Background
CSU began exploring IT consolidation opportunities in the fall of 2010. An IT consulting firm, Adams-Gabbert was selected via an RFP to analyze CSU’s IT environment and make some recommendations regarding consolidation. After collecting data and spending one week on campus in November, 2010, the contract with Adams-Gabbert was terminated due to widespread and uniform dissatisfaction with their understanding of our IT environment. In January 2011, Provost Miranda charged the IT Consolidation Committee, consisting of the authors of this report, with developing a framework to discuss consolidation opportunities, in a report to be delivered to him by March 15, 2011. This document constitutes that report. This report utilizes the data collected by the campus for the visit from Adams-Gabbert, the report from Huron Consulting delivered to Purchasing in spring 2010, and data on server rooms collected by the Facilities Management department.

Current IT Environment at CSU
Currently, the IT environment at CSU is organized and funded in a distributed manner. Central IT operates an environment that possesses unique services, campus units operate their own IT environments each of which can possess unique services, and there is an area of overlap, as shown in the corresponding Figure 1. Note that there are some ‘utility’ or commodity services operated in both areas. This report contains an analysis of consolidating certain of those ‘utility’ or commodity services which are typically common among most IT units on campus. Such a strategy is percolating into higher education environments. Indeed, at a meeting in May 2009 of Chief Information Officers from Carnegie Research Intensive (formerly R1) institutions, 60% of the approximately 45 CIO’s at that meeting reported consolidation activities. The University of Denver, which is half of CSU’s size (approximately 12,000 FTE students), has effected consolidation of certain aspects of their technology environment. Savings exceeding $1.5 million per year have been realized, and more is expected over time, as additional consolidation is effected.

Some elements of the IT environment are and should remain distributed. However, there are aspects of the IT environment for which consolidation will offer both benefits to the campus and cost savings, as depicted in Figure 2. Here, our current state is shown as ‘A’ on the diagram. Some consolidation should result in simplification of CSU’s IT environment and yield cost savings, point ‘B’ on the diagram. Beyond
a certain level, consolidation would yield a negative benefit compared to our current state, i.e. be detrimental to the quality of IT services and support but yield additional cost savings (point ‘C’ on the diagram). Traversing past point ‘B’ could, overall, be in the best interests of the institution, as budgets are shrinking, and the additional consolidation may preserve other, more critical, areas of the institution. For example, tenure-track faculty lines have already gone unfilled and fewer adjuncts are being hired/retained, even as the number of students continues to grow, with a direct result of increase in class sizes and ergo diminished quality of education. This trend of shrinking budgets in higher education is expected to continue nationally, and the degree to which we can raise tuition to offset partially the loss of revenue remains to be tested, and will be determined only as enrollments are established every semester. This report attempts to assess and discuss the trade-offs between benefit and cost savings to serve as a framework for discussion against the backdrop of other budget pressures in the institution.

Management and Analytics
In the current, distributed IT environment, individual units are responsible for their own IT environments. Various aspects of the IT environment are coordinated via a variety of initiatives and actions. Although CSU’s IT Governance structure (http://itec.colostate.edu) supports operational and policy decisions in accordance with the current loosely coordinated structure, there is no overarching management of IT at CSU. In fact, there is no comprehensive knowledge of IT services, devices, staffing, etc. Lacking such knowledge makes it virtually impossible to manage our collective IT environment and deduce effectiveness from analytics. Any consolidation effort should result in improved analytics pertinent to the IT environment that would allow the environment to be assessed for effectiveness and efficiency, and support informed management decisions by upper administration.

One approach in this regard is to better coordinate IT activities, including defining, agreeing upon, implementing, operating, and managing a coordinated environment, under the current structure. While this will likely improve the environment for users, the costs of achieving consistency and the associated overhead of coordinating and managing multiple, disparate environments, even for a subset of activities, may increase costs, rather than reducing them. Another, more aggressive approach would be to consolidate select elements of services and staffing, which would require redefining organizational structures and reassigning staff duties. In fact, as much of the costs of the IT environment are staffing costs, it may not be possible to effect significant savings unless this approach is adopted. Indeed, because IT duties are spread across individual staff in units, reassignment of duties may be necessary in order to effect FTE reductions. In such an approach, it would be prudent to endeavor to achieve greatest common denominator by assembling the staff with the greatest expertise from across the institution. Both approaches are considered in this exercise.
**Simplification of the IT Environment**

The different IT operational paradigms inherent in units responsible for their own IT environments introduces significant complexity in the IT environment, that must be supported by central IT and units which share users and/or IT services. Significant campus benefit and cost savings could be achieved through simplification, where certain IT services are made consistent through consolidation (point ‘B’ on the diagram). Economies of scale could also be realized through such simplification.

IT environments are becoming increasingly complex, and require ever more sophisticated staff for operations and management. In addition, IT security and privacy concerns are ever evolving and demanding greater expertise and more staff and resources. Meeting these needs in various areas of the institution constitutes an inefficiency, deserving reassessment as resources for IT support in both central and distributed units continue to shrink. Preserving capacity, enhancing quality, and deliberately and thoughtfully evolving to a more efficient and effective IT environment, with fewer, more expert staff, may be achievable through sensible, effective consolidation.

Over-consolidation, however, would be detrimental to innovation and meeting individual needs in units, many of which are unique. Furthermore, staff must be embedded locally to ensure that high-quality user support is available in a timely fashion, and with IT support staff knowledgeable about individuals’ needs. Thus, embedded staff should exist in any final state of IT consolidation. Careful consideration is warranted to the balance struck by the ‘appropriate’ level of consolidation.

**Organization of This Report**

The remainder of this report is organized into seven individual IT Consolidation Opportunities, presented below, each including analyses of campus benefits, approximate annual cost savings, approximate implementation costs, IT security risks, staffing changes, impact on the capacity for innovation, and risks/constraints. In these analyses where FTE are consolidated, it is assumed that the proposed staffing reallocations can be done at no net cost, either by direct and immediate reassignments, or over time via attrition. In case this is not practicable, the costs and FTE enhancements needed in a consolidated unit are identified in each section.

