Chapter 2: Creating Mechanisms for Shared Research & Support

Chapter 2 addresses how campus IT may best serve and support the research endeavors of CU-Boulder students and faculty and encompasses specific reports addressing research computing and cyberinfrastructure, cloud computing, mobile computing support services, rich collaboration tools, increasing staff efficiency and effectiveness, web infrastructure, and improving the IT service model. The reports concerned with developing mechanisms for shared research and support provide suggestions and guidelines for ensuring IT serves the mission and vision of collaborative, forward-thinking, and competitive research at CU-Boulder. Each report makes a contribution to envisioning CU-Boulder as a world leader in pioneering research.

To that end, individual reports articulate the resources required to support research including a central data center for facilitating research computing, cloud computing applications, convergence strategies for mobile computing and appropriate support services, network infrastructure and a web hosting environment suitable for providing rich collaboration tools, and central and decentralized support services capable of efficiently addressing a spectrum of resources. Beyond identifying resources and recommended adoption and development, the reports also delineate strategic processes involved in pursuing campus research needs; needs assessment and research concerning current and future tool and resource use, resource and service oversight, and input from campus constituencies are integral components to this process.
2.1 Research Computing and Cyberinfrastructure

Major Issue:

CU-Boulder must expand IT infrastructure and services to support the success of its world-class research activities.

This “cyberinfrastructure” will consist of computational systems, high-performance data networks, extensive data storage facilities and a central data center to house research systems and will include central technical support.

This centralized model will enhance research computing activities and collaborations, allowing researchers to focus on the discovery and communication of new knowledge efficiently, securely, and cost-effectively. Adopting central IT services requires building trust between the research community and its service providers.

Oversight will be provided by an advisory board of research faculty.

A. Background/Rationale

Receiving nearly $340 million in sponsored research funding during fiscal year 2009, CU-Boulder stands out as one of the premier public research universities in the nation. To maintain this stature, the university must recognize the role that research computing plays in modern scientific investigation and expand its information technology (IT) support for a wide range of disciplines.

Advanced research computing has become essential to the success of faculty research endeavors and as a result can directly affect faculty recruitment and retention. Researchers increasingly rely on high-performance computing for sophisticated simulation, visualization and modeling capabilities both to improve scholarly productivity and to enable discoveries that otherwise would not be possible. Funding agencies now recognize the importance of computing in successful research and tend to assess this component more rigorously when evaluating grant proposals. In addition, outstanding research increasingly requires collaboration on a national and international level, which participation in national cyberinfrastructure initiatives such as TeraGrid can greatly enhance.

“Cyberinfrastructure,” according to EDUCAUSE, “consists of computational systems, data and information management, advanced instruments, visualization environments, and people, all linked together by software and advanced networks to improve scholarly productivity and enable knowledge breakthroughs and discoveries not otherwise possible.”

The high barriers to entry into high-performance research computing (HPRC) can significantly limit research options. Many departments do not have resources for initial hardware and software costs, on-going maintenance costs, physical and environmental space requirements, and the technical knowledge necessary just to get started. Some research areas cannot overcome these barriers, nor provide the specialized support skills, and thus may lag behind.

Today, many campus researchers address their research computing needs independently, often by way of startup packages and grants. Although these funding sources may cover upfront costs, they do not always address ongoing expenses and support. This approach leads to the
proliferation of small research computing installations which are challenging to maintain and fail to advance the development of a coherent campus-wide research computing environment.

Additionally, lack of adequate space to house computing systems and peripherals impedes the creation of viable research computing solutions, further increasing the number of small, local server farms. This distributed model is not energy efficient, strains building HVAC systems, and encroaches on valuable laboratory and office space. An estimated 40 facilities on campus use supplemental air conditioners which account for approximately 700 refrigerant tons of cooling. The true costs of such installations, borne both by the departments and the campus, are difficult to capture accurately.

Research computing produces large data sets that increase rapidly in both size and number. Effective information management must address secure storage, ownership, control, access, retrieval, transport and preservation to ensure the success of research computing initiatives.

User support for research computing is both a critical component and difficult to solve at the department level. Technical support may run the gamut from system administration to discipline-specific application support and programming. Technical consulting must be done with an understanding of the research processes and needs in specific disciplines, including the humanities and social sciences.

The researchers interviewed for this report appreciate the difficulty in providing effective and sustainable research computing at the local lab or department level. While administering systems and maintaining computing facilities detracts from their primary research activities, the absence of viable campus-wide alternatives has necessitated such involvement.

The development of a center for HPRC and cyberinfrastructure on the CU-Boulder campus offers a solution to many of these issues. Centralization could more effectively support research computing activities, improve efficiency and foster broader collaborations. A centralized support team would likely yield similar gains in efficiency and effectiveness. Improvements to the campus-wide cyberinfrastructure offers greater options for integrating research efforts with national research initiatives, thus increasing opportunities for partnerships between individuals, as well as with other research universities, national centers, and private industry.

In creating a centralized research computing model, however, the campus must address a number of outstanding questions. Researchers want to know what forms of security and access controls would be in place, how use of systems and access to a shared technical support team would be prioritized, and how control of common systems and data ownership would be addressed. Clear rules must be established and guidance provided on all these questions.

B. Accomplishments to Date

The offices of the VC for Research and the Associate VC for IT & CIO have established a budget to support a Center for Research Computing and Cyberinfrastructure, including operating funds and staffing.

The university has been awarded an NSF grant to acquire a supercomputing instrument (NSF cyberinfrastructure Track 3) to be deployed in the summer of 2010.
The university is in the process of purchasing a commercial building in the Research Park on East Campus. This building is suitable for the development of a data center to support high performance research computing.

**Action Plan**

**C. Explicit Assumptions**

The culture of researcher autonomy and self-funding requires that, to be successful, solutions must reflect voluntary participation, benefit the individual as well as the larger research community, and not diminish current ownership, control or access.

The development of central research computing resources and infrastructure will have economic advantages to the campus and to individual researchers and their departments.

The availability of central resources, including technical support, will open up new opportunities for research disciplines that have had limited access to cutting-edge computing technology.

An emphasis will be placed on developing cyberinfrastructure and support to enhance research effectiveness and efficiencies in the humanities and social sciences.

A funding model can be developed that is transparent, fair, agreeable to the funding agencies, and provides predictable costs that can be planned for.

The development of central research computing resources will serve as an intellectual “watering hole” that fosters greater cooperation and collaboration.

A central data center facility and support staff can effectively meet the diverse needs of the research community while realizing economies of scale.

The development of a central data center will enjoy broad support beyond the researchers themselves because of improvements in energy efficiency, reduced impacts to building HVAC systems, stronger security, and the ability to recover laboratory and office space on main campus.

To foster increased trust over time, the IT service provider must listen intently to the needs of researchers, preserving transparency in decision-making, and delivering on promises.

**D. Specific Recommendation**

1. Create a committee made up of research faculty to oversee development of central research computing resources and to provide continued oversight of the initiative to ensure that it meets the needs of campus researchers.

2. Develop a funding model to sustain centralized research computing resources that is transparent, fair, provides predictable costs, encourages integration of IT resources and is agreeable to the research community and their funding agencies.
3. Create a Center for Research Computing, HPRC, and Cyberinfrastructure to develop, maintain and promote the campus’ research computing capabilities, and to support our research community in the use of these capabilities.

4. Develop capabilities to support computing-, visualization-, and simulation-heavy research in the humanities and social sciences, including the capability to analyze non-numerical types of data, including visual, textual, geographic, and audio.

5. With input from key stakeholders, establish a central research computing data center that meets the research community’s unique requirements for capacity, flexibility, efficiency and security; that accommodates central and independently controlled systems; and that provides the requisite staffing to effectively perform primary support functions.

6. In order to meet the elevated demands of research, improve the reliability of the campus network and its capacity, both intra-campus and to the outside world. Mitigate competition for bandwidth with other network users through segregation and/or traffic management to achieve higher and more predictable performance.

7. Ensure that necessary archival data can be preserved in a usable form in perpetuity.

8. Provide means to further integrate research efforts with national efforts, including participation in national cyberinfrastructure initiatives such as TeraGrid, thereby increasing opportunities for partnerships between individuals, other research universities, national centers, and private industry.

E. Long & Short Term Objectives/Timeline

Short Term: Create an oversight committee made up of research faculty to help guide the development of a research computing center and the policies and procedures that will govern the use of common facilities and resources. Communicate plans and solicit additional faculty input.

Short Term: Draft a charter for a center for Research Computing, HPRC, and Cyberinfrastructure, articulating its function. Define and hire the requisite staff positions.

Short Term: Develop a funding model to sustain centralized research computing operations and communicate the details to stakeholders.

Short Term: Deploy the MRI supercomputing instrument.

Medium Term: Determine locations for new technical staff offices

Spring 2011: Increase network reliability and capacity, both internal and external. Pursue architectural and traffic management strategies to mitigate competition for bandwidth and consistently meet the needs of the research community.
Spring 2011: Renovate space and build infrastructure in a soon-to-be acquired building in the Research Park on East Campus for a data center to support research computing.

F. Possible Risk

- Lack of trust in the centralized model or in IT service provider prevents widespread adoption and participation.
- The funding model as implemented isn’t sufficiently fair and cost-effective or does not garner the funds necessary to sustain this initiative.
- The benefits or attractiveness of a centralized approach have been overestimated and it is not embraced by the research community.
- The central research computing resources serve the needs of some disciplines well, but do not meet the needs of others, therefore becoming only a partial solution for the campus.
- The campus does not achieve the desired consolidation and efficiency gains because the increased data center space only adds to existing distributed data centers rather than replacing them.
- The board and IT service provider cannot formulate fair methods of providing access to computing cycles, data storage and technical support staff.
- Providing user support in a typical helpdesk fashion rather than as proactive and collaborative advanced technical consulting will diminish its effectiveness in supporting research projects.

G. Resource Allocation

Cost of the project: The cost of this project is expected to be high. This is, in effect, developing and staffing a center for research computing and cyberinfrastructure, deploying a supercomputing instrument, developing a data center to support research computing, and improving data storage, data management and networking.

Establish the funding requirements and determine how facilities and services will be supported through a mix of GF, direct and indirect cost recovery.

H. Responsible Parties

Vice Chancellor for Research, Associate Vice Chancellor for IT & CIO, Campus IT Security Office, Information Technology Services, Facilities Management, Research Building Systems, and later the Research Faculty Oversight Committee.

I. Evaluation

- Determine if the number of successful grant proposals increases.
- Determine if the number of grant proposals from underrepresented academic and research disciplines increases.
- Determine if the number of distributed/local server farms decreases, or at least stops expanding.
- Evaluate the university’s energy savings due to consolidation of systems into a more energy-efficient data center.
- Evaluate the continued viability of the established funding model in terms of sustainability and perceived fairness to participants.
• Evaluate the benefits to expanding research collaboration, both internal and external to the university.
• Evaluate adoption rate of centralized services and level of satisfaction of users.
• Gauge compliance with policies governing the use and storage of sensitive data as a result of centralizing services.
• Evaluate the success and value of data management and preservation methods.
2.2 Facilitating Cloud Computing

Major Question: How can we embrace cloud computing and effectively enhance the academic, research, and service missions of the university by providing guidance and services while minimizing costs and risks?

A. Background/Rationale

Clouds by definition are fuzzy objects without clean boundaries and defining what is/is not cloud computing is not straightforward. We adopt the NIST definition of Cloud Computing: "Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." Cloud Computing is an emergent technology. It promises flexibility with access as needed and only as needed to resources. The pooling and centralization of these resources and the resultant economies of scale will provide these resources more cheaply to users than buying and staffing their own dedicated facilities. Since the cloud provider will be responsible for updating the software, new features are likely to be available more quickly and mobility is designed in because services are designed for distance use. Finally, working within a cloud should help users become more active more rapidly because they will have less to set up to get started.

The question is not if we should pursue cloud computing opportunities rather how to best take advantage of what clouds will offer. There are already significant numbers of people on campus benefitting from cloud computing and they roughly divide up into students, administrative/clerical staff, educators, and researchers. Each group has different requirements and presents different levels of security needs. The newness and the complexity of these cloud based technology systems means that many users are relatively unaware of the risks; if data stored off campus by a third party cloud is lost or private information compromised, for example, the campus may still be held liable. So, as a campus we need to understand how to take advantage of cloud computing in a way that maximizes its value and minimizes its costs.

The types of cloud that may be used can be classified by their extent, by who controls the infrastructure, and by who has access to the data. What type of cloud is used by a given application on campus will depend on issues such as how private is the data (e.g. is proprietary research or student personal data involved?), who needs access (e.g. students in a class, research collaborators across the globe), and who participates as resource providers (for example, academic libraries could share access to resources and avoid duplication). The cloud terminology used in the literature is rapidly developing and has not settled to a clear consensus. We decided that rather than provide an extensive review we would provide as an example a few specific deployment models. Again using the NIST nomenclature, these fit into four broad types:

- **Private** - these clouds are operated solely for an organization
- **Community** - these clouds are used by several organizations or support groups with shared concerns
- **Public** - these clouds are available to general public or very large organizations, and
- **Hybrid** - these are systems composed of two or more clouds that remain unique but share some standardization, allowing for data and application portability and the option of cloud bursting/load balancing between clouds.
We would like to stress two things. First, we are dealing with a continuum here of options rather than clear distinct classes – we are taking advantage of the NIST definitions to help clarify the different ways that clouds may be used on campus rather than to say these are the only ways clouds can be used. Even when referring to a particular deployment class there is a range of possible implementations (depending on who provides the hardware, who is in charge of authentication, where the data resides etc.) Second, this is an area where it is especially important that terms are defined before use (when we provide a case study we will include any specifics about how our group is interpreting/developing the NIST deployment models). For example, “private” could indicate to a user that access to their work is restricted to people they choose to allow access to while to technical developers it could mean that the servers and data storage devices are located on campus and under local control.

