Literacy
A student’s ability to recognize what information is needed independent of its format, to know where to find it, and to be able to evaluate it and then use it critically and creatively. Information Technology literacy: a student’s ability to become proficient in new technology applications as they become available for learning and the production of knowledge. Fluency comprises those more advanced abilities that may be specific to particular disciplines or groups of disciplines or to higher levels of learning.

Infrastructure
An implementation of a set of technologies, the integration of those technologies, and the policies and business practices that govern the use and management of the technologies.

Integrity
A resource is intact and has not been damaged, lost or unintentionally or maliciously modified. For example, information content is delivered as originally recorded; services and equipment have not been modified for some other purpose, such as to undermine privacy or authenticity.

Internet
An interconnected system of networks that connects computers around the world via the TCP/IP protocol.

IR
Institutional Relations

IRM
Information Risk Management

IT
Information Technology

ITIIP
Information Technology Infrastructure Improvement Plan

ITS
Information Technologies Services

ITSPI
IT Service Provisioning Infrastructure

JILA
Joint Institute for Laboratory Astrophysics

Kerberos
Kerberos is an authentication service developed at MIT with the purpose of allowing users and services to authenticate. Kerberos provides encrypted authentication, identification of both the server and users, and enables single-sign-on for native kerberos applications. The down-side of kerberos is that very few applications support kerberos natively. As a result the CU-boulder uses kerberos as a central account database to which services verify authentication. This use of kerberos is known at CU-Boulder as Identkey.

LAN
Local Area Network, A system that links together electronic office equipment, such as computers and word processors, and forms a network within an office or building.

LASP
Laboratory for Atmospheric and Space Physics

LDAP

License
A document, plate, or tag that is issued as proof of official or legal permission. ie A software license, which allows a user or group to install and operate said software.

LMS
Learning Management Systems

Mbps
Megabits per second (1 mb = 1,048,576 bits)

Megabyte
A unit of computer memory or data storage capacity equal to 1,048,576 bytes.

Middleware
Technology components that provide directory/identity services, authentication services, authorization services, and other foundational services that applications may need to operate effectively in an Internet-centric environment.

MOUs
Memoranda of Understandings

MSG
Microsystems Group

Multimedia
Of or relating to an application that can combine text, graphics, full-motion video, and sound into an integrated package.

Networked Resources
Data stored in a central location for access from remote locations.

Networking
A system of computers interconnected by telephone wires or other means in order to share information.

