



Information Technology Annual Activities Report 2012-2013

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Information Technology is the central university organization that includes units providing information technology services and infrastructure for learning, discovery, outreach, and administration; robust, high performance networking and computing; safety and security; and software and systems development. The Information Technology organization also sees to the establishment and communication of information technology policies, standards, and best practices to achieve a safe and secure environment for the creation of specific services, tools, and applications that may be needed for particular university functions.

The mission of Virginia Tech's Information Technology organization is to serve the university community and the citizens of the Commonwealth of Virginia by applying and integrating information resources to:

- enhance and support instruction, teaching and learning;
- participate in, support and enhance research;
- foster outreach, develop partnerships with communities and promote the capabilities of advanced networking and communications; and
- provide, secure, and maintain systems allowing the university to accomplish its missions.

The 2013 fiscal year was one of change, with the appointment of Dr. Scott F. Midkiff to the role of vice president for information technology and chief information officer, effective October 2012. Midkiff succeeds Erv Blythe, vice president since 1992, upon Blythe's retirement.

One of the first tasks for the incoming vice president was to update the organization's strategic plan to extend to 2018. The IT Strategic Plan¹ is organized around seven pillars:

1. Enabling networked learning in the networked university
2. Providing competitive advantage through sustainable advanced cyberinfrastructure and collaboration
3. Leveraging information technology to distinguish the Virginia Tech experience
4. Advancing information technology for enterprise effectiveness
5. Ensuring the security and resilience of information technology resources
6. Improving communications with customers and partners

¹ www.it.vt.edu/publications/strategic_plan/Virginia_Tech_IT_Strategic_Plan_2012-2018-v1-1-2013-06-12

7. Strengthening the Information Technology organization

Some units within the IT organization tend to focus on one of the pillars, while other units contribute to multiple pillars. Unit reports follow and detail specific accomplishments during the past year. Some of the highlights, organized around the seven pillars of the strategic plan are summarized in this section, particularly for those efforts that require the collaboration and contributions of multiple units.

Pillar 1: Enabling networked learning in the networked university

Learning Technologies is at the forefront of providing applications, infrastructure, and services for networked learning. This year was one of planning for significant realignment for the coming year as the organization began re-designing internal processes, practices, and organizational structures. In June 2013, the university announced the launching of **Technology-enhanced Learning and Online Strategies**, a re-aligning of units both inside and outside of Information Technology to meet the goals of a networked university. TLOS will work across the university to incentivize and support highly effective distance learning programs, online content for on-campus courses, and hybrid courses.

Included in the plan is a reformulation of the Faculty Development Institute to create the Networked Learning Institute to better provide instructional faculty with the “skills and conceptual frameworks necessary to use technology to provide meaningful student-to-student and student-to-faculty interaction, active learning opportunities, and timely and constructive feedback.” (*A Plan for a New Horizon: Envisioning Virginia Tech 2012-2018*, p. 15). The Networked Learning Institute will begin in the coming fiscal year. The re-thinking and re-organization accomplished in FY13 moves the organization a significant way to “position itself to serve as a university hub for networked learning services, including consulting on instructional design; support for design, development, and creation of digital media content; support for universal design for accessibility; and access and support for in-house and cloud-based services for course management, content delivery, and collaboration.” (*Virginia Tech Information Technology Strategic Plan for 2012-2018*, p. 7).

While **Learning Technologies** and, in the coming year, **Technology-enhanced Learning and Online Strategies**, will become a hub for networked learning, other units within Information Technology provide significant support ranging from the collaboration software acquired through **Information Technology Acquisitions**, to the support in using collaboration tools offered by **University Computing Support**. The VT Google Apps project, an important effort during the fiscal year, reflects the goal of ensuring that Virginia Tech students, faculty, and staff all have access to usable and familiar collaboration tools, a factor in the selection of Google as the provider for the service.

And while cyberinfrastructure is front and center for Pillar 2, it is also a prerequisite for a robust environment supporting networked learning.

Pillar 2: Providing competitive advantage through sustainable advanced cyberinfrastructure and collaboration

Leadership for data-intensive, high-performance, and highly networked advanced computing falls primarily to the **Advanced Research Computing** unit and to **Network Infrastructure and Services**. Together, these groups brought up the BlueRidge supercomputer in March 2013. BlueRidge is Virginia Tech's most-powerful general-access research computing system to date. Virginia Tech researchers have used more than five million central processing unit (CPU) hours on BlueRidge since it went into production. The year also saw an important advance in the data storage capabilities with the purchase of an EMC Isilon HPC storage solution.

Network Infrastructure and Services works to ensure that faculty, staff, and students have access to high performance networks. Organizing for robust networking includes the new non-profit corporation, Mid-Atlantic Research Infrastructure Alliance, Inc. (MARIA). This organization promotes the development and operation of high performance network and computing infrastructure to provide a competitive advantage for Virginia's research universities. MARIA provides high speed connector services linking to national research networks through the NatCap Aggregation Facilities, and the Virginia Tech Operations Center (VTOC) provides 24x7x365 support for research networking.

The year's efforts on the Unified Communications program include work to improve networking, both within the university and from the university to the world. This year witnessed the final phase of the work to upgrade the campus network's fiber-optic backbone, entailing interconnection of many of the campus's larger buildings to the new fiber ring. Each building will receive a new high-strand-count cable capable of providing reliable high-speed network connections and supporting future fiber-based services. Planning for a major upgrade to the core and border networking equipment was related to the year's UC work, as were upgrades to the university's wireless networks.

Pillar 3: Leveraging information technology to distinguish the Virginia Tech experience

The Information Technology Strategic Plan calls for "providing innovative technology-drenched spaces, which will grow in importance in distinguishing the physical university

experience from the virtual university experience; leveraging and appropriately managing information technology to enhance the experience of students, faculty, and staff, including embracing the “consumerization” of information technology and the availability of highly-capable mobile devices; and leveraging converged technologies for the physical safety, security, and resilience of the university community” (p. 10).

Contributions to this pillar are widely shared among Information Technology units.

Advanced Research Computing offers perhaps the most “technology drenched” experience through the Visionarium, a 3D immersive experience promoting visualization for discovery and understanding. Personnel in this unit collaborated with faculty and students to use the Visionarium to conduct research on varied topics during the fiscal year. **Converged Technology for Security, Safety, and Resilience** worked with University Relations and Facilities Services to develop an online interactive map of the Virginia Tech campus. The goal is for intuitive use by new students, parents, and other visitors to better navigate the campus. **Enterprise Systems** work to move more processes online for both employees and students ranges from the new systems for (a) leave, time, and attendance, (b) for travel and expense management, and (c) document management for advising systems. **Information Technology Acquisitions** plays key roles in acquiring software for students, faculty, and staff to facilitate more online work in varied endeavors, as well as using robust technical systems for managing their own software distribution functions. The **IT Security Office** provides online training to university departments—the SANS “Securing the Human” program that allows participants to learn about cyber security. Participation in the online training program increased by 60% this year. **Learning Technologies** redesigned rooms 1120 and 3080 in Torgersen Hall with variations on white board space, flexible seating, new technologies, inviting wall and furniture colors, and experimental room arrangements to promote exploration of teaching and learning with technology—contributions in physical space to the information technology-rich environments. Physical and virtual worlds are brought together in the Learning Technologies-supported TelePresence rooms. The pillar is further supported by a project out of **Network Infrastructure and Services** to facilitate connection of personal as well as university mobile devices to the wireless network. This support for “bring your own device” is Captive Portal/XpressConnect. The project simplifies the process to register users for access the campus wireless network. Of course, the Unified Communication program is aimed at increasing the technology of everyday environments by providing voice-over-IP telephony, along with the accompanying network upgrades, including wireless upgrades. And as the key provider of information technology middleware, **Secure Enterprise Technology Initiatives** supports the technical development, maintenance, and enhancement of the authentication systems required for the conduct of more and more online activities. This year’s efforts include collaboration for the VT Google Apps and the creation of a new network password.

Pillar 4: Advancing information technology for enterprise effectiveness

Pillar 4 embraces several components, including evaluation of delivery models and positioning for the future. Each of these is represented in work accomplished during the year.

One focus is on moving to the cloud those functions that have become a commodity service and keeping in-house those functions where value is added by contributing to the competitive advantages of the university. The plan specifically mentions the decision to outsource most university email, a decision that came to fruition this year in the completion of the VT Google Apps project and migration of the mail service to Google.

Other solutions that require recognition of the unique operations of either the university or the commonwealth have been developed for in-house operations. Examples from **Enterprise Systems** include the modernization and required changes for the Virginia Retirement System and the university's interface with VRS, and the changes to the state-run health care insurance system.

Positioning for the future includes ensuring the technical currency of the systems run by the Information Technology organization. One of the challenges faced continually is how to install upgrades and patches when the university community relies so heavily on the resources the IT organization operates. Installing updates without downtime is an important goal and one achieved for routine upgrades in core systems. Assessment data focuses on "up-time" in several units, an indication of the importance of round-the-clock availability. (See **Enterprise Systems** and **Secure Enterprise Technology Initiatives** for examples).

Understanding the work schedules of our customers is critical: the annual scheduling of select down time for the Scholar learning environment, for example, is on spring graduation day, a time when students, instructors, and critical offices like the University Registrar are occupied with events that do not involve the use of Scholar.

Pillar 5: Ensuring the security and resilience of information technology resources

One of the purposes of upgrades and patches is not only for technical and functional upgrades, but also to keep systems as secure as possible. Security and resilience are significant goals that require the attention of all units within Information Technology and that depend on the expertise of the security-focused organizations, specifically, the **Information Technology Security Office**, the **Converged Technology for Security, Safety, and Resilience**, and **Security Enterprise Technology Initiatives**.

These groups take the lead in the focus on disaster recovery, risk assessment, and continuity of operations planning. This year, the **Converged Technology for Security, Safety, and Resilience** unit disseminated a new risk assessment template for organizations throughout the university, and worked individually with several units to update and improve their risk assessment.

Restricted/Limited Access Network (RLAN) is a key project to safeguard university data. A joint project between the **IT Security Office** and **Network Infrastructure and Services**, RLAN provides select users with a network segment that permits the individuals to do their work, but otherwise limits their online destinations. The project is accompanied by other tools to add safeguards to the restricted network—intrusion detection, malware detection, and firewalls. RLAN is not an “everyone” service, but designed for those individuals whose jobs require processing of sensitive and personally identifying information in relatively large quantities. It provides a means of mitigating the risks associated with the sensitive information.

The Information Technology organization strives to provide, as possible, security *and* usability, rather than setting these two goals against one another. One project successfully completed this year is the InCommon Silver certification that allows highly secure personal digital credentials (security) to be used in a federated identity management system (usability). **Secure Enterprise Technology Initiatives** submitted final documentation to the InCommon federation, resulting in approval in September. The project was a collaboration between the **Secure Enterprise Technology Initiatives** unit and Identity Management Services within the **Converged Technology for Security, Safety, and Resilience** unit.

Pillar 6: Improving communications with customers and partners

The IT Strategic Plan calls for a comprehensive communication plan for conversations with the university community and with internal and external partners. The plan itself will be addressed in the coming year, building on the existing communications.

Such channels of communication range across scales of formality, frequency, and intended collaborators. One of the more “event” type of communication during this year was the Converged Technologies annual meeting. The meeting strengthens the collaboration between the IT organization and the office of the vice president for administration and his staff. Both groups made presentations in the open meeting.

Formal outreach to external partners includes presentations at conferences. **Advanced Research Computing** annually hosts a booth at the Supercomputing conference, and ARC

staff present at other conferences as well. Similarly, the work done by the ePortfolio group within **Learning Technologies** is the basis for a number of conference presentations.

More frequent, less formal in-person communications include users groups and project-focused training. **Secure Enterprise Technology Initiatives** hosts both the VT Windows Users Group and the SharePoint Users Group in bi-monthly meetings. As Unified Communications systems are rolled out, users have choices of in-person or online training to acquaint them with the features and functions of the new system.

These are points on the spectrum of communication that has included, during the past year, Town Hall meetings to spread information and permit questions and comments from the university community on the VT Google Apps project, the Get Connected program that focuses on helping students get settled in with their technology each fall, and the communications campaign by **Learning Technologies** to promote the tutorial software lynda.vt.edu.

Pillar 7: Strengthening the Information Technologies organization

The Strategic Plan calls for meeting the challenges of hiring and retaining highly qualified employees as the demand for information technology professionals grows, locally and nationally. Two emphases for the plan are (a) developing a workforce pipeline, and (b) technical training and professional development.

The Information Technology organization engages students through opportunities for information technology work on both projects and operations. The continuing *IT Intern* program funded by the Office of the Vice President was used well during the year, with 27 students employed through the program. Overall, the IT organization employed 280 student workers during the fiscal year, including 20 on graduate assistantships/graduate research assistantships.

This year also saw the creation of *IT Perspective*, a program for mid-career managers, providing them with opportunities to learn and discuss operations and issues across the breadth of the university. Participants come to select meeting with the leadership of the IT organization, and attend special seminars. The inaugural special seminar was held March 22 with Vice Provost Jack Finney and the second seminar was held on June 17 with Assistant Vice President for Finance and University Controller Ken Miller.

Ongoing technical training includes both on-site and off-site sessions specific to the individual units within the IT organization. In addition, the annual hosting of the SANS

Institute occurred during the spring. This year's offering was *SEC505: Securing Windows and Resisting Malware*.

Ahead

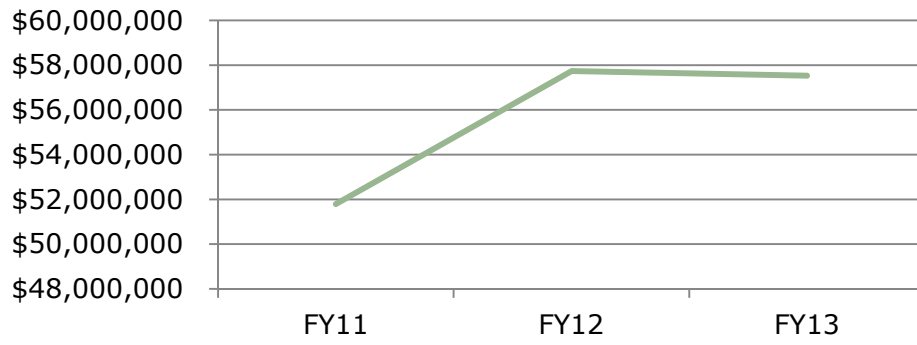
More information on the projects and activities noted above are available in the following reports from the units within Information Technology.

Financials

Financial support for the work of the Information Technology organization derives from different types of university funding. Some variability occurs year-to-year in the funding sources. In FY12, for example, the increase in expenditures reflects one-time investments—\$2.4 million for purchases related to the Unified Communications program and \$1 million for a new back-up generator. The expenditures dropped back again in FY13, but with the partially offsetting addition of \$800,000 in Equipment Trust Funds invested in upgrading the infrastructure for distance education, and increases in research expenditures, notably from research in the Center for Geospatial Information Technology.

	Total expenditures FY13
Educational and General funds	\$30,160,136
Equipment Trust Funds	5,099,323
Auxiliary operations	20,725,560
Sponsored Grants and Contracts	1,317,432
Continuing Education funds	19,568
Overhead funds	42,516
Other sources	163,271
Total	\$57,527,808

Total expenditures



Advanced Research Computing

Advanced Research Computing (ARC) at Virginia Tech mission is to advance the university's computational science and engineering research through advanced computing facility and user service. ARC is currently operating a wide spectrum of high performance computing and visualization resources that include multiple cluster systems, central storage systems, and visualization platforms.

High performance computing infrastructure

Below is the list of systems in operation and a brief description of each of the systems. The addition of BlueRidge and HokieSpeed in fiscal year 2013 brought the combined capacity of ARC's computational resources to 229 Teraflops, nearly a tenfold increase from a year before.

BlueRidge is a 318-node Intel Sandy Bridge cluster that was brought online in March 2013. With a total of 5,088 cores and 20 TB of memory, BlueRidge is, by either measure, Virginia Tech's most-powerful research computing system to date. Each node is equipped with 16 cores and 64 GB of memory, except for five compute nodes with 128GB of memory, and connected via Quad-Data-Rate InfiniBand (QDR IB). BlueRidge also has a RAID6 storage node with 48TB of disk space. BlueRidge was ranked No. 402 on the November 2012 Top500 list of the world's most powerful supercomputers. Virginia Tech researchers have used more than five million CPU Hours on BlueRidge since it went into production.

HokieSpeed is a GPGPU cluster at VT acquired through funding from the National Science Foundation (NSF) Major Research Instrumentation (MRI) program. It ranked #351 and #52 on the June 2013 Top500 and Green500 lists, respectively. The system contains 209 nodes, each equipped with dual six-core Intel 2.4GHz Westmere sockets and two nVidia M2050 448 core GPU cards, which gives 2,508 computing cores and 185,000 graphic cores. In addition to the compute nodes, HokieSpeed has two dedicated visualization-nodes for high performance visualization. These nodes have four GPUs each, and are directly connected to eight 46-in, 3-D HD LED TVs—providing 14x4 ft² tiled display—for creating direct access of data from compute nodes to visualization resources. This heterogeneous cluster system became available to grant PIs and co-PIs in September 2012. HokieSpeed is expected to be available to the entire Virginia Tech research community in FY2014.

HokieOne is a shared-memory SGI UV system that became available to Virginia Tech researchers in April 2012. The system has 504 2.66Ghz Intel Xeon Westmere cores (84 sockets on 42 blades) with 2.62TB of memory (5.3 GB/core), and utilizes a QDR IB interconnection

that has a throughput of 40Gb/sec per link. HokieOne provides Virginia Tech researchers with a large shared-memory resource ideal for large memory or shared-memory applications.

Athena is a cluster with 42 quad-socket, AMD 2.3GHz Magny Cour octa-core nodes (1,344 cores) with 64 GB RAM each (12.4 TFLOP peak). Sixteen of the nodes also have access to 8 total nVidia S2050 Fermi (quad-core) GPU cards with 6GB of memory. These GPUs support OpenGL and also single and double precision operations (96 TFLOP single precision peak). The nodes are connected via QDR IB interconnection and there are 40 TB of file storage attached to this device. This machine is intended for computation and visualization of large data sets.

Ithaca is an IBM iDataPlex system that supports commercial software packages such as Matlab, Fluent, and other third-party software. Ithaca provides 672 cores (84 nodes) with a total peak performance of 6 TeraFLOPS. Each node has dual-socket quad-core 2.26 GHz Intel Nehalem processors. Ten nodes have 48 GB memory and the remainder have 24 GB. Nodes are connected via QDR IB. Twenty-six of the nodes are dedicated to Matlab Distributed Computing Server, providing researchers with the ability to scale simulations up to 224 Parallel Matlab workers. Ithaca was reconfigured in May 2013 to better match the user environment on newer systems, BlueRidge and HokieSpeed. This overhaul substantially improved the usability of this older hardware and will ease user transitions between systems.

Upcoming enhancements to computing resources

In the spring of 2013, ARC purchased 260 Intel Xeon Phi, also known as “many integrated core” (MIC), cards for the expansion of BlueRidge. MIC architecture is considered a significant development in high-performance computing, with accelerated computing reminiscent of GPUs, but offering better compatibility with CPUs by preserving x86 programmability. In June, two MIC cards were installed on each of 130 BlueRidge nodes. They are currently being configured and tested. Once brought into production, the MIC cards will provide Virginia Tech researchers with new, cutting-edge hardware and a substantial increase in BlueRidge’s overall computational capacity.

In FY2014, ARC also plans to bring online a new test bed system to allow ARC computational scientists to experiment with and optimize system configurations before rolling them out to users and to reconfigure Athena to align its user environment with the rest of ARC’s clusters.

In order to effectively manage computing resources, ARC has developed an allocation management system (AMS). BlueRidge is the first ARC cluster that is utilizing the new system allocation mechanism. In the new process, PI’s can create their research project information page to request a system allocation. The allocation balance and account management function are available to the users. The AMS also tracks system usage and

collects PI's research information, promoting effective use of systems by ensuring that all jobs are part of a faculty-led research project. The collected database can be utilized for planning future HPC system acquisitions.



BlueRidge is Virginia Tech's most powerful computational resource to date

Storage. In the fall of 2012, ARC purchased and installed an EMC Isilon HPC storage solution. The selection of the Isilon system was made after thorough testing and benchmarking of this and other alternatives. The system provides 200 TB of stable NFS storage for users' files. All ARC home directories were transitioned to this new storage system in January 2013. The system has proven to be a reliable home for user data since it became available, and is expected to be expanded in FY2014.

In FY2013, ARC also worked with faculty in Mechanical Engineering to develop an ITAR offering for the storage of sensitive data. This important addition will enable security and defense-related research to be conducted on ARC's systems.

Visual Computing

The **VT Visionarium** lab provides a full spectrum of high performance visualization platforms for use by faculty and students across campus. The flagship virtual reality system, the VisCube, consists of three back-projected 10' x 10' walls and one floor where 1920x1920

passive stereo images (Infitec) are rendered. Four nodes render to these screens and high-accuracy, low-latency ultrasound tracking is used for the head and interface devices. In addition, a MOOG motion platform is embedded into the floor of the VisCube and provides a 6-degree-of-freedom hydraulic floor frame that can be synchronized with the VisCube graphics system. Numerous development and 3D graphics workstations are available in the lab including a 65" active stereo wall, six monitor workstations and a roll-able 52" multi-touch display.



Immersive analysis of DNA stretching (Savin, A. V., I. P. Kikot, M. A. Mazo, and A. V. Onufriev, "Two-phase stretching of molecular chains", Proceedings of the National Academy of Sciences, vol. 110, issue 8); mage: Andrew Wood, Alexey Onufriev, Nicholas Polys

Visualization over the network can take many forms: sharing files, sharing screens, sharing applications. Through our support of the ISO/IEC standard of Extensible 3D (X3D), users can view and interact with the same model across platforms from the VisCube to stereo walls to their desktop and even to a mobile, handheld HTML5 client. In many cases, the data is too large to feasibly move, therefore visualization must be performed on the cluster and only the pixels and user interactions sent over the network. ARC supports this model with the latest tools such as Paraview and Visit. Lastly, applications such as mirror worlds and models can be shared synchronously using multi-user gaming technologies, for example. ARC currently hosts several tools for small group collaboration.