Publicly hosted cloud services, versus privately hosted cloud services (separating the service from the architecture), are already used by faculty, staff and students at the University of Colorado. Indeed, it is becoming hard to think of systems or examples of computer usage that are not likely to involve some form of implicit or explicit cloud use – very few computers are without a network connection to the web. These services are popular because they are free or low cost, available on-demand, easily scalable, elastic, and offer rapid development. The majority of these services allow for features such as: access at any time and in any location with internet access, user access controls so they can share with others online quickly, and easy collaboration with others online. The use of cloud technologies allows users to have online centralized file storage, use online digital media storage (including image, audio and video), create online group editing spaces, rapidly develop short and long term websites, manage conferences including paper submission, and review, provide online creative brainstorming and thought/idea/research organization, develop online web sites for growing and evolving bodies of knowledge (while tracking user changes to data), encourage mentorship between industry professionals and students through online professional/educational networks, and make decisions using online forums for discussion and planning.

It is likely that students will benefit significantly from using Software as a Service (SaaS) applications such as email, file storing/sharing. The services provided to the students through SaaS are likely to have limited liability and should be relatively easy to deploy with an implementation mostly transparent to the user. These services are good candidates to be deployed initially. A partial list of software and services already in use includes Dropbox, Flickr, Free SharePoint, Google Apps, Microsoft’s Conference Management Tool, Mindomo, Ning, PBwiki, RegOnline, SkyDrive, Viddler, VoiceThread, Wordpress Online, and YouTube. In addition, some tools that are gaining wide acceptance around campus are also cloud based including Doodle, Google Docs, Zoho, and Zoomerang. Amazon is moving into the hardware as a service (Haas) arena by providing client servers. As cloud computing permeates the organization as a supportive resource, private clouds will become instrumental in providing cloud resources where risk, or other limitations inhibit the use of public clouds. These private clouds may be provided virtually, by an industry provider, or may take an inner cloud approach, where the service is provided locally, but adopts a cloud service model as described by NIST.

The impact of cloud computing on research is harder to assess since many potential tools are still in a development phase and may not become readily available for the foreseeable future. One approach for research computing could be to keep the data storage on campus but to take advantage of the computational power available in clouds. The collaborative editing of documents is already possible. Longer term there may be increased use of "Platform as a Service" clouds but here there are limitations imposed by the services provided by the vendor. For CU researchers collaborating with outside groups assurances have to be made that their
collaborators will not be limited in their interactions with any cloud used by those CU researchers. These interactions could require accessing data (relatively easy to solve) or developing and using specific tools. Depending on how specialized the environment is where the tools are developed it may or may not be feasible for outside collaborators to use these tools without full access to the same environment.

Since the potential impact of cloud computing is so broad we expect that the use of cloud based resources will have a major impact on all of the Flagship 2030 goals. We anticipate that the use of virtual, cloud supported classroom spaces will directly impact our educational mission (this is already beginning to take place) and may provide new ways to support outreach to the more remote parts of our state. Since many resources will be accessible using only a computer terminal and a keyboard it will be easier to work offsite than ever before, this will make it easier to continue key functions in case of a campus closure due to weather or a major outbreak of a pandemic disease. The fact that some resources are offsite has implications for disaster recovery planning and will provide for more flexibility in work options including telecommuting that will allow us to better address work/life balance needs for staff (investing in staff) and faculty. In addition, the improved ability to collaborate across distances will help the campus research missions and the make the campus have a broader global presence and allow for new ways to impact the state and the world.

We need a strategy for a phased approach to the adoption of Cloud Computing on campus that will position us strongly in the "fast follower" category while minimizing costs and risks. We should look first to the possibilities of the cloud when developing new services or replacing obsolete software/hardware rather than initially looking at moving services that are working reliably. We need to identify the key questions that will determine if cloud computing can address a particular need and what type of cloud will be appropriate for that application. The academic environment means that the risk of independent adopters is high (sometimes termed "Shadow IT"). Rather than take a punitive/proscriptive approach we recommend that the campus central IT organization look for ways to encourage use of campus standards compliant cloud services by considering options such as easily available and/or enhanced support as well as highlighting users who have benefited from clouds that are provided to them at low cost and comply with campus standards for adoption. We would point out that the background of cloud vendors can be an indicator of their likely strengths.

Interested readers who would like more information might next go to some of the general articles that have helped shape the approach of the C^4 team (CU Campus Cloud Computing group). In particular, “Defining Cloud Computing” – a Burton group reports by Bob Blakely, Drue Reeves, and Chris Howard, “Demystifying Cloud Computing for Higher Education” an Educause Report by Richard N. Katz, Philipp J.Goldstein, and Ronald Yanosky, and “Cloud Contracts and SLAs” from Information Week:analytics by Jonathan Feldman are good starting points.

B. Accomplishments to Date

We have studied some potential applications of cloud computing to help clarify the benefits and potential problems. One particularly active area of current study is a pilot program to set up a private cloud to be used by participants in the Engineering Honors RAP. The purpose of the pilot is to assist in evaluating possible private cloud usage for learning and/or teaching, assist in surfacing issues surrounding private cloud deployment (specific to CU-Boulder and common to general deployment), and provide a possible model for part of the campus deployment process. This collaborative pilot includes three units; Academic Technology (Kimberly Edwards), Engineering Honors Program (Scot Douglass), and Housing and Dining Services (Alfred
We see this as an outcome representing a confluence of many agendas including flagship 2030 and believe this supports the mission of the University. The Housing IT Department will be allowing the use of infrastructure that has been provisioned for administrative users (500-700 staff members). The extended capacity used by the pilot will not impact the administrative use or mission.

The pilot project will provide virtualized applications and/or complete virtualized desktops to 50-60 Engineering Honors students. The applications available will include those specific to the needs of engineering education, if licensing allows. Students will be able to log in to a virtualized desktop and have ubiquitous access to applications and shared space for collaborative learning. It is a self provisioning model. All that is needed is a list of user names. Students will go to a URL such as enghonors.colorado.edu, self provision and then login to see their customized environment. We see that this model could lead to shared storage, document repository, and virtualized applications; essentially a more comprehensive application services environment. A timeline has been created that would allow the pilot to go live on August 1, 2010.

The planned support model is a mirror of those typically used for pilot projects because users are seen as beta testers for the system. Students have less difficulty with this model than the average campus user and make a good test audience. There will not be a service level agreement. Instead, there will be a general memorandum of understanding which describes what is intended for the pilot and states that there is no guarantee of service availability although the goal is for the pilot to be available 100% of the time. This pilot will help us develop a better understanding of how provisioning within the cloud works.

A key issue raised by this pilot though is how software licensing will be handled for the virtualized environment. Licenses are often attached to a machine and not a user. This specific concern is one of many legal issues which are raised by the use of clouds. We summarize the status of some key issues below and have made specific, related recommendations to address the issues raised.

**Electronic Discovery and data tracking/auditing**
Cloud computing vendors often transfer data among multiple servers making it more difficult to track. In the event of an audit, the ability to show how and where information has been altered and how and where it has been accessed is important to show data integrity. Also, if CU is sued or reasonably anticipates litigation, federal law requires a "litigation hold" and retention of all data relevant to the litigation. It further requires CU to produce an audit trail to demonstrate compliance with the litigation hold.

**Privacy and Data Security**
Unlike a traditional outsourcing relationship where customer information is often segregated on a single server, cloud computing vendors cannot segregate data. Once data is transferred from a traditional server to the cloud, CU must rely upon cloud vendors and sub-vendors (unless CU is providing its own private cloud) to protect student education records protected under FERPA and other private data such as financial aid information protected under the Graham-Leach Bliley Act. iii

**Non Negotiable “Click wrap” Agreements**
Cloud vendors, particularly those using “click wrap” agreements, often seek to allocate the majority of risk to the customer by limiting their liability for certain types of damages and requiring the customer to defend and indemnify the vendor if the customer’s use of the vendor’s services results in a lawsuit. Additionally, vendor agreements often specify that the law and
jurisdiction of another state or country govern and the customer must agree to arbitrate any contract disputes.

Service Levels and Transition Services
In traditional data outsourcing agreements, customers and vendors often agree upon specific levels of service. Cloud vendors often establish service levels applicable to all customers because it is difficult to set different service levels for “tenants” of the same cloud.

Action Plan

A. Explicit Assumptions

The availability of Clouds means that they are being used and will increasingly be used. The campus needs to have central guidelines in place soon to help structure adoption and minimize risk. As clouds become more and more useful the types and numbers of applications on campus will grow. We anticipate that the legal situation will need continual monitoring. We foresee close interactions between campus IT professionals and members of the Office of the University Counsel to ensure that there are negotiated agreements for the use of popular cloud services that allow campus users to take advantage of these services while being in compliance with state and federal regulations. We are also assuming that the campus central IT organization will actively promote the use of services that the campus has negotiated agreements with.

We expect that any external cloud vendor we work with will adhere to the principles of universal design and ensure that accessibility requirements are met or exceeded. Similarly services provided within a cloud need to be accessible. The reactions to the difficulty of using the Kindle device if visually impaired highlight the need to make sure that any technologies adopted need to be considered from a diverse set of perspectives. However, moving towards greater centralization and/or fewer user interfaces should make it easier to monitor for and ensure compliance.

We also see benefits to cloud usage from the perspective of sustainability. Cloud resources can be sited in locations with good availability of energy from renewable sources. In addition, since resources can be adjusted to meet demand, there is less need to purchase resources based on peak demands and less concern about resources lying idle at other times. One of the criteria for selecting cloud providers can be how they deal with the recycling of obsolete equipment.

As well as providing a greener way to address IT needs, clouds can help with the provision of other sustainable practices. In the Fall of 2009, a committee including participants from CU Parking and Transportation Services and the Environmental Center engaged Zimride to provide an online ride sharing solution for students, faculty and staff. The committee evaluated several options including operating their own web site using open source software but were able to negotiate agreeable terms with Zimride by sharing the cost with other local institutions. Zimride offers its campus edition as a cloud-based SaaS. Using Zimride had the added benefit of offering an expanded potential user pool.

B. Specific Recommendations and Overall Strategy

The adoption strategy for the campus should be a phased approach:

- Build Expertise
- Identify possible IT applications that are candidates to migrate to the cloud and prioritize
- Set clear adoption principles that include checking for alignment with campus goals
- Migrate some applications and evaluate
- Continually monitor the legal situation and rapidly changing case law

**Expertise and Influence Development**

The campus IT group needs to **develop a cadre of experts** on cloud computing to stay abreast of issues such as vendor relations and feedback, assessing legal implications, monitoring and influencing interoperability standards, cloud evaluation, and following and responding to usage trends. We suggest calling this group C^4 (CU Campus Cloud Computing).

The campus should provide a crowd sourcing facility for campus cloud users/interested parties. This could include a way to rate applications (like the five star system used by trip advisor and book review sites). Membership should be drawn from a diverse range of campus communities (faculty, admin, student services, library, academic technology, site licensing…). The IT group should help seed the development of this group, but not be central to managing/operating it to encourage broad development of ideas and concepts and help ensure wide buy-in. The goal is to encourage open-thinking by making the group largely self-organizing in the hope of developing an entrepreneurial and cost efficient approach. There are likely other community needs that could be met by such a facility for other campus IT services.

Look for local outside collaborators (NIST,Google) and connectors such as L3D – lifelong learning and design.

Central IT needs to provide local infrastructure and services in ways that will facilitate cloud adoption (for example, handling identity management and endorsing a standard based approach).

Campus representatives must participate in **guiding the early development of infrastructure and standards**

Need to ensure academic needs are not ignored.

Campus representatives need to be part of **and active in** the organizations such as the Common Solutions Group (CSG) which comprises of the 25 top research universities in US, and the Open Cloud Consortium and looking for coalitions and alliances with similar interests (such as other state institutions bound by similar liability laws and other Research Intensive universities) Campus representatives at the Burton group Catalyst meetings (next - San Diego, July 2010) should include people from outside IT central – eg academic technology reps, faculty to broaden the knowledge base.

**Identify Candidates for Migration**

Look at each key campus IT application that is a candidate for migration and decide if the application can be moved.

We recommend that the first applications that the campus considers using cloud resources to provide should either be new to campus, required upgrades of existing systems, or replacements for systems that no longer function well. Until the campus has more experience and understands the costs/benefits of migrating to cloud services better we suggest not
changing systems which are up and running well. We also recommend that applications that involve sensitive data (such as student grades or personal information) not be considered initially.

For applications that pass the initial selection and are serious candidates for migration follow the current practice of developing a roadmap that identifies what resources are required (and impact on current resources such as campus networks), how the application will be migrated, provides a reasonable estimate of internal and external costs, does a risk assessment, decides on a single or multiple vendor approach, and looks for application dependencies and interdependencies.

Provide guidance by outlining models of cloud usage that follow best practices. Since there are so many types of clouds that can be used it will not be possible to predict all possible issues that any cloud usage will involve in advance. Therefore, a few specific models of cloud usage should be studied in detail to develop an overview of the most likely issues that users will need to consider – these models should be chosen to help map out key parts of the space so that many of the other applications can easily interpolate between these models to get a quick impression of what they need to consider.

Look for applications that integrate well with existing software while recognizing the diverse nature of campus computing.

