To: Laura Huenneke, CENS Dean
From: CENS Tech. Committee
CC: 
Date: November 17, 2008
Re: Final Recommendations of CENS Technology Committee on CENS computing resource policies

Dear Dean Huenneke:

At the beginning of the term you tasked the CENS Technology Committee with:

1. Evaluating the current status of computational resources within CENS, including hardware and software associated with instructional labs, faculty desktop machines, and computers in research labs. The specific focus here was an inventory of what resources exist, what their status is (i.e., age, adequacy, etc.), and what current means or policies are in place to fund upgrades or replacements.

2. Analyzing the needs for computational resources across CENS, in an effort to focus less on what we currently have or don’t have, and more on what the actual future needs are. A particular emphasis here was on identifying overlapping needs, i.e., opportunities to share resources between CENS units when similar computational needs can be scheduled around shared hardware/software rather than maintenance of independent resources.

3. Providing recommendations towards developing a set of general CENS policies and guidelines to guide purchasing of all new computing resources, and planning coherently for their maintenance and upkeep.

We have worked diligently on this difficult assignment, meeting about a half dozen times during this semester and working via email in between. This memo reports the final outcomes and recommendations distilled from the committee’s work. We purposely avoid detailed discussions of individual labs and facilities in this summary document, but have attached the data compiled in surveying existing resources and needs as an appendix for reference. It should be noted up front that our recommendations are necessarily general rubrics; the precise computational resources required for a particular purpose or facility may be different and require exceptions to these guidelines. In short, we envision our recommendations not as “rules”, but as a framework for computing resource planning, i.e., “all other things being equal, this is how computing resources will be planned and administered – if this won’t work in your particular case, it’s up to you to justify it and seek explicit approval before moving ahead”.

I have organized our recommendations into a general section, followed by section devoted specifically to the three areas that you tasked us to examine, i.e., instructional computing, faculty/staff desktops, and research computing.
I. General Recommendations

In looking at the survey of existing resources, it is quickly apparent that (a) there are a wide variety of resources currently available in CENS but (b) there is little overall coordination among units of resources, needs, and plans for purchasing and maintaining resources. This leads to the obvious conclusion that coming up with a system to improve coordination and utilization of resources could lead to tremendous efficiencies, not only in dollars, but in space allocation, and time invested by various systems staff and faculty maintainers. The committee proposes the following general guidelines to address these issues:

Recommendation I.a: A comprehensive shift to thin-client technology wherever possible.

The prime motivating observations for this recommendation is simple: despite widely varying software needs, the fundamental hardware platforms needed for many of the facilities/users in CENS is really quite basic and similar: what is needed is a box with a user authentication and access to the relevant software. In the past, the most viable solution to this needs profile was to purchase X number of stand-alone desktop systems to serve X users, each with the relevant software installed. Thin client technology takes advantage of recent advances in network speed and robustness by “virtualizing” desktop systems: End users connect via a very fast, networked “dumb terminal” to their very own “virtual PC” hosted on a central server. In short, (a) the end user experience is completely unaffected: each user feels like he or she is logging into a personal PC just as before but (b) cost and maintenance of the system is radically reduced. The per-user cost of providing a thin client plus some incremental increase in central server capacity is nearly an order of magnitude less than that of purchasing and maintaining a fleet of stand-alone machines.

Recommendation I.b: Develop a fair formula for cost-sharing under the thin-client model.

Although thin-clients promise to be up to an order of magnitude more cost-effective than the current model, there are still costs associated with this infrastructure; these costs can be split into start-up and maintenance costs. The committee suggests the following outline:

- **Startup costs.** The startup costs associated with thin client technology involve (a) purchase of the actual thin client station; (b) incremental purchase of additional server capacity on a per-station basis and (c) purchase of software licenses needed by users. These costs should be borne by the unit with which the resources are associated. Purchase of software licenses should be coordinated CENS-wide, allowing multiple units to jointly invest in a shared set of software licenses for software used by both units. Such sharing is efficient under the thin-client model, as all software is installed centrally, and licenses handled by a central license manager.