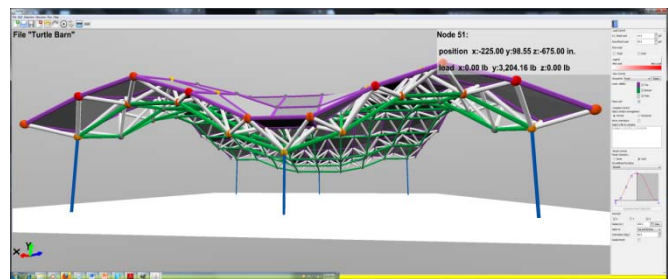


Flying through 3D Blacksburg to the new Center for the Arts building (before construction began);
 image: Dane Webster, Peter Sforza, Nicholas Polys

Research

ARC is innovating on several fronts where high-performance computation and visual analysis are critical requirements. We provide some highlights below:

STEM education. As part of a National Science Foundation-sponsored project, ARC faculty developed a 3D design and structural simulation tool for architects. The project developed a full-featured GUI and simulation service and integrated several 'design-analyze-repeat' activities into the undergraduate curriculum at Virginia Tech, University of Illinois, and Hampton University. Scholar was used to support the class activities. Recent publications describe the educational, software engineering and immersive VR aspects of the work:



Designing a long span steel structure with SAFAS; image: Nicholas Polys

M. Setareh, F. Bacim, B. D. Jones, N. F. Polys, T. Geng, B. Orsa. "Integrating Web-based Visualization with Structural System Understanding to Improve the Technical Education of Architects." Journal of Online Engineering Education 3(2).

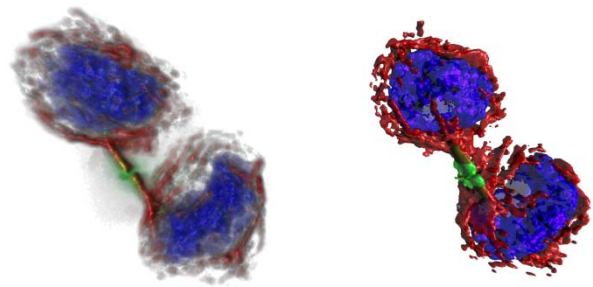
Nicholas F. Polys, Felipe Bacim, Mehdi Setareh, and Brett Jones. 2013. "Building novel Web3D user interfaces: a case study from architecture and structural engineering". In *18th International Conference on 3D Web Technology (ACM Web3D '13)*.

F. Bacim, E. Ragan, S. Serbo, M. Setareh, B. D. Jones, N. Polys. "The Effects of Display Fidelity, Visual Complexity, and Task Scope on Spatial Understanding of 3D Graphs." *Proceedings of Graphics Interface*, 2013.

The latest software releases and account requests are online at:

<http://legacy.caus.vt.edu/setareh/archresearch/>

Volume data. Volumetric information is a fundamental type in many computational disciplines including geosciences, paleo-biology, mechanical engineering, biology and medicine. ARC faculty have co-authored the new ISO/IEC Extensible 3D (X3D) 3.3 specification and applied the pipelines to data from groups around campus. Recent publications demonstrate the variety of applications:



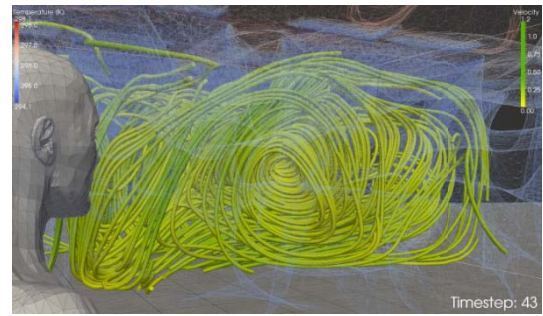
Interactive volume renderings of a multi-channel microscopy data set from cellimages.org; image: Abhijit Gurjarpadhye & Nicholas Polys

Polys, N. F., Wood, A., Ullrich, S., Evestedt, D., & Aratow, M. (2013). "A fresh look at Immersive Volume Rendering: Challenges and Capabilities", in *IEEE VR Workshop on Immersive Volume Rendering 2013: Orlando*.

Polys, N. and A. Wood (2012). "New Platforms for Health Hypermedia." *Issues in Information Systems* 13(1): 40-50.

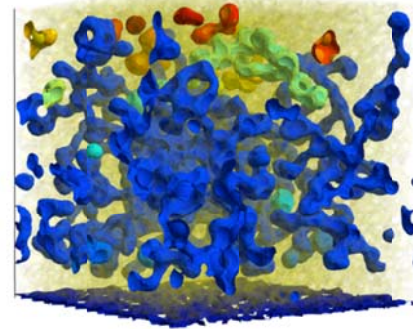
Transportation planning. ARC computational scientists investigated the sensitivity and transferability of travel demand model disaggregate curves to develop recommendations for transportation planners in small and medium-sized communities. See also: Krometis, J., R. Fussell. "If the Curve Fits, Wear It: Applicability and Transferability of Disaggregate Curves for Small and Medium Sized Communities". *Transportation Research Board (TRB) Tools of the Trade Conference*, Big Sky, MT, September 2012.

Flow field dynamics. As part of a Department of Energy project to develop energy-efficient buildings and control systems, ARC faculty have built on open-source scientific visualization software to develop tools that allow scientists to easily visualize flow-fields generated from their simulations. These tools are available for local and remote rendering users.



Visualizing airflow dynamics in a building control system simulation; image: Jeff Borggaard, Gene Cliff, Nicholas Polys

Porous media. The development of algorithms targeted for heterogeneous and accelerator-based supercomputers is a critical challenge for many science and engineering applications. ARC's Dr. McClure, in collaboration with Dr. Hao Wang and Dr. Wu Feng in Virginia Tech's Synergy Research Lab, explored various strategies to scale multiphase lattice Boltzmann simulations across GPU in a heterogeneous setting using Virginia Tech's HokieSpeed and Oak Ridge National Lab's Titan. On HokieSpeed, a heterogeneous algorithm was implemented to take full advantage of on-node parallelism, and a GPU-based implementation has been demonstrated to scale to over 4,000 GPU on Titan. The extreme scalability of this application will enable highly resolved, large scale studies to evaluate carbon sequestration and enhanced oil recovery strategies.



Computing permeability on GPUs; image: James McClure

User service, education and training

The HPC Investment Committee has recommended 10 HPC support positions to serve researchers at VT. In FY 2012, ARC hired three of those ten, plus a new Deputy Director of HPC, Byoung-Do ('BD') Kim, with experience from the Texas Advanced Computing Center (TACC) and National Center for Supercomputing Applications (NCSA). We now have multiple layers of user service: frontline help-desk staff for user ticket handling and advanced user support and research collaborations with the computational scientist team. Continuing this positive trend at the end of FY 2013, we posted two new computational specialist job openings.

As a result of this faculty expansion, ARC resolved more than 93 percent of the 584 help tickets submitted by users in FY2013 and also successfully handled nearly 200 direct outreach or consultation requests. As a part of the user support effort, ARC also substantially increased the software that is available to users via centralized installations and continued to

expand online resources and documentation to facilitate use of ARC's systems and software and lower the barrier to entry for new users.

Another effort in user service is the future **ARC User Portal**. This project is still in the development phase, and we are targeting Q1 of 2014 for initial production service. The portal will provide users with basic functions such as account and allocation management as well as various additional features including a system news feed, job monitoring, research group data sharing, etc. All of these features will be interactive through a web-based interface. This one-stop solution will enhance users' experience with ARC's HPC & Vis resources tremendously.

This year we continued successful offerings of user trainings and seminars, including 24 Faculty Development Institute (FDI) short courses, two two-day workshops, and dedicated training sessions for HokieSpeed and BlueRidge users. This included offering an FDI Faculty Track in High-Performance Computing and Visualization in Spring 2013. ARC also organized and supported a two-day MathWorks Matlab seminar in November 2012 and a two-day Software Carpentry Bootcamp in January 2013. ARC's FDI offerings attracted 522 attendees in FY2013.

In Spring 2013, Dr. Polys taught the Computer Science graduate class 5754: Virtual Environments. ARC has also offered a series of guest lectures in a variety of courses, including the College of Science's Integrated Science Curriculum, to increase awareness of parallel computation among undergraduate students. With our new computational specialist expertise and in collaboration with faculty in Aerospace and Ocean Engineering, ARC began preparing a semester-length graduate-level course in parallel programming. We intend to offer the course Fall 2013.

Outreach

The booth for Virginia Tech and the University of Virginia at Supercomputing 2012 in Salt Lake City was a great success, showcasing Virginia Tech's computational science innovations. Numerous posters and papers were presented as well as a 'Research Reel' video summary and interactive 3D demos in the booth. Other conferences where ARC had a strong presence as organizers and presenters include SIGGRAPH, Web3D, IEEE VR, and the Transportation Research Board's Tools of the Trade Conference. These activities continue to demonstrate Virginia Tech's international leadership in HPC and visualization research and its applications.

ARC faculty are also leading members of several organizations with broad impacts across industry and academia such as the HPC User Forum, the Coalition for Academic SuperComputing (CASC). Dr. Terry L. Herdman, Associated Vice President for Research

Computing, continued his service as Chair of the Board for Oak Ridge Associated Universities (ORAU). Dr. Nicholas Polys was also re-elected President of the Board of Directors for the Web3D Consortium (www.web3d.org) where Virginia Tech leads in international standards development with active projects and liaisons with: ISO/IEC, W3C, DICOM, OGC, Khronos, and the IMS Global Learning Consortium.

Goals for 2013-2014

Infrastructure. Configure Intel Xeon Phi accelerators on BlueRidge and make available to the Virginia Tech research community, substantially increasing the capacity of ARC's flagship computing asset. Acquire and implement a new parallel file system solution to increase the capacity and performance of ARC's storage systems. Begin planning and preparations for the third and final phase of BlueRidge's expansion.

Visualization. Increase impact and adoption of new visualization technologies with new initiatives and technology offerings such as Hokiespeed.

Education. Offer, in collaboration with faculty in Aerospace and Ocean Engineering, a semester-length graduate-level course in parallel programming. Develop and offer an FDI short course on programming for the Intel Xeon Phi to facilitate usage of this new hardware on BlueRidge. Enhance and expand web-based content.

Hiring. Continue to build Virginia Tech's HPC support team by hiring, training, and organizing new staff. Continue to improve user service.

Converged Technologies for Security, Safety, and Resilience

Converged Technologies for Security, Safety, and Resilience (CTSSR) collaborates with other groups at Virginia Tech to develop and coordinate advancements on strategic initiatives that involve the intersection of information technology security, physical security, campus safety, and community/regional resilience. These activities often involve other units within the Information Technology organization, as well as academic and administrative departments including Facilities Services, University Relations, the Office of Emergency Management, and the Virginia Tech Police Department.

CTSSR serves as an advocate within Information Technology for technology infrastructure and resources that could be beneficial for campus police and emergency managers, and provides outreach to communities in addressing applications and processes for technology infrastructure development, public health and safety, and emergency planning. In addition, groups within CTSSR pursue and participate in research, development, education, and training related to our areas of expertise, which include converged technology tools and techniques, geospatial information systems (GIS), data analysis, applications development, and identity management.

CTSSR includes the following units:

- eCorridors (a technology outreach initiative)
- Virginia Tech Geospatial Information Sciences (VTGIS), including both
 - Center for Geospatial Information Technology (CGIT)
 - Enterprise Geographic Information Systems (Enterprise GIS)
- Identity Management Services (IMS)
- Blacksburg Electronic Village (BEV)
- IT Risk Assessment, Disaster Recovery, and Continuity of Operations

eCorridors. The eCorridors technology outreach program works with communities, private-sector, and municipal partners to encourage rapid development of advanced, fiber optic, wireless, and "next generation" Internet infrastructure across Virginia. Under the direction of CGIT and the Center for Innovative Technology, eCorridors is in its fourth year of assisting in a collaborative effort to develop Virginia's statewide map of broadband availability as part of the federally-funded State Broadband Initiative (SBI) project. On the local and regional scale, members of the eCorridors program participate in the regional broadband planning groups and other activities advocating for advanced broadband infrastructure and associated

policy issues throughout Virginia. The eCorridors unit focuses primarily on the Information Technology Strategic Plan Pillar 3, Strategic Theme 6 “Outreach and Community Development.”

Virginia Tech Geospatial Information Sciences (VTGIS). VTGIS includes both the Center for Geospatial Information Technology and Enterprise GIS.

Center for Geospatial Information Technology. The Center for Geospatial Information Technology (CGIT) is an interdisciplinary research center specializing in geospatial information technology as applied to health, community resilience, intelligence/big data, and security and safety initiatives. During the past year, CGIT has actively participated in conferences at the local, state, national, and international level through presentations, publications, and exhibit booths, increasing increased awareness among funding agencies for an array of geospatial research expertise and capabilities. CGIT focuses on IT Strategic Plan themes 1, 3, and 4—respectively, “Safety and security,” “Leveraging technology to advance teaching and learning,” and “Supporting research and innovation.”

Enterprise GIS. The Enterprise GIS unit is a key component of Virginia Tech’s spatial data infrastructure, providing GIS data hosting, systems integration and web application development services to both academic and administrative units of Virginia Tech. Enterprise GIS supports the university’s strategic objectives by lowering barriers to the use of advanced geospatial technologies in research, teaching, outreach, emergency response, facility operations, and campus planning. Enterprise GIS focuses on IT Strategic Plan Theme 7: “Supporting university mission through enterprise systems.” Enterprise GIS works to ensure that well-maintained, current, and secure geospatial information resources are available to fit the needs of administrative and academic units, and that training is provided as needed to fully exploit these capabilities.

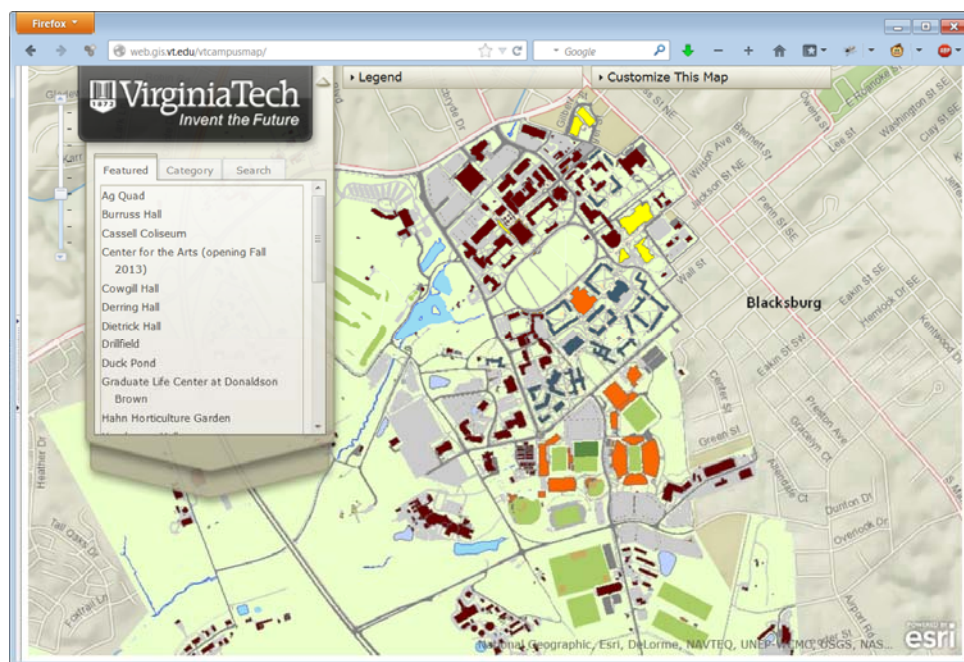
Identity Management Services. Identity Management Services (IMS) is responsible for electronic identity and access management at Virginia Tech. IMS currently manages the lifecycle of approximately 700,000 electronic identities and has defined approximately 40 different affiliations that describe the type of association that an electronic identity has with Virginia Tech. In its role as a second-line customer service help desk, IMS resolves over 6000 trouble tickets regarding access issues each year. IMS is focused on Information Technology Strategic Plan Pillar 5, “Ensuring the security and resilience of information technology resources.”

Blacksburg Electronic Village. The Blacksburg Electronic Village (BEV) provides specialized data management and infrastructure support for a variety of IT-related projects. BEV continues the process of transitioning its focus from external Internet access and web hosting initiatives to the deployment and support of emerging Web technologies. BEV is an integral part of the day-to-day operations of the Enterprise GIS organization within CTSSR,

augmenting the latter's proficiency in GIS with expertise in integration of geospatial tools into advanced Web applications, and providing systems administration support. BEV supports IT Strategic Plan Theme 2, "Creating a resilient and robust computing and network infrastructure for research, teaching, and outreach."

Pillar 3: Leveraging information technology to distinguish the Virginia Tech experience

Helping to make the Virginia Tech campus map interactive. University Relations has, for many years, maintained an accurate and well-designed reference map of the Blacksburg campus in PDF format. With the proliferation of mobile devices and the increasing availability of tools that allow publishing maps on the Web, University Relations collaborated with VTGIS and Facilities Services to develop a flagship interactive map of the Virginia Tech campus to be launched as an integral part of the redesigned vt.edu web presence before the start of the Fall Semester 2013.



Members of Enterprise GIS provided expertise in platform architecture, spatial data integration, and application logic development, while University Relations oversaw the site's "look and feel" and Facilities Services provided real-time access to the most current versions of all the data displayed in the campus map.

The map is intended to be intuitive, with simple controls and a prominently displayed navigation menu to help new students, parents, and visitors (as well as current faculty, staff and students) find their way around our ever-changing campus environment.

Pillar 5: Ensuring the security and resilience of information technology resources

Converged Technologies Annual Meeting. CTSSR organizes and convenes a meeting each year in collaboration with the Office of the Vice President for Information Technology and the Vice President for Administration to share recent developments in technologies being deployed on campus to enhance security and safety. This is an open meeting, allowing anyone to attend on an informal basis and to participate in questions and discussions of the projects being presented. This year's meeting was held on August 7 and included six presentations on current converged technology initiatives. A poster session was also part of the program, with posters and faculty experts from several disciplines available to share a number of interesting initiatives that, in some way, involve technology and safety and security. An afternoon session was held to determine priorities and next steps for new initiatives. An archived collection of information about the 2013 Converged Technologies Annual Meeting is available at <http://www.it.vt.edu/ctssr/annualmeeting/>.



This photo includes some of the presenters at the 2013 Converged Technologies Annual Meeting (from left): Kevin Foust (VTPD), Ron Jarrell (NI&S), William Dougherty (NI&S), Mike Mulhare (OEM), Seth Peery (VT-GIS/CTSSR), Carl Harris (CNS), Karen Herrington (IMS/CTSSR), Scott Midkiff (VP-IT), Sherwood Wilson (VP-AS).

IT risk assessments. Risk assessments enable departments to correlate information technology resources with mission critical business processes and services. Using that

information, it then becomes possible to characterize interdependencies and the consequences of potential disruptions, as well as to generate plans to eliminate or ameliorate risks.

CTSSR is charged with working with university departments to complete the IT Risk Assessment process. In the past 6 months, we have worked with 13 departments in completing the process and are in progress with nine more units that have started but not yet completed the risk assessments.

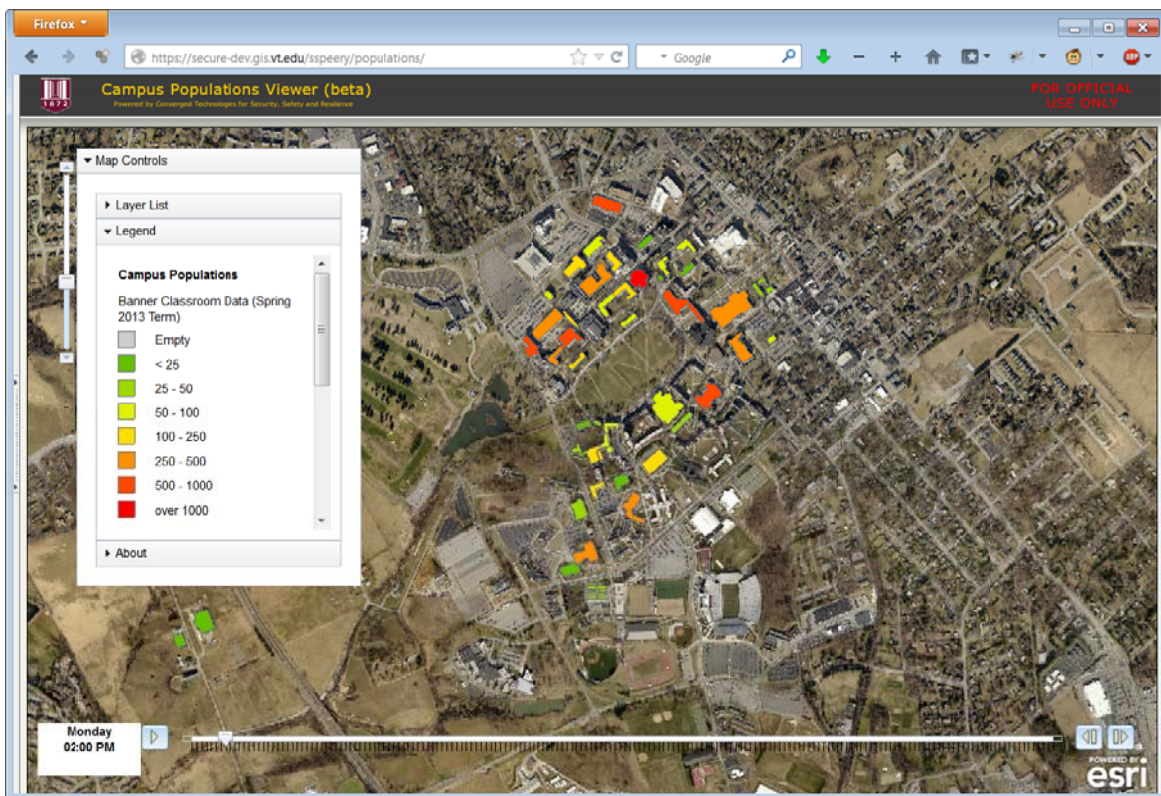
Pillar 6: Improving communications with customers and partners

Information Technology communications. A team of Information Technology communicators, including Angela Correa of CTSSR, began efforts to develop an initial comprehensive evaluation of and plan for communications within the Information Technology organization, giving units a better way to market their initiatives, get their news out to the university community, and communicate within the organization.

Strategic Theme 1—Security

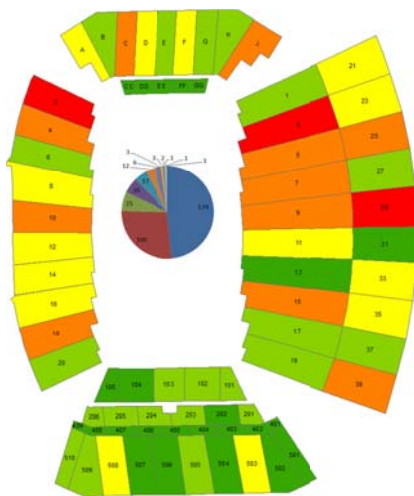
The first strategic theme in the Strategic Plan sets as a goal: “Establishing a level of security that continuously protects university data and research and collaborating with other university units in leveraging IT infrastructure to enhance physical security and safety.” CTSSR contributes to this theme throughout several projects.

Campus populations. The efforts of Virginia Tech’s Office of Emergency Management (OEM), the Virginia Tech Police Department (VTPD), and other emergency responders can benefit from improvements in their ability to estimate the number and location of concentrations of people on campus at a given time. This increased situational awareness is beneficial across all phases of emergency management—preparedness, mitigation, response, and recovery. By integrating data from other university databases into a web-based multi-temporal visualization, Enterprise GIS has developed a tool that displays an estimate of the number of people occupying general-use classrooms and dining facilities, hour by hour, throughout a typical week. The data are generalized and aggregated in general estimates for each building on campus at a given time.