Note that the seven IT consolidation opportunities are presented and discussed separately, even though there are numerous potential dependencies. One that deserves particular mention is the adoption of a single, uniform set of credentials for users, which consolidated services may rely upon for service delivery. Also, the Committee established best estimates of cost savings and implementation costs that should be considered as approximations needing further analysis and definition. Such dependencies and more detailed estimates of cost savings should be further defined and analyzed after the initial directions from this report are determined.
1 Data Center Space & Associated Hardware

1.1 Introduction
Colorado State University has dozens of computer centers and server rooms across campus. Centrally the University also has a data center located in the Engineering basement (referred to in this document as ‘E7’), and a disaster recovery site in the University Services Center. A few select units have invested heavily in their own data centers and disaster recovery locations. To achieve economies of scale, it is prudent to consider centralizing server facilities as much as possible and leverage their:

- Access controls – Centralized/standardized physical access and security and monitoring
- Environmental controls – backup power and room conditioning
- High speed connection to the campus network

Complete consolidation into a single facility for the entire university is inadvisable from the standpoint of backup and disaster recovery. Also, there is a limited amount of space in E7, and there are extremely robust server rooms in some non-central areas on campus.

1.2 Opportunities for Consolidation

1.a ‘Tight’ Collaboration
Provide the option to relocate hardware in non-central server rooms ‘as is’ (e.g. racks of servers) into the centrally managed data center. Non-central servers would be prioritized for such relocation based on criteria developed by Facilities and the IT community (IAC).

**Campus Benefits:** Among the benefits to the campus are:

- Overall better physical security and environmental protection of systems.
- Better compliance with audit requirements for physical security and access controls.
- Recovery of space for other uses.
- Elimination of access control systems for many decentralized locations.
- Decreased utilities usage (electrical & cooling) for decentralized locations.
- Decrease the number of Facilities’ “emergency” calls. Facilities responds as an emergency when air conditioning or power fails in any building where servers are located.

**Implementation Costs:** Costs to purchase additional cabinets to house servers, estimated at $10,000.

**Annual Cost Savings:** Facilities estimates cost savings in the range of $200,000-$400,000 per year.

**Staffing Changes:** None.

**IT Security Risks:** IT security risks are lowered significantly as servers are brought in from multiple, less secure locations into a single well-managed facility, but this would be partly offset by a marginal increase in risk as more individuals have access to the main data center.

**Innovation:** Preserved.
**Risks/Constraints:** Among the constraints are:
- Adequate redundant disaster recovery facilities must be made available.
- There is insufficient physical space within the central data center to accommodate all systems (physical servers and cabinets) from decentralized locations as they exist today.

**1.b Hybrid Model A: Server Infrastructure consolidation**
Migrate servers and services to virtualized environment in the main data center, move existing server systems into high-density blade chassis housed in new water-cooled cabinets. Virtualized servers would be managed by central staff, while services and storage would be managed by non-central staff. To maximize the benefits, virtualization software should be able to easily host most server operating systems (Windows and Linux).

**Campus Benefit:** Among the benefits to the campus are:
- Same as 1.a plus:
  - Greater expansion potential as servers are deployed at much higher density. Multiple virtual servers can be hosted on one physical server.
  - No significant cost related to change in management; conducted as a relocation effort.
  - Ability to charge research contracts directly for such IT services creating an economically viable and sustainable business model.

**Implementation Costs:** Cost to supply water cooled cabinets in the main data center estimated at $100,000. Need to add or reallocate one-half to one FTE toward this effort.

**Annual Cost Savings:** Potential savings by relocating servers and virtualizing 75% of them ranges from $400k to $500k annually. Over time, the University will realize savings in economies of scale by leveraging a single, central, and robust virtualized environment. Also, the FTE effort in units devoted to maintaining virtual environments for departmental systems would be available for reallocation to other tasks, perhaps involving assistance with instruction.

**Staffing Changes:** Anticipated effects on staffing are:
- For non-central units FTE savings as follows:
  - Elimination of hardware management.
  - Elimination of the need to create and manage virtual environments.
  - Reduced hardware costs via virtualization.
- Centrally:
  - Additional responsibility to manage the virtual environment for university systems.
  - Need to manage and coordinate this effort, including deployment and operations.
  - Need to add one to two FTE to manage this effort.

**IT Security Risks:** Same as for 1.a.

**Innovation:** Virtualized servers are far more flexible technologically and financially, offering great potential for savings. Departmental professionals will be able to configure systems for their clients without having to worry about maintaining hardware, thereby possibly enhancing innovation.
**Risks/Constraints:** Critical services in a virtualized environment must be implemented redundantly, i.e. duplicated in the Disaster Recovery site.

1.c Hybrid Model B: Server and storage infrastructure consolidation
Migrate servers & services to a virtualized E7 environment as in 1.b, but also migrate storage systems into a central ‘cloud-based’ storage model for user files (document folders) and redundant systems. Core infrastructure and storage would be managed by central staff, and services would be managed by non-central staff. Since there is a high utilization of existing storage, simply shifting existing storage would not gain much cost savings. However, differentiating and provisioning for different storage requirements allow the university to save money by using less expensive appliances where appropriate.

**Campus Benefit:** Among the benefits to the campus are those as in 1.b, as well as:
- Simplification of storage access for end users (ubiquitous across campus).
- Reduced effort managing multiple vendors.
- One storage system would result in less complexity for users.
- Economies of scale realized in the area of disk storage.
- Collaborative virtual space for campus research will be created.
- Guidelines emerging from federal granting agencies will be incorporated.
- Possible cost savings:
  - Cost for 10 terabytes from HP = $10,000 = $1,000/TB.
  - Cost of 90 terabytes ‘home grown’ ACNS solution = $10,000 = $111/TB.
  - Colleges alone now have approximately 180 terabytes in storage capacity.
  - Approximately 25% of that data (45 TB) could be stored on the home grown solution.
  - Cost for an HP solution = $90,000. Cost for ACNS storage = $10,000.

**Implementation Costs:** Same as 1.b, plus $40,000 for storage and backup.

**Annual Cost Savings:** Same as 1.b. Also, assuming storage doubles annually: $80,000/yr.

**Staffing Changes:** Same trend as 1.b., but more so. One additional FTE required to manage storage.

**IT Security Risk:** Same as 1.b, plus an increased risk associated with a single, emerging, monolithic storage solution.