NSF
National Science Foundation
<table>
<thead>
<tr>
<th><strong>OKI</strong></th>
<th>Open Knowledge Initiative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optical Fiber</strong></td>
<td>A flexible optically transparent fiber, usually made of glass or plastic, through which light can be transmitted by successive internal reflections.</td>
</tr>
<tr>
<td><strong>PACT</strong></td>
<td>Planning Across the Curriculum for Technology</td>
</tr>
<tr>
<td><strong>PBX</strong></td>
<td>Private Branch Exchange (private telephone switchboard)</td>
</tr>
<tr>
<td><strong>PDA</strong></td>
<td>Personal Digital Assistants</td>
</tr>
<tr>
<td><strong>Pedagogy</strong></td>
<td>The art or profession of teaching.</td>
</tr>
<tr>
<td><strong>PKI</strong></td>
<td>Public Key Infrastructure. A PKI issues digital certificates to users for the purposes of authentication and, sometimes, authorization. A digital certificate is a public key that has been digitally signed by a trusted entity who has validated that the public key belongs to the individual in possession of the accompanying private key.</td>
</tr>
<tr>
<td><strong>Platform-independent</strong></td>
<td>Same user interface on any of the supported computing platforms.</td>
</tr>
<tr>
<td><strong>Platform-neutral</strong></td>
<td>Same basic feature set available from supported computing platforms, though interface and advanced features may vary slightly from one to another.</td>
</tr>
<tr>
<td><strong>PLUS</strong></td>
<td>Personal Look-Up Services</td>
</tr>
<tr>
<td><strong>Portal</strong></td>
<td>A website considered as an entry point to other websites, often by being or providing access to a search engine.</td>
</tr>
<tr>
<td><strong>Privacy</strong></td>
<td>only appropriate persons can use a resource. For email, privacy may mean that only the sender and the intended recipients can read a message. For an email group, it may mean that only registered members of the group may participate. For a departmental server, privacy may mean that only the intended user can access an account, and that accounts are limited to affiliated departmental users. For an open computer lab, privacy may mean mechanisms to protect users who have forgotten to logout. For a personal workstation, privacy means that only that person can access the workstation.</td>
</tr>
<tr>
<td><strong>Provisioning</strong></td>
<td>The act of <em>determining</em> who can access what services and <em>assigning</em> identities, roles, permissions, and criteria at the user and system level that allow for that access.</td>
</tr>
<tr>
<td><strong>Provost</strong></td>
<td>A university administrator of high rank, usually second in command.</td>
</tr>
<tr>
<td><strong>PWR</strong></td>
<td>Program for Writing and Rhetoric</td>
</tr>
<tr>
<td><strong>QoS</strong></td>
<td>Quality of Service</td>
</tr>
<tr>
<td><strong>RADIUS</strong></td>
<td>&quot;Remote Authentication Dial-In User Server/Service&quot; Initially developed to provide authentication, authorization, and accounting for modem services RADIUS now supports a wide range of networking services including modems, broadband networking, virtual private networking, wireless networking.</td>
</tr>
<tr>
<td><strong>Registry</strong></td>
<td>A university-wide database that houses information used by the Enterprise Directory. Logic applied at the database level (prior to populating the database) enforces the identity management and data reconciliation business rules upon which the Directory depends.</td>
</tr>
<tr>
<td><strong>Remote</strong></td>
<td>Located at a distance from another computer that is accessible by cables or other communications links.</td>
</tr>
<tr>
<td><strong>Same sign on</strong></td>
<td>the same username/password combination is used with each authentication to an application or resource.</td>
</tr>
<tr>
<td><strong>Satellite</strong></td>
<td>A secondary station that is an extension of the main station.</td>
</tr>
<tr>
<td><strong>Server</strong></td>
<td>A computer that processes requests for HTML and other documents that are components of webpages.</td>
</tr>
<tr>
<td><strong>Single sign on</strong></td>
<td>Authentication information (username/password) is entered once and permits access to multiple applications or resources.</td>
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<tr>
<td><strong>SIS</strong></td>
<td>Student Information System</td>
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<td><strong>Social Engineering</strong></td>
<td>Originally from the social sciences there are many definitions for social engineering. In the context of IT security a working definition would be the use of psychological manipulation to gather information for the purpose of subverting system security.</td>
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<tr>
<td><strong>Software</strong></td>
<td>The programs, routines, and symbolic languages that control the functioning of the hardware and direct its operation.</td>
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<tr>
<td><strong>Supercomputer</strong></td>
<td>A mainframe computer that is among the largest, fastest, or most powerful of those available at a given time.</td>
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</table>
TBD  To Be Determined
TCO  Total Cost of Ownership
TEC  Technology Experimentation Center
Telephony  Communication, often two-way, of spoken information, by means of electrical signals carried by wires or radio waves. For purposes of this report, telephony refers to the current CU-Boulder telephone system.
UCE  Unsolicited commercial email
UCSU  University of Colorado Student Union
UGGS  United Government of Graduate Students
UMS  University Management Systems
UNIX  An interactive time-sharing operating system.
Videoconferencing  A teleconference using video technology, such as closed-circuit television.
Virtual  Created, simulated, or carried on by means of a computer or computer network.
Virus  Cracker program that searches out other programs and 'infests' them by embedding a copy of itself in them, so that they become Trojan horses. When these programs are executed, the embedded virus is executed too, thus propagating the 'infection'.
VoIP  Voice over IP
VPN  Virtual Private Network
WebCT  A proprietary software package that enable students to take online classes and interact with their professors.
Wireless Networking  A term describing a computer network where there is no physical connection (either copper cable or fiber optics) between sender and receiver, but instead they are connected by radio.
Workstation  A sophisticated standalone computer used for a specific purpose, such as imaging.
Worm  A malicious program that replicates itself until it fills all of the storage space on a drive or network.
List Of Participants