Since security is an important consideration at all levels of the application architecture, only those personnel working in an official capacity with a need to access this information will be authorized to use this tool. In the coming year, Enterprise GIS aims to explore the possibility of bringing in additional “feeds” of information into the viewer, improving confidence in estimates via the triangulation of methods.

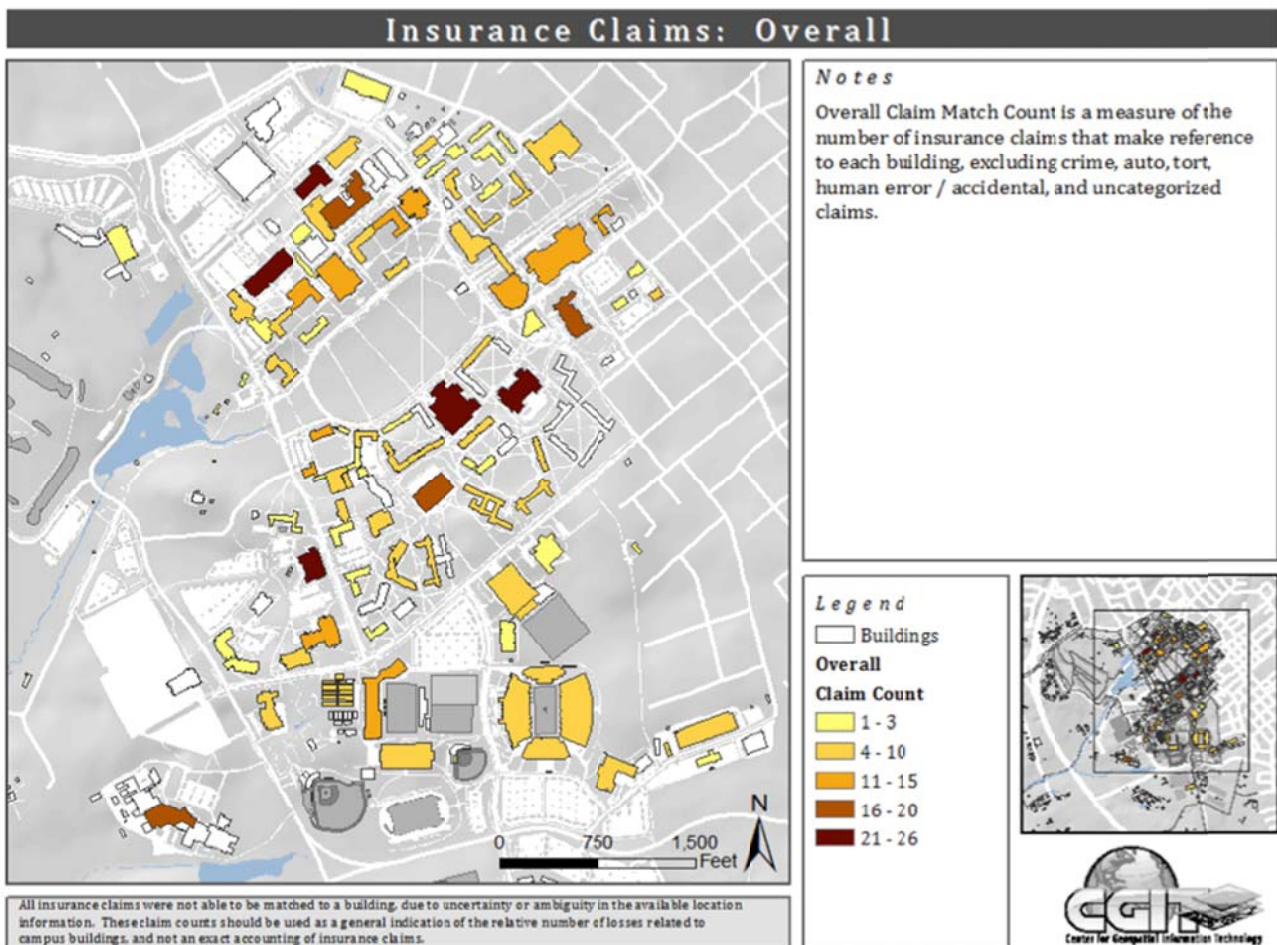
Gameday GIS Stadium Safety application.



The “Gameday GIS Stadium Safety” application is a web-based situational awareness tool developed by Enterprise GIS for use by OEM and VTPD. The tool creates a time series of incident data that can be analyzed to ascertain patterns and trends, informing future redeployment of law enforcement and emergency personnel. The initial application was developed in 2011, and underwent a major redesign in 2012. The 2012 football season was the first time that analytical data from the Gameday GIS could be visualized by the leadership of the VTPD and OEM, and the data helped inform a shift in the overall policing strategy inside Lane Stadium for home football games. Analysis of this data as applied to subsequent stadium events enabled emergency responders to use personnel resources more efficiently and effectively in maintaining security and safety at large stadium events.

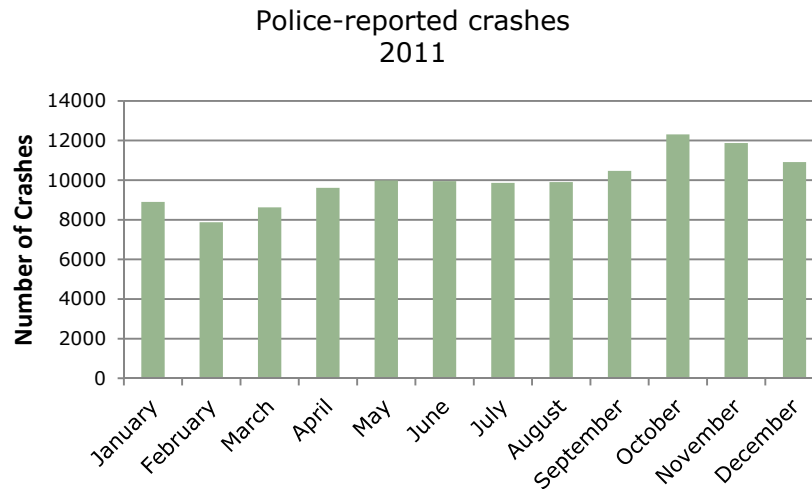
Gameday GIS continues to evolve, and its “DNA” has been repurposed to create a more generalized framework of reusable software components that have been incorporated into both the public-facing Virginia Tech Interactive Campus Map and the Campus Populations application. Future plans include incorporating this situational awareness capability beyond football games to enhance safety at other large events on campus.

Hazard mitigation plan update. The updated Hazard Mitigation Plan, created by the Center for Geospatial Information Technology (CGIT), identifies and assesses a variety of hazards impacting the main Blacksburg campus, and develops strategies to reduce their impact. CGIT collected best-available data describing campus facilities, including building footprints and building attributes, and intersected this information with known hazard data, such as FEMA-designated floodplains. The updated plan is a central part of Virginia Tech’s overall hazard mitigation and emergency preparedness strategy.



The color-coded campus map shown depicts aggregated insurance claims by building where the incident occurred. This is just one of several useful visual representations of data that are part of the updated hazard mitigation plan, which also includes relative risks of Virginia Tech buildings and facilities to fire, winter storm damage, and earthquake; and maps FEMA floodplains.

Funded research—Department of Motor Vehicles project. In 2012, 123,579 police-reported vehicle crashes occurred in Virginia. Understanding and targeting the causes of these crashes is necessary to increasing highway safety and reducing their number in the Commonwealth, and knowing precisely where these crashes occurred is important to how resources are allocated.



CGIT has partnered with the Virginia Department of Motor Vehicles (DMV) Highway Safety Office to locate all police reported crashes within the Commonwealth of Virginia. Staff members use the ESRI ArcGIS environment and custom tools to interpret and analyze police reports, crash diagrams, GIS road center line layers, and satellite imagery to identify the most probable location of a crash as documented by the officer. The resulting standardized information, which includes geospatial coordinates, standardized addresses, and milepost data, is added to DMV’s Traffic Records Electronic Data System (TREDS). Because of this process, Virginia is the first state in the nation to fully describe and map all crashes on all roads to the location identified by the officer. The resulting information supports the ability of highway safety stakeholders to improve highway safety education and enforcement, as well as to provide an extensive resource for research and analysis.

CGIT has developed a process that has doubled the processing rate and substantially improved consistency. As a result, DMV and highway safety stakeholders have access to located crash information for 2013 as well as earlier years and are now able to plan and allocate resources based on the most recent and comprehensive information. This funded project is expected to continue into 2016.

Strategic Theme 2—Computing and network infrastructure

CTSSR contributes to the second theme, “Creating a resilient and robust computing and network infrastructure for research, teaching, and outreach.”

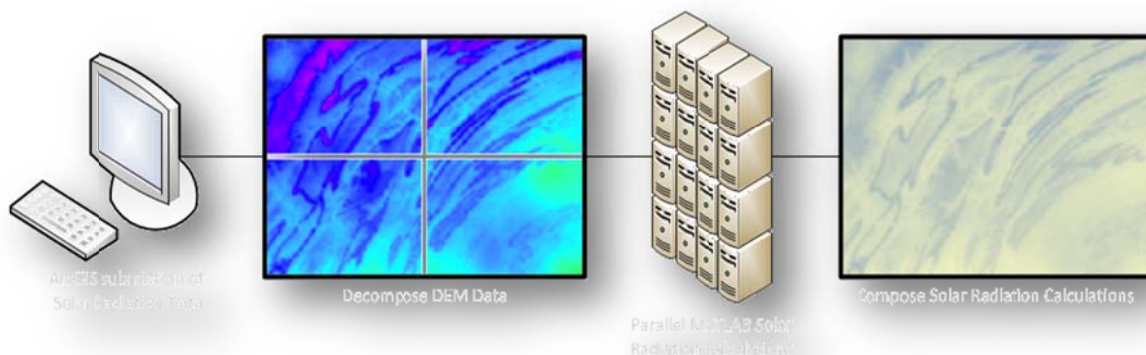
JavaScript-based SPAM blocker. The Blacksburg Electronic Village (BEV) unit developed a JavaScript-based tool that almost completely eliminates automated SPAM postings to web contact pages, forums and similar types of open communication.

Infrastructure management. Expert consultative assistance and support provided by BEV has allowed Enterprise GIS and CGIT to focus on the development of geospatial tools with the knowledge that the infrastructure is being managed appropriately, or to tackle complex web interface issues in elegant, technically-sound, and secure ways.

Strategic Theme 4—High performance computing

“Supporting university research through the development and support of high-performance computing and communications technologies, advancing competencies and capacity in computational science,” is theme 4.

CGIT collaboration with Advanced Research Computing (ARC). CGIT has collaborated with ARC to develop high performance workflows on the university’s Athena and Ithaca systems in support of a USDA-funded research project that requires processing and analysis of a significant amount of geospatial data for the eastern United States. Analysis of large GIS data sets with complex computations can cause even the most powerful desktop computers to process jobs inefficiently and ineffectively. For example, calculating solar radiation in an ArcGIS environment with large digital elevation models is resource intensive. In order to address this bottleneck, CGIT employed high-performance computing (HPC) resources utilizing parallel MATLAB to perform parallel calculations and developed an ArcGIS Add-In to manage the communication between the HPC cluster and ArcGIS. The graphical user-interface presents the user with the ability to select an HPC cluster, various computations, and fine-grained tuning options for computation parameters. By employing HPC clusters for large and complex computations, we were able to analyze large data sets that ArcGIS would fail to complete. The ability to access HPC clusters from an ArcGIS interface greatly facilitates the transition to parallel computations for GIS technicians.



Strategic Theme 6—Outreach and community development

“Providing leadership and service to apply new information technologies creating opportunities to improve quality of life and economic competitiveness for the citizens of the Commonwealth and all people.”

Funded research—NTIA Broadband Mapping Initiative. Federal funding from the Department of Commerce National Telecommunications Information Administration (NTIA) continues to support CTSSRs efforts in the NTIA’s Broadband Mapping Initiative. CGIT is leading the research effort combined with the expertise and support of the eCorridors group, in partnership with Virginia’s Center for Innovative Technology and Virginia Geographic Information Network (VGIN) for the development of next generation broadband mapping data and tools within the Commonwealth of Virginia. The commonwealth’s participation in the national broadband mapping effort (managed by NTIA) was leveraged using modeling and simulation strategies to extend the commonwealth’s Broadband Toolbox with a new suite of data-driven and web-based tools.

The tools developed by CGIT include verification and analysis models, map books for efficient communication and sharing of information, RF propagation models, a next generation vertical asset inventory, a database of federal, state and local telecom policies, and interactive mapping tools for presentation and application of the data, models, and products. These tools enable stakeholders including state and local governments, citizens, and businesses to plan and deploy new broadband infrastructure within the commonwealth.

Localities across Virginia are focused on providing improved broadband options to their constituents, but seldom have the resources to perform needs assessments or to develop a strategic broadband plan (community telecommunications plan) without assistance. Some community broadband grants exist, but may not be accessible to the localities without a broadband plan in place. Limited funding is available for the development of these plans. Resolving these broadband service gaps, especially for rural areas, requires insight into the existing vertical assets; impact of federal, state, and local policies; and the ability to estimate potential value of proposed new vertical asset locations. All of these tools allow the majority of strategic broadband planning to take place offsite for a much lower cost to local governments.

Outreach—Accelerate Virginia. The eCorridors speed test crowd-sourced data collection and analysis engine, *Accelerate Virginia* continued to engage a significant number of Virginia counties in Internet speed testing. To date, Accelerate Virginia has received over 9000 (9074) speed tests from businesses and residents across the state. Internet service characteristics have been recorded from 132 of the 135 counties and independent cities in Virginia.

Accelerate Virginia has been featured at several statewide meetings, including the Virginia chapter of the American Planning Association, the Virginia Municipal League Town Sessions, Virginia's Rural Summit, Broadband Communities Economic Development Series, county board of supervisors meetings, and the Virginia Broadband Council.

In the past year, *Accelerate Virginia* has been used to provide specific input into several regional broadband strategy planning projects conducted by the Center for Innovative Technology.

CTSSR goals for 2013-2014

CTSSR contributions to the IT Strategic Plan involve leveraging the capabilities of our geospatial administrative and research groups, identity management, broadband infrastructure advocacy, and safety and security technologies development and utilization efforts.

Achieving progress in this area would also involve other units such as Network Infrastructure and Services for the VT Alerts system and related signage and security cameras; the VT Police and the Office of Emergency Management; academic faculty working in geospatial research areas; the VT rescue squad; VPAS Facilities and Space Management; University Libraries; and others.

Selected goals for 2014 are mapped to the Information Technology Strategic Plan in the following matrix.

<p style="text-align: center;">IT STRATEGIC PLAN PILLARS</p>	<p>Pillar 1: Enabling networked learning in the networked university</p>	<p>Pillar 2: Providing competitive advantage through sustainable advanced cyberinfrastructure and collaboration</p>	<p>Pillar 3: Leveraging information technology to distinguish the Virginia Tech experience</p>	<p>Pillar 4: Advancing information technology for enterprise effectiveness</p>	<p>Pillar 5: Ensuring the security and resilience of information technology resources</p>	<p>Pillar 6: Improving communication with customers and partners</p>	<p>Pillar 7: Strengthening the information technology organization</p>
<p>GOALS</p>							
<p>Continue to develop geospatial tools for situational awareness</p>			✓		✓		
<p>Work with other groups to increase interoperability and utilization of university building data for security and safety purposes</p>			✓		✓		
<p>Increase university adoption of IT Risk Assessments and complete the IT Disaster Recovery Plan</p>					✓	✓	
<p>Continue to participate in local and regional initiatives involving the increased availability and affordability of broadband connectivity to residences of university students, faculty and staff</p>		✓	✓			✓	
<p>Work with communications personnel within IT to complete an evaluation of current communications practices, and develop a workable communications plan to benefit the organization as a whole</p>						✓	✓
<p>Create an affiliate management system to enable creation and lifecycle management of loosely affiliated VT identities</p>				✓		✓	

Enterprise Systems

Enterprise Systems develops, coordinates, and manages application software systems that provide critical information services for university constituents. Its role is to facilitate an enterprise-wide view of university applications while ensuring that these systems maintain an effective balance among information technology standards and practices, university functionality, and security and compliance. Enterprise Systems collaborates with university constituents to encourage process transformation and to promote alignment of enterprise applications with university priorities.

The eight units of Enterprise Systems focus on different aspects of the mission:

Advancement, Human Resources, Finance, and Student Applications are four units within Enterprise Systems that support application subject areas. These four units are responsible for acquisition, development, and maintenance of the university's core administrative systems for their specific areas of subject matter expertise.

Business Intelligence Services provides services for data reporting, analytics, distribution, and modeling to promote utilization of data for university operations and decision making. This team configures, designs, implements, and supports the Virginia Tech enterprise data warehouse as well as enterprise business intelligence tools.

Database and Application Administration provides the necessary controls, oversight, performance monitoring, and 24x7 on-call responses for application administration, database administration, web hosting, and filebox services.

Web Services and Development provides information technology support in the areas of web development, portal administration, integration processes, web content management, the Banner General Person module, and Enterprise Directory interfaces.

Document Management Systems provides enterprise technology services for document management, wiki services, and workflow, as well as software development and support for the Office of Information Technology Acquisitions.

Accomplishments for the year are organized according to these Enterprise Systems' objectives:

- Provide new enterprise systems, technologies, and applications that expand and broaden services and functionality in support of the missions of the university

- Expand the functionality, usefulness, and usage of production enterprise systems
- Sustain and support university enterprise level applications to ensure long term viability of the university applications and systems
- Promote best practices that enable the Enterprise Systems organization to effectively manage the development and ongoing support of enterprise applications

Expand functionality through new systems and services

This objective is to provide new enterprise systems, technologies, and applications that expand and broaden services and functionality of the mission of the university. This year, Enterprise Systems completed several projects aimed at broadening the services available to the university and continues to expand upon these implementations.

Research Administrative Systems. Enterprise Systems provided technical services and direction in support of the goals and deliverables identified by the coordinating groups of the Research Administration program. In particular, the research administration functional and technical project teams created and implemented a solution to track the progress of agreements for Office of Sponsored Programs using JIRA software as the workflow and productivity management technology. Enterprise Systems also participated in the evaluation and purchase of the Cayuse SP product for managing university research proposals.

Business Intelligence System. Enterprise Systems coordinated the compilation of requirements for a business intelligence system that would advance Virginia Tech's reporting and analytics capabilities as well as enable the university to create a virtual data modeling environment. To aid in gathering requirements, Enterprise Systems worked with several vendors to create proof-of-concept demonstrations of the capabilities of analytical tools and virtual data models. In January, Virginia Tech released an RFP for an enterprise business intelligence system. The RFP process is progressing with system selection and purchase expected to occur in the fall of 2013.

Financial Aid and Scholarship administration. The Office of University Scholarships and Financial Aid and Enterprise Systems continued the design and development of a scholarship administration system to improve scholarship fund utilization and management. To that end, processes were implemented to correlate financial aid funds to appropriate organizational units across the university and to more effectively maintain award eligibility requirements for college and department scholarships. Additionally, colleges and departments can now enter scholarship recipients into the system and receive immediate verification of the recipient's eligibility for a particular scholarship. Colleges and departments receive improved information concerning the defined requirements for the scholarships they manage. Reports for the Financial Aid staff now provide information on student eligibility and ineligibility for scholarships to promote better utilization of scholarship funds. In addition, students have

benefited by receiving more detailed updates on scholarship availability and financial aid deadlines.

Leave, time, and attendance system. To meet audit and university requirements for an enterprise-wide time clock system, the central time clock system, TimeClock Plus, was implemented in production on December 1, 2012 with Recreational Sports as the initial users. Since then, approximately 6000 jobs have been established in the time clock system, vastly reducing the amount of time spent each pay period entering hours worked into the Banner system. The system now serves seven departments utilizing thirty-one remote terminals. Enterprise Systems worked with the vendor to enhance the TimeClock product for CAS user authentication. All remaining hourly jobs will be migrated to the central time clock system during the fall of 2013.

Travel and expense management. Enterprise Systems continued its work with Ellucian to resolve various performance and user interface issues that Virginia Tech has reported for Banner Travel and Expense Management (TEM). Custom workflows in the product were refined and enhanced based on feedback from the initial pilot group and developers improved integration between TEM and Banner Document Management. Collaboration with Identity Management Services provided account provisioning that was critical to the expansion of the pilot implementation. With these changes in place, the pilot was expanded to include two academic departments in January 2013. Work to implement per diem functionality was started in spring and summer 2013 with the upgrade to TEM 8.6.

Street address conversion. The initiative to assign street addresses to all buildings on the Virginia Tech's Blacksburg campus resumed this year. Enterprise Systems assisted the Procurement Department with updating the "ship to" codes used by departments. Automated processing in the Procurement Department of employee address changes that are made by the employee was implemented, replacing a manual process. Processes for accounts receivable statements and purchase orders were updated to have street addresses on their output.

Online giving application. In coordination with the University Development Office, Enterprise Systems completed the development of the redesigned online giving pages. The application provides a more user-friendly online giving web site for university academic gifts, athletic gifts to the Hokie Club, and academic gifts to the Virginia Tech Carilion School of Medicine. The initiative included working with the third-party credit card vendor, Nelnet, to create iFrame support for our giving pages and enabling the Development Office staff to use the university web content management system to manage the ongoing "look and feel" of their giving pages independent of staff from the Information Technology organization.

New projects

In addition to these initiatives, a number of new projects were begun during the year to address evolving university priorities.

Salary planner application. In collaboration with the College of Engineering, Enterprise Systems worked to define a new application to facilitate salary planning, maintenance of salary adjustments, tracking of salary savings commitments, and communications of adjustment to principal investigators. The initial phase of this initiative resulted in a prototype for salary planning that is being finalized for production use.

University Honors Program. The University Honors Program requested a system for electronic application of eligible students to the University Honors program. Enterprise Systems developed and implemented an honors application system that also includes a more efficient evaluation process for the applications, resulting in faster notification of acceptance into the Honors program.

Student athletic advising. A student athletic advising system was developed and implemented by Enterprise Systems for more efficient and timely collection of information from faculty with student athletes in their classes. Processes similar to tentative grade processing and academic advising were implemented to eliminate paper processing of faculty comments related to an athlete's academic progress.

Fixed asset data mart. At the request of Internal Audit, Enterprise Systems implemented a fixed asset data mart with new reports. This data mart includes funding and grant information for assets and analysis of fixed asset data.

College of Engineering advising. The College of Engineering academic advising office and Enterprise Systems collaborated to create a document management system for student folders for advisers in the college. The system provided cost savings and streamlined the process for students to change from another major to an engineering major or to change majors within the college. The success of the implementation has exceeded expectations and has garnered significant interest across the campus. In response, the college is considering sponsoring a pilot of a university-wide implementation in 2013. In addition, the employees who led the implementation were nominated for a 2013 Governor's Award. See www.vtnews.vt.edu/articles/2013/08/080513-hr-governorsawardnomineesmclothlinlesterandsmith.html.