**Innovation:** A campus cloud would provide space for researchers to store data that is physically secure, and backed up, thereby enhancing and enabling innovation and collaboration.

**Risks/Constraints:** The same as 1.b, plus a campus storage solution relies on use of central identities. *Home grown system does not have the same redundant engineering as an HP system.*

1.d Full Server and Storage Consolidation
Migrate servers & services to a virtualized E7 environment, migrate storage systems into central ‘cloud-based’ storage model. Core infrastructure, storage, services, and servers managed by central staff.
Campus Benefit: Among the benefits to the campus are:

- Same as 1.c. Additionally:
- Simplification of access of services for end users (ubiquitous across campus).
- Consistent management of systems, ensuring an identical user experience for accessing services.

Implementation Costs: The same as 1.c.

Campus Cost: The same as 1.c.

Staffing Changes: Wholesale change to the staffing structure on campus to a central IT staff. A potential loss in service agility and flexibility for non-central units.

IT Security Risks: The same as 1.c.

Innovation: Consolidation inherently decreases innovation, particularly for advanced, disruptive innovations.

Risks/Constraints: Reluctance of the campus to adopt such a significant change. The marginal benefit to complete centralization is insignificant with respect to virtualization. All the savings can be achieved (licensing, service provisioning, hardware administration and purchasing, etc.) without complete centralization of staff.

1.3 References:

LINDA L. BRIGGS, “VIRTUALIZING THE CAMPUS DATA CENTER,” CAMPUS TECHNOLOGY, 03/03/11.


2. Applications and Licensing

2.1 Introduction
The licensing area encompasses all of the licensed application software in use at the university, as well as any corresponding licensing issues. Currently, Departments are responsible for either purchasing or developing their own applications to meet their needs.

2.2 Opportunities for Consolidation

2.a Tighter Collaboration
Consolidating to this level would involve requiring the units, at a minimum, to check with RamTech before purchasing or licensing any applications. This would ensure that the best price is obtained for software purchases as RamTech would be aware of any current contracts in place. This level of consolidation does not address units developing their own applications; it merely covers licensing.
Campus Benefits: Savings may be realized on the licensing and management of standard applications used throughout the university. In addition, some savings might be possible for operating a single, virtualized licensing service for the campus.

Implementation Cost: None.

Annual Cost Savings: Currently, RAMtech manages most licensed content at CSU. Additional cost savings should provide greater economy of scale as a result of tighter collaboration, but insufficient information exists at this time to estimate annual cost savings.

Staffing Changes: None.

IT Security Risk: No change.

Risks/Constraints: Diligent and effective communication is essential to the success of this option. Without a complete understanding of the potential savings for colleges and divisions, especially in the Apple product line, the success of such an effort is indeterminate. RAMtech must be responsive within a reasonable period of time for this option to be successful.

2. b Hybrid Approach, some Consolidation
Common applications would become the responsibility of a consolidated unit, either RAMtech or an outsourced vendor. For department-specific applications, the departments would still be responsible for purchasing or development. Departments could use new resources available (a new programming-innovation activity and a centralized purchasing function) or use their own internal resources. Purchased applications, such as Adobe Acrobat, could be used throughout the university. By moving towards centralized licensing for more standard applications, the university may be able to take advantage of greater volume purchasing.

Campus Benefits: Savings may be realized on the licensing and management of standard applications used throughout the university. In addition, some savings might be possible for operating a single, virtualized licensing service for the campus.

Implementation Cost: May require more personnel to manage centralized purchasing and licensing functions, and the Committee members recommend that outsourcing this licensing activity be considered as an IT Consolidation opportunity.

Annual Cost Savings: Currently, RAMtech manages most licensed content at CSU. Additional cost savings should derive from tighter collaboration, but enough information is not available at this time to estimate annual cost savings.

Staffing Changes: None.

IT Security Risk: No change.

Risks/Constraints: An analysis of the costs of outsourcing versus insourcing at RAMtech needs to be conducted. This option may require more personnel to manage centralized purchasing and licensing
functions, in either case. It is difficult to conceptualize an effective and efficient outsourced model where all departments at CSU interact separately and possibly disparately with that vendor. In addition to software license contracts, an additional contract with an outsourced service provider would be required.

2.c Complete Consolidation
Consolidating to this level would involve the complete removal of software purchasing and licensing responsibilities from the units. The units would have to communicate with a central licensing or purchasing entity, whether RAMtech or an outsourced vendor, to meet all of their needs. As this seems to be an ineffective solution, no further analysis of this option will be included in this document.

3. Web Design and Programming

3.1 Introduction
The area addressed herein is web design and web-based programming and application development. Although CSU has a Department of Web Communications (DWC) that maintains the main web page for the campus as well as web design standards, responsibility for website design and implementation is distributed throughout the academic colleges and units. Similarly, web application development to a large extent remains distributed under local control – a model that fosters creativity and facilitates innovation.

Although it is difficult to diagram all web design activities at CSU, the figure above provides a schematic illustrating generalized responsibilities from the top (university level) to the faculty level. The DWC is responsible for building and maintaining top-level WebPages for CSU. They manage key e-mail and web-based communication activities targeting alumni, prospective students, and others. Although DWC maintains web standards (standards for web graphics, etc.) and is available to work with university units to establish or maintain a professional Internet presence, there are no requirements that units work with the DWC. Although assistance is “available,” there is no formal connection that would indicate a requirement to work together.

It would be very difficult to map or diagram application development at CSU. These activities happen at all levels and are sometimes very informal. This distributed environment is beneficial for innovation; however, it seems that the institution lacks a mechanism to diffuse high-quality innovations throughout the university.
3.2 Opportunities for Consolidation

3.a Tight” Collaboration: Enforce Web Standards
Under this model, DWC would be charged with enforcing the Web standards across all units (a “look and feel” policy). In addition, the web communication committee could be reenergized and used to communicate with stakeholders across campus about standards (look-and-feel) policy and requirements.

**Campus Benefit:** Among the benefits to the campus are improvements in web communications, web presence, utilization of expertise in web-based design, and ADA compliance.

**Implementation Cost:** Additional training would be required to enforce web security and standards, estimated at $10,000, but this training could most likely be done internally.