Avoid proprietary solutions.

Given the specific restrictions on contracting for cloud services that arise from the state constitution it is important that one of the aspects studied/discussed is how compliance and any other legal issues will be addressed.

**Set Clear Adoption Principles**

The campus should develop a standards based process for evaluating cloud providers. This should include a list of questions that all vendors must address to be considered. The process should be repeatable and rigorous and able to evaluate, assess and deploy clouds. The campus may choose to adopt or adapt a process provided by expert consultants (such as the Burton group) while ensuring that the process allows for assessing the total costs/realistic costing of cloud vendor services.

CU must ensure that all cloud vendors’ security procedures comply with federal and state law and all vendors contractually commit to maintain a specific level of security. Because the State Controller’s fiscal rules and the Colorado Constitution prohibit CU from agreeing to indemnify another party, to arbitrate contract disputes or to agree to be governed by foreign law, CU must negotiate to shift risk back to vendors and to edit indemnity, arbitration and choice of law provisions to comply with state law.

CU should negotiate specific levels of service and the right to terminate a vendor services agreement or receive adequate monetary “credits” or damages when a vendor’s performance falls below standards established in an agreement. Further, CU should develop data exit strategies and should include in all services agreements a plan for locating, extracting and migrating data back to CU servers or to a different vendor. It is important to consider how to enforce these agreements if need be – that is, what tools CU can use in such a situation if it develops. As part of ensuring this, the campus will need to consider exit strategies in advance to avoid vendors feeling that CU has no alternative to continuing to work with them.
CU should ensure that any cloud vendor can accommodate audit trail and litigation hold requests and do so in a timely manner.

The campus should only invest in applications that provide future portability- adopt open standards requirements to ensure transferability of applications to another provider. CU should also look for vendors of services hosted within clouds that can work in a variety of settings. The campus should encourage the use of clouds by offering efficient, financially attractive solutions for the majority of needs of campus users. The campus also needs to stay abreast of individuals’ usage of clouds by investing in internal research to identify emerging conversations and efforts. Make “Shadow IT” unattractive through marketing strategies like “float away on the CU cloud” and by helping units modify/adapt centralized solutions that are not a good fit to their needs.

Specific recommendations related to Risk Mitigation/Legal Issues

Given the specific restrictions on contracting for cloud services that arise from the state constitution look at models for addressing liability that will allow easy compliance. For example, could the equivalent of a landlord/tenant model which limits the liability of the vendors and allows the campus to insure itself against some amount of risk be developed that would satisfy the legal needs?

Task a group to look at how best to wrap cloud services to control access/encrypt data being sent off site and look at general strategies to mitigate risk.

Develop appropriate policies and enforcement mechanisms to minimize risk and ensure meet compliance requirements.

Consider looking at risk from the perspective of different campus user groups (students, faculty, administrative staff) as well as by specific applications.

Using cloud based systems may challenge current licensing models which are often linked to a particular machine rather than a particular user. Negotiations of any new licensing agreements should consider the possibility of cloud usage and incorporate this option.

C. Long & Short Term Objectives/Timeline

Immediate:
Identify critical stakeholders and develop cadre of cloud innovators and experts that interact regularly. Charge this group with developing a more detailed plan including a list of roadmap questions and evaluation criteria.
Look for possible local collaborators such as participants from NIST and Google. Look for “connectors” between efforts.

Short Term:
Develop a list of questions/guidelines to identify and prioritize candidates for migration.
Develop and evaluate the RAP prototype.

Medium Term:
Have a rigorous and reliable process for migrating applications to the cloud
D. Possible Risk

There are certain inherent risks to University data when utilizing cloud services. If the provider fails, is purchased, or changes the terms of service access to University data may be adversely impacted. Some provider agreements may not protect, or even transfer to the provider, intellectual property rights.

Those who are arranging for cloud computing service may be under the impression that they are transferring risk to the provider. However, unless the provider agreement explicitly addresses security requirements risk still remains with the campus. To both protect University data and transfer risk requires establishing a contract with the third party to appropriately articulate required protections.

We are in the infancy of this field – which providers and systems will survive through to maturity is not clear. So, in general, consideration of recoverability issues from provider failure and transportability to other providers is important. This means that attention needs to be paid to sustainability and the trade-offs involved in engineering in any dependence on a specific product or feature. CU should avoid entering into markets where arbitrage seems to be in play.

E. Resource Allocation

It is very important that the IT group and the Campus administration recognize the need for an upfront investment in cloud computing and that this investment will initially focus on allocating human resources to planning, evaluating, and developing cloud based applications. As part of this, the IT group needs to be paying attention to the skill set it needs to be hiring and developing so that the human resources allocated are able to be most effective. The likelihood is that this investment will be repaid with a good return – but the savings will not be immediate.

Given the wide range of services likely to be provided and the variation in the users of these services it is likely that there will be many models for funding these services. Once the funding requirements are established consideration will need to be given to if the service will be supported through the GF or on a cost recovery basis or by a mix of these.

The costs will be very dependent on the details of the model adopted and the application. To give some idea of the range, a ballpark cost estimate for a private dedicated cloud facility puts it in the $1M region if there is little or no existing infrastructure present, decreasing to around $500K if significant datacenter and networking infrastructure is already in place. At the other end of the scale providing a server and a reasonable amount (about 100GB each) of storage for around 50 users would currently cost around $10K. Some things that will need to be considered in the cost model are licensing, the delivery infrastructure/network needs, storage requirements, vendor support, development needs, and providing long term support. It should be noted that while cost savings may be achieved in many service elements, networking costs should be expected to rise as cloud computing nearly always place a greater burden on the network.

F. Responsible Parties

ITS Program Management Office, Legal counsel, Campus-wide Governance Group.

G. Evaluation
• Need to set up a group to discuss and develop strategies.
• Look at if the tools can be shown to actually help the units function, e.g. Does Doodle have demonstrable advantages over a central calendaring tool? Does Voicethread increase student learning?
• Develop a metric representing the ratio of campus standards based cloud computing to un-vetted services.
• Monitor number of users of key cloud services and develop measures of the adoption rate of centralized services and the level of satisfaction of downstream data users and data owners.
2.3 Campus Strategy for Mobile Computing Support and Services

Major Issue: Handheld, or “highly mobile,” communication and computing devices are currently pervasive among campus faculty, students and are already integral to students lives and campus business. CU-Boulder must plan for these devices being ubiquitous, increasingly more capable, and the assumed method of interaction with many, if not all, on-line information and collaboration services.

A. Background/Rationale

Cellular phones with cameras, texting and multimedia messaging are currently lowest denominator devices among CU-Boulder faculty, students and staff. According to the most recent statistics from Comscore (see http://comscore.com), nearly 30% of all cell phones are used to browse the web and this is an increasingly upward trend. It is safe to assume that within the time window of this plan all campus constituents will have increasingly powerful mobile computing devices with very capable browsers and on-device compute, graphics, and storage.

It’s conceivable, if not likely, that in fewer than five years it will be expected that much of the knowledge work, communication, and collaboration that is currently done using “traditional” keyboard/mouse/screen computers be most naturally done via highly portable devices that have high speed network access whether on campus (anywhere on campus), at home, at the park, or studying abroad.

A majority of newly recruited students, staff and faculty will either have a smart phone, a phone that connects to the Internet or will have a text messaging plan. Whether this is true for all students or not, for CU to remain cutting edge, and stay a renowned, technologically advanced, university for recruitment purposes, service geared towards those that have this technology is a must.

The portability and the capabilities of these devices will lead to new approaches in teaching, learning, working, and collaborating that can’t be anticipated today. However, there are many scenarios that are not only imaginable, but immediately possible and perhaps even essential in meeting the expectations of today’s students, faculty and staff.

Example Scenarios

Student Administration:
- A student, using her phone, drops a course while sitting in the classroom;
- An applicant researches campus and course information at lunch using her phone;
- A student retrieves final grades on phone for mom and dad on the way home from the airport during Christmas break!

Teaching and Learning:
- Student retrieves and views recorded lecture or supplemental multimedia course materials while riding the bus,
- Students use phones in class as “clicker” response units,
- Simple and no-extra-cost point-point faculty-student communication without regard for the location.
Research:
- Field research using GPS capabilities for location finding,
- Collaboration from the field using cellular devices,
- Share licensing and infrastructure costs if multiple researchers need similar software or devices.

Emergency Communication:
- “Push” messages to devices with alerts,
- Location aware messaging to devices alerting people in a particular building of some life/health situation.

Enterprise Communication:
- Replace radio “walkie-talkie” devices with multi-function phones that can use campus or carrier networks;

Landline Replacement (or augmentation):
- Landlines phones in dorm rooms have already been removed,
- Department replaces or augments landlines by providing cell phone to staff.

Barriers to Adoption:

We have infrastructure challenges. A cell phone signal strength analysis was done for all the buildings on campus including residence halls. The results found that the residence halls have some areas with some carriers that have poor reception. Likewise it was discovered that most campus buildings have even more cell signal strength problems. Areas with poor or no signal affects both the delivery of content and communications for students and cause dangerous situations where faculty, staff, students and visitors are not able to use their most on-hand communication devices in the event of an emergency to access services or dial out for assistance.

Smart phones are not yet ubiquitous. According to the ECAR Study of Undergraduate Students and Information Technology, 2009, at least 90% of undergraduates own a cell phone. Some 63% of undergraduates own Internet capable phones or plan to purchase them within the next year. However, only slightly more than half (33%) of those students use the phones for internet access. (This corresponds with the above noted Comscore data). A larger number of students (35%) do not have Internet capable phones and do not plan to purchase one in the next year. Many of those who do not access the Internet with their phones cite the cost of the phones and the cost of data plans as reasons.

On the other hand, according to the ECAR study, 9 out of 10 undergraduates use text messaging with a median frequency of “daily”. It should be noted, however, that currently unlimited data pans from major carriers typically cost only about $10/month more than unlimited texting plans, so cost isn’t likely to continue to be a factor in whether students use their phones for Internet/web access.

Current applications are not oriented toward mobile devices. The only service specifically targeted to mobile devices is the Rave emergency notification service. Also, students waiting for technical assistance at the walk-in center in Norlin Learning Commons provide a cell phone number and are texted when it is their turn.
Most campus and university administrative applications are web-based and while many of them may display acceptably on the higher-end mobile platforms, very little thought has gone into the mobile experience. Little or no testing has been done to understand how on-line applications (like CULearn, CUConnect, CUIdm, the new expense system, etc) work on the various mobile platforms.

Some of the most useful web-based functions that students, faculty and staff might like to access via a mobile device either have sophisticated workflow (examples are the shopping-cart schedule builder in the new ISIS system, and the approval processes in the new expense system) or have a purposeful look and feel designed to work optimally with traditional display/keyboard/mouse in mind. The browser capabilities, display sizes, and user input capabilities on even current state-of-the-art handheld computing devices do not allow for an acceptable end user experience with these applications.

Current university and state policy pose barriers for employees. The administrative burden that currently comes with either accounting for personal use of a university owned device, or business use of a personal owned device are burdensome and act as a disincentive for campus departments or employees to make widespread use of their capabilities as part of doing business.

B. Accomplishments to Date

Some steps have been taken by campus departments in recognizing mobile communication as a currently viable and a growing trend:

- **Wireless carrier coverage study**: As noted above, a study has been conducted to assess cell carrier signal strength in campus buildings. The conclusion is that about 50% of the indoor space on campus has weak, poor, or no service to some or all of the major national carriers (AT&T, Verizon, TMobile, Sprint/Nextel). New, LEED certified, construction is particularly disruptive to cell signals.

- **Emergency communications via SMS**: The campus very successfully uses the Rave notification service to send texts to registered phones in case of emergency or urgent need.

- **Walk in technical service center notifications via SMS**: Students can get technical support or help using their personal computers at the ITS walk-in center in the Norlin Commons. They are served on a first-come first-served basis and during busy times, students use an on-line form to sign in and provide a phone number to text when it is their turn. They then don’t have to wait in line for their opportunity to get support.

- **Landline replacement in dorms**: Landline phones are not provided by default in the residence halls. Very few students request one.

- **Nextel push-to-talk phones used by Facilities Management and ITS**: Maintenance workers and other “dispatched” jobs rely on push-to-talk “walkie-talkie” functionality on Nextel phones to communicate with each other and the central dispatcher.
• **Pagers:** Many employees who once carried pagers for emergency contact now rely on text messaging to their personal phones as a replacement (so as not to carry two devices).

• **4.9Ghz Mesh Network Study by Public Safety:** The Department of Public Safety has completed a scope and cost study for implementing a campus mesh network using the 4.9Ghz band (which has been designated for public safety use by the FCC).

### Action Plan

**A. Explicit Assumptions**

The mobile application space is immature and subject to rapidly changing capabilities and uses, evolving standards, and disparate strategies among major hardware and software vendors. Today, the most capable applications are written for specific devices with specific capabilities that are served by specific carrier networks with their own restrictions. **It is our assumption** that web browser capabilities in mobile devices will rapidly improve and adopt open standards such as HTML 5, CSS, and Javascript so that very rich and capable web-based applications that are platform and carrier independent can be deployed, avoiding the need to write for any specific platform.

A challenge for device independence will be accessibility. Some devices, notably the iPhone 3GS and new versions of Android, have accessibility features such as voice screen readers, speech to text, high contrast display settings, and extreme zoom. Nonetheless, care will be needed to ensure adequate accessibility of applications designed for mobile devices, including being sure that these applications are operable on platforms that can be used (for example) by people with motor challenges.