The Office of Student Conduct. Electronic document management capability was implemented for the Office of Student Conduct. This capability provided secure storage for incident reports, notification letters, sanction reports, and reflection letters which are now available for quick and easy access for the advisers and case workers in the Student Conduct office.

General accounting journal vouchers. The General Accounting unit of the Controller's Office needed a system to image journal vouchers and enable viewing in Banner. Enterprise Systems deployed a solution that enables access to appropriate financial managers and fiscal technicians throughout the university with required fund/org security. When combined with invoices and travel documents that were already available, this provides a more complete collection of financial documents for the university community.

Purchasing Department vendor documents. Enterprise Systems designed a document management system which enables the Purchasing Department to attach vendor-related records (W9s and associated forms) to the FTMVEND record in Banner. Vendor information has now moved from a paper-based system, accessible only to the Purchasing—now called Procurement—office, to an electronic system that makes tax and other necessary vendor information available to university areas needing this information.

Expand the functionality, usefulness, and usage of production systems

Enhancements to the functionality and usage of existing systems occurred throughout the areas of Enterprise System support.

Fundraiser benchmarks. Enterprise Systems completed an extensive analysis of the impact of adding extended leave functionality to the Fundraiser Evaluation and Performance Benchmarks system for Development and has subsequently made extensive modifications to the system to accommodate this added functionality.

Advancement business process analysis. Enterprise Systems has continued to participate with University Development in a post implementation analysis of the Banner Advancement system to evaluate Virginia Tech's usage of the system and assess opportunities for more effective business processes and practices.

Virginia Retirement System modernization. The process to calculate employee and employer cost for the Virginia Retirement System was rewritten to address the rules of the new state VRS Modernization project including VRS retirement, buy back retirement, life insurance, and VSDP contributions. This also required a new VRS interface program, reconciliation program, and numerous reports for prompt monthly reconciliation to the state system of record.

Health care changes. The new health plans defined by the state required numerous modifications of all uploads and reconciliation reports for plan changes and incentives.

Payroll enhancements. Enterprise Systems developed programs for the August 2012 pay increase for graduate students and the December 2012 bonus for faculty and staff. In addition, we modified programs to create and report on the new additional Medicare tax for high earners that went into effective December 2012.

Electronic management and storage of work authorization documents for non-resident employees was designed and implemented with access rules that enable sharing documents between HR and Payroll offices. This document management solution has created a unified document source, improving the security and access to personally identifiable information and promoting business process efficiencies.

Winter semester. In 2013, the university's board of visitors added a new term to the Virginia Tech calendar to enable the university to offer courses between the fall term and spring term. Enterprise Systems has begun analysis and development of application, registration, and course catalog processes required to support the winter semester.

Financial aid. The reasonable academic progress (RAP) process for financial aid was redesigned to support end of term processing requirements for compliance with changes in federal regulations.

Veterans educational benefits. Enterprise Systems enhanced the processing of veterans educational benefits to enable a student to apply for veterans benefits online and check the status of their application.

Identity applications. The Group Manager application was enhanced to allow for the creation of Google groups from existing Enterprise Directory groups. Account Manager was enhanced to allow for the movement of email accounts to VT Google Apps.

Graduate School admissions. The Graduate School and Enterprise Systems collaborated to enhance the business processes for handling graduate admissions documents, resulting in more efficient and faster document processing. The workflow system monitors new documents and notifies appropriate staff of documents requiring attention.

Enterprise Systems also developed processes to provide data extracts for the Graduate School to the Hobson's Connect CRM system.

Ensure long-term viability of the university applications and systems

This objective is to sustain and support university enterprise level applications to ensure long term viability. Implementation of software upgrades and patches is an essential activity in

achieving this objective to promote application security and maintain vendor support. The following list details the upgrades completed this year.

FY13 Enterprise Systems Upgrades

Product	Application	Version
Atlassian	JIRA	5.2.7
Atlassian	Confluence	5.0.3
Ellucian Banner	Accounts Receivable	8.4 & patch
Ellucian Banner	Advancement	8.5, 8.5.1, 8.6 & patches
Ellucian Banner	Advancement Self-Service	8.6, 8.6.1
Ellucian Banner	Database Extension Utility	8.0
Ellucian Banner	Document Management System	8.4.0.3 & patch
Ellucian Banner	Effort Reporting and Labor Redistribution	8.7
Ellucian Banner	Einvoice	8.6
Ellucian Banner	Employee Self-Service	8.7, 8.7.1, 8.8.1 & patches
Ellucian Banner	Finance	8.7 and patches
Ellucian Banner	Financial Aid	8.14, 8.15, 8.16, 8.17 and patches
Ellucian Banner	Financial Aid Self-Service	8.15 & 8.16
Ellucian Banner	General	8.5.1 & patch
Ellucian Banner	General Web	8.5.1
Ellucian Banner	Human Resources	8.7, 8.7.1, 8.8.1 & patches
Ellucian Banner	Position Control	8.7, 8.7.1
Ellucian Banner	Student	8.5.3 & 8.5.4
Ellucian Banner	Student Self-Service	8.5.2 & 8.5.3
Ellucian Banner	Faculty Self-Service	8.5.2 & 8.5.3
Ellucian Banner	Travel & Expense	8.5.0.3, 8.5.0.5, 8.5.0.6
Ellucian Banner	Web Tailor	8.5.1 & patch
Ellucian Banner	Workflow	8.0.1
EMC	ApplicationXtender	6.52 & patch
eVA	DGS JavaClient	4.0
Hokie Mobile	Hokie Mobile Android Version	1.1.0
	Mobi Web Service	1.3.0
ITA	WebObjects	5.4.3
	WebObjects Wonder Frameworks	r83
	Apache	2.4.4
	Java 7	update 25
	Samba	4.0.3
Jaspersoft	Jaspersoft Server	4.7.1
Oracle	Enterprise Manager Cloud Control	12.1.0.2
Oracle	Oracle Enterprise Linux	6.3
Percussion Software	Percussion CMS (Ensemble)	7.1, 7.2
Percussion Software	TCPDF	6.0.12
SciQuest	SelectSite (HokieMart)	12.2, 12.3, 13.1
TimeClock Plus	TimeClock Manager	3.0.1.101
VTLS	Vital	5.4.1

Availability. Production Banner and Warehouse databases were migrated from a virtual hardware configuration to physical hardware to improve performance, availability, and reliability.

Availability of systems was improved through the deployment of standby databases to other Virginia Tech campus sites. Hardware was purchased and provisioned for standby databases for production Banner, Warehouse, and Scholar databases. Significant progress was made in designing the processes and procedures that will be required to implement standby databases on a larger scale.

Best practices

The objective is to promote best practices that enable the Enterprise Systems organization to effectively manage the development and on-going support of enterprise applications.

Automation and testing. Selenium IDE was implemented to test the overall functionality of the new online giving website. Ten scripts were developed to process over 4,000 checks, which the application must pass before it can be deployed to production. This testing method improves efficiency by greatly reducing end-user testing while simultaneously improving the accuracy of the production product.

Professional development. Enterprise Systems established an infrastructure to define, document, and promote technologies necessary for moving Enterprise Systems into the future. As a first step, the group has identified developers to act as early adopters of Java-related technologies and object oriented programming methodologies. Evaluation of training opportunities for a larger initiative to educate existing developers has also been initiated.

Goals and objectives for 2014

The Information Technology Strategic Plan for 2012–2018 presents pillars that support Virginia Tech’s “A Plan for a New Horizon” and the information technology capabilities of the university. See www.it.vt.edu/publications/strategic_plan/Virginia_Tech_IT_Strategic_Plan_2012-2018-v1-1-2013-06-12.pdf. For 2014, Enterprise Systems has the following planned initiatives to advance the goals presented in the strategic plan.

Business intelligence system. Enterprise Systems plans to complete the procurement of a new business intelligence system and begin implementation to provide Virginia Tech with new and expanded data reporting and analytical capabilities including leading-edge technology to create a virtual data store. The business intelligence system is a key component for positioning Virginia Tech’s enterprise systems for the future.

Cloud-based services. Cloud-based services, which provide significant opportunities for enterprise applications, will be the basis for several planned implementations during 2014. In collaboration with the Bursar’s office, Enterprise Systems plans to implement a cloud-based

budget tuition system as well as a cash receipts system. In addition to leveraging cloud-based technology, these implementations will expand the future of our enterprise technology infrastructure by replacing existing VT systems that have reached end of life. The Offices of the Provost and of the Vice President for Administration, and Enterprise System are collaborating to implement a cloud-based instantiation of CollegeNet 25Live and X25 for event management, scheduling, and analytics.

Mobile applications. Enterprise Systems is partnering with the Division of Student Affairs to identify opportunities for mobile applications that enhance the Virginia Tech student experience. Enterprise Systems will also be analyzing the usage and future of the university portal and mobile administrative applications to identify opportunities for advancement and to create a unified roadmap for these technologies.

Enterprise resource utilization. To address the challenges of effective utilization of information technology, Enterprise Systems will continue to pursue opportunities to improve our processes for managing requests, resource assignments, and timelines. Enterprise Systems is also planning to hire a project manager who will be dedicated to Enterprise Systems' project management responsibilities.

Information Technology Acquisitions

Information Technology Acquisitions (ITA) procures, manages, and distributes goods and services for the university using best value concepts. The department is organized into three operational entities: Computer Purchasing; Software Distribution (Departmental and Student); and Contract Management, Licensing, and Billing. This unique organizational structure provides a multitude of services to the university. The Computer Purchasing arm of the ITA organization assists end-users through the various steps of the procurement process. Daily procurement activities include requesting quotes from vendors, coordinating agreements between Virginia Tech's legal division and the vendor's legal department, and finalizing purchase orders. Additionally, this arm of the organization conducts high-dollar complex software system procurements for the university. Contract Management, Licensing, and Billing manages application distribution for thirty-eight contracts, which encompasses 170 software titles, for numerous departments across the university. This office also negotiates terms and pricing on behalf of Virginia Tech as well as institutions across Virginia that participate in our statewide ESRI and Wolfram Mathematica contracts. The Software Distribution component of ITA serves as the face of our organization to over 35,000 faculty, staff, and students at the Blacksburg campus as well as to the numerous populations at the university's satellite locations and extension agencies. Located in Torgersen Hall, Software Distribution combines a personal touch with today's high technological distribution methodologies to fulfill the software needs of the university community in a face-to-face environment. Though separate entities, ITA departments work together seamlessly as we serve the needs of the university.

Pillar 1: Enabling networked learning in the networked university

As software needs change to meet the demands of a blended university that offers traditional and online courses, ITA continues to research new software solutions and develop necessary resources to fill these needs. This year, Contract Management acquired Camtasia Studio and Camtasia for Mac, which allows users to create and disseminate informational videos, lectures, or present research at professional conferences. Moreover, Contract Management offers online software training opportunities such as Microsoft IT Academy and ESRI Virtual Campus, as part of a collection of services ITA provides to university organizations across the state. IT Academy allows users to tap into a multitude of Microsoft resources to expand their professional skills or receive certification for industry-leading technologies. Virtual Campus provides hundreds of self-paced training opportunities in the science, application, and technology of GIS. Departments across the university, including Geography, Civil

Engineering, Entomology, and Biological Systems Engineering, incorporate these sessions into their curriculum. These learning options are available to faculty, staff, and students at the Blacksburg campus, satellite locations, extension agencies, and colleges and universities across Virginia that engage in the statewide ESRI contract. This training provides faculty, staff, and students with the opportunity to take advantage of learning outside of the classroom.

Pillar 2: Providing competitive advantage through sustained advanced cyberinfrastructure and collaboration

To best serve the Advanced Research Computing team, ITA currently hosts license managers for five software titles. Users connect to the high performance computing cluster, and the cluster seamlessly connects to the license manager. Users are added to an ED-ID group to access the software. For example, Abaqus, a sophisticated engineering simulation software, requires tokens to run jobs for members of the Abaqus user groups. A complex mapping file stores information related to user access, number of tokens a user can access at a time, and how many tokens the license manager must reserve for the groups to complete their jobs. ITA negotiated a contract with SAS to provide unlimited server licenses for research computers. This allows HPC to utilize SAS on a considerably larger cluster. In addition to the support we deliver to the Advanced Research Computing team, ITA also assists the Virginia Tech Carilion Research Institute (VTCRI). Contract Management developed a specialized solution that designates constant access to the Matlab license server on the VTCRI cluster. Through this dedicated system, users have access to a complete version of Matlab, Parallel Computing, and other advanced toolboxes to facilitate their research. ITA will continue to partner with advance research departments to procure the software and resources they require.

Pillar 3: Leveraging information technology to distinguish the Virginia Tech experience

In alliance with Document Management Systems, ITA provides access to license files as well as access to over 170 software titles on the ITA Network Software Server. This service provides end users with constant access to their software twenty-four hours a day, seven days a week. Not only does ITA host software on our servers, but our department also monitors license usage through a complex “rule-based” system that ensures compliance based on end user affiliations. In addition, these highly available software servers support redundancy, specifically in failover situations. The load-balancing servers allow ITA to minimize response time and avoid system overload. Load balancing is critical during periods of high server traffic, such as the beginning of each semester, when students return to the university, as well as the end of a semester as students finish research projects. ITA hosts a

license manager server for Abaqus and ANSYS; applications that are critical to the College of Engineering. Through analysis of license manager data, our team can identify possible license usage conflicts that could interrupt research projects and our work also enables ITA to suggest solutions such as staggering processing sessions or adding additional licenses. As a result, faculty and students are able to complete their work in the most expedient manner.

In addition to acquiring and renewing software agreements, Contract Management performs an array of services that benefit Virginia Tech. At the request of departments across the university, Contract Management assists departments during software licensing audits by providing accurate software inventory assessments, which ensures license compliancy. Additionally, self-extracting installations and ISO images are available options for downloading and installing software. ITA provides detailed documentation that allows more straightforward software installations customized for faculty, staff, and students. Within the year, ITA will provide installation videos along with PDF instructions on the network server to further aid our end users with their downloads, installs, and activations. By managing the licenses from procurement through installation, ITA offers a reliable solution for departments to manage their software, which minimizes departmental costs and allows the university's faculty and staff to focus on teaching, learning, and research.

Pillar 4: Advancing information technology for enterprise effectiveness

In February 2013, ITA implemented a license management system using the workflow capabilities of JIRA. ITA personnel enter license and contract renewals into the JIRA License Management System (LMS) along with supporting documentation including license agreements, quotes, legal reviews, addendums, correspondence, etc. The JIRA LMS provides up-to-date information that is available for review at any time, and assists staff members in processing renewals accurately and on time. The system also creates an auditable trail since renewal documents are stored in one area. The implementation of this systematic workflow process has been a significant upgrade. This system helps ITA overcome the physical barrier of our two different locations. Over the next few years, Contract Management will continue to build on the foundation of the JIRA system, include additional departments on campus into the LMS, and increase efficiencies through new technologies. Due to the success of the JIRA LMS, in June 2013, ITA designed and put into production a JIRA ordering system used by all ITA offices. This tool has been invaluable in tracking the purchase and shipment of the large number of software and supply orders that are placed within each entity of ITA.

Pillar 5: Ensuring the security and resilience of information technology resources

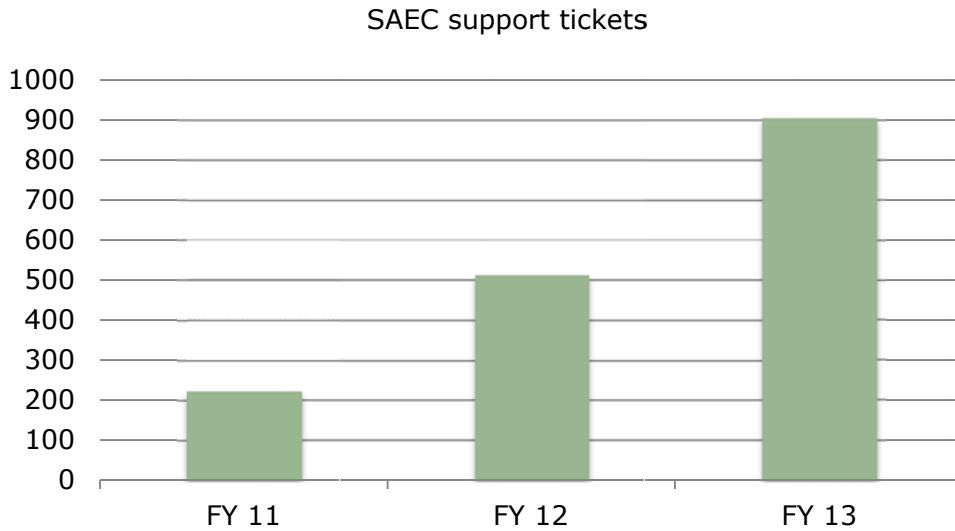
Software licensing is the overall driving force in managing access to software. ITA supports various teaching and research activities across campus: from managing advance research software hosted on the high performance computing cluster to the basic, but integral, service that provides users across the Blacksburg campus and satellite locations access to the most current version of the Microsoft Office Suite. Licensing requirements, as specified in software contracts and agreements, determine which university affiliations can access specific products. A complex set of access rules controls access to software hosted on the ITA network software server. Faculty, staff, and students authenticate through CAS, which passes affiliation and enrollment status to the software server rule set. Access to software is based on the user's affiliation with VT and/or a product purchase as reported by Banner. ITA also utilizes ED-ID groups as a control mechanism by incorporating them into the rule set when necessary. ITA strives to provide uninterrupted access to software resources, while adhering to stipulations specific to each software license agreement.

As discussed in IT Strategic Theme 7, a goal of our organization is to continue our exemplary performance in the area of data and application security. It is of utmost importance that the university be secure with its data. Conducting research on the best service delivery models (i.e. Cloud-based, Saabs, vs. In-House) to meet the "data store" needs of the university is imperative. ITA will continue to facilitate discussions between departmental representatives and vendors so solutions can be found that meet both the functional as well as the security needs of the university. In addition, ITA will continue to expand its efforts in regard to application security by constantly evaluating and updating our own authentication and distribution methodologies. This is crucial to the continuing success of the services we provide to the campus and satellite locations through the use of our network software server.

Pillar 6: Improving communications with customers and partners

Service to the university community is the nature of the business ITA conducts on a daily basis. Each year our team looks at ways ITA can help Virginia Tech's faculty, staff, and students succeed. In that vein, ITA, in conjunction with University Computing Services, created Software Assistance and Education Center (SAEC) in 2010. SAEC's purpose is to help the university community through a hands-on approach manage their own computers, where the end-user is involved in resolving their own technical issue(s). By engaging the end-users, we attempt to transfer knowledge so learners become more self-sufficient in the management of their own machines and perhaps able to support others. The graph below represents the users that utilized the SAEC help desk during the past three years. SAEC

utilization increased significantly in 2013 as a result of extended hours of operation. Surveyed users gave SAEC support staff a 98% positive approval rating.



Software Distribution services the university with personalized customer service. Software Distribution and Contract Management work closely together to assist the university community with their purchases, license requirements and software inquiries. Each semester, members of this team stocks inventory to supply faculty, staff, and students with the titles they need for teaching, research, and learning. Additionally, trained staff issue eTokens to employees eligible for personal digital certificates (PDCs) contributing to the university's goal of security through strong user authentication. Software Distribution staff serve as part of the New Student Orientation team. Each summer, transfer students and incoming freshman receive the Undergraduate Software Bundle, which permits students to access to the most current versions of the Microsoft operating system and Office Suite during their undergraduate career at Virginia Tech. In addition to the Undergraduate Bundle, Software Distribution supplies six major software bundles for the School of Architecture and Design, the Myers-Lawson School of Construction, the Pamplin College of Business, the College of Engineering, and the College of Landscape Architecture. This office also offers several titles for faculty, staff, and student personal use, including several Adobe and Microsoft titles.

In order to best assist the university community, Computer Purchasing works with departments to determine the best means for procurement. There are several types of procurement activities that Computer Purchasing conducts. These include sole sources, invitations for bids (IFB), invitation for qualified contractors (IFQC) and request for proposals (RFP) resulting in purchase orders and/or contracts. The most complex type of procurement that ITA handles is the request for proposal (RFP). These six-to-twelve month long system acquisitions are designed to fully explore alternatives that meet the university's needs at the best value. Computer Purchasing also coordinates legal agreements and researches available

cooperative contracts to achieve efficiency and effectiveness. This department has awarded a number of cooperative contracts, which allows all VASCUPP—Virginia Association of State College and University Purchasing Professionals—schools and other state agencies to purchase from Virginia Tech negotiated contracts. Computer Purchasing manages these contracts by issuing amendments that modify and/or renew the terms during the contract period. Computer Purchasing also dedicates itself to the inclusion of SWaM—small, woman-owned and minority-owned—vendors in an effort to strengthen the department’s vendor base and encourage competition. Through competition, we achieve strong pricing, quality service, and supplier diversity.

The Contract Management, License, and Billing section of ITA manages various software license agreements distributed to the university and agencies across Virginia. New releases and additional software acquisitions drive much of the work generated by this division of ITA. Contract Management assists the university community by negotiating license agreements and pricing, maintaining software releases on the servers, and processing renewals. This past fiscal year, Contract Management processed renewals for twenty-seven software titles and negotiated a complex agreement for Camtasia. Most notably, Contract Management successfully negotiated a multiple-year contract with IBM that avoided a ten percent price increase for SPSS software, saving \$24,000 over the next two years. In addition to successful SPSS negotiations, Contract Management negotiated a three-year agreement with TecPlot on behalf of the College of Engineering, which saves the department \$3,600 over the next three years.

Through the efforts of the Contract Management staff, Virginia Tech is in its twelfth year of managing the Environmental Systems Research Institute (Esri) statewide contract, which delivers GIS software to 16 universities and 23 community colleges. Each participating school saves between \$10,000 and \$15,000 per year on their renewals by taking advantage of this statewide contract. In addition to cost savings, this contract supplies complimentary, full version software to students, as well as unlimited access to free training to faculty, staff, and students at each university. As holders of the contract, ITA is the single point of contact between ESRI and the statewide users.

Another successfully managed statewide contract is Wolfram Mathematica. Currently, 18 public and private colleges and universities across Virginia engage in the three-year contract. Contract Management staff negotiate on behalf of the participating schools and serve as the point of contact between the vendor and institution. This office also collects and remits all fees associated with the site license to Wolfram. By centralizing these services, Contract Management offers the participating schools a cost savings and frees up administrative resources so these procurement officers can focus on their individual end users. Through our work with Virginia Tech’s communities and agencies across the state, Contract Management will continue to work to ascertain our customers’ software and resource needs in order to provide them with the best service for the best value.