- **Maintenance costs.** With no moving parts or local computation and memory installed, the service life cycle of thin client stations should be significantly longer, perhaps as long as 10 years. However, replacement should still be planned for. Under the thin client model, upgrades are made centrally, to the server; these costs must be planned for and fairly distributed. Details depend on the exact nature of the resources and are discussed below.

Recommendation I.c: Develop a formal mechanism for planning, coordinating, sharing and maintenance of computing resources between units. Our resource analysis shows that there are significant potential redundancies in resources being maintained in various units; this applied mostly to hardware, but in some cases to software (e.g., where individual licenses are purchased rather than sharing a site license). The failure to leverage sharing potential seems to stem from (a) lack of awareness of what other units are purchasing/supporting and (b)
logistical constraints or challenges arising from the technology (i.e. labs full of stand-alone workstations). What precise resources might be shared – i.e., hardware, software, space – varies depending on the situation; we have attempted outline some specifics in the following sections.

After defining some relevant concept, the following sections examine the three primary areas of computing resources relevant within CENS – instructional labs, faculty and staff desktop computing, and research support. Each of these areas falls under the overall recommendations given above, but has special considerations that must be taken into account.

II. Basic Thin Client Concepts and Definitions
To simplify the prose, it is useful to establish several concepts related to thin clients and other technology that will appear repeatedly in this document:

• **Using thin clients “wherever possible”**. There are several important limitations to thin-client technology: First, they can not support specialized attached hardware. Although this may change as the technology evolves, the current clients allow attachment of only USB storage devices (e.g. "thumb drives") to the terminals. Thus, installations requiring attachment of scanners, hubs, laboratory instruments, and other sophisticated peripherals\(^1\) will have to rely on standalone host desktops as before. The high-performance graphics capabilities of thin clients are limited as well. Thus applications (e.g. some 3-D CAD/CAM tools) that require advanced video hardware to function correctly will continue to require standalone hosts.

• **Annualized Cost of a Thin Client.** The annualized costs of a thin client are: (a) for software, the annual cost of upgrading or paying annual license fees for specialized software used on the client and (b) for hardware, the annualized cost of replacing thin client stations on a suitable cycle (TBD, e.g. every 7 years) plus a per-station fee (TBD by system staff) to cover maintenance and upgrade of central server resources. The concept can be easily generalized beyond thin clients as well: annualized cost is the annual maintenance cost of a resource, plus the annualized part of an eventual replacement cost. These costs must be monitored regularly and adjusted to reflect changes in the costs of relevant hardware and software.

III. Instructional Computing
Instructional computing centers around computing resources primarily for student use, and for use in classroom teaching of students. Our primary focus here was on computer labs, i.e., access to a desktop environment, often including certain specialized software for completing work or analyses associated with some course. Almost all CENS departments rely on some sort of lab access to some extent to allow students to explore programming or computational techniques associated with the discipline.

The committees findings with respect to instructional labs center around deficiencies in organization and planning. Levels of planning and organization of labs varied widely. Engineering disciplines have had a long-standing practice of coordinating computing resources within the building; most units have some plans in place for upgrading labs. Although overall planning and organization in Engineering is good, the committee felt that some potential for better sharing exists; in may be possible to collapse several distinct labs into a single lab in which more

\(^1\) Note that most CENS printers are now “networked”, requiring no attachment to a host desktop. Given that units can be required to purchase network-ready printers only, the thin-client model should work fine for printing.
seats are filled more of the time. Under the current model (standalone machines), labs are more difficult to share due to challenges associated with coordinating, installing, and maintaining the software needed by various users on each and every box in a lab. If we adopt the thin client emphasis, sharing can be greatly enhanced because any software can be made available on any thin client in any lab with minimal configuration of the central server.

In the Natural Sciences, the committee found less organization in instructional computing, with most units maintaining one or more independent labs. Replacement and upgrade costs of these facilities were not explicitly planned for, i.e., units rely on general operating budgets or occasional infusions of cash to upgrade facilities. As for Engineering, considerable potential for sharing may exist, i.e., when several labs are located in the same proximity, they might be collapsed under the thin client model, with all relevant software made available on all clients via the central server.