It is also an assumption that, while mobile devices can be an invaluable asset with respect to life/safety concerns, they also present reliability concerns. Batteries die. Signals get disrupted, networks become overloaded, and what is mobile can be dropped, broken and lost. Campus strategy must continue to provide highly reliable land-line telephone service and all safety guidelines and regulations with regard to proximity of a working phone respected.

**B. Specific Recommendations**

1. Expand wireless coverage on campus so that it is “ubiquitous”. This consists of both expanding the campus wireless network to outdoor areas so that a vast number of devices can use it without incurring monthly carrier data charges AND expanding in-building coverage of the major wireless vendor networks so student/faculty/staff customers of those carriers have signals in basements, stairwells, etc. (This includes evaluating installation of a distributed antenna system (DAS) within campus buildings, assessing use of university owned spectrum in the 2.5Ghz band for WiMAX coverage, and assess deploying 4.9Ghz band coverage across on campus for public safety use.)

2. Immediately start development of a basic set of CU-Boulder branded mobile apps based on the MIT Mobile Web project, within the framework of the iMobileU Initiative. Continue to maintain and enhance this over time.
Applications that should/could be part of an initial suite of applications (in no particular order):

- Campus maps and location photos
- Campus RSS news and announcements
- Bus schedules w/ nextBus tracking of available busses
- Whitepages directory search
- iTunesU
- Open seats in computing labs
- Campus event/academic calendars

Longer-term, we should explore effective uses of location aware or augmented reality applications. An example may be a simple “beacon” application that allows a student to select a building or location on a campus map and then continually points them in the correct direction until they arrive at the selected place.

3. Immediately explore expanding use of SMS text messaging to provide info beyond emergency notifications to include other categories of information pushed to phones as well as some basic information requests initiated on demand by the person sending an SMS information request.

4. Immediately adopt a “convergence” strategy for all current and future web applications that assumes applications will be accessed by mobile devices and plans appropriate changes or additions to the application interfaces.

5. Immediately explore possible changes to administrative policy or processes that make it less onerous to procure and use mobile devices when there’s no easy separation between business and personal use.

6. Establish ongoing management/oversight functions that examine:
   - Emerging technologies and service options for comprehensive wireless coverage on campus for emergency communication and other purposes.
   - Trends in student, faculty, and staff device choices, including evidence about how often services are actually used on devices of different types.

C. Long & Short Term Objectives/Timeline

Short Term (2010):
- Understand options and costs for expanding coverage in buildings.
- Assign some cross-campus resources to begin “playing with” iMobileU platform.
- Evaluate expanded Rave services.
- Draft, publish, and communicate a “guidance” document imploring those who deploy and manage application to start planning for mobile convergence.

Longer Term:
- Have a viable and funded plan for expanding cell carrier coverage into buildings;
- Have deployed an initial suit of CU-Boulder “branded” mobile applications;
- Have an active, cross-campus (cross university?) development and oversight function to facilitate continued development and planning of mobile applications;
• Have a mobile strategy documented for a specific set of key university applications (eg. Campus Solutions, CULearn, etc).

D. Possible Risks

• Possible high cost and complex logistics of providing carrier coverage to interior spaces (current estimate is approximately two million square feet to be covered @ $1-$2 per square foot).
• Prioritizing mobile application development as budgets decrease, resources are overloaded, and the ISIS project remains a high priority.
• BUT – there is an opportunity risk: NOT acting on these recommendations and creating a mobile presence has the risk of falling behind our peer institutions and not meeting the expectations of our students and faculty.

E. Resource Allocation

Cost of the recommendations:
As noted above, there is a potential infrastructure investment of $2M-$4M to provide cellular coverage within campus buildings; however, we are exploring possible ways of not incurring these costs (having vendors bear them).

If currently owned 2.5Ghz spectrum is not viable for outdoor wireless coverage for public safety use, a proposed 4.9Ghz mesh network is expected to cost $550K.

Other costs would be in the form of deploying campus resources – an estimated team of 2-3 part-time developers - to create an initial application suite.

Indirect costs would be imposed on other campus application managers by requiring them to deploy mobile friendly versions of their applications. These costs could vary widely, as some of these applications are vendor provided and may simply start coming “out of the box” mobile ready, while others may take considerable effort to “mobilize”.
2.4 Developing Rich Collaboration Tools

Major Issue: An increasing number of collaboration technologies exist which facilitates communication, coordination, and shared content authoring for individuals working in a partnership. Collaborating through these technologies is poised to be a way of life across academia. No consistent approach exists for developing a common collection of collaboration tools across campus. If employed, a consistent approach would improve all aspects of the space including, but not limited to, cost models, support models, ubiquitous access, and robust, scalable solutions.

CU-Boulder needs to progress the adoption and development of functionally rich collaboration tools in four specific areas. 1) The campus community needs one, or more, “shared canvas” tools. 2) The campus community needs one, or more, content and media repository tools. 3) Enhancing communication using video and videoconferencing by embracing greater standardization, support, and deployment of video technologies. 4) Adopting a unified communications.

A. Background/Rationale

Shared Canvas Tools
Shared canvas tools, such as wikis and blogs, have been requested by academics, researchers, and administrative users on campus for a gamut of needs. Students, faculty, and staff rely upon external social networks, such as Facebook or LinkedIn, and external messaging and productivity tools, such as Gmail and GoogleApps, to fulfill needs unmet by CU-Boulder services. Many use cloud sources without consideration of security concerns about data, and many would like to have a campus option.

Content and Media Repository
Sharing content and media such as publications, images, audio, video, or large research data sets presents several technology problems. Solutions for sharing must accommodate broad audiences of both CU-Boulder specific and external users. As with the outsourcing of shared canvas solutions mentioned above, these localized solution may not address security, privacy, and intellectual property issues as completely as a campus solution would.

Video and Videoconferencing
A number of diverse videoconferencing facilities exist today on campus. Some are managed by departments with IT units, some built by a grant with no support structure behind it. Though many installations have occurred, CU-Boulder has not fully developed and supported a videoconferencing service model. Without a standard service model, the campus may see reduced overall value of these videoconferencing investments due to limitations in interoperability, difficulties in supporting more technologies than necessary, and an inability to aggregate equipment purchases in a way allowing for the negotiating of preferential pricing agreements with vendors.

The importance of videoconferencing will continue to rise as access to services becomes more prevalent and as needs for the services increase. Flagship 2030 identifies the development of East campus as a strategic effort that will extend for multiple years. There will be significant needs around collaboration between Main and East campus, sharing data and virtual work
spaces, and virtual transportation. Some researchers have very distinct needs for extremely high resolution communications when working with physical lab equipment or projects. Many different needs, with increasing importance over time, require attention.

**Unified Communication**

Unified Communications technologies attempt to combine all of the ways individuals communicate, initiate contact, leave and receive asynchronous messages, and communicate their availability and status information into a single, integrated suite of applications. These capabilities become possible through the deployment of a Unified Communications solution, though not all solutions encompass all areas. Each solution provides a unique collection of capabilities.

Unified Communication technologies integrate tightly with voice, voice messaging, electronic messaging, calendaring, and LDAP directories. Since all of these capabilities are offered as campus wide, enterprise services, achieving the majority of Unified Communication capabilities requires strategic investment in a campus wide solution. Individual colleges, schools, and departments have limited ability, and for some of the specific Unified Communication functionality, no ability, to provide these services on their own.

**Relationship to Flagship 2030**

The strategic plan recommendations for developing Rich Collaborative Tools (RCT) align with specific action items promoted in Flagship 2030. These include the following:

- Curriculum Enhancements
- Developing a New Research Model
- Investing in Our Staff
- Serving the State of Colorado
- Internationalize the Campus

**B. Accomplishments to Date**

- Reservable locations exist across campus that provide installations of videoconferencing.
- Campus, including ITS, has been researching desktop conferencing tools that can be used across campus, and tie in to the room based VTC (videoconferencing) systems.
- ITS has opened up the Learning Management System, CULearn, to CU Community uses - anyone can request shared canvas spaces and collaborate within them today.
- ITS and faculty collaborators are working on a next generation learning system, that will have sophisticated wikis, blogs, shared data space, federations and partner access, etc. This is in the works for campus rollout for Spring 2011.
- The new capital construction projects, which tend to outfit 100% of rooms with technology, are moving into a more standards-based direction around collaboration tools in the physical space - distance learning, lecture capture, videoconferencing.
- A central, “common good” Microsoft Exchange 2007 service is being deployed by ITS.
- Many Unified Communications technologies integrate with Microsoft Exchange.
- An iTunesU initiative and a YouTube EDU initiative are underway.

**Common assumptions across all four categories of RCTs**

Because there are overlapping assumptions across all three categories of RCT, they are highlighted in this section before specific assumptions about each tool is discussed in its own section.
Appropriate funding is needed for RCT; additional or new funding sources may need to be identified.

As much as possible, Universal Design should be considered and should be a feature of any product/service acquired or developed for RCT. ITAG and/or other appropriate review committees should review any campus-wide systems purchased or developed for usability, effectiveness, and section 508 accessibility compliance.

The process for selecting specific RCT technologies should include collaboration and input from campus groups such as the Boulder Faculty Assembly (BFA), Chancellor’s Committee on Programmatic Access, and similar groups.

Sufficient support personnel and resources (ITS Tiered support system/5-Help) need to be provided for RCT systems.

As new tools and pedagogical techniques become more popular, new technological and human support systems will need to be developed to close the gap between the new and the existing tools.

**Specific Recommendations across all four categories of RCTs**

We will treat each of the four main categories of Rich Collaborative Tools in separate sections below. Common areas of concern for all four categories share the following recommendations:

1. Make sure the network infrastructure can handle the increased load of rich collaboration tools, e.g. bandwidth requirements, multi-cast requirements.
2. Develop some level of oversight for rich collaborative tools.

Surrounding issues include:
- Outsourcing tools to 3rd party vendors vs. localizing tools on campus.
- Develop redundant “back up” systems for each tool used.
- Use International Telecommunication Union definitions and other industry standard terms when writing about RCT.
- Keep an eye toward “emerging” technologies.
- All four RCT categories should account for potential emergency communication needs during implementation.
- Emphasize outreach efforts to campus affiliates prior to, during, and after any implementation.
- Reach out to different units on campus to assess their current usage and their needs surrounding the use of rich collaboration tools.
- Should address where any IP (Intellectual Property) protection plans should be reviewed and incorporated in the solutions.
- Develop governance model for this initiative.
- All four RCTs should be treated as enterprise strategies.

Possible Risk across all four categories of RCTs
Given the type of convergence, richness, and shared capabilities of the new tools adopted, educational technology support services and IT security teams will need to work more closely together to bring a wider-angled response to the heightened risks involved.

The adoption of more tools for collaboration also suggests the possibility of more hires at IT security.

Due to the very nature of RCTs, collaboration means students and researchers will share more data, so involvement from the Registrar's Office and the CU Legal Department may be necessary in order to include all FERPA considerations in tool deployment. Since the collaboration involves university owned content, questions about where the content resides and how it can be accessed also need to be raised.

Given that the definition of RCT invariably includes an abundance of video, high-resolution still images, and audio, the risk that it is not ADA compliant is also very real. Section 508 adherence is a must, which means incorporating functional performance criteria in all technology choices; therefore, an abundance of audio and video can pose an economic risk as it may require expensive 3rd party transcription, a technology that will diminish in price over time but currently is a very expensive service.

Evaluation across all four categories of RCTs

- The evaluations for all implementations should be iterative and longitudinal. Data should be derived from all end users: faculty, staff and students.
- Evaluations should be quantitative and qualitative with focus groups as one option for eliciting more qualitative data.
- Faculty Course Questionnaires would be a good means of data collection.
- Pilot programs of any new tool should include a survey, but we could repeat the evaluation later on to have a longitudinal picture of the adoption process. This would enable us to capture the change of attitudes towards the technology and perhaps even why the change occurred.
- Periodically conduct future benefit/cost and investment analysis to justify and document benefits.

B. Action Plan

Shared Canvas

Explicit Assumptions

Identification of currently existing resources would determine commonly used shared canvas technologies to inform the selection process for developing robust shared canvas tool sets. Strategic recommendations for infrastructure and robust shared canvas tool set must evolve from this effort for it to be of value.

Specific Recommendation
• Perform an in depth, campus wide assessment/audit of current shared canvas tools and resources.
• Select and implement one or more shared canvas tools as a "common good" enterprise service available to all CU-Boulder students, faculty and staff.
• Provide adequate infrastructure and scalability to support sustainable growth.
• Develop support and training for the shared canvas solution(s).

C. Long and Short Term Objectives/Timeline

Objectives:

Short term – Assess and plan for implementation and conduct a proof of concept.
Long term - Put in place the shared canvas tools to serve the community. Evaluate for effectiveness.

August/September 2010: Conduct assessment and plan implementation; report due in Fall 2010. The report should include specific recommendations including the evaluation for the implementation.

February/March 2011: A progress report detailing all accomplishments and commitments to date should be issued.

October 2011: Phase I completion date.

May 2012: Evaluation of Phase I.

January/May 2014: Overall project completed along with final evaluation.

Resource Allocation

CU-Boulder needs for RCT will likely require more than one tool. For each tool, there will be high expenditures and personnel resource commitments.

Three tools would require approximately $150,000 to $400,000 for the hardware and software infrastructure and 2-3 additional staff for implementing, maintaining, and supporting the tools. Exact figures depend upon the specific technologies selected.