Although comprised of three distinct operational entities, ITA operates together with great cooperation and efficiency. Our unique organizational structure sets us apart from others across the state and country. ITA streamlines the procurement activities from simply ordering new software or services to ensuring license compliance and managing distribution to users across the university as well as other state agencies. Because of our uniqueness, procurement offices from across the country and vendors regularly consult with our staff seeking suggestions on effective ways to distribute and manage software. By offering our guidance, ITA forms a community of partners with vendors, other higher education institutions and state agencies.

As licensing methodologies change and evolve, ITA's knowledge must continue to change and evolve and be shared with the university community at large. This means staying abreast of the most current technologies and evaluating them in relation to the needs and system capabilities of the university. It also means ITA must continue to actively listen to our customers and extend guidance and support as procurement decisions are made. Over the next year and into the near future, as positions are filled, one goal of our organization is to actively reach out to the university community through training initiatives that deal with the procurement of IT goods and services.

Pillar 7: Strengthening the Information Technology organization

Being comprised of three unique but interconnected entities, it is important that personnel understand how ITA operates as a whole. Training and cross training are key elements to the success of an organization such as ITA. Staff members take advantage of educational opportunities that enhance their skills and abilities. Three members of ITA have received state procurement certifications, two Virginia contracting officers (VCO) designations and one Virginia contracting associate officer (VCA) designation. To maintain certification, holders of VCOs and VCAs must attend training courses and symposiums. Developing the knowledge, skills, and abilities of our staff members has always been important to ITA and will continue to be even more so in the future.

As technologies change and emerge, skill sets need to do so as well. Over the last three years, ITA employees have taken over 25 classes and seminars each year. This dedication to personal growth and improvement has had a tremendous positive effect on ITA's ability to operate more efficiently and effectively. This skill acquisition has also led to several system improvements in many areas across the three branches of ITA. In essence, through the educational efforts of our staff we see better communication, a more thorough understanding of new technologies and team dynamics, and better customer service skills that have contributed to an overall more satisfied client base.

ITA offers an important service to the university during New Student Orientation and Check-in. Through our summer internship program, ITA employs students who assist Student Software with distributing undergraduate bundles during Orientation sessions and major bundles and other software titles during Check-In. Working with ITA personnel, interns learn about the department's various software distribution methods, while expanding their customer service skills sets.

The distinct nature of our organization allows Information Technology Acquisitions to streamline the procurement process, reduce duplication of effort, yield cost savings, and respond quickly to end user requests. By providing these services, the university can focus on teaching, research, and learning with the latest technologies.

Information Technology Security Office

The mission of the Information Technology Security Office (ITSO) is to provide technology tools and services, education, awareness, and guidance necessary for all Virginia Tech users to work towards a safe and secure information technology environment for teaching, learning, research, outreach, and the conduct of university business. The IT Security Office focused FY13 efforts on sensitive data protection, network monitoring and analysis, awareness, security reviews, and cyber security related projects.

Network monitoring

Virginia Tech FY12 investments in network monitoring equipment and additional ITSO personnel greatly increased network monitoring efforts during FY13. The addition of dedicated malware detection appliances, commercial intrusion detection devices, and improved in-house developed intrusion detection sensors improved network visibility. The ITSO also increased its capacity to archive network connection data for historical analysis. These tools gave the ITSO greater insight into real-time and historical security-related occurrences.

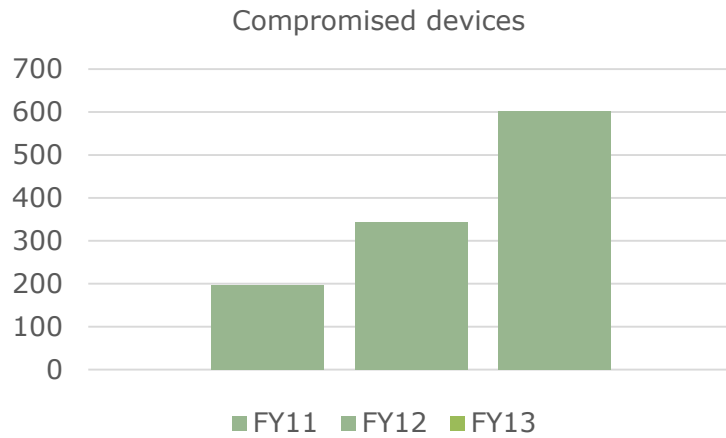
Network attacks. Emerging cyber threats continued to pose a risk to Virginia Tech's information technology assets. Network probes numbering in the thousands occurred daily. The ITSO believes much of this activity was malicious and conducted in an attempt to discover and attack vulnerable systems for the purpose of gaining control over computing resources or obtaining Virginia Tech data.

Malware. Sophisticated malware continued to pose a serious threat to Virginia Tech's academic, administrative, and research data and systems. Discovered malware infections exhibited the ability to hide from traditional antivirus software and find and exfiltrate sensitive data elements including passwords, social security numbers, and credit card numbers. Malware observed during FY13 could log keystrokes and allow attackers to gain full control over infected systems, allowing the infected systems to attack other systems. The threat from malware infections continued to grow during FY13.

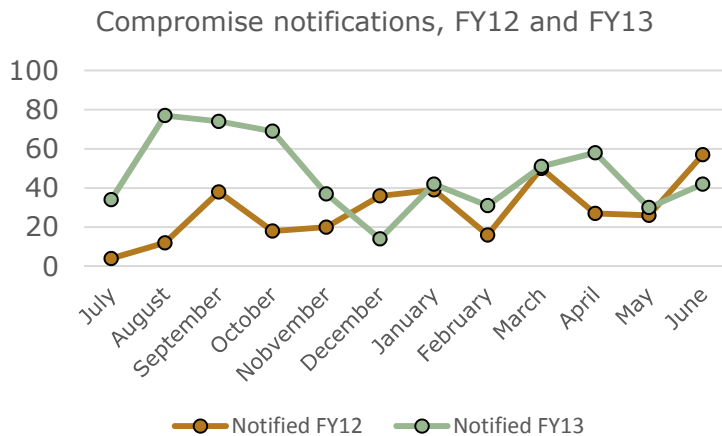
Compromised systems

The installation of additional network monitoring equipment has allowed the ITSO to increase its detection of compromised machines by 75% over the previous year. A majority of

the 602 compromised machines were discovered by malware detection appliances added during FY12. Over 45 separate academic, administrative, and research departments experienced a system compromise. The majority of infections seemed to leverage vulnerabilities found in third party software and unsafe computing habits. Departmental personnel consistently reported unpatched versions of Java, Adobe Reader, and Adobe Flash software on infected machines. Not all malware infections required user interaction to be activated. However, there were numerous reports of users clicking on links associated with phish emails.

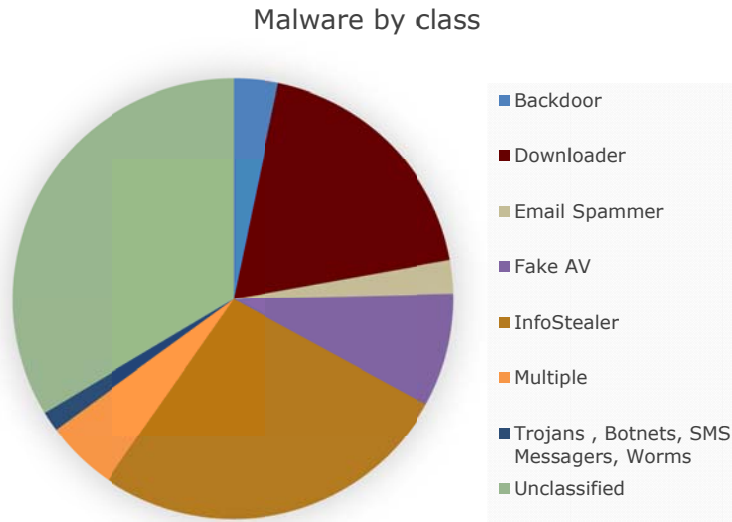


Surges in compromised machines coincided with the return of students and faculty to campus. Monthly FY13 counts of compromised systems exceeded or equaled FY12 counts for every month with the exception of December 2012 when Virginia Tech was closed for winter break.

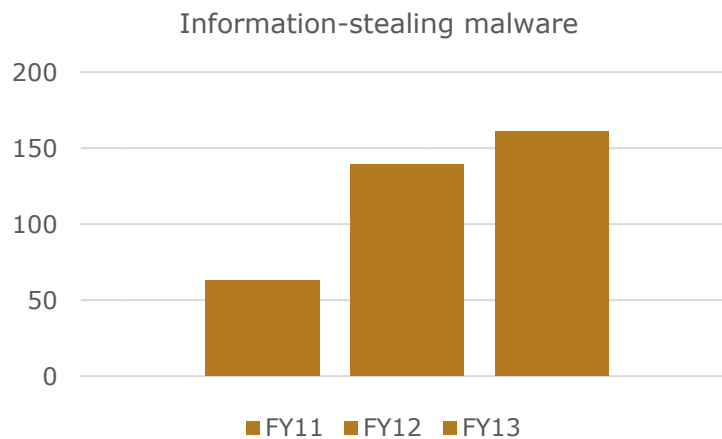


In a typical month, we observed over 100 identified and classified pieces of malware. Detected malware infections included fake antivirus products, email spammers, and bots that

could participate in a distributed denial of service attack on other systems. Other malware infections were more insidious and could steal data, download other malware, or give an attacker a backdoor into the system.

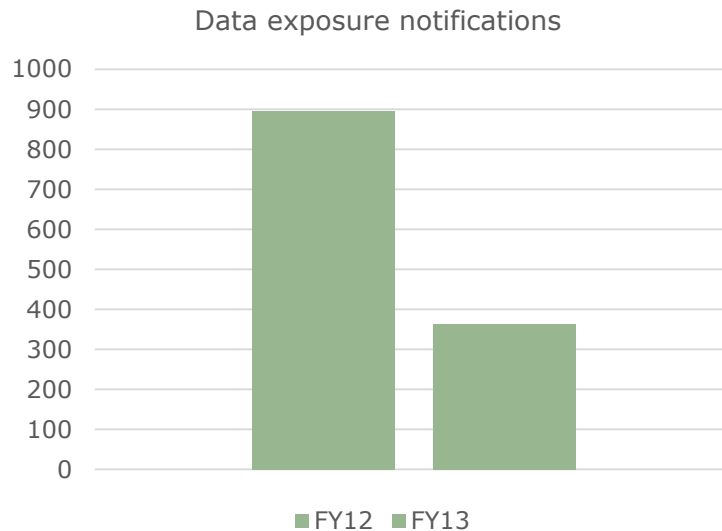


Information-stealing malware infections increased slightly during FY13. Polymorphic malware makes it harder to detect and classify. Industry estimates that standard antivirus (AV) software is capable of detecting only 40% of the malware available today. The ITSO believes that the coincident increase in unclassified malware may mask additional instances of information-stealing malware. The ITSO issued 122 suspicious activity reports to university departments as a precaution.



FY13 data exposure notifications. The possibility of data exposures is an unfortunate consequence of compromised machines. While the number of compromised machines increased during FY13, the number of data exposure notifications decreased to 364. This 246% reduction in notifications is likely attributed to the increased use of encryption and Identity Finder software on university computers storing personally identifying information (PII). Identify Finder has the ability to search system and locate PII elements such as social

security numbers, credit card numbers and other items that require protection. The ITSO has worked with the university community to raise awareness, provide training, and to ensure the software's availability. Over 3800 copies of the software had been downloaded by the end of FY13.



Opportunities. The ITSO believe that many of FY13 goals have been reached. However, upgrades to Virginia Tech's Blacksburg campus network present new challenges. The ITSO would also like to expand monitoring and detection capabilities to the National Capital Region campuses at Ballston, Alexandria, and Falls Church. The ITSO has set the following goals:

- Improve the network monitoring capability to accommodate Blacksburg campus network upgrades
- Extend network monitoring capabilities to the National Capital Region
- Continue to find ways to share collected data about cyber threats with the university community
- Improve data collection and event correlation
- Work with departments to increase PII discovery and protection

Awareness and training

The ITSO believes that awareness and training activities remain an effective and proactive way to reduce cyber security issues. The ITSO continued its efforts to educate the university community about cyber threats through online training, skills training, and participation in student events. The ITSO also presented to several departments upon request.

Advanced cyber security training. The SANS course “SEC505: Securing Windows and Resisting Malware” was hosted by the ITSO in the spring of FY13. Over 120 participants took part in the training. Participants gained insight into Microsoft system hardening and PowerShell scripting.

Faculty and staff training. The ITSO continued awareness training through the Faculty Development Institute. Participation was down from previous years but the ITSO regards this venue as an excellent opportunity to speak to faculty about cyber security issues. Courses include the following:

- General Security Awareness: Hunting for and Protecting Sensitive Data
- Security Question and Answer
- Using TrueCrypt for Encryption
- Securing Your Own PC
- Securing Your Own Mac
- Identity Finder—Finding Sensitive Data on your Computer

Online awareness training. The ITSO offers online training to university departments. The SANS “Securing the Human” program allowed participants to learn about cyber security issues in a self-paced environment. Participation in the online training program continued to grow at a steady pace and increased by 60% to just over 4700 users. Training material is updated twice a year and departments are returning to the system to refresh employee knowledge.

Student awareness. The ITSO and University Computing Support (UCS) applied for and received a Parent’s Fund grant to raise cyber awareness among students. Funding supported three separate events during October as part of National Cyber Security Awareness Month. One of the events included Gobblerfest.

The premise of the events was to engage students in a cyber-security themed game. Thousands of students participated and won a prize with the awareness message stay “Cyber Safe.” The combined events allowed the ITSO and UCS to answer questions and distribute promotional items and informational pamphlets to students.

US Cyber Challenge Camp. The IT Security Office hosted the Eastern Regional US Cyber Challenge Camp at the Hotel Roanoke (Roanoke, VA) at the end of FY13. Invitations to the camp were sent to the highest scoring individuals in various cyber competitions such as NetWars and CyberQuest. Fifty-one individuals from states east of the Mississippi attended the camp. The ITSO provided technical support to the camp. CBS Morning News and the BBC ran features on the camp on TV and print media.

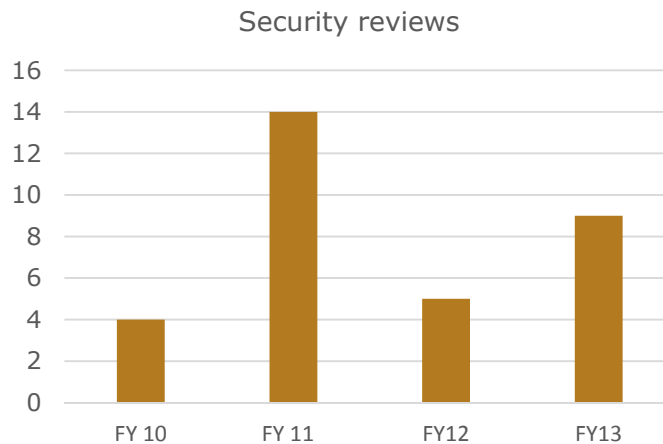
Opportunities. Awareness training is a key component of the ITSO cyber security strategy. Even though progress was made in online training participation, the ITSO believes that improvement should be made in awareness efforts among faculty and staff that handle sensitive data.

The following goals have been set for FY14:

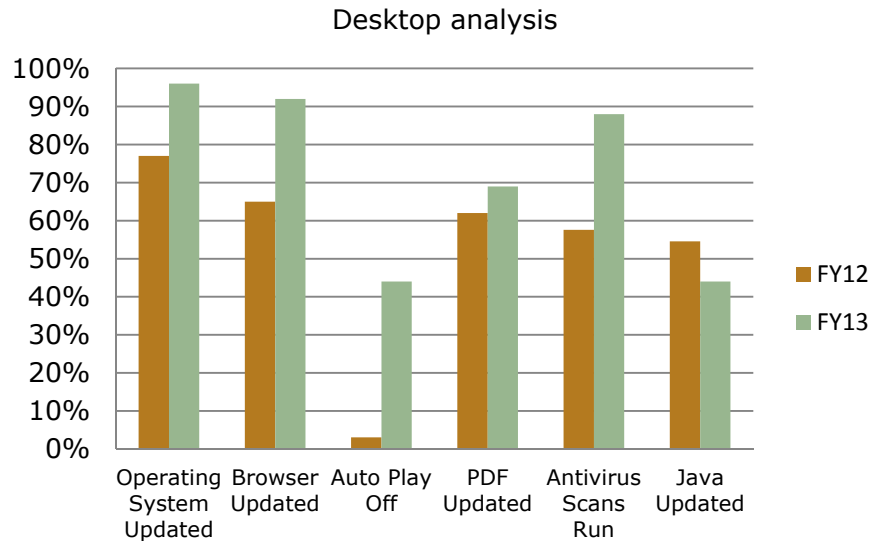
- Improve and increase awareness efforts among faculty and staff members
- Develop an awareness initiative to highlight the importance of protecting sensitive data
- Increase the number of outreach presentations made to the community
- Increase awareness presentations delivered to departments

Security reviews

Security reviews offered by the IT Security Office help departments discover potential cyber problems that weaken information technology systems. The ITSO improved FY13 performance by starting and engaging with 10 departments but failed to reach its goal of 20 security reviews.



Departments reviewed during FY13 revealed that outdated and vulnerable third-party software remains an issue. Java and Adobe Flash were observed to have updated patch levels below 50%. Only 37% of the reviewed departments had an appropriate screen locks and only 73% encrypted PII to a satisfactory level. Reviews also found poor documentation practices, backup procedures, and inappropriate firewall configurations.



Opportunities. Security reviews help departments prevent problems that can lead to system compromise and data exposures. The ITSO is committed to expanding efforts in this area.

The following goals have been set for FY14:

- Reduce security review performance times
- Perform 20 security reviews for departments

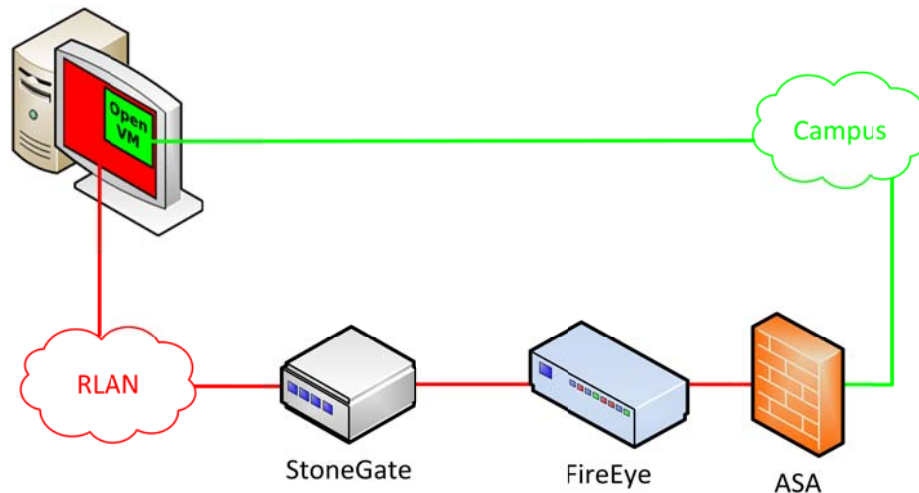
Related projects

Restricted Limited/Access Network (RLAN). A joint project between the ITSO and NI&S created a network segment intended to provide additional layers of protection for departments through improved network threat detection and blocking. The RLAN components include StoneGate intrusion prevention systems, FireEye® malware detections appliances, and Cisco® ASA firewalls that are placed inline to automatically block detected attacks.

Creation of the network is intended to offset risk posed by network-based attacks and information-stealing malware. The deployment of the RLAN will allow participating departments to separate computer activities based on security needs. Computers inside the RLAN will only communicate with authorized systems.

The pilot phase of the project included extending RLAN network capabilities to the offices of the Registrar, University Bursar, and University Scholarships and Financial Aid. The RLAN project has entered the second phase of its implementation. The ITSO believes that the

RLAN's "defense in depth" architecture is appropriate for many departments working with PII and will increase efforts to encourage its adoption.



Patch management. A critical funding request was granted to University Computer Support and the ITSO to implement a patch management system to assist RLAN departments with patching vulnerable software. A scalable patching system from IBM was obtained. Because of the system's capacity to patch computers outside of the RLAN, a pilot project was started to expand its use. Use of the IBM Endpoint Manager patching system has been expanded to more than 18 departments to patch software for more than 1000 computers during FY13 as part of the pilot. Participation is expected to increase through FY14 to 4500 computers.

ITSO Lab

The IT Security Lab (ITSL) serves as a test bed for production-oriented hardware and software security systems under the direction of the IT Security Office and provides a hands-on learning environment for undergraduate and graduate students.

Class support. A goal for the FY13 was to create a virtual environment to allow students in a class setting to work with unsecured machines to experience real world challenges of information technology security. The environment was created in early FY13 and supported three classes during the academic year. The benefits of virtualization included improved system stability and management overhead. The environment supported over 150 students enrolled in these classes:

- ECE 4560 Computer and Network Fundamentals
- ECE 5585 IT Security and Trust

- ECE 5586 IT Security and Trust II

Application development. The ITSL serves as an ideal environment for students to further enhance their secure coding techniques. Two production web applications were developed by the ITSL students. The Digital Data Request System (DDRS) is a secure record keeping and workflow system used by university stakeholders to request and track the progress of forensic work and digital imaging on university computers. The system is used by the ITSO, University Legal Counsel, Communications Network Services, and others who require digital forensics work.

ITSL students also developed an application to track firewall change request for departments using the RLAN. The RLAN Access Request System facilitates a workflow for requesting, authorizing, and documenting firewall changes.

GM gift. General Motors provided a gift of \$20,000 to be used to advance an open source phishing testing system and support the cyber security club. This generous gift has allowed the funding for student wage positions and to support the annual Undergraduate Cyber Security Summit for the Cyber Security Club.

SANS support for students. SANS provided support for the ITSL's internship program in the form of a \$30,000 gift. This generous gift will allow the ITSL's to extend paid internships for students looking to gain practical cyber security related skills before entering the workforce.

S2ERC research. Multiple research projects were performed through the Security and Software Engineering Research Center. Sponsored by Lockheed Martin and Centripetal Networks, these projects researched moving target defense testing and high speed URL blocking, respectively, and totaled \$47,500. The results of these projects were presented at the semiannual S2ERC conference in Chicago in May.

Cyber Security Club. The IT Security Lab sponsors and advises the Cyber Security Club at Virginia Tech. The club has regular, bi-weekly meetings where current issues in cyber security are discussed. Also, the club hosted the third annual Cyber Security Summit, where eight teams from regional universities competed in a "virtual capture the flag" competition. The club's computing resources, specifically the server used for the group, is hosted by ITSO.

MTD6 research. The Moving Target Internet Protocol version 6 Defense (MT6D) was developed in the Information Technology Security lab by Matthew Dunlop and Stephen Groat under the advisement of Randy Marchany and Joseph Tront. The objective of this research is to protect hosts from targeted IPv6 network attacks, preserve the privacy of communicating hosts, and allow hosts to communicate anonymously over the network. MT6D was in the functional prototype stage and successfully demonstrated its ability to pass

numerous forms of network traffic to include streaming video and voice-over-IP traffic. It has now also been deployed to mobile devices.