With these observations in mind, the committee makes the following recommendations specific to instructional labs:

**Recommendation III.a. : Emphasis on thin clients in instructional labs.** All instructional labs should be equipped with thin-clients when possible. The cost savings of thin clients in a lab setting are particularly compelling, with initial costs roughly $500 versus $1500 per system. The true savings, however, is in maintenance. With nearly maintenance free client stations, all resources can be focused on the server. Rather than installing X copies of X kinds of software on each machine (and then maintained over time), software is installed and managed centrally; the enormous saving in system staff time invested should quickly eclipse even the cheaper hardware costs.

**Recommendation III.b. : Conversion of labs to thin-client.** Labs should be converted to thin clients as quickly as financially feasible, with the most outdated or non-functional labs prioritized. Units that have planned appropriately and have class fee funds allocated for upgrades should be encouraged to upgrade immediately, possibly making available replaced systems for redeployment in truly non-functional labs facilities to allow continued operation until newly instituted class fees can generate funds for replacement.

**Recommendation III.c. : Development of explicit costs and funding plans.** Units should be required to develop an explicit plan for maintaining and upgrading instructional labs on a regular basis, by instituting appropriate course fees on all courses that use the resources. Specifically, this plan should explicitly list all hardware and software instructional computing resources used by the unit, and the annualized cost of each of those resources. Each resource should then be associated with one or more courses, and the relevant costs included in course fees for each course. This explicit approach to covering costs of instructional computing should avoid crises and special funding requests to remedy “outdated labs”, allow students to absorb appropriate technology costs associated with courses that rely on such technology, and ensure that students always have access to modern, well-maintained computational resources.

**Recommendation III.d. : Maximize sharing of computing costs.** Units sharing proximal physical spaces should coordinate to explore the possibility of shared, jointly-funded computer lab facilities. In this case, the hardware replacement and maintenance costs of the clients are divided between the two units, with costs allocated to corresponding course fees based on average course enrollments; specialized software costs are allocated to the courses that use the software as before.

**Recommendation III.e. : Maximize space utilization; consider combining labs.** Utilization of existing computing labs should be closely monitored to provide maximal access to machines.
while minimizing vacant seats. This is particularly viable under the thin client model where every terminal has access to software for all support courses, i.e., labs are no longer specialized based on the installed software on the machines.

**IV. Faculty-Staff Desktop machines**

The committee found that, in general, there has been a pervasive failure in long-term sustained planning for addressing faculty and staff desktop computing needs. Although some centralized planning existed in Engineering as late as 2002, upgrades and replacements since then have been haphazard and department-specific. In the Natural Sciences, no uniform mechanism has existed, with departments generally managing faculty and staff needs individually. In general, many faculty and staff clearly have aging or outdated systems; a more reliable, sustainable approach is needed.

More diversity exists in the needs profile of faculty than was the case for instructional labs. Although many faculty and staff have quite limited and similar computing needs, others do rely on a variety of specialized peripherals, making them unsuitable candidates for the thin client model. Examples include cameras and microphones (videoconferencing), speakers (music and audio), and specialized instruments (some researchers); some engineers and computer scientists require specialized hardware or make significant modifications to their machines required as part of their normal teaching and research duties. Many faculty and staff, however, have the relatively basic needs profile amenable to the thin client model.

The committee makes the following recommendations with respect to faculty/staff computing:

**Recommendation IV.a. : College provides core infrastructure; units manage software and maintenance.** The college (CENS) should provide for the basic computing hardware and infrastructure required by its units, while maintenance, supplies and specialized software should be covered by departmental budgets. Thin clients should be emphasized as the “default” solution, with exceptions requiring explicit justification and approval by the dean. Of course, units/faculty may take the thin-client allotment provided by the college and selectively “upgrade” systems at their own expense.

