

DRAFT PROPOSAL FOR NEXT-GENERATION EOS

College of Engineering, North Carolina State University

In 1990, engineering students selected “Eos,” Greek goddess of the dawn, as the name for the unifying technology that was being set up in the college to create an educational computing environment for engineering. Eos was initially built on technology from the MIT Athena Project, and even today, NCSU Eos and MIT Athena are very similar. From its beginning, Eos was taught to COE freshmen in E115: Introduction to Computing Environments, on UNIX in the 1990s and Linux since 2000. The system has diversified over time with new platforms and technologies, most recently adding student-owned computers (see following table). ***Eos now names the computing services and software that the College of Engineering shares across departments and curricula. It is the foundational technology on which departments build and then diversify their educational and research computing.*** The following proposal is a strategic plan for keeping Eos viable and productive as our college academic computing system.

Role of the College of Engineering Computer Committee

The College of Engineering Computer Committee, composed of faculty representatives from all departments and staff from ITECS, advises the Dean in the use of resources to support academic computing. The Computer Committee is currently designing a next-generation Eos that includes both lab and mobile platforms via wired and wireless connectivity. Two subcommittees have been organized to address **student-owned computers**, which 98% of incoming freshmen have, and **discipline-specific software**, required by departments to fulfill their academic mission. The work of these committees will inform the Computer Committee’s planning for Eos in the next five years and more.

Need for a New Computing Model

The following table illustrates how our UNIX-only model of the past decade has given way to a multi-platform Eos. This diversity, demanded by users, has been difficult to develop and support within our current lab-centric model. The Eos model is characterized by delivering a complete locked-down environment to a clean computer, including all pertinent application software and custom user configurations. The highly customized setup to “Eos-ize” lab computers does not scale well outside the labs. In the case of the Windows setup, it does not even scale well within labs, with workstations requiring constant attention and support. Windows was designed with home and office computing in mind, not labs, and cannot be forced into the Eos mold easily.

Scaling Linux has been easier, but it has a narrower user base and suite of applications. Solaris has offered the most tractable platform for both student labs and faculty offices, but only on campus on high-end workstations. In short, current Eos does not effectively support:

- student-owned computers
- distance education students
- non-Solaris-based faculty computing in their offices
- computing in the classroom
- department-specific computing labs

<i>Eos and SOC Platforms and Their Use in E115</i>											
Table shows when each platform/operating system was introduced and changed. Lab platform seats are added together for total seats.											
Lab Workstations											
	1990-95	1996	1997	1998	1999	2000	2001	2002	2003	2004	
UNIX	Ultrix	Solaris 2.5.1 ----->			2.6 -----	----->	7	8 ----->			
Seats	200-500	515	522	463	361	215	208	195	184	183	
Windows				NT 4.0 ----->		Win2000 ----->					
Seats				68	239	268	296	288	274	274	
Linux						RH 6.2	7.1	7.3	9	Enterprise	
Seats						182	182	170	190	190	
Total Seats, all Oses	200-500*	515*	522*	531	600	665	686	653	648	647	
Student-Owned Computers (pilot program)											
Windows						Win2000	XP Pro ----->				
Linux						7.1	7.3	9	Enterprise		
Mac						OS X					
New Laptops Each Year						33**	45	200	300		
Cumulative SOC Totals						33**	78	278	578		

* DEC Ultrix was the principal OS in Eos labs until 1996, when 300 Sun SPARCstations running Solaris were purchased to replace DEC 2100/3100 workstations. Total seats 1990-1997 include workstations running other UNIX Oses: DEC OSF/1, IBM RS/6000 and AIX, HP/UX, and Sun OS. These were gradually phased out, and by 1998, all UNIX lab workstations were running Sun Solaris.

** In the first SOC pilot in 2001, the laptops were set up with dual-boot Linux and Windows. From 2002 on, students accessed UNIX/Linux through PuTTY and X-Win32. Since 2003, students have also had access to AFS through Wolfcall. (**RH-Red Hat**)

■ Gray-shaded areas show the OS taught in E115, principally in 100 Leazar Hall, which houses ~150 of total college lab workstations. Leazar was exclusively Solaris 1996-99 and Dell Linux since 2000. The facility is closing fall 2004, and workstations are moving to Daniels Hall. Linux and Windows were taught in SOC pilot E115 classes, with Mac OS X being introduced fall 2004.