Responsible Parties

ITS, Campus-wide Governance Group(s) ITC, CEC, etc. Organizational Unit Information Technology support personnel

Content and media repository tools

A. Explicit Assumptions

Identification of currently existing resources would determine commonly used content and media repository tools to inform the selection process for developing robust tool sets. Strategic recommendations for infrastructure and robust content and media repository tool set must evolve from this effort for it to be of value.
There will be some repository tools that need to be local, but there may be some that can be cloud-based. The issue will be to create a set of criteria to determine which data is eligible for the cloud. By default, no data should be stored in the cloud without passing certain security requirements, especially FERPA regulations.

B. Specific Recommendation

Perform an in depth, campus-wide assessment/audit of current content and media repository tools and resources.

Select and implement one or more shared content and media management repository tools as a “common good” enterprise service available to all CU-Boulder students, faculty and staff. Provide adequate infrastructure and scalability to support sustainable growth. Develop support and training for the repository tool(s). This recommendation should be cross-referenced with content management recommendations from sections Offering Teaching and Learning Tools (1.3) and Developing Web Infrastructure Services (2.6).

C. Long and Short Term Objectives/Timeline

Objectives:
Short term – Assess and plan for implementation and conduct a proof of concept.
Long term - Put in place the content and media repository tools to serve the community. Evaluate for effectiveness.

August/September 2010: Conduct assessment and plan implementation; report due in Fall 2010. The report should include specific recommendations including the evaluation for the implementation.

February/March 2011: A progress report detailing all accomplishments and commitments to date should be issued.

Oct 2011: Phase I completion date.

May 2012: Evaluation of Phase I.

January/May 2014: Overall project completed along with final evaluation.

Resource Allocation:

CU-Boulder needs for content and media repositories will likely require more than one tool. For each tool, there will be high expenditures and personnel resource commitments. Two tools would require approximately $100,000 to $250,000 for the hardware and software infrastructure and 2-3 additional staff for implementing, maintaining, and supporting the tools. Exact figures depend upon the specific technologies selected and the total disk space required.

Responsible Parties:
ITS, Campus-wide Governance Group(s) ITC, CEC, etc. Organizational Unit Information Technology support personnel
Video and Videoconferencing

A. Explicit Assumptions

Identification of currently existing resources would determine commonly used video and videoconferencing technologies to inform the selection process for developing robust shared canvas tool sets.

Strategic recommendations for infrastructure and robust shared canvas tool set must evolve from this effort for it to be of value.

B. Specific Recommendation

The campus should develop videoconferencing standards for software and hardware and the final choice should be based upon alignment with campus needs, reliability, cost, and ease-of-use.

- Interoperability needs to play a critical role in selecting videoconferencing standards.
- Once standards exist, CU-Boulder should work out deployment and training.
- The campus should invest in tools that connect multiple people “where they are” rather than investing in high-end, very costly “Telepresence” solutions.
- Nevertheless, the campus should remain informed about improvements in pricing for and use of “Telepresence” technology and prepare to deploy as it becomes a standard nationwide.
- The campus should consider a solution that features a combination of fixed and mobile devices.
- The campus should continue/expand CU-Boulder’s relationship with CU-Denver’s videoconferencing “bridge” facility and invite other CU campuses to participate in such facilities.
- The campus should consider investing in our own “MCU” or multipoint control unit.
- The campus needs to provide for video specific aspects of classroom (peer-to-peer and multi-point and multi-participant), interactive web-based conferencing and lecturing, and high-definition functionality in certain spaces on campus.

Long and Short Term Objectives/Timeline

Objectives:
Short term – Assess and plan for implementation and conduct a proof of concept.
Long term - Put in place the video and videoconferencing tools to serve the community.
Evaluate for effectiveness.

August/September 2010: Conduct assessment and plan implementation; report due in Fall 2010. The report should include specific recommendations including the evaluation for the implementation.

February/March 2011: a progress report detailing all accomplishments and commitments to date should be issued.

October 2011: Phase I completion date.
May 2012: Evaluation of Phase I.

January/May 2014: Overall project completed along with final evaluation.

C. Resource Allocation:

Videoconferencing technologies will require large investments in hardware and software infrastructure as well as personnel time for developing standards, implementing solutions, and training and supporting campus.

A needs analysis will determine how many of the VC rooms the campus should deploy. Each high quality conferencing center could be $150,000. The more security we build into the solution, the more money it will cost.

D. Responsible Parties:

ITS, Campus-wide Governance Group(s) ITC, CEC, etc. Organizational Unit Information Technology support personnel

Unified communications

A. Explicit Assumptions

Identification of currently existing resources would determine commonly used unified communications technologies to inform the selection process for developing robust shared canvas tool sets.

Strategic recommendations for infrastructure and robust unified communications tool set must evolve from this effort for it to be of value.

B. Specific recommendations

CU-Boulder needs to research and adopt a standard approach for a unified communications solution, negotiate licensing, and determine implementation, support, and training needs. When considering integrations with telephony versus messaging/calendaring, the campus must decide whether to emphasize enhanced call routing features or the integration of desktop productivity applications for computers.

The Unified Communications strategy must also consider and provide direction for Voice Over IP (VOIP) integration and implementations. Provide adequate infrastructure and scalability to support sustainable growth. Develop support and training for the Unified Communications solution.

C. Long and Short Term Objectives/Timeline

Objectives:
Short term – Assess and plan for implementation and conduct a proof of concept.
Long term - Put in place the unified communications tools to serve the community. Evaluate for effectiveness.
August/September 2010: Conduct assessment and plan implementation; report due in Fall 2010. The report should include specific recommendations including the evaluation for the implementation.

February/March 2011: A progress report detailing all accomplishments and commitments to date should be issued.

October 2011: Phase I completion date.

May 2012: Evaluation of Phase I.

January/May 2014: Overall project completed along with final evaluation.

D. Resource Allocation

Unified Communications will require a significant investment. Hardware and software solutions range from $100,000 to $500,000 and additional personnel would be required to implement and maintain the service.

E. Responsible Parties

ITS, Campus-wide Governance Group(s) ITC, CEC, etc. Organizational Unit Information Technology support personnel
2.5 Increasing Staff Effectiveness and Efficiency through Technology

Major Issue: Integrating IT with business needs in a cost effective manner thus increasing staff effectiveness and efficiency. Current challenges are related to a misalignment between technology services and staff needs as each area is often independently addressed or evaluated. While we believe opportunities for quick gains in efficiency and effectiveness exist, long term success ultimately is based on a commitment to shared values, principles, and objectives that consider business needs and supporting technology in a holistic manner.

A. Background/Rationale

The past decade has been one of constant technological change that is often burdensome to staff and faculty. This change has had an impact across every spectrum of staff work, but the most notable recent changes include major budget reductions across the campus, significant enrollment increases, state and federal compliance issues on numerous issues, and the rollout of the new student information system. Campus staff must adapt to these changes, often without the benefit of sufficient resources being applied to address change consequences.

Despite formidable challenges employees have accomplished amazing feats of business productivity with minimal resources. With little likelihood of an immediate improved budget climate and the strong likelihood that the pace of change will only increase, improved operations through efficiency and effectiveness are a necessity.

Shared values, principles, and objectives are commonly considered pillars of success for large organizations. Long term success for any organization requires a common vision and a shared strategy to achieve that success. We recommend the university as well as each campus operation adopt the following principles in delivering information technology services:

- Prioritize business needs and provide supporting technology in a holistic manner.
- Develop a common understanding of what effectiveness and efficiency is.
- Promote and develop the concept of customer service excellence.
- Maximize current technology to achieve immediate efficiencies.
- Reward effective uses of technology and technological standards that promote quality, accessibility, and ease of use.

B. Accomplishments to Date

There have been significant accomplishments in managing and adapting to considerable change; however, the accomplishments that worked well when implemented often don’t always keep pace with the dynamic environment. Noted accomplishments include: updated and integrated financial and human resource systems, increased support for mobile, wireless, and cross-campus communication, an increase in “common good” services including improved product licensing, increasing shared or integrated services, and highly visible security policy and communication programs.

Units on campus typically work well together to accomplish campus objectives, but there are points of friction between technology and business needs that have created disharmony. There is a growing gap between the needs of clients, business end users and IT regulatory, security, and standardization requirements. Regulations, security and standardization can place
significant additional burdens on end-users, particularly if they are imposed without first
supplying resources and sufficient training, or if they require end-users to create burdensome
workarounds.

The gap can be partly explained by the highly diverse needs of a tier one research university.
Additionally, the pace and complexity of change has escalated such that workers must become
more specialized in their own area of expertise and thus are less familiar with challenges faced
by other units. Because expertise resides within both the technology arena and in business
systems, linking expertise across organizations and technology support units to provide
contextually appropriate solutions and services will mitigate change complexity.

Action Plan

A. Explicit Assumptions

The effectiveness of these recommendations depends on campus leadership at all levels
embracing these values, principles, and objectives as central to all business decisions. Campus
leadership must establish priorities, assign accountability, and create communication plans that
promote collaboration, customer service, and professional development.

Significant new technological investment is not required to achieve the goals of this
recommendation; however, we assume that specific individuals will be identified to assume
responsibility for the report recommendations, empowered to allocate or reallocate resources,
directed to form working groups, committees, or resource pools. We assume a governance
forum will be established to set transparent campus priorities. Given current fiscal constraints,
the objectives defined herein assume this responsibility and prioritization is necessary.

B. Specific Recommendations

1. The campus needs a better understanding of its collective present and future business
needs in order to systematically build efficient technological systems and processes. Holistic
business/technological planning requires anticipating, recognizing, and adjusting for inherent
change. We recommend the campus create an administrative organizational structure
dedicated to identifying, planning, and building efficient business processes using
technology. We recommend that this unit be dedicated to business analysis, problem
solving, and utilizing existing talent to improve efficiency.

The Flagship 2030 goals provide insight regarding emerging administrative needs. For
example, globalization will create administrative challenges that may include the need for
24/7 access to all systems, accessibility for non-English speaking personnel, remote access,
and global service centers. Although the timeline for Flagship 2030 goals is uncertain, there
is a general expectation that the campus will align operations with these goals as resources
and circumstances allow. These long term changes and short term challenges suggest a
need for a formal business planning structure.

Often referred to as business analysis, or business process management, holistic planning
requires business analysts to understand the needs of different groups, translate jargon and
bridge innovative thinking and effective problem solving.
Staff members working in diverse and distributed positions can recognize and contribute towards these goals, provided there is a well managed forum for managing the communication, correlation, and integration of these ideas into concrete priorities.

2. We recommend a commitment to developing and promoting a common understanding of what staff effectiveness and efficiency is. To achieve this, a dedicated and diverse administrative technology planning function must be identified to define measures, ensure clear communication and understanding, and to ensure consistent, ongoing evaluation of business effectiveness and efficiency objectives. Consistent application of effectiveness or efficiency priorities cannot be assured without meaningful measures and evaluation for all priority applications.

Today, inefficiencies are largely unrecognized and are collectively costly to the University. We have no commonly understood, measurable benchmarks to objectively evaluate effectiveness and efficiency for specific business processes. We have no mechanism for evaluating whether business processes enhance or diminish overall organizational effectiveness.

The campus must recognize shortcomings within our current systems that have inadvertently contributed toward inefficiencies. For example, the lack of an administrative structure for business planning has led to the creation of countless “shadow” systems. These systems may represent an innovative effort to make up for inadequacies in the functionality or effectiveness of enterprise systems, or an inability to adapt to the demands of those systems. In either case, the resulting systems often do not result in sufficient attention to improving enterprise systems and often demonstrate redundancy and a lack of rigorous quality assurance or adequate lifecycle support due to skill or resource barriers.

3. We recommend that the IT service environment promote and encourage a customer service orientation that better understands the needs of end users within the context of their business environment.

The fast and furious pace of technological innovation can provide distraction or obstacles for the average staff member who may not recognize the reason for change or who that change might serve. Left to their own resources, staff members may not be able to keep pace with technology opportunities, or even in distinguishing a technology’s potential value. It is important to recognize that the profile of an average staff member varies considerably in terms of business function, the resources available to them, and their technological proficiency. A customer service orientation would support end users with an appreciation for the difficulty and constraints end users experience in trying to keep pace with and understand technology. Complexity and change create inefficiencies as staff members require consistency and predictability to efficiently complete tasks. Highly diverse business needs across the campus require an agile, flexible customer service model that can address the specific needs of that business. A “one-size-fits-all” service model can compromise effectiveness and efficiency.

4. We recommend that current technology be better utilized to achieve immediate efficiencies.

The campus should promote and take advantage of existing technologies by identifying “low hanging fruit.” This committee could not measure or evaluate the extent to which current technology functionality is presently underutilized. However, across campus there are individuals who undoubtedly have first-hand knowledge and ideas worth consideration. We
believe there are two primary strategies for cultivating an environment that encourages staff members to engage in the improvement of our current systems: professional development and communication.

Targeted, accessible, and high quality training and development must become an embedded expectation that encourages staff to routinely engage in supportive professional development. Staff members should be strongly encouraged to engage in professional development opportunities outside their areas of immediate expertise. Throughout their career, staff members should be regularly and intentionally exposed to a wide range of topics that might include project management, customer service, accessibility, business processes design and management concepts, etc., in order to recognize and react to changes in the business environment and facilitate the adoption of technology.

Communication across units is the underpinning of this type of business and technology collaboration. Networking groups and consortiums can achieve cost savings through sharing best practices. There are also the intangible benefits of relationship building, developing expertise, establishing benchmarks, rapid learning, avoiding duplication of errors, and establish common ground. Groups encourage entrepreneurial partnerships.