MT6D development continues to move forward. It was presented at the INSA Annual Innovator's Showcase and MissionLink SOCOM, as well as academic conferences focusing on enterprise security, systems engineering, and smart grid. New research avenues, including moving target detection strategies and the impact of the defense on mobile networks, have been identified. L-3 has also identified MT6D as a priority research project for their Virginia Tech partnership and offered funding to support continued research. The US patent is still pending. Five papers were presented to national and international conferences.

Opportunities. The ITSL will continue to expand and improve on the inclusion of students in cyber security. It is the ITSL's goal to continue to conduct cyber security research and provide students with an opportunity to gain real world experience. The ITSL will

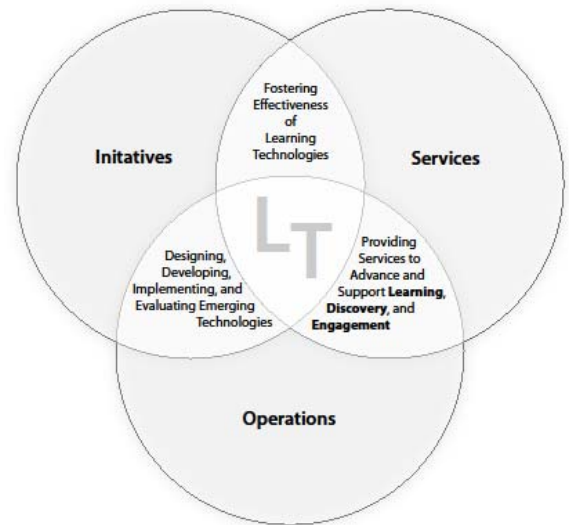
- continue to seek and recruit exceptional students;
- seek internal and external funding opportunities.

Learning Technologies

Learning Technologies provides a learning infrastructure actively designed to meet modern needs for integrating technology across content areas. We seek to create and support robust environments for learning, discovery, and engagement for faculty, staff, and students that are grounded in sound principles of learning, and in a thorough knowledge of integrating technology for effectiveness and efficiency of effort.

We work

- through comprehensive development programs and training activities in the appropriate use of emerging technologies;
- through systematic application of appropriate resources to designing, developing, implementing, and evaluating technology-assisted instruction;
- by providing highly responsive services that advance and support network-assisted teaching, research, and outreach.



Highlights

Re-visioning for university strategic plan aims. In January 2013, Learning Technology began re-designing internal processes, practices, and associated organizational structures to support the university's new strategic plan. By June 30, the university announced the launching of TLOS—Technology-enhanced Learning and Online Strategies, a re-aligning of units both inside and outside of Information Technology to meet Virginia Tech's aims as a networked university (*A Plan for New Horizon, 2012–2018*: www.president.vt.edu/strategic-plan/strategic-plan.html).

TLOS leverages an array of activities, services, and leadership in online programs and technology-enhanced learning already in place at the university. Using strategically focused, existing resources, Virginia Tech aims to significantly benefit student learning with a range of high caliber, technology-enabled programs and activities. TLOS will work across the university to incentivize and support highly effective distance learning programs, online content for on-campus courses, and hybrid courses.

Distinguished Innovator in Residence. Virginia Tech's two Distinguished Innovators in Residence (DIR), Cameron Neylon (see www.vtnews.vt.edu/articles/2012/10/100912-univlib-neyloninnovator.html) and Janet Murray (see <http://blogs.lt.vt.edu/innovator>), were in Blacksburg in Fall 2012 and Spring 2013 respectively. In partnership with University Libraries, the DIR program will continue in the coming year, with distinguished innovators planned for both fall and spring semesters.

Re-visioning Innovation in Learning programs. The Innovation in Learning grants program was launched and awards were made in Spring 2013. In addition, other new programming activities continued to grow, one of which the New Media Faculty-Staff Development Seminar, a flagship program which officially launched in Fall 2012. Over both semesters of the 2012-2013 academic year, increasing cohorts of Virginia Tech faculty and staff took part in this learning experience. Others will be invited to join the seminar in the coming year.

eBook pilot. Learning Technologies continued to expand an eBook pilot in partnership with EDUCAUSE and Internet2 that progressed throughout the 2012-13 academic year, extending participation to more course sections where faculty volunteered to participate.

New learning spaces. Learning Technologies redesigned 1120 and 3080 Torgersen Hall with variations on white board space, flexible seating, new technologies, inviting wall and furniture colors, and experimental room arrangements to promote exploration of teaching and learning with technology. More new learning spaces are in development for the coming year.

Testing and Data Services. Testing and Data Services (TDS) has historically supported the assessment of student learning through the accurate and timely scoring of optical scan forms for all colleges. This year was a transition for TDS as the centralized test-scoring operations were ended and a new decentralized, self-service model of test scoring was deployed. Several scanners were purchased for self-scanning throughout campus. Colleges and departments were contacted to determine locations for scanners. A full communication plan was implemented throughout the year to alert faculty and departments to the impending changes. Extensive training was provided and will continue to be provided throughout the upcoming year as needed. TDS will cease operations on August 1, 2013.

Digital Media Services. Video/Broadcast Services was given a new charge in early 2013 with a new name, Digital Media Services (DMS), to reflect a change in the mission and services in support of the university's Plan for a New Horizon. Throughout the spring and summer, DMS transitioned from Network Infrastructure and Services to Learning Technologies.

Digital Preservation Network. In partnership with University Libraries and the Office of Information Technology, Learning Technologies continues to provide support for a national

Research University Repository and its associated Deep Archive Project. The project is currently progressing through an initial three-year launch phase.

Discovery Commons. The research repository opened in 2011 as a public access portal for viewing project findings and collections of significant data associated with faculty and departments at Virginia Tech. For example, the American Civil War Newspapers project became operational with the completion of the first newspaper, the Macon Daily Telegraph, and public access and online viewing continues to grow. Other major projects are in development for the repository (e.g., for example, in veterinary medicine internally and with the Marshall Papers externally), including a new emphasis on learning objects. Discovery Commons is available as a permanent location for hosting and preserving collections associated with research and providing myriad levels of access to those university assets. The repository is hosted by the Database and Application Administration unit and managed by Document Management Systems, both within Enterprise Systems. Storage and backup are provided by Network Infrastructure and Services. The repository application consists of VITAL, the institutional repository solution designed by VTLS, Inc., and built on Fedora Commons Repository Software, an open source solution for the development of digital object repositories.

4-VA, a partnership designed to benefit technology-enriched learning in Virginia. 4-VA is a Commonwealth of Virginia program that has provided general funds to George Mason University, the University of Virginia, Virginia Tech, and James Madison University. In a public-private partnership between those institutions and Cisco, each institution has installed Cisco TelePresence facilities to promote shared learning across campuses. Through TelePresence-facilitated planning, programs are developing for STEM course redesign, foreign languages, research initiatives, and more. For example, a conference on course redesign in biology occurred at JMU that was attended by 4VA biology faculty and others from across the commonwealth in July 2012. At Virginia Tech, 4VA course redesign grant support currently underpins significant instructional redesigning activities for two biology courses and three math courses linked to improvements in learning activities in biology and math. Virginia Tech's 4VA grant activity also supported research in visualization that aimed to provide for enhanced remote manipulation of videoconferencing capabilities.

External links. Learning Technologies actively participates in select organizations, from maintaining the benefits of membership for the university community to serving as board members, reviewers, and editors. These include the following:

- Association of Active, Experiential, and Evidence-Based Learning (AEEBL)—institutional representative and regional conference sponsor
- CAMPUS TECHNOLOGY Advisory Board— members
- EDUCAUSE Center for Applied Research (ECAR)—institutional representative
- EDUCAUSE Learning Initiative (ELI)—board member

EDUCAUSE Learning Technology Leadership Institute— co-director and faculty
Electronic Campus of Virginia (ECVA)— officer and institutional representative
International Journal of ePortfolios— review editors
Journal of Interactive Technology and Pedagogy— editorial board
Learning Technologies Advisory Committee at SCHEV – institutional representatives
Learning Technology Consortium (LTC)— institutional representative
New Media Center Consortium (NMC)— member
National Institute for Technology and Liberal Education (NITLE)— board member
Pearson Strategic Advisory Board— member
ResearchChannel— board member
Redesign Alliance— board member
Sakai_ institutional representative
WICHE Cooperative for Educational Technology (WCET)— institutional representative

ePortfolio, FDI, GEDI

Within Learning Technologies, the units that focus on ePortfolios, the Faculty Development Institute (FDI), and the Graduate Education Development Institute (GEDI) form a hub of activity focused on transforming teaching and learning across the university.

ePortfolio Initiatives

As we approach the end of our fourth year, the ePortfolio Initiatives (eP) continue to grow and expand their place in the culture of Virginia Tech. Nationally, 52% of students in higher education are reporting some type of ePortfolio activity (Source: AAEEBL Survey, 2013), and Virginia Tech continues to lead the way in finding appropriate ways to use ePortfolios in a variety of educational settings. This report highlights a general trend in growth, gaining new groups each term, but also a deepening understanding of our purpose to support that growth at Virginia Tech, with activities such as a student showcase, a faculty and student peer mentoring program, and a steady improvement of our technological offerings. In addition Virginia Tech and the ePortfolio Initiatives continues to lead the country as a model for ePortfolio adoption in a large, R1 university, and we have been active participants in the growth of this transformative educational field of study. We look forward to our fifth year, which officially begins in January 2014, and we hope to see a continued expansion of understanding of the ePortfolio concept with faculty and students across the university.

Our office has expanded this year in several ways. From a project management perspective, we have worked at least seven programs to initiate the rollout of new ePortfolio projects and at least 15 programs that had on-going ePortfolio projects in order to further develop their implementations. We conducted 30 training sessions for existing or new projects Deepening

support for electronic portfolios is the new peer mentor program (eMentors). Mentors represent a wide array of disciplines and technology platforms. Mentors assist their peers in everything from deepening their critical thinking and reflection skills to design elements of the ePortfolios. This year we hosted the first annual Undergraduate Student ePortfolio Showcase, with resounding success. From over 70 submissions, we selected the top 10 students that best represented ePortfolios in the areas of research, learning, professional development, service, and mentorship/leadership. Links to the Showcase portfolios and videos can be found here: <http://blogs.lt.vt.edu/eportfolioinitiatives/index.php/student-showcase>. This summer, we initiated the Portfolio Development Network. Within this group, we identified six ePortfolio faculty leaders and invited them, and any additional team members of their choosing to participate in this yearlong community of practice. We spent a week in the summer identifying issues and challenges to their development and planning for fall and spring ePortfolio implementations. Each faculty group left the summer planning workshop with a clear plan for implementing or further developing the ePortfolio work within the program. Finally, our development team has made significant improvements in the user interface and is developing reporting functionality of Scholar ePortfolio tools. These tools facilitate ePortfolio adoption, specifically in the use of the Scholar ePortfolio tools.

While we have had significant expansion within the Virginia Tech community, we have also had broader impact on the national and international ePortfolio field. Last fall we presented a hands-on workshop to an international audience at the EDUCAUSE annual conference, as well as presenting sessions at the international Open Apereo conference and three other national conferences. We met with faculty from Davidson College, James Madison University and with an international contingent from Japan, representing Hosei, Kyoto University, and Kumamoto University. We continue our participation in the FIPSE-funded Connect 2 Learning (C2L) grant and attended the C2L Institute this summer. Under the aegis of the C2L grant, we have worked with two groups of faculty to facilitate the use of Peer Mentors and conduct research related to peer mentors and ePortfolios. Finally, we have continued our involvement with the Association for Authentic, Experiential, and Evidence-Based Learning (AAEEBL). Marc Zaldivar was recently appointed as a member of AAEEBL's Board of Directors. The ePortfolio office continues to manage the publication of *The AAEEBL Learner* newsletter.

Our plans for the coming year involve a deepening of our pedagogical mission by re-envisioning the ePortfolio Initiatives office into a unit that focuses on the pedagogical processes enabled by ePortfolios and folio thinking. As we shift our focus, we will emphasize processes afforded by technologies such as ePortfolios. Such processes include collaboration, integration, synthesis, and communication. These types of processes can potentially activate such qualities within the student population as a deeper sense of self, awareness of growth over time, awareness of multimodality and digital identity, and digital citizenship. From this perspective, we will continue to actively support the growth of electronic portfolios across campus, as well as additional emerging technologies, such as blogs, badges, Twitter

microblogging, and professional networking, to name a few. We will also continue the growth of eMentors, our Student Showcase, and our Portfolio Development Network (ePDN), and these areas will also be influenced by our stronger emphasis on pedagogical processes. We plan to continue our ePDN community of practice meetings with faculty, as they contribute to an evolving, growing blog that will house a bank of best practices. As we prepare for the second ePDN cohort, we will ask our current members to volunteer as faculty mentors to continue the sharing of technology-enhanced active learning practices. Finally, this year we will organize and host the regional AAEEBL conference, which will focus on emerging technologies and ePortfolios.

Faculty Development Institute

The mission of the Faculty Development Institute (FDI) is to inspire a flourishing community of learning at Virginia Tech by encouraging the faculty's integration of information and communication technologies into teaching/learning, research/discovery, and outreach/engagement. The campus-wide demand for FDI offerings is fed not only by requirements connected to the computer replacement cycle but also by a growing awareness that digital technologies, especially those relevant to networked, interactive computing, are rapidly proliferating and growing in importance. FDI strives to help faculty engage with these rapid changes within the context of their work at a 21st-century university, and thereby benefit their students, their research portfolios, and the broader community. FDI also strives to model active, learner-centered pedagogy in the curriculum it shares with the university community. Thus FDI's objectives are closely aligned with other technology-enriched learning initiatives in the division of Learning Technologies, particularly the Center for Innovation in Learning (CIL), the Graduate Education Development Institute (GEDI), and the ePortfolio initiative.

During the spring and summer of 2013, 493 faculty members participated in short courses and themed tracks associated with receiving a computer and software, and the remainder of our enrollment is the result of other faculty, staff, and graduate student participants seeking new learning opportunities with contemporary technologies. Our curriculum also helped support continued large-scale deployment of Scholar and ePortfolio.

FDI continued to leverage online affordances to increase both ease of access and overall participation in our curriculum. FDI classes were conducted online through Adobe Connect. The use of Adobe Connect, or similar online products, was virtually non-existent with FDI classes two years ago.

Short course breakdown by semester

Term	Total short courses and workshops	Total seats filled	Online courses	Online participants
Fall 2012	316	2200	63	579
Spring 2013	400	2910	100	480
Summer 2013	41	380	9	36
Totals	757	5,490	172	1,095

The FDI staff meets regularly with faculty and deans from all colleges to gather feedback for our program, and participants are asked to provide suggestions for future FDI workshops. This information has enabled us to ensure our offerings continue to stay relevant and timely, allowing us to continue to contribute to the diversification and growth of Virginia Tech's applications of technology in research and instruction. The evolving version of faculty development 2.0 within TLOS, highlighted by the creation of the NLI—Networked Learning Initiatives, will offer the opportunity to take the best of the FDI and weave it into a 'rebooted' version of faculty development opportunities for technology-enhanced active learning in both face-to-face and e-learning settings.

In 2012-2013, FDI partnered with the InnovationSpace and other Learning Technologies groups, as well as with the University Libraries and other units across campus to create a robust and diverse variety of short courses and workshops. Faculty development also occurred in Learning Technologies via a close partnership with the Center for Innovation in Learning (CIL), a unit in Learning Technologies. CIL has continued to thrive. Approximately 60 faculty are now 'graduates' of the CIL's New Media Faculty Staff seminar. The seminar provides faculty, staff, and graduate students the opportunity to explore a brief history of mediated communication and invention from Vannevar Bush to Scott McCloud in a 14-week weekly seminar setting. The CIL's creation of the Distinguished Innovators in Residence (DIRs) brought Dr. Janet Murray to campus this past spring <http://blogs.lt.vt.edu/innovator>. The CIL contributed to the selection process that named two outstanding X-Caliber award winners on behalf of the Provost's office this fall, and awarded five Innovation in Learning grants, enabling the sponsorship of several innovative initiatives in the arena of teaching and learning in three different colleges across the university.

FDI track offerings, 2012-2013

New Faculty: Community and Computing

Completing the Cycle: Developing, Implementing, and Assessing with Electronic Portfolios

Improving Instruction using Scholar

Building, and Conducting Courses in Scholar (An Online Scholar Track)

Improving Instruction using Scholar: Beyond the Basics

Planning, Developing, and Delivering Online Instruction

Improving Online Instruction: Strategies, Pedagogy and Best Practices

New Horizons—Emerging Technologies for Teaching and Learning with Technology
 Mindful Learning: Strategies for Increasing Student Engagement And Student Success
 Digital Citizenship: Cornerstone to Capstone
 From Kindles to Open Access: The New Ecosystem of Digital Publishing
 Community of Practice: Librarians at Virginia Tech
 MATLAB Fundamentals (21-hour online course)
 At-A-Distance Track—Improving Teaching and Learning—Design Your Own Development Experience
 Strategies for Inclusive Teaching and Mentoring
 Statistical Data Exploration, ANOVA, and Regression using JMP
 Advanced Statistics—Design and Analysis of Experiments using JMP
 Geographic Information Systems—Fundamentals, Analysis and Web-based Mapping
 Life Cycle of a Sponsored Project: Research Administration Fundamentals
 Field Trips to the Future
 High-Performance Computing
 Protecting Your University Data: Whether it is Research, Personal or Student Data
 Using the Apple Ecosystem in Higher Education
 Design Your Own Development Experience

Summary of FDI computer distribution, Spring/Summer 2013

	Apple	Dell	Fujitsu	ASUS	Totals	Percentage
Desktops	45	75	0	0	120	24%
Laptops	217	96	0	2	315	64%
Tablets	0	0	57	0	57	12%
Totals	262	171	57	2	492	
Percentage	53%	35%	12%	0%		

FDI has developed solid partnerships across campus and with outside vendors to provide a significant number of workshops that bear no out of pocket costs and fit well into the current scalability of our classroom availability and registration system. Below is a list of the main partnerships in 2012-2013:

Office of Vice-President of Research	Computer Security
University Relations	ARC and Visualization
University Libraries	VT Engage
Institute of Distance and Distributed Learning	Honor Code Committee
VTGIS	College of Engineering IT
LISA	Office of Diversity and Inclusion

Corporate partners include Mathworks, SAS, Comsol, and LabVIEW.

It should also be noted that the vendors who provide computer hardware for FDI all take part in the Hardware Showcase each year. This allows faculty to see the new line of computer options available to them and make a more informed computer selection. Vendors include Dell, Apple, and Fujitsu.

The Graduate Education Development Institute

Engaging graduate student instructors in the process of discovering and defining their pedagogical praxis continues to be an important programmatic focus within Learning Technologies. The partnership between the Graduate School and TLOS will provide new ways to foster connections between pedagogical and curricular redesign across the disciplines. During this past academic year, the Graduate Education Development Institute (GEDI) provided graduate students opportunities to explore technology-enriched active learning. The GEDI program provided professional development curriculum within multidisciplinary learning communities of peer colleagues to complement mentoring offered at the department level.

As part of our ongoing collaborative efforts with the Graduate School, the GEDI Fellows taught over 200 graduate students throughout the fall semester in Phase II workshops for the Graduate School's GTA Orientation course, GRAD 5004, focusing on using Scholar for interactive learning and web tools for time and information management. The Director also co-taught a GTA workshop on ethical dilemmas to 61 students. Over the AY 2012-13, 84 graduate students enrolled in the semester-long, for-credit, graded GEDI graduate seminar, the GRAD 5114 course, "Pedagogical Practices in Contemporary Contexts."

Assessment data for the GEDI pedagogy course indicates that the graduate seminar plays a vital role in the professional development of graduate teaching assistants at Virginia Tech. Most of the graduate students began the course without a clear understanding of how to define problem-based learning for a course they would teach; this year's exit data indicate that 98 percent are now either likely or very likely to incorporate case studies and problem-based learning into their curriculum. And 72 percent indicated a new awareness of and interest in using collaborative 2.0 tools (including those in Scholar) within the courses they teach or will teach. The GEDI participants provided qualitative assessment exit data, and their feedback continues to suggest that the course has a positive impact on their praxis:

"This class has inspired me to be an innovative teacher. At the beginning of the semester when the goal of discovering alternative ways to teach was introduced, I was skeptical because I did not think there was anything wrong with the traditional way of teaching. However, as the semester continued I realized that just because the traditional way worked for me it does not mean it works for today's students. I am eager to implement new teaching strategies in my teaching."

“[t]his course introduced me to a way of teaching that I had never really thought about . . . I have a lot more tools now and new ways of trying to help students learn.”

“I’ve come to understand more fully the challenges (and opportunities) that face us as teachers of the future!”

The reorganization of Learning Technologies into Technology-enhanced Learning and Online Strategies provides opportunities for the programs gathered into the networked pedagogies division to discover new initiatives and partnerships within the unit. In particular, the GEDI program looks forward to networking and collaborating with the NLI and ePortfolio initiatives during the coming academic year.

Integrated Innovation (formerly Services) Group

The Integrated Innovation group, as part of Learning Technologies, includes Assistive Technologies (AT), Computer-Integrated Learning Spaces (CILS), the InnovationSpace (IS), the Office of Technology for the Arts (OTA), Testing and Data Services (TDS), and collaborations with Digital Media Services (DMS).

Assistive Technologies (AT) ensured that students and employees with disabilities had appropriate technologies needed to access programs and services of the university. AT worked for inclusive environments for learning, discovery, and engagement for faculty, students, and university employees grounded in a thorough knowledge of integrating accessible technologies.

Computer Integrated Learning Spaces (CILS) supports learning, research, and outreach through the development and ongoing support of computer hardware and software in over 20 locations on campus maintained by CILS. These labs and classrooms include hardware, software, and maintenance at the Math Emporium, 3 classrooms in Torgersen (1010, 1080, and 3250), 3 classrooms in Shanks (160, 180, and 360), and 9 other labs across campus. CILS also coordinated the ordering and distribution of more than 500 FDI computers. CILS continued to support pay-for-print services and maintenance and support of the President’s Conference Room.

The InnovationSpace advances 21st-century learning environments through three complementary services areas. The first is The Lab @ InnovationSpace, which supports teaching and learning through equipment loans, a multimedia lab, and expert support. The second is through Teaching and Learning @ InnovationSpace, which explores emerging technologies, provides connections for between teaching and technology, consults with faculty on transforming teaching, and pilot tests technologies to support the university’s strategic goals. The third service is the Technology Exploration Lab @ InnovationSpace,

which provides a flexible learning space with emerging technologies for faculty and students to explore collaborative technologies.

The Office of Technology for the Arts (OTA) supports the technology-related needs of the arts at Virginia Tech with special focus since 2009 on the Center for the Arts (CFA) and the Institute for Creativity, Arts, and Technology (ICAT) housed therein. In so doing, OTA helps those organizations to engage Information Technology (as the strategic resource it is) in the fulfillment of their respective missions. Both the 21st century *learning community* (trans-disciplinary, collaborative, holistic, and experiential in nature) and the land grant tradition frame OTA's activities.