**Annual Cost:** Costs will increase to attain and maintain additional staff to oversee policy changes and compliance. Estimated cost increase is approximately $150k/yr.

**Staffing changes:** An aggregate of 2 FTE unit staff to absorb the additional workload associated with compliance.

**IT Security Risk:** Lowered, due to greater consistency and quality of web presence and coding.

**Innovation:** Innovation is preserved within this framework as long as changes to the policy can be realized through the web communications committee.

**Risks/Constraints:** Without additional staffing, DWC may not have the capacity for the additional effort of communicating, coordinating, and training inherent in this model.

3.b “Tighter” Collaboration: Enforce and Support Web Standards
Develop a process that will allow programming innovations (IT applications developed within units) to become institutionalized at the university. Currently the development and control of customized web applications (innovations) occur campus wide at all levels. These applications are developed utilizing a variety of programming languages and tools. Such a distributed development environment is vital to innovation, and applications developed and used by numerous units at CSU (examples include scholarship and time tracking applications) could be shared across campus. Therefore, the opportunity lies in defining and enforcing standards for building and establishing a process for sharing such innovations (e.g., universal authentication) and for leveraging innovations across the campus. Also, an opportunity exists for the deployment of a consolidated set of platforms for development of active web pages (those interacting with back-end databases). Currently, ACNS does not support some web programming languages and services used by some units. An opportunity to consolidate such services would yield cost savings by eliminating duplication of these services across campus. Although this offers an opportunity for consolidation of web services, it is not discussed further in this section, but may instead be considered part of IT Consolidation Opportunity.

**Campus Benefit:** A service level improvement by leveraging IT innovations across campus.
**Implementation Cost:** Potentially low cost. Additional training required to enforce web security and standards, estimated at $10,000, but this training could most likely be done internally.

**Annual Cost Savings:** Minimal.

**Staffing changes:** None.

**IT Security Risks:** Lowered, due to greater consistency, and quality checks in applications being utilized with the IT environment.

**Innovation:** Preserves and enhances diffusion of innovation

**Risks/Constraints:** Currently a process does not exist to define and move application innovation from the unit level to an institutional level. Effort will be required to institute this process and build a culture of open innovation and sharing.

### 3.c Hybrid Model – Some Consolidation

The hybrid model considers web designers (not developers) are consolidated into a central unit – presumably under the DWC. This model would leave the web application developers in the external units to preserve innovation. An estimate is that there are ten FTE web designers distributed across campus. Under this model the web look-and-feel would be tightly controlled leading to a more consistent CSU web presence.

**Campus Benefit:** Improvement in web communications, web presence, utilization of expertise in web-based design.

**Implementation Cost:** Potentially low cost. Additional training required to enforce web standards, estimated at $10,000, but this training could most likely be done internally.

**Annual Cost Savings:** An estimated cost savings of $160,000 may be realized under this model. If staffing could be reduced by 25 percent through consolidation, a savings of $160,000 may be realized in efficiencies ($65,000 x 10-estimated x .25 = $160k).

**Staffing changes:** Staff in units would be relieved of the responsibility of web design but would retain responsibility for web application development.

**IT Security Risk:** Lowered significantly.

**Innovation:** Preserves innovation.

**Risks/Constraints:** The DWC may need additional space for consolidation. In addition the DWC would need to establish an efficient process for handling workflow.

### 3.d Complete Consolidation

A completely vertical model would place all web-design and application development activities in the hands of a consolidated development group. Although this model has the greatest potential for ensuring
high-level control and management, it has a disadvantage in that response times may be significantly reduced and innovation may diminish to a low level. If application developers are centralized, they would be distanced from innovation centers, thereby reducing innovation.

**Campus Benefit:** High-level control but a negative impact on innovation.

**Implementation Cost:** Potentially low cost. Additional training required to enforce web standards, estimated at $10,000, but this training could most likely be done internally.

**Annual Cost Savings:** It is estimated that the cost savings would be similar to the hybrid model.

**Staffing changes:** Staffing changes/reductions significant. FTE in the units would be reorganized under the auspices of a consolidated unit.

**IT Security Risk:** Reduced due to centralized administration.

**Innovation:** Significantly reduced.

**Risks/Constraints:** This would require significant redirection of resources into a centralized entity (presumably the DWC). While possible, this may require some transition planning that will require operational attention.

3.3 Discussion

Any new model adopted should move us forward in terms of building and maintaining a consistent and high-quality CSU web presence. Also, any new model should strike an appropriate balance between the an effective overall environment and cost savings, while maintaining innovation.

4. Identity and Access Management (IAM)

4.1 Introduction

Identity and Access Management (IAM) is defined by the Burton Group as “...the set of business processes, and supporting infrastructure for the creation, maintenance and use of digital identities.” IAM systems provide means for authentication (i.e. logging in), authorization (i.e. permitting access to specific services after having logged in), and operations and management of electronic identities. At CSU centrally, this is currently eID. IAM systems are essential to the conduct of business and are thereby mission critical. IAM systems also provide the ‘keys to the kingdom,’ as they provide the potential to access to virtually all sensitive and personal data for all of CSU’s constituents. As such, the IAM system requires the highest levels of operational excellence, and protection in terms of IT security and privacy.

Over the past three years, a number of efforts have been initiated focused on campus identity management to define the needs of the campus related to IAM, and assess whether the current eID system is adequate for present and future needs of the campus. The findings from these efforts have revealed a number of recurring themes related to IAM and eID. Specifically;
1. The multiple sets of credentials for accessing electronic services on campus continues to be confusing and problematic for users. There are systems on campus which either do not or cannot take advantage of eID credentials. Some services use proprietary authentication systems, and each child domain (currently thirty-four in number) that exists in the distributed Microsoft Active Directory forest on campus uses unique credentials.

2. While eID provides authentication functionality, authorization services (determining who should have access to particular services) are not currently accommodated. This functionality was not included as a requirement in the original eID project, due to the extreme complexity of meeting the diverse needs of the separate and distinct IT environments in units.

3. Support for external constituents is problematic. A process (Associate access) has been developed that allows access to campus services to those who are not in CSU’s official systems of record, but have a legitimate need to access CSU resources; visiting scientists, Extension Agents, and federal employees are examples. The eID system is not extensible in its current state to support additional large external constituent types such as alumni, donors, parents, and guardians.