5. We recommend that the campus promote and reward the adoption of standards based approaches for technology where it promotes accepted best practices, such as in areas like ADA accessibility. Many staff functions are repetitive and predictable, and would be well served by consistent approaches. This does not preclude the adoption of flexible and adaptive methods, but rather highlights that general staff needs may be significantly less able to adapt to unguided dynamic design elements than within other campus communities.

Meeting this requirement requires business units to identify, agree to and accept recommended standards or best practices. Business units will adopt agreed upon standards when it is delivered in ways that are easily accommodated and not difficult to comprehend. Consistent communication strategies that demonstrate the benefits of standardization and best practices for the business unit will promote rapid adoption.

For example, consider that the standards proposed for application accessibility are important due to regulatory requirement compliance; however compliance itself is often not convincing enough to encourage participation. We must demonstrate that standards improve every user’s experience by creating consistency thus encouraging greater overall participation. Implementing standards that meeting regulatory compliance requirements will also increase business efficiency by removing barriers that impede users.

Consistent standards can improve workflow timeliness by promoting best practices such as key stroke consistency, information placement and help mechanisms, and predictable designs. Customer service requests will be easier to communicate and resolve because of shared approaches and expectations. Investing in standards should not be seen as a limitation, but an opportunity for key shared service areas to remove barriers for participation and improve interaction with other campus business partners.

A. Long & Short Term Objectives/Timeline

The recommendations in the preceding section are described largely as values and principles which we believe can be adopted immediately to establish a foundation from which more specific ideas and recommendations can emerge. Recognizing that budget reductions and the
implementation of ISIS will consume most resources over the next year or two, we appreciate that it is unlikely that specific recommendations involving a direct investment of funds is viable; however, we believe there is value in promoting a culture of collaboration built on strong communication channels. A nominal investment in actual dollars, a commitment by leadership to promote collaboration and communication will naturally nurture innovation and creativity thus creating considerable intangible benefits for both the short term and long term.

Within that context, we identify several specific ideas for consideration; however, we believe that within the context of a collaborative environment, other viable ideas will naturally emerge.

Short Term Objectives (within 18 months)
- Adopt customer service orientation with a high level transparency
- Establish an expectation of professional development and training for all staff. Communicate existing training and development opportunities.
- Identify key stakeholders and begin administrative planning for infrastructure to support 2030 goals. Encourage strategic thinking within ranks of business process owners and users.
- Establish communication channels to build relationships between ITS, other campus IT providers, and end users establishing consortiums and business network groups
- Encourage standardization (such as W3C standards for accessibility) and better search engine capabilities. Recognize and reward models of excellence within peer community to encourage adoption of such standards
- Improve people directory search capability (particularly important with discontinuance of printed directory)
- Promote document imaging (reduce cost, save space, accessibility of document)
- Promote a relationship with University Information Systems (UIS) that better recognizes the diverse and complex nature of the Boulder campus.

Long Term Objectives (within 24-48 months)
- Create business analyst positions to understand business needs and lead the development of appropriate information technologies to support those business needs.
- Build sustainable business, staff, and technology partnerships and networks across the campus to create efficiencies, improve systems and processes.
- Develop and establish meaningful benchmarks for gauging effective and efficient processes.
- Develop and establish training and development standards, expectations, and opportunities for business process owners and end users as well as information technology workers beyond what is currently offered. Encourage rapid adoption by improving communication and exposure.
- Invest in staff by improving current tuition benefits. Current credit and availability limitations reduce usefulness and potential development opportunities.
- Analyze and determine the best mix of centralized and decentralized services to maximize efficiencies.
- Faculty hiring is a critical business processes integral to our mission of teaching and research. Procedures and processes for hiring faculty on the Boulder campus are extensive and complex. The system is largely paper based with each academic unit maintaining their own systems. Begin development of a comprehensive faculty recruiting tool used across campus to eliminate current duplication and redundancy. Maintain common a database set from which a dashboard system can be developed to discern trends and their underlying cause in order to plan for the future. Utilize basic technologies such as electronic signatures to eliminate routing of paper documents.
Identify high demand systems (shadow systems, local installations of enterprise level services and systems) and prioritize some for analysis and improved service delivery. Potential focus areas discussed included high-use, under-supported local business systems such as PeopleSoft Lite; enterprise licenses for event scheduling or time-keeping; and assorted customer help desks or communication and relationship management tools.

B. Possible Risk

Technology Risks: Technologies themselves can present problems that distract focus on business solutions, or that move resources to technology support from process or personnel support.

Strategic Risks: Internationalization poses great resource implications. Increased service windows and increasingly diverse customer base from culturally and technology dissimilar locations will make standardization and simplification even more challenging. Assumptions about timing, authority, regulatory priorities and so-on begin to add layers of complexity to the service and process questions raised here.

Resource Risks: Reductions in central computing staff and a shift in support and tools from campus providers to central providers puts greater distance between customers and providers. Understanding local business needs and support requirements requires organizational changes which may be unsupportable with current resources.

We identify expertise needs that are not currently available or dedicated to the topics discussed, particularly in the analysis and process quality areas. Hiring and training these resources is unlikely given budget cuts and widespread need.

Environmental Risks: Current and recent system-wide efforts to streamline business requirements and reduce training requirements appear contrary to the committee’s conclusion that standardization and training are needed. Sentiments about poorly received training may disrupt or negate the positive aspects that relevant and viable business technology training could provide.

Massive system changes are just coming online. These will be a distraction from energies that could be directed towards staff efficiency and effectiveness.

Support for staff and business processes has long been located far from the individual administrative units and context of localized business process. Improving that gap during a shrinking resource cycle and with existing process inertia will be all the more challenging.

C. Resource Allocation

Nominal cost - requires a cultural shift in how we approach our business:

- Build relationships between IT providers and end users establishing consortiums and business network groups
- Promote innovation and creativity to create efficiencies, improve systems and processes, and build sustainable partnerships. Promote streamlined approaches, and the creation of partnerships to improve communication and leverage the innovative work of others.
Medium costs - requires resources for development, implementation, or training:

- Standardization of web development to improve accessibility, consistency, ease of use, and consistent customer experiences. Provide services and guidance that improves campus web infrastructure search capabilities. Provide awards or recognition for examples of excellence.
- Improve people directory search capability (particularly important with discontinuance of printed directory)
- Develop remote computing technologies and guidelines to support telecommuting and access to work materials.
- Enhance document imaging (reduce cost, save space, accessibility of document) capabilities and provide support tools (guidelines, training, user manuals, testing capabilities) to simplify adoption and acceptance of the technology.
- Develop and establish meaningful benchmarks or principles for gauging effective and efficient processes.
- Analyze the mix of centralized and decentralized staff services to ensure maximum efficiencies and remove common incremental costs and unsupported dependencies.
- Establish training and development standards, expectations, and opportunities for business process owners and end users as well as information technology workers that support improved information an efficient and effective business computing environment as described in the recommendations above.

Higher cost

- Business analyst positions to understand business needs and lead the development of appropriate information technologies, procedures, and service information to support those business needs.
- Develop a comprehensive faculty recruiting process and application used across campus.
- Invest in staff by improving current tuition benefits. Current limitations reduce usefulness and potential development.

D. Responsible Parties

Responsibilities for staff efficiency and effectiveness are rich combinations of attributes and communication channels involving various parties. Observations are provided within Appendix A to provide insight into executing the recommendations of this report. This information is in no way comprehensive.

E. Evaluation

- Campus priorities are available, transparent, and supported at all organizational levels.
- Accountability for staff efficiency, effectiveness, and service programs is explicit.
- Definitions for and evaluation of efficiency and effectiveness standards are common.
- Identifiable communication forums are established.
- Management at all levels regularly promotes collaboration through recognizable communication forums and methodologies between business an technology leaders.
- Business analysis services are identified.
- Governance priority is clear and measurably adopted.
- Staff development in priority technology areas is measured and improving.
**Preliminary Observations for Matrix of Responsible Parties.**

<table>
<thead>
<tr>
<th>Responsible Party</th>
<th>Primarily Accountable To</th>
<th>Primary Role for achieving recommendations</th>
<th>Primary Implementation or Communication Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business Administration:</strong></td>
<td>External constituents, funding and regulatory bodies, campus customers</td>
<td>Identifying direction, allocating resources, defining E/E, mission clarity</td>
<td>Direction, Priority</td>
</tr>
<tr>
<td><strong>Campus IT Governance:</strong></td>
<td>Business administration, faculty, research organizations, university IT governance</td>
<td>Determining tech priorities, aligning with admin direction, standards and policies, clarity and transparency</td>
<td>Priorities, Policies, and Standards, campus decisions</td>
</tr>
<tr>
<td><strong>University Information Systems (UIS):</strong></td>
<td>External constituents, campus administration(s)</td>
<td>Enterprise systems and services usability and E/E, relevant training and support materials, correlation between workgroups and campuses, university architecture, enterprise analysis</td>
<td>Campus administrative support guidance, standards, system policies, training materials and supportability materials</td>
</tr>
<tr>
<td><strong>Information Technology Services (ITS):</strong></td>
<td>Campus administration, campus IT governance, direct customers, general good service customers, contracted agreements</td>
<td>Guidelines, and support in defined programmatic areas, correlation of Campus technology activities, input to governance forums, campus architecture, programmatic analysis</td>
<td>Campus IT architecture and direction, service information and procedures, infrastructure and architectural definitions, campus IT policy, ITS training and support materials, security, forum contribution</td>
</tr>
<tr>
<td><strong>Organizational IT:</strong></td>
<td>Organizational administration, organizational customers, campus IT governance,</td>
<td>Campus standards and guidelines, organizational administration, awareness and development, contextual</td>
<td>Standards and guidelines, local technology practices, local business technical constraints and objectives,</td>
</tr>
<tr>
<td>Business Application Developers:</td>
<td>Organizational administration, organizational customers, campus IT governance, campus administration, organizational IT</td>
<td>Organizational administration, campus standards and guidelines, technological integration into business process</td>
<td>Application support materials, lifecycle documentation, procedural documentation, integration documentation</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Staff Supervisors and Managers</td>
<td>Organizational administration, campus governance</td>
<td>Staff development, participation, resources, transition</td>
<td>Staff guidelines, opportunities, and service availability, PDQ documentation and relevance</td>
</tr>
<tr>
<td>Staff, System, and Application Users</td>
<td>Staff supervisors and managers, organizational administration, campus governance</td>
<td>Personal development, guideline and policy observance, forum contribution</td>
<td>Situational need, roadblocks, conflicts, local procedure and work process, workflow</td>
</tr>
</tbody>
</table>
2.6 Developing Web Infrastructure Services

Major Issue:
As of the summer of 2010, 10 years will have passed since CU-Boulder last made a significant investment in campus wide, generally available web hardware and software infrastructure. The lack of investment has resulted in a highly disperse web infrastructure environment. As of late February, 2010, the CU-Boulder IT Security Office had registered more than 500 distinct web servers spread across dozens of colleges, schools and departments. Many of these web servers were created due to the lack of progress on upgrading the generally available web solutions. Maintaining an extremely disperse web environment results in many inefficiencies. Consolidating around a collection of “common good” web services addresses these inefficiencies, leading to a web environment which is more cost effective, more durable, less complicated, more broadly available to anyone with web technology needs, and easier to support. In addition to inefficiencies, the extremely disperse web environment complicates CU-Boulder’s efforts to implement the University of Colorado System branding initiative. When the final details of the new visual identity standards become available, CU-Boulder will begin an effort to systematically align campus, college, school, and department web content with the new standards. CU-Boulder would greatly benefit from the development of additional web infrastructure services.

A. Background/Rationale

The CU-Boulder Web Environment
The CU-Boulder web environment includes two broad categories of service: 1) the primary WWW service, hosted by ITS, serving as a general purpose, “common good” but basic web site hosting environment, and 2) the highly distributed and localized campus wide web environment.

ITS has provided the “common good” www.colorado.edu web server environment since the earliest inception and identification of the world-wide-web as a core campus technology infrastructure need. No significant investment in improving the web server infrastructure available to campus as a whole has been made in nearly 10 years; the practices and technologies have not been significantly changed since the inception of web technologies in 1994. The age and stagnation of current central web technologies has, in large part, contributed to the second category of web environment, the collection of localized web solutions deployed by colleges, schools, and departments.

The current campus wide web environment at CU-Boulder is highly distributed and diverse. This highly diverse, highly distributed environment, though very flexible and suitable for meeting any number of business needs, results in a very inefficient use of university resources. The challenge of consolidating the CU-Boulder web environment will be finding the proper balance of a flexible enough environment to support many, but perhaps not all, of the technology combinations while still remaining sustainable.

Web Developer and Content Manager Support and Community
University Communications has developed resources for the large number of web developers and web content managers existing at CU-Boulder. The “Web Central” web site includes a description of web technologies available, resources for training and certification available, a
collection of help documents and guides, and lists the policies and standards governing web publishing at CU-Boulder. Though "Web Central" and the mailing list provide a useful collection of information, web developers and content managers would benefit from greater support and community development.

Brand Management
University Communications currently provides assistance to colleges, schools, and departments in developing their web visual identity on a for fee basis. CU-Boulder has developed guidelines for the web visual identity, but no mandatory standards and campus approved policies exist. The upcoming branding initiative of the Office of the President for the University of Colorado will require a change in this practice. The initiative will require the reevaluation and revision of the existing CU-Boulder “Web Identity Standards”, an increased need for mandating compliance with visual identity standards, and the systematic review and refurbishment of existing CU-Boulder web content to align with the new standards.