Core Team
Deborah Keyek-Franssen  Dennis Maloney
Bobby Schnabel  Marin Stanek

Steering Team
Laura Border  Kevin Boyer  Greg Carey
Deb Coffin  Andy Cowell (Reviewer)  Jean Delaney
Robert Dixon  Bob Herbstreit  Pat Jensen
Terry Kleeman  Ken Klingenstein  Dave Makowski
Ric Porreca  Ron Ried  Barb Schneider
Jim Williams

Committee Leads
Dave Bodnar  Richard Borkowski  Jean Delaney
David Normann  Linda Drake  Burton Fox
Gary Franz  Bob Fryberger  Bill Herbstreit
Dan Jones  Deborah Keyek-Franssen  Howard Kramer
Dennis Maloney  Malinda Miller-Huey  Bobby Schnabel
Ken Schuetz  Paula Vaughan  David Wood

Committee Members
Jim Avery  Karin Berglund  Dave Bodnar
Richard Borkowski  Barbara Buttenfield  Mike Carter
Kent Cearley  Dave Clough  Deb Coffin
Dean Colby  Barry Compton  John Culshaw
Jim Curry  Don Diebert  Robert Dixon
Cynthia Donahue  Linda Drake  Larry Drees
Steve Ekerholm  Donnie Emeson  Pete Fahlenkamp
Jane Folger  Mike Forbes  Paulette Foss
Burton Fox  Gary Franz  Bill Freud
Bob Fryberger  James Garnett  Kate Gilbreath
Dave Goldhammer  Kathe Graham  Keith Gresham
Bill Herbstreit  Phil Hugger  Patricia Jensen
Zan Johns  Dan Jones  Melinda Jones
Richard Jones  Brad Judy  Deborah Keyek-Franssen
Ken Klingenstein  Brian Koberg  Howard Kramer
Yvonne Kristy  Dennis Maloney  David Monarchi
Focus Group Participants

Consultant Phil Long, CIO from Yale University, conducted interviews and focus groups with the following individuals and groups:

- Chancellor Byyny
- The Chancellor’s Executive Committee
- The Vice Chancellors Group
- The Council of Deans
- Jim Williams, Dean of Libraries
- Faculty representatives from the Boulder Faculty Assembly

In addition, the following focus groups were convened as part of the ITSP process:

- Representatives from Staff Council and staff members at large
- Representatives from the Arts and Sciences Council
- Members of the Instructional Computing Working Group (which manages the student technology fee)
- IT Providers from ITS and across campus
- Representatives from the Libraries
- Student Representatives from the Legislative Council

Those who participated included:

<table>
<thead>
<tr>
<th>Susan Anthes</th>
<th>Tony Barker</th>
<th>Barbara Bintliff</th>
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<tbody>
<tr>
<td>David Bloom</td>
<td>Hoyt Boles</td>
<td>Edo Cohen</td>
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<td>John Crittendon</td>
<td>John Culshaw</td>
<td>Stephen Dowdy</td>
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<td>Linda Drake</td>
<td>Allan Fasick</td>
<td>Anne Flint</td>
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<td>Yem Fong</td>
<td>Burton Fox</td>
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<td>Keith Greshem</td>
<td>Drew Guyon</td>
<td>Lew Harvey</td>
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<tr>
<td>Michael-Scott Heberling</td>
<td>Janet Hill</td>
<td>Jason (freshman student)</td>
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<tr>
<td>Brad Judy</td>
<td>Dan Jones</td>
<td>Terry Kleeman</td>
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<tr>
<td>Merrill Lessley</td>
<td>Bob Lombardo</td>
<td>Rani Machoi</td>
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<tr>
<td>David Monarchi</td>
<td>Mary Ann Myer</td>
<td>Joyce Nielsen</td>
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<tr>
<td>Harriet Rebuldela</td>
<td>Jim Davis-Rosenthal</td>
<td>Ken Schuetz</td>
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<td>Paula Vaughan</td>
<td>Alan Vidmar</td>
<td>David Wood</td>
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<tr>
<td>Patti Zike</td>
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