4. The need exists for CSU to continue to increase its use of federated authentication to meet the needs of the research community, for example to participate in the emerging federal grants.gov system, and also as an efficient means for authenticating with external services such as the Electronic Book Library (EBL) and Lynda.com.

5. A need exists to support Levels of Assurance (LoA) for identities, specifically for the research community. This will require the identities of individuals entering our systems and for which we have eIDs to be established according to formal rules and procedures, to verify their access to systems, especially grants.gov.

Two potential models exist for approaching opportunities ‘b’ and ‘c’ listed below; 1) leveraging the strengths of the existing campus solution for authentication, and a ‘point solution’ for additional functionality, and 2) identifying and implementing a full-scale move to a single IAM (likely vended) solution. The first model implies either a development effort or upfront cost for a vended point solution along with a mid-level effort on the part of the campus to implement the system and develop management processes. The second model will likely include the need for substantial upfront funds for the initial purchase of a solution and will also require a significant effort on the part of unit, IS, and ACNS staff to migrate existing processes to the new system.

Note: Items #4 and #5 above need to be addressed regardless of the level of IAM consolidation and as such, are not included in the analysis below.

4.2 Opportunities for Consolidation

4.a Tight Collaboration
The opportunity exists to engage in a communications campaign for end users in an effort to minimize the confusion inherent in multiple sets of credentials. Elevated collaboration also presents the opportunity for some units to begin using central credentials while maintaining their Active Directory child domain to manage local resources, as CVMBS has done.
**Campus Benefit:** More reliance on central authentication; better understanding on the part of the end users will decrease the amount of frustration and incrementally increase their efficiency.

**Implementation Cost:** None, implemented with existing staff.

**Annual Cost Savings:** Savings are in efficiencies; Assuming a 50% reduction of password resets per day by central IT/HR staff (from 20 to 10),

**IT Security Risks:** None above today’s current model.

**Staffing Changes:** None.

**Innovation:** Preserved.

**Risks/Constraints:** Purely an educational effort to increase efficiency. This only partially addresses the multiple login issue and does not address the authorization of services gap identified by the campus.

### 4.4 Hybrid Model
The opportunity is to extend the campus IAM system by adding authorization components that include distributed or delegated administration functionality. This would allow IT staff in non-central areas to manage access to local resources based on centrally-defined roles and attributes, and could potentially allow non-central units to define department-specific attributes for extensive and more granular management of local resources. This should also allow some of the many Microsoft Child domains across campus to be decommissioned.

**Campus Benefit:** This would enable the use of a single, consolidated solution for credentials (login and passwords), thereby eliminating the confusion of multiple login systems on campus, and preserve the ability for distributed IT staff to meet their local needs. Also, moving to a more ubiquitous model for central authentication enables efficient management and deployment of other services as they may be consolidated.

**Implementation Cost:** Initial investment required (see Introduction). One additional FTE would need to be added to manage the additional effort at a cost of approximately $77k/yr.

**Annual Cost Savings:** Savings of greater efficiency for end users (fewer logins) and for IT support staff who would not need to run separate Microsoft Domains. While managing the 34 child domains on campus is not a resource intensive function, it is estimated that collectively across all of the domains, approximately 1 FTE is required ($85K/year). The additional effort of managing a complex set of policies, procedures, processes, and users may offset some of these cost savings. User savings are difficult to estimate, but a user saving just an average of 1 minute per day, amortized over all 5,500 faculty and staff, at an average total hourly rate of $40 would yield an annual increase in productivity of more than $700,000.

**IT Security Risks:** Enabling distributed management by nature implies increased complexity and risk due to the many ‘points of control’.
**Staffing Changes:** None, but would require communication and coordination for IT staff and application developers to transition to the new model.

**Innovation:** Preserved.

**Risks/Constraints:** Success will require normalization of rules, processes, and procedures across a potentially large number of distributed units with disparate business needs.

### 4.c Complete Consolidation

A completely consolidated IAM environment would include systems, operations, and staffing that support the central IAM, including the Microsoft Active Directory forest. Along with providing a single system for authentication and authorization, this would also facilitate consistent operations as operational staff would be consolidated in one administrative unit.

**Campus Benefit:** Single set of credentials as described above. The complexities of establishing a complex set of procedures and processes for use by distributed IT staff are reduced and this ensures a consistent and adequate level of expertise.

**Implementation Cost:** Initial investment required (see Introduction). ACNS would need to add 1 FTE staff for operations, that could be offset by FTE reductions in units.

**Annual Cost Savings:** Savings would be realized as staff would report to a single manager thereby minimizing complexity, and provide the most efficient approach and the greatest cost savings. User savings will be the same as for item 4.b.

**IT Security Risks:** A consolidated model for IAM provides a more effective framework for management of identities which enhances IT security and compliance.

**Staffing Changes:** IT staff (fractional FTE, total of 1.0) in non-central units would be relieved of duties associated with provisioning access to services, freeing them up for reassignment to other services. ACNS would need to add staff (1 FTE, $70K/year) to support the demand generated by the non-central units to ensure users have proper access to resources (disk storage, printers, software, etc.).

**Innovation:** Decreased as central support would not have the detailed knowledge of the non-central units, limiting their ability to support unique & specialized needs.

**Risks/Constraints:** This approach presents the greatest risk in terms of users’ needs not being recognized and handled. If the additional staff needed to operate and manage this environment were not implemented, the system would lack agility and responsiveness. Some systems which require other means of logging in will not be addressed. Further, non-central units put a relatively small amount of identifiable effort into formally managing IAM related activities, and determining which staff members are involved in this area on behalf of the distributed units would be onerous.
4.3 Discussion
Regardless of the level of consolidation, there are very likely no cost savings for FY12. In fact, direct cost savings in this area will likely be small, and only realized over a longer period of time in terms of efficiency. However, advances in this managing the IAM space is critical as it will enable more efficient implementation of other campus services as they are consolidated.