Testing and Data Services (TDS) supported the assessment of student learning through the accurate and timely scoring of optical scan forms for all colleges. 2012-13 was a transition year for TDS as the centralized test-scoring operations ended and a new decentralized, self-serve model of test scoring was deployed. Several scanners were purchased for self-scanning throughout campus. Colleges and departments were contacted to determine locations for scanners. A full communication plan was implemented throughout the year to alert faculty and departments to the impending changes. Extensive training was provided and will continue to be provided throughout the upcoming year as needed. TDS will cease operations on August 1, 2013.

Video Broadcast Services was given a new charge in early 2013 with a new name, Digital Media Services (DMS), to reflect a change in the mission and services in support of the University's Plan for a New Horizon. Throughout the spring and summer, DMS transitioned from Network Infrastructure and Services to Learning Technologies.

The work completed during 2012-2013 primarily supports Pillar 1: Enabling a Networked University and Pillar 3: Leveraging Information Technology for a Distinguished Virginia Tech Experience and to a lesser extent Pillars 6 and 7. Additionally, much of the work is directly in support of Strategic Theme 4 in the Information Technology Strategic Plan. The activities included in this report are organized around the pillars with links to the strategic themes as appropriate.

Pillar 1: Enabling a networked university

Contributions to Pillar 1 support the concept of a networked university. In the words of the IT Strategic Plan, "Networked learning recognizes the interconnection of disciplinary expertise, pedagogy, and technology to improve the quality, effectiveness, and efficiency of teaching and learning.: And that "networked learning recognizes both the "physical" and the "virtual" university in that it facilitates in-person and online interaction among faculty, supports teaching and learning in a variety of contexts, and connects faculty and students

with both virtual spaces and physical spaces.” The Integrated Innovation Group contributed to this plan during the year in a variety of ways.

Staff in CILS upgraded more than 250 computers across six classrooms and the Math Emporium, and newly assumed responsibility for 90 public computers in Newman Library and their satellite library locations in Veterinary Medicine and Architecture. In support of SCALE-UP classrooms—Student-Centered Active Learning Environment for Undergraduate Programs—and the associated goal of providing highly collaborative, hands-on, computer-rich, interactive learning environment for large-enrollment courses, CILS consulted with several departments on implementation. These included Newman Library and the Center for the Arts. Classroom supported was further enhanced by collaboration between DMS and IS to create and deliver a pair of networked classrooms. These provide an immersive technology-enhanced learning space in Blacksburg and in northern Virginia that can include remote participants.

Technology for learning environments include DMS and IS evaluating and purchasing a lecture capture system for large scope recording of courses, and a web-conferencing system for enterprise-wide use for teaching, learning, research, and outreach. InnovationSpace staff also developed a partnership with Herman Miller to leverage their Learning Spaces Research Program to conduct research in four learning spaces. Assistive Technologies tested and developed a process for closed-captioning of videos for both teaching and learning and university relations. The group procured emerging technologies for testing and deployment, notably the Beam personal telepresence robot and the Leap motion control. This group also provides enterprise-wide software support for the Apple Developer Program and iTunesU.

The area also provided teaching consultations and support for a variety of technology-enhanced learning activities, including blogs, digital narratives, clickers, web sites, web 2.0 tools, and more.

As Testing and Data Services deployed the new, de-centralized 12 testing-scoring scanners throughout campus noted above, they worked with faculty to rethink assessment. Other redesign includes grants through the 4-VA project for biology and math.

Pillar 3: Leveraging information technology to distinguish the Virginia Tech experience

“The Information Technology organization will partner and lead, as appropriate, with other units at Virginia Tech to distinguish the Virginia Tech experience in both its physical and virtual forms,” indicates this pillar of the IT Strategic Plan. The Integrated Innovation Group contributed over the past year to this pillar through ongoing work.

The Office of Technology for the Arts (OTA) supported the Center for the Arts (CFA) construction through consultation of the technology infrastructure of the new Center for the Arts. This support puts the CFA and the Institute for Creativity, Arts, and Technology (ICAT) in positions second to none to research, and engage in, networked learning for the twenty-first century, particularly given the charge to collaborate directly with K-12 schools, community organizations, and arts venues. OTA also supported and promoted ICAT programming. The ICAT summer “Maker Camp” (piloted locally in 2012) is being expanded for 2013 and delivered simultaneously in Blacksburg and Martinsville, Virginia. Virginia Tech faculty and staff are on site at both locations joined by two-way audio/video. Thus, K-12 “campers” in Martinsville are affiliated with Virginia Tech as they begin to build or expand personal portfolios

CILS developed and began test deployment of a wireless display and presentation system using inexpensive components. Randolph Hall is the site for a newly installed large screen display and AppleTV for wireless collaboration.

Assistive Technology provided full Braille services for course materials, class notes, quizzes, tests, lab manuals, and exams and textbooks for physics, mathematics, astronomy, and other science courses.

A pilot program for eTextbooks included free textbooks for students, while InnovationSpace staff undertook extensive data collection on the experience. Additional work of IS included discussions with the library on the new learning space design and functionality, consulting on learning space design, and partnered with faculty to develop and deliver technology-enhanced activities for active and engaged learning.

Pillar 6: Improving communications with customers and partners

As new – and existing – services are put in place, the group made particular efforts to communicate with customers and partners. We developed and executed a marketing plan for a newly deployed site-license of lynda.com; we promoted the iLearn student workshops for technology-enhanced learning; and we publicized the availability of technology equipment loans for classes, presentations, and conferences.

Pillar 7: Strengthening the Information Technology organization

The staff engaged in activities to support technical training and professional development of information technology staff both within the IT organization and beyond. Promoting the use of iPads and Notability to supplant the paper inventory and surplus forms can enhance productivity without significant external costs. Training and tutorials provided by

Lynda.com includes technical training for the entire university. We also worked to provide access to EDUCAUSE and ELIG webinars for IT personnel.

Internally, we deployed LabStats software to collect baseline data on software and hardware usage. And by ceasing the operations of TDS, we enable the reallocation of human and fiscal resources for technology-enhanced teaching and learning projects

Additional outreach and service

Outreach and service of the group include the activities below:

- Maintained/fostered relationship with the Boys & Girls Club of the Blue Ridge leading to the remote Maker Camp (above)
- Blacksburg Electronic Village (ex-officio member)
- Blacksburg Partnership Collaboration for the Arts (member)
- Blacksburg Museum (consultant on technology infrastructure)
- Consulted with various university and community college systems on the development of Math Emporium style spaces.
- Upward Bound and Institute for Government and Policy Digital Storytelling Workshops

Goals for 2013-2014

The goals for the coming year include the items below:

- Complete construction, commissioning, and shepherd the technology punch list and revision requests through the first full year of building occupancy. (OTA)
- Solve the problem of open-access public wireless service in the Center for the Arts. (OTA)
- Strengthen the relationship between IT and CFA/ICAT, in the context of the university strategic plan, via joint project and activities. (OTA)
- Link CFA/ICAT programs to at least one K-12 or arts partner in at least three of the following areas of the commonwealth: Southside, Southwest, NCR, Tidewater. (OTA)
- Identify and implement a recurring arts-related use of Telepresence or similar technology at the university level. (OTA, IS)
- Get CFA contracts with artists to include options to
 - stream performances via the network to “affiliated” venues;
 - include remote sites in master classes and workshops via 2-way audio/video via the network
- use the artists VT materials for education purposes with charge (OTA, DMS)

- Collect and evaluate baseline data on hardware and software usage for all machines managed by CILS
- Develop and actively promote Assistive Technologies' services related to universal design of course materials and
- Explore the virtualization of Assistive Technologies' software for access by any university faculty, staff, or student.
- Create and execute a plan for digital media production that partners Digital Media Services, the InnovationSpace, Assistive Technologies, the Networked Learning Initiative, and the Instructional Design groups for the development of high quality, interactive media.
- Evaluate technologies and plan for the delivery of instruction to the device or asynchronous delivery of course materials.
- Implement a rapid testing and deployment group called Tech Teams that is comprised of faculty, staff and students to examine emerging technologies for teaching and learning. Actively promote and publish the results of this group to the university and beyond.
- Implement a grant program that leverages 4-VA funding and priorities to promote course redesign focused on technology-enhanced learning.

Development and operations

The operations teams within Learning Technologies provide production support, documentation, quality assurance, maintenance, and application development for several enterprise-level systems. Those managed by Online Learning and Collaboration Services (OLCS) are Scholar, including ePortfolios and our SPOT survey system; the FDI tracking system; Lynda.com; and WordPress. Together the development and systems administration teams that work on these systems provide practical and innovative technologies for university-wide use.

Major systems supported

The operations teams are responsible for several significant production systems described below. For general information on the two operations teams noted above see www.olcs.lt.vt.edu and www.emd.vt.edu.

Course evaluation data mart. This data mart, managed by the Information Warehousing and Access (IWA), is the first Virginia Tech data warehouse to use open-source JasperSoft software for reporting. It works as part of our end-to-end solution for SPOT surveys (see Scholar SPOT Survey System below and <https://webapps.es.vt.edu/jasper/login.html>).

Discovery Commons Research Repository. Discovery Commons is available as a permanent location for hosting and preserving collections associated with research and providing myriad levels of access to those university assets. The repository is hosted by the Database and Application Administration unit and managed by Document Management Systems in the University's Information Technology Enterprise Systems group. Enterprise Systems provides server support for data integrity and security, with storage and backup provided by Network Infrastructure and Services. The repository application consists of VITAL, the institutional repository solution designed by VTLS, Inc., and built on Fedora Commons Repository Software, an open source solution for the development of digital object repositories. (<https://dcr.emd.vt.edu>).

FDI tracking system. The tracking system is used to manage program participant activity, workshop registration, web pages, and computer selection, delivery and inventory.

Lynda.com. This suite of online e-learning courses is available for use by university faculty, staff, and students for professional development and regular coursework. (<https://www.lynda.com>)

Scholar. This course management system is based upon the open source Sakai Project (www.sakaiproject.org), a project started in 2004 and used by hundreds of universities worldwide. We are active members of the open-source community that maintains Sakai, participating in conferences and development activities year-round. Scholar is an integrated system made up of many tools that combine to support learning, teaching, and collaboration for faculty and students. ePortfolio tools are part of the Scholar system. (<https://scholar.vt.edu>)

Scholar SPOT Survey System. This tool facilitates administration of end-of-semester course evaluations. It is based upon a Sakai tool named the "Evaluation System" and has modest adoption by the open source community, with active development by approximately 10 universities. (<https://eval.scholar.vt.edu>)

WordPress. WordPress provides a blogging platform for faculty, staff, and students. Our enterprise instance is hosted offsite by a company named ZippyKid. (<https://blogs.lt.vt.edu>)

Key initiatives completed (OLCS along with LT Systems and Development teams)

Each of the systems required work by the operations teams this year. The most critical initiatives are highlighted below.

Scholar. We upgraded Scholar from version 2.8.1 to 2.9.1 in May 2013, introducing several hundred bug fixes, enhancements, and performance improvements, along with a few new

tools. Notably, we added a Lessons tool and substantially upgraded the main interface. For more details, see <http://help.scholar.vt.edu/Upgrade/index.html>

WordPress. A production level instance of WordPress was used for the second straight year. A yearlong contract extension (with options for renewal) was signed with our outsourced hosting company of this service. We grew to 6,000+ users of the platform in year two with more growth on the horizon.

Lynda.com. This new service was launched in the summer of 2012 to replace the dated ElementK. Feedback on friendliness of the platform and usefulness of the courses has been quite strong.

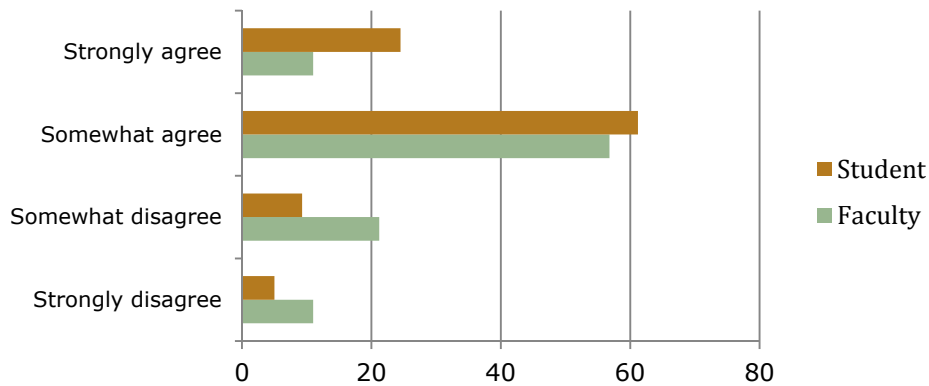
Scholar SPOT Survey System. In partnership with the Office of Academic Assessment, we continued operation of this system, university-wide. We grew from two colleges hundreds of courses in 2011 to running this for the entire university in spring of 2012 (over 4500 courses and 85,000+ responses from students).

Support of departmental goals (OLCS along with LT Systems and Development teams)

Our operations teams strive for continuous improvement, taking input from those who use these technologies. A Scholar advisory board was continued this year, which includes representatives from all colleges and other major Scholar user groups (like VTTI and VCOM) to provide for ongoing discussion about what is working and not working with the system. Regular self-assessment and outside assessment of our offerings allows us to learn, grow, and improve regularly. Furthermore, such feedback helps us prepare for future maintenance releases and larger upgrades. In the spring of 2013, a comprehensive survey was run asking students and faculty about their use of Learning Technologies services. Selected details are below.

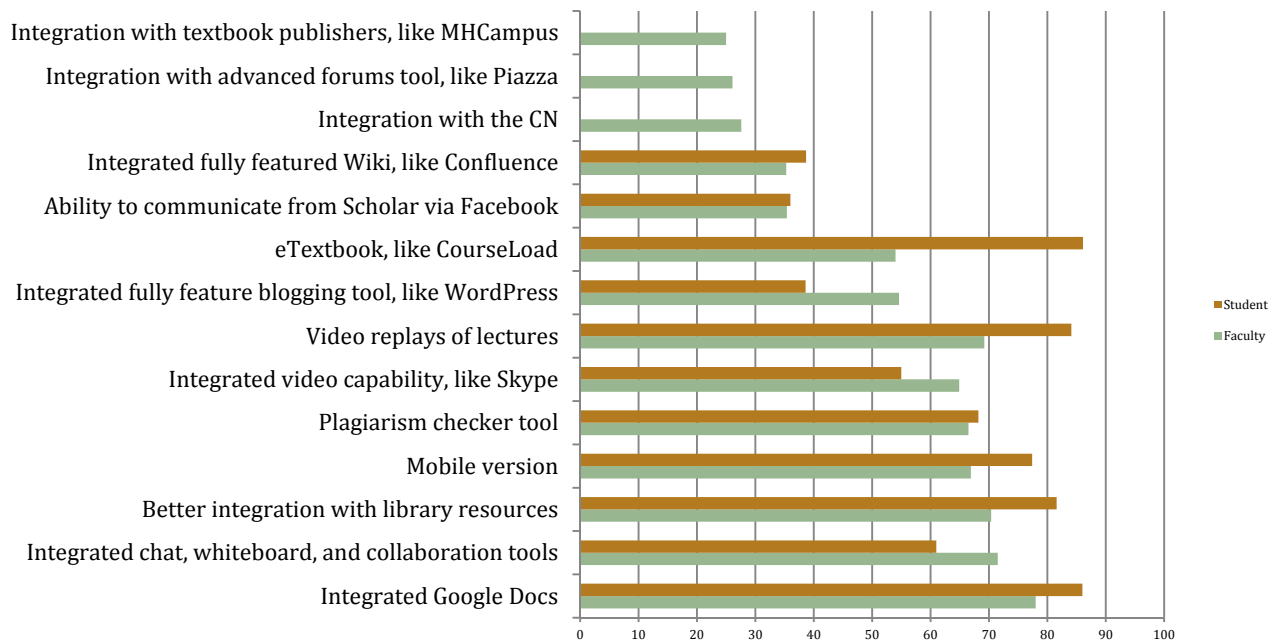
The SPOT system generally gets high marks from students and faculty, with 85% of students and 68% of faculty agreeing that the process is valuable.

To what extent do you agree that the SPOT Survey system allows you to gain valuable insights into your teaching? Is it a good way to provide valuable feedback to your instructors?

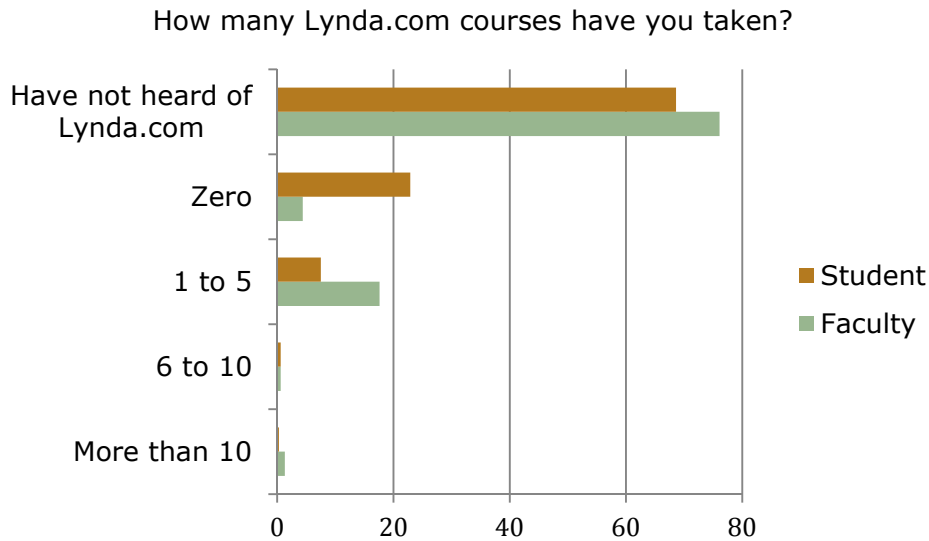


Interest in adding new technologies to Scholar is a focus of our team with Google integration and collaborative tools at the top of the faculty interest list. Student interest in eTextbooks and video replays of lectures are services targeted for implementation during 2013-14. Faculty and student responses to the question about integrations are relatively consistent and will help guide us in future development activities for Scholar.

Percent interested in using each of the Scholar capabilities if they were made available in the future



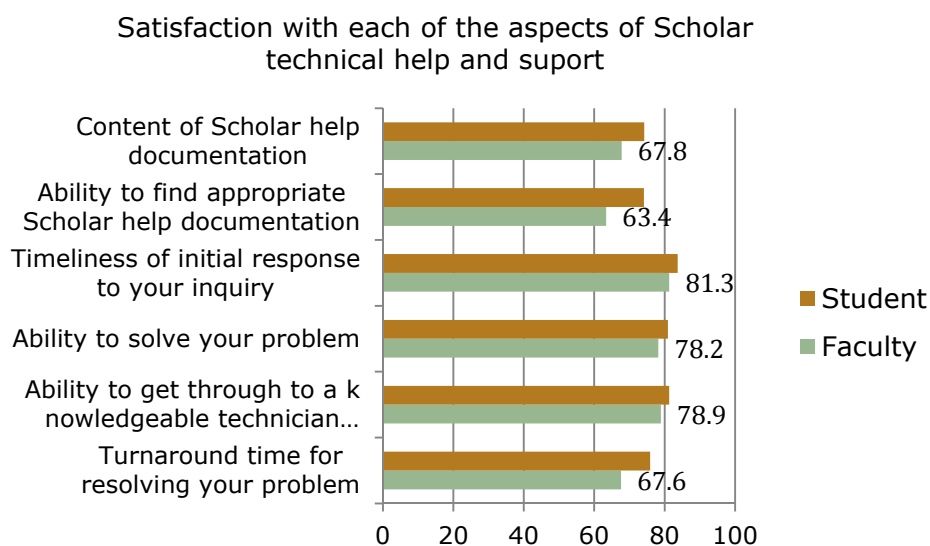
While Lynda.com has been available for more than a year now, clearly there is still some room to grow in terms of campus penetration (marketing) and knowledge of the offering. Most faculty and students surveyed did not even know this service existed.



Learning Technologies' application development and systems support teams provide the technical capabilities to enhance, maintain, and scale-up our systems. The Scholar/Sakai platform has been the focus of these teams. OLCS continues to build up our expertise in quality assurance, improving our skills in this domain to ensure high quality Scholar releases. Responding to trouble tickets opened by faculty and students remains another important function of OLCS. One measure of our success regarding trouble tickets is driving volume down, while providing a high level of customer service, accomplished by providing better tools (fewer bugs, more intuitive) and better proactive support upfront through discussions and FDI training. The table below shows how a concerted effort to provide more help documentation, better FAQs, and more targeted training has driven the overall ticket volume down year over year, while also illustrating that 4help is closing more tickets now than in the past. By arming 4help with better information, they are better able to quickly respond to customer needs. There is a limit to how much this can improve, so we do not expect the ticket counts to keep dropping year over year, but this is great progress over the 5 years of data reported (2011 to 2012 shows a 27% drop and 2012 to 2013 an 13% decrease).

FY	# closed by OLCS	# closed by 4help	Total	% completed by 4help	Notes
2009	4225	Not available	Not available	Not available	Running Blackboard and Scholar
2010	3458	Not available	Not available	Not available	Running Blackboard and Scholar
2011	2116	1949	4065	48%	Blackboard turned off Dec 2010
2012	1560	1400	2960	47%	Scholar only
2013	1095	1490	2585	58%	Scholar, SPOT, and WordPress

Coupled with the raw numbers above in terms of the ticket counts, satisfaction with Scholar help and documentation is strong, as evidenced by this data from the survey:



Finally, we have continued relationships with other universities around the globe that use Sakai as their main learning management system—critically important relationships when running community/open-source software.

Digital Imaging and Archiving and Discovery Commons

Digital Imaging and Archiving serves as a primary university resource for converting traditional analog materials to digital formats used in classroom presentations, online instruction, and research collection building. Services range in scope based on scheduling and academic need with the current focus on creating access in a repository setting.

The Discovery Commons Repository Initiative (www.emd.vt.edu) managed by the Digital Imaging and Archiving group, provides university-wide services for the development, distribution, and stewardship of academic related digital assets. A public access repository

since March 2011, Discovery Commons also provides comprehensive support for academic research projects based on proposals received by individual faculty, departments, and colleges located on the main campus of Virginia Tech.

The repository application is hosted by the Database and Application Administration unit and operated by Document Management Systems, both groups in Enterprise Systems. The repository application consists of VITAL, the institutional repository solution designed by VTLS and built on Fedora™, an open source solution for the development of digital object repositories. Site development and content acquisition is managed through the repository-working group, Digital Imaging and Archiving.

Our role as a state supported agency provides opportunities for extending our services beyond the boundaries of the campus to include other state institutions. This outreach component maximizes the investment of state supported infrastructure while serving all citizens of the Commonwealth of Virginia.