**HARDWARE:** Each unit should develop a planning document to explicitly document their faculty/staff hardware needs, i.e., the number and type of workstations (whether thin-client or conventional stand-alone) required. Focus should be narrowly on needs associated with regular service as a faculty member in the discipline, i.e., rather than specialized research-specific capabilities. The college should agree on a uniform formula for basic peripherals (e.g. printers and scanners) necessary for a department operations; these should be included as well. Replacement cycles should be specified for all hardware. The total annualized cost of faculty/staff hardware should be clearly communicated.

**SOFTWARE:** Individual units are responsible for software, supplies, maintenance and upgrading or expansion of their departmental faculty/staff computing in all ways that exceed the basic hardware replacement schema. Examples include personal printers for individual faculty members, printer supplies, cables, additional peripherals, and so on.

**Recommendation IV.b. : Explicit sustainable funding for faculty/staff computing.** CENS administration must develop an explicit plan for funding faculty computing costs, either as an explicit annual request, or as a reasonable portion of allotted unit operating budget. It was beyond the committee’s scope or power to identify an appropriate revenue stream to support such a mechanism. What is clear, however, is that desktop computing has become an integral and indispensable tool in our academic environment; many regular administrative functions (grading, human resources, communication) have been explicitly moved to electronic forums by
the upper administration. In this light, it is reasonable to see desktop computing as a basic “facility” of modern university function, which must be covered (or at least subsidized) by the university in the same way that physical facilities are. The hope is that making those costs explicit and open for review as recommended here will help to justify resources to cover them.

**Recommendation IV.c. : Scheduled, prioritized upgrades.** Upgrades to faculty/staff computing (including conversion to thin clients) should be scheduled over several years as finances allow, with oldest and least functional systems being replaced first.

**V. Research Computing**

The committee found that research computing is generally highly specialized and not particularly amenable to the thin client model or other college-wide approaches. Many labs rely on specialized equipment (e.g., microscopes, spectrometers, etc.) driven by a host computer, or specialized hardware (clusters, servers, etc.) used for high-performance applications. There are, however, at least some cases where computer access in research labs is limited to relatively narrow standard requirements, e.g., access to the web via a browser; in these cases, thin-client technology might be applied.

The committee makes the following recommendations for research computing:

**Recommendation V.a. : Thin client technology should be emphasized where possible.** This can lead not only to lower costs, but recovery of valuable space due to the smaller footprint of thin clients.

**Recommendation V.b. : Make explicit and charge for instructional use of research labs.** Where research labs are used for instructional purposes, a fair and reasonable portion of the annualized cost of computing resources must be associated with relevant courses, based on the percentage of usage associated with teaching activities. This specifically includes “research” course lines that have typically not had technology fees associated with them. Individual research labs should document computing-related costs in ways similar to departments, communicating the appropriate computed annualized costs to departments using those facilities for educational purposes.

**Recommendation V.c. : Research computing primarily supported by research funding.** The non-teaching related (i.e. research-dedicated) portion of computing costs for research computing resources are the responsibility of the facility manager or department hosting the facility. It is appropriate for ICRs returned to the unit to be invested in such resources.

**Summary**

The overall observation of this committee is that, while the costs of college computing have crept up steadily with the rapid advance of network technologies, increasing use of computational techniques in many disciplines, and general increase in reliance on computer infrastructure, the university has never systematically acknowledged or planned for this changing technological environment. Although upgrades to campus networking and infrastructure have been substantial, providing hardware and software to access this infrastructure has been left to individual colleges and units. In many cases, this has led to increasing hardships at the department level, as units struggle to provide modern training with no explicit increase in resources, or in poorly-maintained computing resources. At the same time, the lack of explicit policy or guidelines – and sometimes simply a failure to acknowledge real costs – has led to a failure of some units to utilize funding streams that do exist (e.g. class fees) to properly plan for maintenance and upgrade of their facilities.
The goal of this committee has been to evaluated the current state of computing resources in the college, as well as the looking specifically at the core computing needs that exist across units. The recommendations given in this document are an attempt to begin developing an explicit mechanism for identifying, exposing, and pro-actively addressing the costs of providing college computing resources, including the coordination of planning among units and the choice of cost-efficient technological solutions. While we recognize that much work remains to be done as we move towards a sustainable computing infrastructure, we hope that the recommendations here provide a reasonable start.