IT Strategic Plan 2006
The IT Strategic Plan of 2006 included a recommendation for implementing a web content management system and requested funding for the infrastructure and staffing for the service. Since funding never materialized, the effort stalled. The need still exists. Section 2.6.2 “Adopt and Deploy a Web Content Management Solution” renews the recommendation and request for funding.

Relationship to Flagship 2030
The strategic plan recommendations for Developing Web Infrastructure Services align with specific action items promoted in Flagship 2030. These include the following:

- Curriculum Enhancements
- Research Excellence
- Internationalizing the Campus
- Serving the State
- Investing in Our Staff
- Information Technology
- Developing a New Budget Model

B. Accomplishments to Date

- The www.colorado.edu service provides basic web capabilities, receives more than 1 million web page hits per day, and contains hundreds of thousands of web page content.
- More than 500 local web servers provide numerous web applications and frameworks for a variety of college, school, and department web needs.
- University Communications provides guidance and for fee assistance for colleges, schools, and departments seeking web development and content management assistance.
- ITS and University Communications collaborated on developing a functional requirement definition for a Web Content Management solution. The initiative has never been funded and, therefore, has not progressed further.
- ITS and University Communications have collaborated on identifying emergency communications needs and developing plans for enhancing web and messaging infrastructures.
- The Office of the President for the University of Colorado has begun a CU-System wide branding and visual identity alignment initiative. Details and expectations will become available during the summer of 2010.
Action Plan

Campus Assessment and Audit of Current Web Tools and Resources

A. Explicit Assumptions
A detailed assessment of current web practices and technologies would greatly assist setting strategic directions for web infrastructure services.

B. Specific Recommendation
- Perform an in depth, campus wide assessment/audit of both current and desired web tools and resources.
- Maintain the gathered information through periodic review and reassessment.
- Summarize the results in a report.

Note: The general needs and current use assessment/audit should explore combining efforts with the IT Security Office.

C. Long & Short Term Objectives/Timeline

Short Term:
Perform audit/assessment

Long Term:
Provide one or more summary reports.
Continue periodic updating of the baseline audit/assessment.

D. Possible Risk:
Web infrastructure services may involve private or restricted data.
The audit/assessment outcome documentation may contain information which could include sensitive detailed server, service, network, and data descriptions.

E. Resource Allocation:
The majority of the cost of this project involves personnel time for conducting the audit/assessment. Hiring an additional staff member responsible for conducting and maintaining these audits would require approximately $80,000 in ongoing funding.

Responsible Parties:
ITS, Campus-wide Governance Group(s), Organizational Unit web Information Technology support personnel, Organizational Unit web content developers

Evaluation:
- Completed audit/assessment and summary report(s).
- Impact of the audit/assessment on selecting appropriate web technology solutions for campus wide implementation.
Adopt and Deploy a Web Content Management Solution

A. Explicit Assumptions:

- Several funding requests for a Web Content Management solution have been issued but never granted. New, less expensive solutions may be available, but ongoing and one-time funding will still need to be granted to proceed with this project.
- Developing work flow, delegating responsibilities for a Web Content Management solution, governance over standards, and policy/procedure development will require campus-wide involvement.
- A Web Content Management solution would assist with the CU-System branding initiative.
- A Web Content Management solution supplements, but cannot immediately replace, the current [www.colorado.edu](http://www.colorado.edu) service.

B. Specific Recommendation:

Select and implement a Web Content Management solution available as a “common good” enterprise service available to all CU-Boulder faculty, staff, colleges, schools and departments. Provide adequate infrastructure and scalability to support sustainable growth.

The Web Content Management solution must account for CU-System and CU-Boulder policies and guidelines for Web Visual Identity standards, ensuring section 508 accessibility requirements are met for all content, and accommodating Universal Design for all content.

C. Long & Short Term Objectives/Timeline

Short Term:
- Reevaluate and refine Web Content Management functional requirements developed by University Communications and ITS.
- Investigate and select a Web Content Management solution.

Long Term:
- Implement the solution.
- Develop policy, practice, procedure, and work flow for the service.
- Migrate content from the [www.colorado.edu](http://www.colorado.edu) and localized web solutions to the Web Content Management solution.

D. Possible Risk:

Some content may include sensitive information requiring greater security measures.

E. Resource Allocation:

Hardware and software infrastructure costs for a Web Content Management solution vary greatly depending upon the specific solution selected. One-time infrastructure costs are expected to be within the range of $100,000 to $250,000. Ongoing funding for a five-year renewal and replacement is expected to be within the range of $20,000 to $50,000. Additional staffing for operating and maintaining the service: one ITS employee for the core infrastructure and one University Communications employee for application support are required. The equivalent of two FTE’s for a total of $200,000 in ongoing funding would be needed.

F. Responsible Parties:
ITS, University Communications, Campus-wide Governance Group(s), Organizational Unit web Information Technology support personnel

Evaluation:

- Customer satisfaction and usability.
- Increased consistency and compliance with web branding standards and policy/regulatory compliance.
- The amount of web traffic (in hits and data transfer) served by the solution over time.

Create a Flexible, Robust, Multi-Purpose Web Hosting Environment

A. Explicit Assumptions:

- Sufficient funding commitments must be made in order for the Web Hosting Environment project to succeed.
- The Web Hosting Environment would accommodate many, but not all, of the needs leading colleges, schools, and departments to deploy localized web technology.
- The audit/assessment discussed in section 2.6.1 would provide highly valuable information for developing web hosting environment plans.
- A central “common good” Web Hosting Environment is expected to increase security by reducing complexity, reducing redundancy and the need to repeat security constraints across multiple solutions, and focus greater security expertise on developing a single robust solution.

B. Specific Recommendation:

- Implement a “common good” web hosting infrastructure capable of supporting a flexible, multi-purpose collection of web technologies including.
- Provide “common good” backend database structures.
- Design the solution for scalability and highly availability.
- Investigate the applicability of cloud computing resources to meet these needs.
- The Web Hosting Environment solution must account for applying CU-System and CU-Boulder policies and guidelines for Web Visual Identity standards, ensuring section 508 accessibility requirements are met for all content, and accommodating Universal Design for all content.

C. Long & Short Term Objectives/Timeline

Short Term:
Determine strategy for providing a web hosting environment and backend database solutions. Develop deep technical proficiencies in the small subset of web technologies that will be broadly supported for CU-Boulder. Develop shallow technical proficiency for the full collection of web technologies the web hosting environment will accommodate.

Long Term:
Implement the web hosting environment and backend database solutions. Develop policy, practice, procedure, and work flow needs for the solution.
Migrate local college, school, and department web applications and application frameworks to the web hosting environment.

D. Possible Risk

Many localized web solutions maintain some form of sensitive data. The suitability of a shared, central web hosting environment for interacting with sensitive information will need to be carefully analyzed.

Cloud computing solutions may limit CU-Boulders ability to directly respond to service incidents and develop service enhancements.

E. Resource Allocation:

Hardware and software infrastructure costs for a Web Hosting Environment vary greatly depending upon the specific solutions supported, and whether the service is built locally or contracted to an external cloud provider. Onetime costs for developing the service are expected to be within the range of $100,000 to $200,000. Ongoing funding for renewal and replacement, or alternatively for ongoing contracts with external service providers, is expected to be within the range of $20,000 to $75,000.

Additional ITS staffing for operating and maintaining the service is required. The equivalent of one FTE for a total of $100,000 in ongoing funding would be needed.

If both the Web Content Management Solution recommendation and this Web Hosting Environment recommendation were acted upon, it is expected that some of the deployed infrastructure could serve both purposes and potentially lower the overall cost.

F. Responsible Parties:

ITS, University Communications, Campus-wide Governance Group(s), Organizational Unit web Information Technology support personnel

G. Evaluation:

- Measurable reduction in the number of distributed web servers on the CU-Boulder network.
- Customer satisfaction and adoption rates.
- The amount of web traffic (in hits and data transfer) served by the solution.

Establish Greater Campus Web Support, Training, and Community

A. Explicit Assumptions:

Sufficient funding commitments must be made to develop robust support, training, and establishment of a community for CU-Boulder web developers and content managers. These positions are critical for supporting the proposed Web Content Management and/or Web Hosting Environment. If funding is provided for the services but not the support staffing, the value of the deployed services will be reduced.

B. Specific Recommendations:
Create and hire a position in ITS Strategic Communications, Outreach, and Documentation for a Tier 2 Web Support Coordinator. The position would combine duties similar to the ITS Tier 2 Computer Support Representative Coordinator, facilitating communication and collaboration between central and college/school/department web personnel, and ITS Escalated Support, maintaining proficiency and currency with a wide variety of web technologies to provide web service support and advising assistance. The position would also develop and promote a web developers and content management community to encourage collaboration and knowledge exchange between the many web experts on campus.

Create and hire a position in ITS for Web Escalated Support to specifically support the enterprise web services: the legacy WWW service, the recommended Web Content Management solutions, and a small subset of the additional web technologies available within the web hosting environment.

Create and hire a position for a Web Business and Functional Analyst to provide in depth consulting to colleges/schools/departments on which web technologies and solutions could best meet their needs and to provide periodic information, training, and evangelism for current and emerging web technologies. The role would also need to gain and maintain awareness of CU-Boulder visual identity policies and standards, policies and federal regulations including section 508 accessibility requirements, web development best practices and standards such as W3C, and security and privacy practices in order to assist colleges/schools/departments in understanding and meeting these needs.

All three positions must maintain close coordination with both ITS and University Communications, serving as a bridge between the primarily ITS concerns of technology specifics and content creation, editing and hosting, and the primarily University Communications concerns of content composition, structure and presentation. These positions must understand and represent all of these concerns while assisting campus with their web technology needs. They must understand and provide assistance with meeting and retaining compliance with branding and visual identity guidelines.

C. Long & Short Term Objectives/Timeline

Short Term:
Create and hire an ITS Escalated Support position for Web Technologies.
Create and hire an ITS Tier 2 Web Support Coordinator.
Begin developing a CU-Boulder web developers and content managers’ community.

Long Term:
Create and hire a Web Business and Functional Analyst.
Possible Risk
None

D. Resource Allocation:

The recommended positions require hiring staff with considerable expertise:
$100,000 for the Web Support Coordinator
$100,000 for the Web Escalated Support position
$100,000 for the Web Business and Functional Analyst position.

E. Responsible Parties:
ITS and University Communications

F. Evaluation:

- Development and use of a “web developers community” for CU-Boulder.
- Increased communication and collaboration between CU-Boulder web developers and content managers.
- Customer satisfaction.

Develop CU-Boulder Web Standards and Achieve Compliance

A. Explicit Assumptions

- The CU-System is currently working on branding standards for the entire university. Once developed, all campuses will be required to align their web content with the brand.
- University Communications will be responsible for understanding the new branding requirements, assuring compliance for sites directly maintained by University Communications, and assisting other web administrators at CU-Boulder with understanding how to achieve compliance.
- CU-Boulder web identity and style standards, policies, and guidelines will need to be reviewed and updated and/or supplemented.

B. Specific Recommendations:

- Review and revise CU-Boulder Web Visual Identity standards to align with the CU-System branding initiative.
- Ensure CU-Boulder web sites achieve compliance with forthcoming CU-System web branding standards.
- Deploy a web reverse proxying and caching solution that will answer for all www.colorado.edu web requests.
- Conduct periodic audits of CU-Boulder web content to ensure ongoing compliance. Explore state and/or federal grant opportunities which may provide funding for and accessibility expert and auditor for campus.

C. Long & Short Term Objectives/Timeline

Short Term:
Review CU-System branding initiative standards once released.
Form plans for achieving compliance.
Review and update relevant policies to align with the CU-System branding initiative.

Long Term:
Select and deploy a web reverse proxying and caching solution.
Update web site layouts and content to conform to the branding initiative.
Conduct ongoing audits for compliance.

D. Possible Risk:
TBD

E. Resource Allocation:
Estimated costs for a cloud based reverse proxying and caching solution is $24,000/year. University Communications has the expertise for working towards comprehensive campus wide branding compliance, but would require backfill money to free the resources and maintain current obligations. The effort would require $200,000 in temporary money to backfill 3 positions for three consecutive years for a total of $600,000.

F. Responsible Parties

University Communications, ITS, Campus-wide Governance Group(s), Program Accessibility Committee, Disability Services, Organizational Unit web Information Technology support personnel, Organizational Unit web content developers

Evaluation:

Pre and post assessment of web site branding.

**Establish Standard eCommerce Solutions**

A. Explicit Assumptions:

Many colleges, schools, and departments have the need to accept internet payments. A few have adopted their own solutions. Standard policies, practices, and procedures for if/when/how organization units accept internet payments would decrease the risks associated with handling credit card data and increase efficiencies for accepting the payments.

B. Specific Recommendation:

- Reevaluate and revise CU-Boulder campus policies and procedures for if, when, why, and how colleges, schools, and departments conduct online eCommerce payments.
- Evaluate and adopt one or more eCommerce solutions as standards for all CU-Boulder eCommerce: a payment portal or gateway for CU-Boulder web transactions, a campus wide agreement with one or more vendors, and/or specific shopping cart solutions.

C. Long & Short Term Objectives/Timeline

Short Term:
Review, update, and create eCommerce policies.

