Imagine a student with the flexibility to work on course-related engineering design projects anytime, from anywhere no longer tethered to a fixed-location computing lab on campus. Imagine a student or researcher able to easily self-deploy clusters of computers on a cloud dedicated to their use without the need to be encumbered by administrative processes that often surround resource provisioning. Imagine a student being able to do hands-on work using emerging computer technologies before they reach the market.

These are a few of the groundbreaking capabilities deployed this year by a new SEAS infrastructure service unit--Instructional and Research Computing Services (IRCS), launched by SEAS on May 6, 2010. IRCS has an initial complement of five technical staff, three of whom have doctoral degrees--including two from Harvard--and a collective experience of about 60-person-years in advanced technical support and computational science. Administrative oversight is provided by Dr. Joy Sircar, the new Associate Dean for Research and Planning, who previously also led Information Technology (IT) and was responsible for deploying grid and supercomputing services at SEAS.

IRCS was established to recognize three important and rapidly growing needs of the new School: Experimental Test Beds, Instructional Computing, and Research Computing.

**Experimental test beds**-Faculty aim to expose our students and researchers to emerging technologies and very high-performance computing platforms using experimental test beds. IRCS staff work closely with the faculty, students, and researchers to rapidly innovate and integrate systems, software, and middleware to build new test platforms to specific requirements. A few highlights of recent work in this area include:

- A new in-house cloud computing middleware service was integrated and successfully deployed that enables a user to easily provision computer clusters in the Amazon EC2 Cloud with a runtime environment of user specified software and tools with any assistance from technical staff.
- A new virtual remote desktop service (vRDS) was deployed that provide students easy and secure access to software and systems tailored to the requirements of engineering design lab courses. This new ‘virtual lab’ has demonstrated a new and exciting alternative to building engineering labs at fixed locations while at the same time offering students the flexibility to conduct projects on their own schedules.
- IRCS deployed one of the first systems in the world using the exciting, pre-production NVIDIA Fermi architecture as part of the SEAS "NVidia CUDA Center of Excellence".
• A new ‘SEAS’ Linux operating system distribution service tailored to the needs of researchers and engineers at Harvard was released for testing by the campus community. With computer security vital priority, this release satisfies the urgent need at SEAS for a secure and safe Linux operating system both for use in classes and for personal research workstations.

**Instructional Computing:** Significant increase in the faculty’s use of new and advanced computing environments to complement the curricular experience motivated the need for course computing platforms tailored specifically to the needs of courses. As new ideas and thoughts emerge during the conduct of a course, often the faculty and students require just-in-time changes to the run-time computing environment. In response to these types of just-in-time service demands, IRCS staff built the capability to quickly deploy highly agile service delivery platforms. During the present reporting period, systems maintained by IRCS supported a record 20 courses impacting 500 students, faculty and teaching fellows. A few of the exciting highlights in this area of activity are shown below:

• In the course CS 262, "Introduction to Distributed Computing", SEAS students for the first time were able to easily deploy small clusters to the cloud (Amazon EC2) for developing and testing code among many computers.

• Students in ES 128 "Computational and Solid Structural Mechanics" enjoyed the new flexibility of using the new “virtual” lab (vRDS) to run computer simulations for their coursework no longer limited by computational resources nor forced to work at a fixed-location engineering computer-lab on campus at only specific times of the day.

• CS 264 "Massively Parallel Computing" is a course where students, as the course title suggests, were trained in parallel programming with the additional new opportunity to explore the new GPGPU technology at a hands-on level during their final projects.

**Research Computing:** SEAS faculty interest on Computational Science and in the use of high-performance, high-throughput computing hardware and software systems is rising. Computational Science research in SEAS is helping to solve grand challenge problems, ranging from climate modeling to the modeling of blood flow. As part of this area of responsibility, IRCS strives to maintain responsive, quality support to the SEAS research computing community for a number of advanced and high performance computing platforms that includes the support for both hardware and science/engineering software. These resources include:

• An IBM Blue Gene/L supercomputer with 4096 processors, primarily used for scalability testing of parallel codes

• A computing grid of 224 Intel cores that support pre-production phase HPC software development and testing by our research labs.

• An 8-processor IBM server with 100 Gigabytes of memory dedicated to interactive and CAD computing in support of interactive, computer based engineering design.

• A 16 node NVidia GPUGPU cluster using 32 NVidia Tesla GPUs that was donated last year by NVidia.

In addition to hardware and software, IRCS now provides an outreach service that is rapidly gaining popularity among the faculty and students. At this time, the outreach services range from technical consulting to help researchers implement highly parallel and scalable codes, and a new workshop
series on various topics in research computing, such as python, parallelization, and version control systems for research codes.

IRCS provided over 7 million CPU hours of compute time to more than 270 researchers from 42 faculty research groups (which represents roughly half of the total number of faculty at SEAS) and approximately 15 faculty labs across the university. The breakdown of the proportion of SEAS faculty within each Academic Area now relying on the use of computation as a key tool is shown in the following figure:

**Impact** - IRCS serves as a key enabler to SEAS faculty innovations in teaching courses that are increasingly exposing our students to new technologies, and to advanced research computing capabilities described in the previous sections. IRCS technologists also contribute directly to faculty research projects by providing technical assistance for highly scalable parallel code development and performance testing. This year, we celebrate the selection of a paper by Professor Efthimios Kaxiras and his research group, for their work on ‘Multi-scale simulation of cardiovascular flows’ as a 2010 Gordon Bell Prize finalist. A significant portion of the scalability and performance testing of this research project was achieved due to direct IRCS support on the IBM Blue Gene /L platform.