5. Purchasing

5.1 Introduction
The current purchasing of computer hardware is generally distributed, although some ad hoc aggregation of purchases does occur. Needs for equipment are evaluated at the time of purchase, and the evaluation may involve users, department staff, and the local IT support staff. While some units may have developed procedures to streamline the process within their units, there is no campus-wide agreement with vendors to achieve efficiency and economies of scale in the purchasing process.

CSU has pricing contracts with more than one vendor, and those contracts generally provide discounts of up to 27% off listed prices for higher education (per Huron Consulting Group Study in 2010). Campus staff may realize some efficiency by consolidating purchasing activities for their areas, or standardizing some administrative machines, but there has not been a coordinated effort to organize the effort campus-wide.

Opportunities exist to negotiate favorable pricing and discounting for the most commonly used computers. Additional efficiency may be gained by “freeing” local support staff from piecemeal purchasing activities, and providing a more uniform desktop/laptop environment to facilitate and streamline support. It is realized that faculty and researchers often have needs that will require exemptions from any group purchasing plans, and it is affirmed that these will be available under any of the models suggested below.

5.a Tight collaboration: Group Purchases
Increasing collaboration could effect savings and increase staff efficiency at this level. Increased collaboration would be implemented as a University-wide purchasing plan is put in place for administrative desktop and laptop computers.

The University owns over 11,000 desktop and 4,800 laptop computers, (Fall 2010 Campus IT Manager inventory), and spends approximately $5,200,000 annually on this equipment (Huron Consulting report), about 81% of which is for several standard/administrative models.

A second aspect of this collaboration would be the purchase of zero clients to replace basic computers (Dell 380’s, for example). Zero clients are devices that connect to a server over the network to bring a “desktop experience” to the user. There is very little technology (network card and keyboard-video-mouse connections), so they are extremely inexpensive ($200) and have a longer lifetime (at least 5 – 10 years). Zero clients are now in use as lookup stations in the Morgan library.
Campus Benefit: The standardization of devices and purchasing process are likely to increase efficiency in purchasing within the units. Configuring and installing the computers could also become more efficient.

Implementation Cost: None.

Annual Cost Savings: Savings of $400,000/yr. for both purchasing consolidation and zero clients.

IT Security Risks: Reduced slightly due to standardization for computers and significantly in the ‘zero clients’ environment.

Staffing Changes: None. Where technical support staff are currently engaged in ordering computers that are fairly standard, they may be able to redirect their efforts to more critical tasks.

Innovation: No change, provided the exemption process is effective.

Risks/Constraints: The need for liberal and timely approvals for exemptions from a consolidated purchasing opportunity need to be part of this model. If a single vendor were selected, problems with a specific product line may exist.

5.b Hybrid Strategic Business Alliance with a Single Vendor
A hybrid approach could result in savings of approximately $760,000 annually (Huron Consulting). This approach would include negotiation of a strategic business partnership, and purchase of all machines in the category. While additional resources would be required initially to negotiate agreements, efficiencies may be realized in the same way as noted in the previous section. In addition to direct cost savings, other benefits (scholarships and internships) to the University may derive from the establishment of the strategic partnership.

Campus Benefit: The standardization of devices and purchasing process are likely to increase efficiency in purchasing within the units. Configuring and installing the computers could also become more efficient.

Implementation Cost: None.

Annual Cost Savings: Savings of over $800,000/yr. for a single-vendor strategic business alliance, and implementing zero clients where appropriate.

IT Security Risks: Reduced slightly due to standardization, and significantly in the ‘zero-clients’ environment.

Staffing Changes: None. Where technical support staff are currently engaged in ordering computers that are fairly standard, they may be able to redirect their efforts to more critical tasks.

Innovation: No change, provided the exemption process is effective.

Risks/Constraints: Computers that require specific capabilities and or greater capacity would be exempt, and subject to the same purchasing processes that are currently in place. Since technical
support staff would no longer be engaged in configuring and purchasing standard administrative units, their expertise could be utilized more effectively at a higher level. If a single vendor were selected, problems with a specific product line may exist.

5.c Complete Consolidation
Complete consolidation is considered to be centralization of all hardware purchases, likely within Purchasing. At this time, we did not identify additional desktop or laptop configurations for consolidated purchasing opportunities.

Together with the reduced opportunity for monetary savings, additional consolidation would likely offset staff time saved in individual units (which would probably be re-deployed to higher priority work, rather than reflected in reduced staff size) by increased staff time required centrally to process and track changing conditions and University needs.

6. Helpdesk/Desktop Support

6.1 Introduction
Currently, colleges/units manage helpdesk and desktop support activities as they see fit: some staff student-run helpdesks, others rely on professional staff for desktop support, others contract desktop support from ACNS, and still others have no help desk.

The disparate helpdesks and support staff currently have no formal means of communication and collaboration, save for periodic, campus-wide, informational meetings and utilization of a couple of email distribution lists.

This model has been in place at CSU since the early 1990s, incurs very little overhead costs, and allows for innovation and strategic delivery of support. The commonly held belief in the decentralized IT units is that this model allows for more value-add when it comes to support: when faculty members in a college is seeking IT support, they will likely reach a person who will knows them, what their specific needs are, and how to address them.

However, this model is not without its drawbacks. Since there are so many different units providing support, it can be confusing for faculty, staff, and students when trying to determine who to call for what. Since desktop support has an IT security component, there is potential for security breaches in this model due to the lack of collaboration among the disparate IT units. Further, it can be argued that the units are duplicating efforts in this area.

6.2 Opportunities for Consolidation

6.a Tight collaboration
Consolidating to this level would involve simply providing a structure and tools to allow the disparate help desk staffs better to share information, work together, and where necessary, hand off certain tasks to each other. This could be accomplished by providing the following items to the campus.
1. A single, shared trouble ticket system. This would allow for greater collaboration among staff by providing a structure by which information can be shared and trouble tickets can be reassigned. This would also allow for the generation and analysis of consolidated help desk metrics, which would show trends that could possibly be addressed at a more global level.

2. A well-defined IT support staff committee that would meet periodically to share ideas and methods. This would also expose the disparate nature of support, which should be addressed to achieve greater efficiency and effectiveness.

3. A clear desktop support decision tree: if a student from college B calls and asks about something related to college C, they should be redirected appropriately. If that same person calls and asks about eID, then they could be appropriately redirected, etc.