D. Long Term:
Adopt standard solutions for CU-Boulder eCommerce.
Meet and ensure PCI data security standard compliance.

E. Possible Risk:

eCommerce solutions must meet legal and security requirements for complying with PCI data security standards. Specific needs for interoperability between the web application, eCommerce application, and the payment gateway are usually unique and complicated. Finding an eCommerce solution for campus must recognize those needs and be able to adapt and accommodate those needs.
F. Resource Allocation:

Cost of the project: TBD

G. Responsible Parties:

ITS: ITS Program Management, ITS Security Office, ITS Project Management, ITS Operations Office of University Controller, Office of the Treasurer of the University, Campus-wide Governance Group(s)

H. Evaluation:

- Adoption rate of eCommerce solution(s).
- Customer satisfaction.
2.7 Improving the IT Service Model

Major Issue: There is considerable dissatisfaction with the current model and practices of providing IT services to users on campus. Four main issues have emerged:

1. The hierarchical model of support with one point of contact does not meet the needs of many of the users, especially those with high levels of expertise;

2. Policy is set by the same people who provide support and services. Users have no clear way to influence support policies with which they disagree. The issue of policy and governance must be decoupled from the issue of providing services;

3. There is a lack of appreciation for the diversity of the customer base and for the diversity of the needs of the customer; There is a need to develop an understanding of the user’s point of view in order to meet the expectations and needs of the user;

4. There is a lack of transparency (the black box approach) that destroys trust in the system

A. Background

Significant portions of the campus do not have adequate IT support service because they cannot afford to purchase services offered by central ITS as it is now organized. Too much of the current “4-tier” model depends on enrolling people who are not IT support experts (e.g., the mandated Tier 2 contact people). Experts in distributed units outside of the ITS organization are expected to enter at Tier 1 rather than communicate with directly with appropriate experts inside of ITS. This problem is exacerbated by the current hub (ITS) and spoke (the distributed customers) model of support because efficient and effective use is not made of the expertise of people in other units on campus.

ITS currently has a classic hierarchical structure typical of a corporation. This structure has advantages of clear lines of responsibility but suffers from inefficiency because of the isolation of the lower level people from each other. Communication flows vertically not horizontally. Thus knowledge cannot be easily shared with those who might benefit most from it. Another characteristic of this structure is that authority to make decisions is always limited by the next level up.

The organization of the organization of the four-tier support system currently in place reflects this same corporate organization structure. It is characterized by a vertical flow of information and a lack of transparency about the internal workings.
This hierarchical corporate structure stands in contrast to the functional organization of typical academic units such as departments and institutes. These units are better described as a rich interconnected network of people with very little rigid reporting structure. One consequence of this network structure is that faculty and staff are able to communicate with whomever they need to in order to collaborate and achieve their goals both within units and across units. Such a structure is relatively transparent because each individual has multiple ways of gaining information from others in the group. Such a structure is flexible because most of the connections among people are based on need to communicate (for example to carry out a research project or teach a course). When needs change, the connections change.

These very different organizational structures have led to serious mismatch of expectations, assumptions, and beliefs held by the staff of ITS about those it is mandated to serve and visa versa. This mismatch has led to an inefficient use of resources and expertise on the campus. There are many on campus, both IT professionals and others, who have a very high level of knowledge and expertise about information technology who are not employees of the ITS organization. This expertise is currently underutilized by ITS staff largely because of the rigid organization and hierarchical support model and because of a cultural attitude towards these “outsiders.”

The current support model isolates people working in central ITS from the people they are serving, both distributed IT support staff (e.g., Housing, UMC, academic departments) and actual end users. Although ITS managers might meet with administrators in different units, the staff in central IT are relatively isolated from, and are not familiar with, the nature of the research, teaching, and other work that is being done in the academic departments and other campus units. Mechanisms, procedures, and policies within central ITS discourage the ITS experts from engaging in conversations and collaborations with those outside of ITS. In addition, there needs to be more transparency in the functioning of the ITS support model. There is not sufficient collaboration among the different units and service providers nor is there enough sharing of knowledge to avoid the problems outlined here. There is not enough flexibility in support offerings, and more recognition that determining these levels should be a product of collaboration not dictation.

Finally, there are difficulties with scope—it is not clear who owns which responsibilities and services. Yet, at the same time (and because of this), there are significant relational difficulties and organizational mistrust, because the central unit (ITS) advocates to perform services located in the different units (competing for resources and budget with the very people they also promise to support). This competition for resources makes cooperation and trust more difficult.

**B. Accomplishments to Date**

ITS currently operates a call-in Service Center that receives approximately 60,000 calls per year. Approximately 70% of these calls do not get escalated to anyone else in ITS; ITS also operates two walk-in service centers that provide support for faculty, staff and students;
The service structure that is now in place is a hub and spoke structure. ITS is positioned at the hub and has a series of support agreements with many units on campus. These connections radiate from the hub out to the units like the spokes of a wheel.

ITS personnel are highly motivated and competent information technology professionals. The problems that we have identified do not reflect on the people, but rather on the organization and structure of how ITS interacts with the many different units on the campus that they are to serve. It is this organization that we recommend changing;

**Action Plan**

A. **Explicit Assumptions On Which This Plan Is Based.**

We need to separate governance from the provider providing the technology. Governance represents the business aspect and is concerned with establishing policy. Technology provides services. Establish a policy/oversight board that reports to the CIO. This board coordinates policy of ITS and other IT units so that the needs of all users are met. As a general principle, this board would not be made up of the same people who are providing services. The chair of this board should not be the same person who is running ITS services.

We agree that the mission of the university is to achieve excellence in education and research. ITS’ own mission should be to support the mission of the university. The role of staff is to help units within the University carry out the mission and achieve the goal of excellence. The University mission is our central, shared focus. The functioning of the University requires high degree of flexibility and adaptability, because practices and needs vary widely across different disciplines and units (one size does not fit all).

We agree that every unit is to be supported at a level that meets their basic needs. A support model should not depend on a unit’s ability to pay in order to achieve this basic level of support. A call center in and of itself is not a sufficient level of support. Similarly, the more that the support staff understands and is familiar with the particular work that is being done by those they support (faculty, staff, students), the better able they are to support those user. Quality support depends on familiarity with the end user and his/her work.

There must be a recognition of and respect for the "expertise across campus" and of the importance of area or content knowledge (that needed expertise cannot be centralized). All support staff on campus must actively work to establish trust among them, particularly when the relationship requires one unit to be dependent on the services provided by central ITS. There must be a respect for boundaries of existing support groups, and a recognition of support staff across units as peers.

Support staff in distributed units must accept that elevated access (i.e. the ability to bypass parts of the work flow) also means certain elevated responsibilities relating to troubleshooting and correctly identifying a problem. Managing these expectations and privileges will be a challenge for everyone involved.

There must be transparency in the system, especially in how to prioritize resources, cost-modeling, and decision-making. More transparency is needed about what services are provided by support units and how they are provided. It must be easy to track the status of reported problems through the system.
Scaling must be part of the logic, including a shared understanding of how to prioritize services (for example, not every need can be the highest priority). The goal of our recommendations is to unfold ITS to make it more transparent and to align it with the mission of the faculty and staff.

B. Specific Recommendations

1. Reduce the mission of current ITS organization to focus on what it does well—to emphasize its strengths in providing IT infrastructure technology. To make a break with the past, the name of the new unit should be changed to reflect this new focused mission (e.g., ITI—IT Infrastructure).

The three core services should be:
   a. Developing and maintaining the campus networks and servers
   b. Supplying central support for campus users (help desk and higher level support)
   c. Developing and maintaining central computing spaces to house server and other specialized computing equipment

2. Create new and separate units out of the current ITS organization to provide specialized expertise (e.g., Security, Research Computing, Academic Technology, Classroom support) in specific areas needed by the campus. These units, like the new, reduced ITI, would implement policies set by the IT Policy board established in recommendation 3;

3. Establish an IT Policy and Oversight Board that reports to the CIO. This board will develop policy for ITS and coordinate policy with other IT units so that the needs of all users are met; The board will strive to make the campus IT community more cohesive and to reduce conflicts. The chair of the board would not be the director of the new ITI (or the other units, see number 3) to avoid conflicts of interest. The function of the board is to set policy, not to deal with daily operational issues. The membership of the board should be drawn from the campus administration, faculty and staff;

4. Develop mechanisms to **significantly increase and sustain** involvement, communication, coordination, and collaboration among all relevant units on campus to leverage distributed expertise. Ownership of the mechanisms needs to be shared, rather than controlled by one central unit. Develop mechanisms for discussions of non-urgent issues on a regular basis.

5. Establish a different working relationship between the different service providers, especially between a central IT service provider and the different levels of end users (including support staff). Develop a rotation system in which key ITI personnel serve in appropriate units and other IT (e.g., Housing) personnel serve in ITI.

6. Develop ways to prioritize for 24/7 escalated service; develop a model of how some levels of service could be provided;
7. Develop mechanisms for staff or units to request more coverage of service than they currently have.

C. Short and Long Term Objectives

1. Immediate Objectives

- Establish a policy board as recommended in 1 above.
- Begin an assessment of the needs of the diverse pool of users on campus with the aim of gathering information about the specific nature of the work (teaching, research, administrative support) within units. Needs change and should be frequently assessed. The results should be communicated to relevant support staff, and mechanisms should be established for those support staff to follow up by themselves communicating to users and unit support staff.
- Begin evaluation of options to provide some form of 24/7 help service by phone or email for the most important services such as network. Develop reasonable guidelines for what is an appropriate after hours service call. Leverage Tier 2/support staff as a resource to help extend service beyond business day (e.g., local staff could filter the service requests so that central IT staff might simply be "on call.")
- End the practice of making pronouncements of infrastructural changes, especially in situations where substantial number of users will be affected. Create a web page where these proposed changes can be made public and where policy input can be given. Detailed technical information about changes to services provided, including new services, should be available to end users who are relying on those services. Keep the campus informed of project schedules.
- Rethink the way SupportWorks is used in order to increase its utility to all units on campus. Open access to the system to non-ITI support staff—make it an campus resource rather than an ITI resource. The object is to use support resources more efficiently because local staff could handle some of the case load, and could also add their knowledge. A shared web portal could be another option. At the very least, there should be a way for support staff in units to communicate with each other and back to central ITI with regard to applications, services, hardware, etc., especially if the unit is deploying services that may have an effect on central services.
- Provide more open access to elevated support levels and ITI experts.
- Place online information that would be useful for support staff across campus to know, and make it accessible to support staff across campus. Limit or end the practice of holding information as a central resource. For example, make available more information on campus software site licenses, along with details regarding the terms of use (End User License Agreement - EULA) and contact information, for the license holder and vendor.

2. Short-Term Objectives

- One of the objectives of the needs assessment (from #1 above), should be to identify potentials to offer standard hardware or software configurations, or to link units that have similar hardware/software needs. In other words, to assist the campus with achieving efficiencies through standardization. (However, this does not mean to try to fit all uses within a standard.)
- Rethink the model and the process for software licensing. Re-assess who should own the process (need a model that is flexible and has variation, for times when more efficient for a non-ITI unit to lead).
• Rethink the cost models for support services, e.g., rather than linking positions to computers supported, link them to actual work performed. Look for potentials to reduce marginal cost for each user supported.

• Institute campus conversations and involvement about what services different units find are most valuable for customer support and which set of that support common to all. Rather than having "effective customer support" defined primarily by central ITI, the decisions about what central resources the campus should invest in (e.g., what email service, web services, network services, security services) should be made by the IT Policy Board with effective input from the whole campus.

• Consider a funding model that involves a sliding pay scale for central services (i.e., to subsidize units with lower budgets).

• Coordinate procedures for academic units to cooperate with technology support staff with regard to reporting needs that need fixing, and develop ways to coordinate among support staff and central ITI to determine who is responsible for the need.

3. Long-Term Objectives

• Rethink campus relationships between support staff. Create a system that increases communication among relevant people in different units across campus.

• Accountability -- develop outcomes based assessment not only for specific services, but for system/structural elements as well. (i.e., to assess decisions made about how to do things). And provide mechanism to feed these back into the system to improve it.

• Continue discussions involving faculty, staff, and students all together to determine reasonable expectations for minimum level of support. Do not depend on central IT to make that decision in isolation. Build feedback – communication– into the system so that it can better meet the needs of units and end users, while maintaining openness and transparency.

D. Possible Risks

Any organizational change poses risks that the new organization structure will not achieve its goals and that the net impact on the campus will not be positive. We believe, however, that the current situation is far from optimal in terms of supporting the academic mission of the university. Since we are not recommending elimination of functionality and services but a reorganization of how they are achieved, we believe that the risks of implementing the recommendations are very low. The potential benefit is an increase in user satisfaction across campus and a higher level of support for the university mission.

E. Resource Allocation

For the most part these recommendations are resource neutral. The recommended changes are largely organizational and structural in nature. They will result in a better use of existing resources because personnel will focus on doing what they do best and will not be operating outside the bounds of their expertise.

The two exceptions are the recommendation that some form of 24/7 help be made available and the expansion of the SupportWorks license. The current ITS administration has made one preliminary estimate of the cost of these additional services using an outside vendor, but this committee has not done an in-depth analysis the estimate nor evaluated the costs and benefits of providing the help service internally or externally. How much these recommended changes
would cost depends on the specific implementation chosen. This choice of how to implement the recommendations should be made by the CIO and the Policy Board. The CIO would then include this cost as part of the budget request process.

F. Responsible Parties

Policy will be set by the campus administration, specifically by the Chief Information Officer/Associate Vice Chancellor with the guidance of the policy board.
The NIST Definition of Cloud Computing - Authors Peter Mell and Tim Grance, Version 15 10-7-09. This is essentially the same as the Burton Group definition “The set of disciplines, technologies, and business models used to deliver IT capabilities (software, platforms, hardware) and an on-demand, scalable, elastic service”

These documents are available on the wiki at https://itswiki.colorado.edu/display/itplan10/Home.

There is an existing Administrative Procedure Statement (APS) giving the guidelines for data and record retention.