Overview of New Model

In first-generation Eos, workstations for each of the three platforms were identically configured, and everything on the system was available to everyone. However, location was limited to Eos labs, and in time, these labs became islands in a sea of other computers that also needed access to resources. Next-generation Eos shifts the focus to these other computers, redefines lab computing, and rebuilds its infrastructure around remote access services.

Owned Computers

Most students and faculty have their own computers and use them 24/7 from their homes and offices. For doing work, their first choice is to use these “owned” computers rather than an Eos workstation. The College of Engineering has been running a very successful pilot laptop program in student-owned computing (SOC) for three years (<http://www.eos.ncsu.edu/soc/>). The SOC pilot program has given ITECS and the college experience with:

- integrating SOC computers in courses
- working with vendors to license software and specify hardware for SOC computers
- setting up wireless access in engineering buildings
- preparing E115 instructors to adapt content for students with laptops

At the same time, ITECS and the college have had to develop more services to support the growth in distance education. This development has given us additional experience with:

- delivering services and software by remote access
- improving security for distance access
- developing web applications to replace many command-line tools
- documenting services for the distance user coming in from a variety of platforms

At the Dean’s Retreat in summer 2003, deans, department heads, and directors agreed to broaden our college computing infrastructure to deliver software and services to “owned” computers, i.e., student-owned computers and university-owned computers belonging to faculty. In fall 2004, the student-owned computing pilot will continue with a parallel pilot in faculty laptop computing. Forty faculty will work in the new Eos model on laptops provided to them on a grant from the Dean (see **Proposal for Instructional Laptop Computers for COE Faculty**).

Remote Access Services

To provide services and applications to faculty- and student-owned computers, ITECS has:

- set up servers for Solaris and Linux remote access services (remote.eos.ncsu.edu, remote-linux.eos.ncsu.edu) and secure terminal and ftp services (PuTTY, WinSCP, F-Secure).
- licensed the X-Win32 Windows-based X-Server to run Solaris and Linux applications back to Windows clients.
- written the Wolfcall Windows Kerberos/AFS authentication application to access the AFS campus file system.

- developed web applications to replace many command-line tools.

User demand is highest for third-party software, mostly for Windows applications, followed by Solaris and Linux. As a result, work has begun to build the infrastructure needed to deliver Windows applications to users via remote access.

With the release of UNIX-based Mac OS X, faculty have also asked for Mac applications to be added to the mix. To add this or any other platform in our current infrastructure would require more resources than we can afford. However, in the new model, the workstation is no longer considered part of the infrastructure that has to be fully integrated. Rather, it is a thin client that can run any current OS on a wide range of computers, both desktop and laptop. For this reason, Mac OS X is being tried in both student and faculty pilots in 2004.

If development continues in this direction, future users will simply connect to desired applications and services, installing only what they need to facilitate access. Remote access services are the means by which most applications will be delivered, from downloading a licensed copy of an application that has been purchased on a group discount plan, to connecting to a dedicated computer that can run an application natively.

Targeted Labs

Labs will continue to be part of the college landscape. They will range from traditional hard-wired locales to recombinant wireless clusters that change size, location, and purpose. Fixed-location labs will still be needed for complex specialty software, high-end graphics and CAD, high-performance computing, and interfacing with physical equipment or tools. Other labs can be spontaneously created in classrooms, open spaces, and common areas by students working wirelessly on mobile devices.

Based on 2002 data for the 2003-04 ETF 3-Year Plan, ITECS maintains 22 Eos labs with 653 (49%) of the computing seats in the college. The departments maintain the other 693 (51%) of computing seats in 48 classroom and lab clusters. General-purpose Eos labs will be preserved as long as needed but reduced in size and number. “Targeted labs” that are based in departments to support education in the discipline will become the primary focus.

Targeted labs will no longer run everything the college supports, as Eos labs have, but mainly what students need in their majors. These labs, like the wireless lab and classroom clusters, will rely heavily, though not exclusively, on remote access services. The current “one size fits all” environment will transition to custom labs, which can be better tailored to department needs but still united by a common infrastructure and remote access services.