**Campus Benefit:** Improved help desk support based upon the improved communication among the various helpdesk staffs.

**Implementation Cost:** Initial investment estimated between $27,000 and $130,000, depending on the trouble ticket solution selected. Staff may need to be trained on the trouble-ticketing system, and communication processes would have to be defined and implemented.

**Annual Cost Savings:** No cost savings in this model; rather, costs would increase by an estimated $25,000 in annual maintenance costs for trouble ticket software.

**IT Security Risks:** Reduced slightly due to standardization, and improved/more timely communication of incidents.

**Staffing Changes:** None.

**Innovation:** No change.

**Risks/Constraints:** A single trouble ticketing system would be required for greatest efficiency and effectiveness.

6.b Hybrid (some, but not complete, consolidation)
Consolidating helpdesk activities to this level would involve the creation of a single, central, tier-1 helpdesk. This helpdesk would be responsible for initially receiving all IT support calls at CSU once fully phased in, and would provide all faculty, staff, and students initial IT help and support. In cases where the staff at the central helpdesk cannot resolve a problem specific to a unit, the problem would be elevated to tier 2, in other words, to the appropriate support staff (central or non-central).

This model would provide the university a higher level of staffing efficiency, most of which would derive from student hourly staff reductions. To estimate savings on staffing, assume an estimated 32 student helpdesk FTE and approximately 30 professional helpdesk FTE are currently employed at CSU (Fall 2010 IT Manager Inventory). If an average hourly salary for student helpdesk staff member is $12, then CSU currently spends approx. $768,000/year on student desktop support staff, funded across a myriad of fund types (13, 25, 16, 53, etc.). If consolidating to a single tier 1 helpdesk could result in a 33% reduction of helpdesk staff, the savings to CSU would be approx. $253,500/year across all fund types.
For professional staff, assuming an average salary of $50,000 (including fringe), CSU spends an estimated $1.5 million on professional desktop support staff. Assuming many of these staff members would have to stay in their units as tier 2 support contacts, the reductions would be approximately 10%, a savings of about $150,000/year across all fund types.

**Campus Benefit:** Improved help desk support, by providing professional staff at tier 1 (currently rare), increasing the number of hours of staffed support, and clarity for users by providing a single point of contact.

**Implementation Cost:** Initial investment estimated between $27,000 and $130,000, depending on the trouble ticket solution selected. Staff may need to be trained on the trouble-ticketing system, and communication processes would have to be defined and implemented.

**Annual Cost Savings:** Costs would increase by an estimated $25,000 in annual maintenance costs for trouble ticket software, but cost savings in providing more efficient staffing for help desk services yielding cost savings of up to $400,000 per year.

**IT Security Risks:** Reduced slightly due to standardization, and improved/more timely communication of incidents.

**Staffing Changes:** None.

**Innovation:** This model should help improve innovation by freeing up professional staff FTE for strategic IT tasks, such as application development, systems design, etc.

**Risks/Constraints:** A single trouble ticketing system would be required for greatest efficiency and effectiveness.

6.c Complete consolidation
This model likely damages the university far more than it helps. The aim would be to move all desktop support activities (including tiers 1 and 2, as well as any other elevated level of support) to one central unit. Any money saved by pursuing this model would almost certainly be offset by the increased frustration among faculty, staff, and students as well as the loss of efficiency by splitting up FTE in the decentralized units (since many of them do not hire dedicated support staff).

6.3 Discussion
This topic requires a great deal of discussion, and some topics that should be considered are:

1. How unique are the needs in the units? Consolidation to level 2 makes no sense if the units aren’t able to reduce FTE costs (whether student or not).
2. How does CSU determine who is actually doing desktop support in the units?
3. How much time and effort does it take to generate the decision tree for the central helpdesk? And how many people need to be involved with the process?
4. At level 2, how long does it take to get the campus through the learning curve (who do I call now instead of the individuals in my unit)?
5. Will faculty adopt such a change?

7. Networking and Networking Support

7.1 Introduction
A schematic of CSU’s physical network topology is shown in Figure 7.1, from which this discussion proceeds. Figure 7.1 depicts the optical interconnect in the wide area, the border router, the campus core backbone switches, building switches, and distribution switches. Generally, core backbone switches ‘fan out’ to connect to building switches; building switches fan out to connect to distribution switches; and distribution switches fan out to connect to end users. However, there are exceptions when economies can be realized, i.e. a core backbone switch may be used as a building switch for the building in which the core backbone switch is located, and a building switch may be used as a distribution switch for the end user connections in its telecom closet. Not shown on the diagram is the wireless network, where wireless access points are connected to the physical network, typically to distribution switches.

![Figure 7.1 Network Topology](image)

Currently, ACNS is wholly responsible for design, operations, maintenance, management, alarming, and monitoring of all devices from the core switches in the backbone and outward towards the Internet, including the border router and the optical wide area network. Generally, ACNS is responsible for all wireless networking devices in our network, ensuring that we comply with federal regulations, including
the Communications Assistance to Law Enforcement Act (CALEA) and other pertinent regulations. Units are responsible for their own networks including funding for replacement of distribution switches, and for operating their own networking environments up to and including the building switch. However, some unit IT staff coordinate closely with ACNS in such operations, and ACNS operates networking switches for units, at their request.

ACNS, by default, assumes networking responsibility for all life and safety devices that may be connected to the network, usually by Facilities Management personnel who coordinate with ACNS. Life and safety devices may be deployed in any location on any type of switch. Effective and efficient operation of life and safety devices requires end-to-end knowledge of the networking topology and the end-to-end knowledge of the details of the switch configurations. Because there are areas where ACNS lacks knowledge and operational responsibility over the network, ACNS indicates that effective and efficient operation of the network to support life and safety devices in these areas is currently not possible, which has resulted in a Campus Infrastructure Committee recommendation that is defined by an installation of separate, redundant networks everywhere as the only practical means to support life and safety devices. The IT Consolidation Committee deprecates such duplication as a problem that must be solved, and provides this analysis to address this deficiency.