Infrastructure

A robust infrastructure and enterprise resources will support this architecture, including networking, shared file system, license servers, user storage and backup, email, web services and applications, course and content management, enterprise printing, security, etc. Infrastructure has always been and will continue to be a major part of college Eos development. It is the

foundation that “glues” owned computing, remote access, and targeted labs together. The phrase, “Wherever you go, there you are,” which has been used to describe the Eos environment since its beginning, is even more descriptive of next-generation Eos. More people from more locations will be able to access the immense resources that have been amassed over the system’s lifetime.

Education, Communication and Information

Finally, and most important, are education, communication, and information. E115 will need to be revised to be an introduction of students to their own computers and how to use them to interface with the Eos infrastructure and get to the resources they need. Other computing topics such as networking and safe computing practices also need to be added to the E115 curriculum. Faculty will likewise need instruction and support so that they can successfully integrate computing into their classes to further the educational experience of students through technology. Organized venues of communication and training will help students, faculty, and staff access the full array of campus resources and become adept users of the system.

Migration Plan

Transitioning between models, while requiring a great deal of preparation and many changes, should not be disruptive to the user community. The shift to the new model will be evolutionary, not revolutionary. Eos labs will be maintained and upgraded to keep educational computing stable, but new investments in lab-centric infrastructure will gradually taper off. The following changes are anticipated to initiate the transition and make it as seamless as possible.

Change in Student Computing

The most significant change will be in the principal student platform, which no longer will be an Eos lab computer but a student-owned computer. However, since October 31, 2001, when the Computer Committee voted to “strongly recommend that students own or have access to a personal computer,” students have been advised that lab computing would not be able to provide all the computing they needed and that individually owned machines could give them an educational advantage.

Fall 2004 begins our fourth year of the student-owned pilot laptop program with 300 incoming students. Twelve sections of E115 will be taught with the revised E115 curriculum that focuses on students taking personal responsibility for their own computers and learning how to interface with the Eos infrastructure. Students will also begin using the developing facilities for remote access. The computers in these sections are all laptops, but the principles taught are applicable to desktop computers as well.

Personal computers can run Windows (2000, XP), Linux (Enterprise), or Mac (OS X). Hardware manufacturers can vary, although the college will continue to pursue advantageous educational pricing for students from hardware and software vendors. The freshman year remains the best time to get students oriented to the college computing environment because of E115, E101, and other resources targeted to first-year students.

Graduate students should also be encouraged to own computers and have instruction tailored to their needs.

Change in Faculty Computing

A grant for 40 faculty laptops in fall 2004 will begin the transition of faculty to the Eos 2 model. The focus will be on computing in the major using these computers to enhance teaching. The full plan in **Proposal for Instructional Laptop Computers for COE Faculty** looks ahead to the future when all faculty can participate in next-generation computing using “owned” computers and remote-access services to access the same software and tools as their students.

Faculty will likewise need instruction and support so they can take advantage of system resources and be prepared for the frequent changes that are inevitable in enterprise computing. When current Eos was Solaris only, faculty and students shared a common environment and applications, and faculty could integrate computing and course content fairly easily. With the diversification of Eos, that capability eroded. Next-generation Eos will need to keep faculty and student platforms and technologies harnessed together and rely on user education to coordinate academic computing across the college.

Delivery of Applications

Applications can be provided in a number of ways. When unit prices are low--in the range of a textbook--students may be expected to purchase their own copies of software. In some cases, software is included with the textbook at no extra charge. However, most software will be delivered to students by remote access from the college with licenses paid for from fees. Linux and Solaris applications, plus special utilities, have already been delivered this way, and work has begun on serving Windows applications. Applications might also be delivered directly from the vendor via a subscription service or some other method.

Transitioning applications to the new model will be application by application with careful testing and review. All applications are currently under review to identify (1) core applications needed by all engineering students, and (2) discipline-specific software needed by departments to fulfill their academic mission. **College of Engineering Essential Software** is a first cut at assembling college and department software requirements. The Subcommittee for Discipline-Specific Software continues to develop this document with faculty input.

Conclusion

Eos needs to be re-structured in order to continue providing platform diversity, deliver to faculty the same computing environment that their students are using, and introduce mobile and remote services into academic computing. The transition from our current model to a new one is already under way and will not be widely noticed until the labs begin to change. Faculty and students will first see more and more resources being available to them remotely. If re-structuring is successful, Eos's immense resources of application software, secure development environments, high-end computing, and enterprise file system and tools will be available to labs, classrooms, and individuals, regardless of their location.