This situation will become even more of an issue as our communications infrastructure is upgraded to higher speeds and for the deployment of the next generation of voice communications infrastructure that must support E911, a critical and pervasive life and safety infrastructure. Under the current model, network availability (uptime) averages between 99.1% (0.9% or 79 hours unavailable per year) and 99.4% (0.6% or 35 hours unavailable per year). In the near future, networking will become an even more critical infrastructure as more life and safety devices will be added to it, more applications will rely on it, and more data will be passed at higher speeds across it. A worthwhile goal is to harden the network to support increasing numbers of life and safety devices, and to provide a reliable, robust infrastructure for the academic and research functions of CSU. A goal of 99.9% availability is a reasonable target.

### 7.2 Opportunities for Consolidation

#### 7.a Tight’ Collaboration
One opportunity is to formalize and enforce practices for design, configuration, and operations of the network to the switch level, encompassing connections to all devices, including life and safety devices. Under this model, units operating networking switches would become responsible for the life and safety devices in their environment, including being identified as contacts for Facilities Management and other staff for the installation of such devices, identified as contacts for alarms, and be available around the clock to receive and respond to alarm notifications including assuming any related liability. This would require local IT staff to be identified as being responsible for geographic segments of the network, become trained experts in switch configuration and operations, establish and maintain cable records for life and safety devices, and require detailed coordination and oversight from ACNS to ensure smooth
and effective interoperability. Overall, the effort to establish the needed high level of training and coordination would probably be extreme.

**Campus Benefit:** Improvement in network availability, clarification of responsibilities.

**Campus Cost:** Significant in attaining and maintaining expertise in switch configuration, and communications and coordination among unit IT staff, ACNS, Facilities Management, CSUPD, etc. Estimated cost: ½ FTE (IT Pro I level) in ACNS to be responsible for communicating and coordinating, and an aggregate of 2 FTE unit IT staff to absorb the additional workload = $200k/yr.

**Staffing changes:** None, but requirement for training and registration of unit IT staff who are network operators.

**IT Security Risks:** Lowered, due to greater consistency and quality of network operations.

**Innovation:** Preserved.

**Risks/Constraints:** At current staffing levels, it is questionable whether either ACNS or IT staff in units have the capacity for the additional effort of communicating and collaborating, and training inherent in this model. Also, because the network for life and safety devices spans multiple buildings and the campus backbone, unit staff may have great difficulty isolating and debugging problems associated with the life and safety devices under their purview.

### 7.b Hybrid Model - Some Consolidation

An enhanced consolidation is to make a single group responsible for design, configuration, and operations of all network switches. Here only a consolidated group, managed by and reporting through one department, would be permitted to configure all switches, thereby minimizing opportunities for misconfiguration of these switches. Local IT staff would still assist in managing and operating the network, including installing network connections to end users, and only in close collaboration with ACNS, effect changes on distribution switches (e.g. adding hardware to expand capacity, adding Power over Ethernet for phone service, etc.).

**Campus Benefit:** Improvement in network availability. This model substantially improves the efficiency and effective operation of the network.

**Campus Cost:** Moderate to minimal. ACNS will need additional staff (IT Pro II level) to operate under this model (1.0 FTE = $60K/year).

**IT Security Risk:** Lowered significantly, due to consistent and high-quality operations.

**Staffing changes:** IT staff in units would be relieved of the responsibility of operating networking devices, but retain responsibility for serving end users with networking. The fraction of an FTE in units currently responsible for this activity would be available for reassignment to other duties.

**Innovation:** Preserved, under the assumption that an efficient and effective work flow process would result in timely responses.
**Risks/Constraints:** Under this model, some inconsistencies related to accountability and responsibility exist. Staff not in the consolidated group have physical access to and will make modifications to switches for which the central group is responsible.

**7.c Complete consolidation**
Here, a completely vertical model would place control of the entire network, including all devices and connections to the end user, in the hands of a consolidated networking group. This is similar to the model under which telecommunications infrastructures have been operated for some time. This model has the greatest affinity for ensuring consistent, high-quality management and operations, but has the disadvantage of inevitably slower response time during periods of high activity.

**Campus Benefit:** Improvement in network availability.

**Campus Cost:** Significant in assuming end-to-end responsibility, although this cost could be partially funded from telephone revenues, and possibly through recoup from units as unit IT staff are reassigned to other functions. Assumed 4 FTE unit IT staff savings = $240k/yr. that may be offset by staffing additions in ACNS/Telecom.

**Staffing changes:** IT staff in units would be relieved of all responsibility for networking devices. The fractional unit IT staff FTE currently responsible for this activity would be available for reassignment to other duties. ACNS would have to add IT Professional staff to assume central responsibility for this activity in order for them to respond as quickly as local IT staff do now.

**IT Security Risk:** Lowered, due to greater consistency and quality of unit IT staff.

**Innovation:** Diminished via lower response times for networking connections during periods of heavy load if central staffing is not increased.

**Constraints:** This would require redirection of telecom resources into the networking area. While possible, it may require some transition planning, particularly as the existing telecom environment continues to exist, requiring operational attention.

**7.3 Discussion**
Any new model adopted here should move us forward in terms of networking quality to ‘harden’ (i.e. elevate the quality of) the network and to facilitate more efficient and effective operations. Also, any new model should provide the most efficient and effective overall environment, minimizing costs and maximizing quality. Finally, as the next generation of voice communications is deployed across campus, the business model should be reexamined to identify a portion of the monthly telephone costs to be dedicated to upgrading and replacing distribution switches. This would address a critical lack, in that the upgrade/replacement of these switches in not currently funded.
Final Thoughts

In addition to the above analysis, the Committee members believe that the following avenues for efficiencies should also be pursued:

1. Consider outsourcing to external providers commodity services including email for faculty, graduate students, and staff, as we have accomplished very successfully to Google for undergraduates.
2. Consider outsourcing to external providers for basic services, including virtual platforms.
3. Consider provision of open source dynamic web page infrastructure (e.g. LAMP - Linux + Apache + MySQL + (PHP | Perl | Python) for use campuswide.
4. Explore operational, organizational, and strategic models for the next generation of campus telephony.

There are significant privacy and security concerns associated with activities 1 and 2 above, and for life and safety issues associated with item 4 above, that should be further explored.

Finally, any change implies new skill development. To the extent possible, we recommend assistance with training opportunities for already highly skilled staff members so that the University can re-direct staff time to critical, high-priority work.