Academic support goals

Support for enhancement of classroom and online education is a primary function associated with why repositories exist. As a result, each repository site is designed with the goal of creating opportunities for online discovery and access that compliment classroom activities.

Because repositories are intended to remain available indefinitely, access to information allows users to continue learning well past the schedule for university courses, making it possible for content gathered by one generation to remain available to future generations long after the original deposit of the information. This role of repositories is the basis for the goals we set during the fiscal year:

- To increase access to digital materials represented by research while adding value to those materials as discovery resources by taking the concept of "access" beyond the characteristics of "locatable" and "reachable" to include "approachable" and "navigable" for potential learners
- To assist departments and faculty in developing mechanisms that simplify data entry while incorporating validation formulas for consistent content tagging
- To introduce a high-level preservation component to our service lineup for digital archiving guided by elements of data redundancy and security for master file storage

Project development

To track progress toward completion of repository projects, a checklist mechanism was developed to monitor the specific steps required for project development (as shown below).

The numbered list represents a process for identifying and mapping the stages of project building from initial concept to publication, while also allowing us a means of calculating the percentage of completion. Each project is then measured on this scale and the progress made during the year is discussed in the following pages.

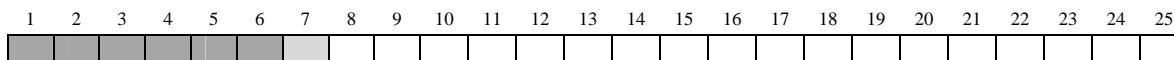
Repository development—project tracking

VITAL DEVELOPMENT				REPOSITORY PREPARATION			
1)	Site design and storyboard development based on Proposal specifications	8)	Changes to site design (in Prototype) made based on sponsor input	14)	Develop site is reviewed and compared to sponsor approved Prototype site	20)	Additional site modifications are made per Sponsor request, and verified
2)	Development of Dublin Core metadata and subject keyword descriptors	9)	With approval, new site is added to Develop instance of VITAL for testing	15)	With approval, new site is added to Preview, verified, and tested	21)	Repository Project is approved. Preservation requirements are defined
3)	VITAL content model development and Integration with existing Prototype sites	10)	Batch loading scripts developed, metadata spreadsheets developed	16)	Access guidelines are implemented and tested (download restrictions, etc.)	22)	With approval, new site is added to Discovery Commons, and verified
4)	Extensive testing and adjustments to new site design with sample loading	11)	No further action taken until client file samples and metadata are received	17)	Sample files and metadata are loaded, Preview site review is conducted	23)	All available files and metadata are loaded
5)	New Prototype site is ready for sponsor review (scheduled for meeting)	12)	Upon receipt of file samples and metadata, batch testing is initiated	18)	Sponsor is notified that Preview site is available for evaluation by associates	24)	Sponsor makes commitment to submit collection materials and metadata
6)	Project site (in Prototype) is reviewed and discussed with the site sponsor	13)	Batch loading script is verified for site requirements, files and metadata	19)	Site evaluation by sponsor and associates is completed	25)	Project is complete
7)	Delivery of collection samples and metadata (Sponsor Commitment)						

Hospital Patient Medical Records. This collection represents the patient records generated at the Virginia-Maryland Regional College of Veterinary Medicine teaching hospital. Beginning

with the very first patient, these records demonstrate the history and evolution of patient care over time for animals treated at the hospital and for diagnosis and treatments prescribed based on symptoms and observations. In many cases these records outline methods that eventually assisted with the identification of animal disease and other species related disorders. The need to preserve these case studies is especially significant to retrospective research and other valuable research originating from the Veterinary Medicine Teaching Hospital.

Hospital Patient Records | step 7: awaiting metadata primary field definitions



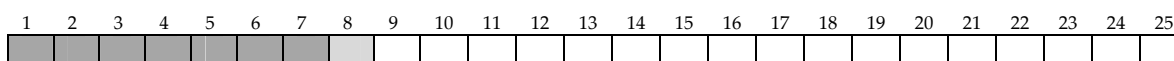
53,564 pages, representing 788 patient folders for the past fiscal year

160,592 pages, representing 2573 patient folders for the project to date

Kenyan Law Archive. The Kenyan Law Archive represents three elements of the laws and regulations associated with the Republic of Kenya. The law volumes represent the published laws as passed by the Kenyan General Assembly. The Hansard publications describe the government debates in the Assembly where aspects of the legal code were debated and approved. And finally, the Gazettes provide a record of local proceedings where the laws are applied to individual cases in and around the Nairobi region of Kenya. Together, these documents illustrate the growth of this independent country as it moved away from British control as a colony. This project is sponsored through the History Department, the government offices of Kenya, and Brett Shadle, associate professor, Department of History.

The first phase of this project involves moving the Gazettes into the repository with structured metadata and indexing appropriate for faculty and student discovery.

Kenyan Law Archive | step 8: awaiting metadata for final approval



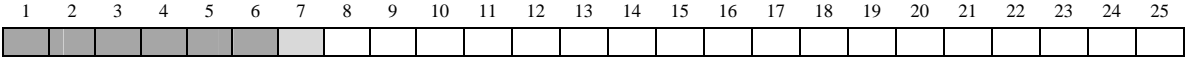
5,200 documents, representing publications dating from 1907–2013

metadata entry was started in April for these documents (two graduate assistants, Department of History)

SCS and Agricultural Engineering historic photographs. This collection represents materials associated with watershed studies or erosion studies conducted by the Federal Government's Soil and Conservation Service from the 1940s through the 1960's. The photos are important as historical archives for Virginia Tech in general, but also serve as important resources for research conducted in Biological Systems Engineering for watershed management and best management practices. Many of the photos contribute directly to

studies that investigate the impact of climate change when paired with new data records generated by ongoing experiments. The need to preserve the watershed photos is especially significant to retrospective research and other associated research originating from Biological Systems Engineering. To date 40 boxes of images have been identified as part of this collection.

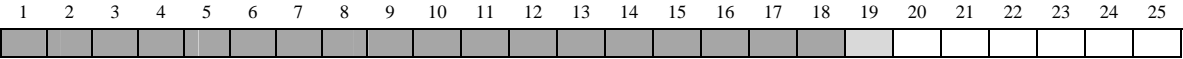
BSE Agricultural Engineering Historic Imagery | step 7: awaiting metadata refinements



668 images, representing three completed boxes for the past fiscal year
3,392 pages, representing 25 annual reports and other documents

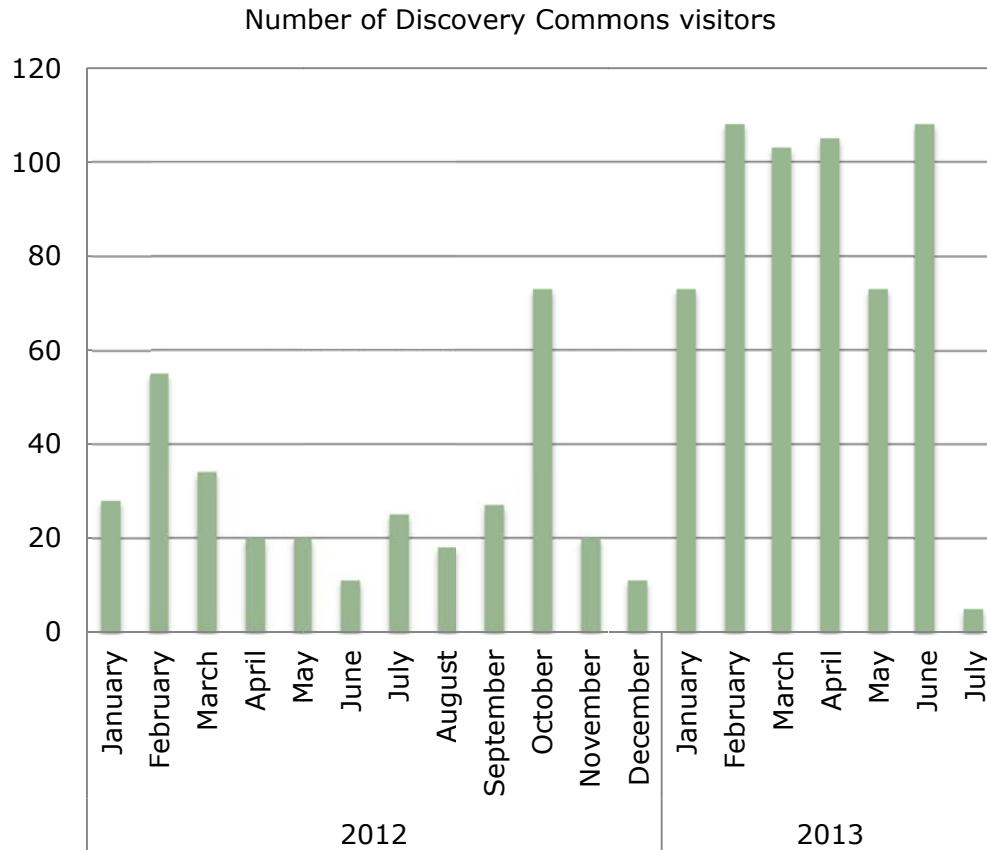
The Athletics Collection. This collection represents a history of the student athletes who have participated in National Collegiate Athletic Association sponsored events while attending Virginia Tech. The materials presented form a record of interest for media, faculty, alumni, and fund-raisers engaging in historical research for a variety of reasons. Expected to grow over time to house as many as 100,000 images of student athletes, this archive describes events that provided opportunities to enhance the overall Virginia Tech experience for the student athletes as well as the extended university community at large. Participation, along with graduation dates, major, and distinguishing awards are highlighted as part of this record with new students added over time as their eligibility expires.

Athletic History | step 19: awaiting final repository approval



8,000 images, originally scanned in 2003
metadata is available awaiting administrative approval for access permissions

Usage of the Discovery Commons repository continues to increase as indicated below for the existing American Civil War Newspapers project.



Digital archiving. The purpose of preservation storage, sometimes referred to as a “dark archive,” is to function as a repository for information that can be used as a failsafe during disaster recovery. This storage is represented by the master files associated with archiving imaging projects along with metadata that describe the technical aspects for creating each digital representation. In addition, checksum values for each archival master file are also created to track bit data integrity for the files as they are deposited. These checksums are then randomly verified over the life of the file storage.

Access to preservation storage is completely restricted and limited to a small set of individuals who serve as administrators for the storage. This security is a vital component for maintaining and archiving valuable digital assets.

At the conclusion of the 2012-2013 fiscal year, approximately 1.4 Terabytes of data had been deposited to permanent storage representing twenty projects completed during the 2002-2004 timeframe. Preservation transfers will continue into the next year with the goal of completing all legacy project transfers prior to the end of 2014.

Collections designated for archiving only are represented by the following selected projects:

VT Motorsports Formula SAE vehicle research. Formula SAE conceives, designs, and manufactures a Formula style race vehicle as part of a hands-on research project guided by Dr. Bob West, associate professor, Mechanical Engineering. The restrictions on the car frame and engine are limited so that the knowledge, creativity, and imagination of the students are challenged. The cars are built with a team effort over a period of about one year and are taken to the annual competition for judging and comparison with approximately 130 other vehicles from colleges and universities throughout the world. The result offers student engineers a meaningful engineering project as well as a real life learning opportunity of working in a dedicated team effort. Several vehicle part models were scanned for use in digital simulation and computer-aided manufacturing. These included the following:

- 3D scanning of customized formed grips for improving Formula car steering.
- 3D scanning of a shift-drum that remaps shift sequencing from first to neutral.
- 3D scanning of a valve cover to improve electronic fuel injection systems.

The Marshall Plan Volume. The Marshall Plan Volume is a unique compendium of the official government records of the public laws and reports authorizing programs and appropriations as well as hearings and congressional testimonies that established the European Recovery Act (ERA or Marshall Plan). This 16-section volume of approximately 3400 pages is the only known copy in existence, making this historic artifact a significant holding within the Commonwealth of Virginia. The volume was assembled under the direction of Richmond, Virginia Third District Representative J. Vaughan Gary and printed by the U.S. Government Printing Office in 1967, a year later it was donated to the Marshall Foundation Archives.

The Marshall Plan, assembled by the Honorable J. Vaughan Gary, House of Representatives, U.S. Government Printing Office, 1967. First Impression.

Aerial photography of the New River Valley. This project involves the digitization of historical aerial photographs of southwestern Virginia in order to make them publicly accessible to students, scholars, and citizen scientists from around the world for use in research and instruction. In its digital form, the collection will be useful for several research communities including natural resources, landscape architecture, urban planning, and others. Students on campus use the physical collection for instructional purposes. In some cases, students have marked the originals. The library would like to put them online so that a) more students can concurrently use the collection without further physical degradation, b) they can remove the physical materials from the library floor and use the space for other purposes, and c) they can allow the GIS community on campus to employ the content in a variety of applications. Developers, and other representatives from the library met with faculty representatives from multiple departments and discussed digitization of the library's geospatial materials to confirm that this would be a useful service for current students and faculty with rich potential for re-purposing in future projects.

50 images, representing 10% of the total collection

William F. Friedman cryptology papers. William F. Friedman is America's greatest cryptanalyst and wrote 23 papers on cryptology collectively known as the "Riverbank publications." Prior to World War II a team led by Friedman deciphered the Japanese code used to encrypt Japanese diplomatic traffic, which directly contributed to our success in the Pacific Theatre during World War II. The Marshall Foundation in Lexington, Virginia holds the materials associated with the Friedman personal collection. This project is designated as part of a larger project and collaboration between the Marshall Foundation; Virginia Tech; the Virginia Military Institute, Folger Library; the University of Pennsylvania; and, the New York Public Library. The digitization schedule is ongoing and represented here by the first three volumes that were scanned during the past fiscal year.

The Shakespearian Ciphers Examined by William F. and Elizabeth S. Friedman, Cambridge University Press, 1957. Second Impression.

Methods for the Solution of Ciphers, Publication, 15-22 Incl., Riverbank Laboratories, Department of Ciphers, Riverback-Geneva, IL.

The American Black Chamber by Herbert O. Yardley, The Bobbs-Merrill Company, 1931. First Edition.

Production achievements. The Discovery Commons Repository VITAL software went through a major upgrade this fiscal year to incorporate enhancements and add functions to address issues that we discovered during our efforts in the previous year. Implementing the new version of the software consumed many hours of staff time in migrating content, working through bugs in the new version, and modifying our existing sites and prototypes to incorporate changes to the software.

A total of 66,023 unique scans were also processed over the past year. Each image was formatted for archiving and preservation either in TIFF or JP2 format. Many of these images were re-purposed as surrogate files for presentation in the repository with those images forming the basis for adding three new projects to the repository scheduled to become accessible this fall with the upgrade to VITAL 6.1 in October.

Goals for 2013-2014

Support for enhancement of classroom and online education will increase as we move forward into the next fiscal year. This challenge provides us with multiple opportunities to expand our collaboration efforts within Technology-enhanced Learning and Online Strategies, and to address specific areas of the Information Technology Strategic Plan, especially those outlined as part of Enabling Networked Learning in the Networked University. While we continue to support faculty proposals on projects that require

repository solutions, our expanded focus for support of course archiving will enhance exposure for Discovery Commons and the projects we support for providing online discovery and access to collections of significant academic value.

Looking ahead we plan to:

- add a course archive repository site where selected course materials will be archived for access by students and faculty as supplemental resources for teaching and learning;
- complete the transfer of existing archival master files to preservation storage;
- expand the scope of the repository to further increase collaborative site development;
- explore capabilities for adding video streaming as an integrated component for sharing repository hosted information.

Network Infrastructure and Services

Network Infrastructure and Services (NI&S) administers information technology infrastructure and related services. The organization operates highly available, reliable, and secure networks and computing systems, and provides assistance and support in using information technology services. NI&S researches, tests, and advances emerging technology, and works to disseminate that information to the university community.

The Technical Operations group in NI&S provides leadership for planning and investment in technologies of tomorrow while operating and maintaining those of today. The group includes Applications Engineering, Network Engineering, Field Engineering, Facilities Management, and Video/Broadcast Services.

Business Technologies includes Fiscal Management, Human Resources and Safety, Business Services, 4Help, the CNS Warehouse team, and Process and Compliance Management.

Infrastructure and Application Development (IAD) includes the Application Development, Infrastructure and Service Development, the Wide Area Networking support group, Research and Development, and the Emerging Technologies group. IAD is responsible for planning and designing Virginia Tech's next-generation communications solutions.

NI&S further includes the newly formed Client Services, and Quality Assurance groups, and the Strategic Initiatives team, which help Virginia Tech play a vital regional and national role in networking projects. Systems Support, made up of the E-Communications/Windows Administration Services team, the Storage Management Team, and the UNIX Administration Services team, and the E-Discovery and Data Center groups round out the units working to maintain the advanced network and computing services needed by the university.

Highlights

Unified Communications (UC) began in December 2012 as a comprehensive upgrade to improve the quality of communications services. The program provides faculty and staff with modern telephone, unified messaging, contact center, conferencing, mobility, and collaboration services. During the year, 54 buildings on the Blacksburg campus along with the Alexandria and Falls Church locations were migrated to the new system, or nearly one-third of the intended service migrations anticipated for the program. In addition, work to re-cable buildings for the UC effort, building and outfitting some new equipment rooms, and

upgrading the campus wireless network proceeded in conjunction with the primary UC work. The effort is a significant project that engages all faculty-staff employees.

VT Google Apps is another effort that engaged not only all faculty and staff, but also students. By moving to Google, the university gains larger mail store for each person, along with access to calendaring, and other Google tools. Open enrollment began June 2012, and mandatory transitioning began in October. Over 60,000 accounts were migrated from university-run services to this outsourced system, allowing the decommissioning of local equipment.

BlueRidge Computer Cluster is the latest and fastest supercomputer, released in 2013 for general research use. NI&S collaborates with the Advanced Research Computing group to administer and promote supercomputing. Blue Ridge is a 318-node Appro GreenBlade cluster.

Projects

Unified Communications

Network Infrastructure and Services (NI&S) began implementation in December 2012 of the Unified Communications (UC) program as part of a comprehensive, technology upgrade initiative to improve the quality of the communications services offered to the university community. The program will provide Virginia Tech's faculty, staff, and students with modern telephone, unified messaging, contact center, conferencing, mobility, and collaboration services. Combined with related projects to upgrade the data network and communications cabling infrastructure, UC will provide Virginia Tech with advanced communications capabilities essential to supporting its research, instruction, outreach, administrative, and public safety activities. Follow are highlights of the array of areas undergoing updates and upgrades.

UC service migration. The effort to bring Unified Communications (UC) to Virginia Tech has gained momentum over the last twelve months. Tremendous progress in facility infrastructure development, cable infrastructure improvement and electronics upgrades has facilitated an aggressive migration strategy. We began "rolling migrations" in which we re-cable, install phones and activate service all in one operation, instead of one team re-cabling and another team later placing the phones and activating the service. The installation teams, with stakeholder input, continue to modify and streamline their processes, and customer satisfaction with the project affirms the success of the process improvements.

The Unified Communications team has successfully migrated services from the Rolm telephone system to UC services in 54 buildings on the main campus of Virginia Tech and both the Alexandria and Falls Church locations in the National Capital Region. More than 3700 communications services have been migrated which includes approximately 500 analog services and 250 digital services, in addition to the voice-over-IP services.

University core and border network service. Multiple NI&S engineering teams have collaborated with several vendors to identify the most appropriate design for a next generation core and border network. During the evaluation phase, teams conducted site visits at vendor labs, collaboration exercise and performed tests on all proposed devices. It was determined that the Juniper platform will best support the university's current and future needs. Equipment was ordered in April, while planning, testing, and refinement of the implementation strategy proceeded. Deployment of the next generation core and border is planned for the third quarter of calendar year 2013.

SIP trunking. The session initiation protocol (SIP) trunking initiative is a key component of the UC project. The project has provided Virginia Tech with the more flexible and cost-effective connectivity to both the ROLM telephone system and the new unified communications system.

SIP trunking services utilize Internet protocol (IP) technology to provide additional flexibility for adjusting the number of concurrent telephone calls that can be delivered over the facilities. The ability to quickly expand and contract the size of the SIP trunk group without adding or removing physical circuits will allow NI&S to respond to seasonal or event-driven changes in demand for trunking resources. The SIP services also provide a high level of redundancy and geo-diversity.

The migration to SIP trunking from Verizon to Level 3 has also lowered the costs associated with delivering direct-dialed, domestic, long distance service. The cost savings and simplified billing have been passed along to the university's departmental customers, who now receive unlimited direct-dial long-distance as part of their voice service subscription. Additionally, the per-minute rates associated with direct-dialed calls to most international locations have been reduced.

UC cabling upgrades. In support of the Unified Communications program, Field Engineering upgraded telecommunications station cabling in 15 "Class B" campus buildings to Category 6 cabling. While Class B buildings have adequate telecommunications rooms, preempting the need for room construction, new cable pathway construction was required in many of these buildings. In total, over 1800 new station cables were installed during the year, requiring over 50 miles of station cabling. Station cables connect telecommunications equipment from the nearest telecommunications utility room to the telecommunication portal in the wall near an individual's telephone and/or computer. New copper and fiber

telecommunications riser cables were also installed in many of these buildings. Riser cables interconnect the telecommunications utility rooms within a given building.

UC network equipment. The Network Operations team’s charter is to maintain and continuously improve and expand services provided through Virginia Tech’s data network. Network equipment has been upgraded in 77 university buildings on and off campus. Networks have been fully replaced or reconfigured in 72 buildings. The upgrade incorporated 126 new devices and improved the capabilities of over 3,240 user interfaces required to support the university’s transition to Unified Communications services. The end state for each building’s upgrade will be increased bandwidth, power-over-Ethernet services and improved redundancy.

UC Facilities. Facilities Engineering designs, builds, and maintains the telecommunications rooms and associated electrical and mechanical systems required to support the university’s network infrastructure. Over the reporting period, new racks, power, grounding, and cable management switch centers were installed or updated. To facilitate communication, planning, and tracking of unified communications, network infrastructure, and cabling system upgrades, all university buildings were classified based on the state of the existing building infrastructure:

- A. Requires network equipment update and verification of electrical power service requirement
- B. “A requirements” plus updated cable pathways and cabling
- C. “A and B requirements” plus updated or new telecommunications closet(s)

Updates to enable operation of Vo IP telephone service were completed for the several buildings this year.

Pathway/electrical upgrades for Class A and B buildings	Room/pathway construction for Class C buildings
Health and Safety Grounds	Smyth Hall—95% completed Whittemore Hall—requested design drawings from Architecture and Engineering for two telecommunications rooms
Media Media Annex Wallace Annex Burchard Hall Parking Services	Randolph Hall—completed

UC Applications. The UC Applications project is part of a comprehensive, technology reinvestment initiative that is providing Virginia Tech with high-quality communications services. UC is not a specific product or technology. Rather, it is a vision for integrating

multiple communications applications and modalities to drive improvements in productivity and efficiency and to better enable innovation and collaboration.

The scope of the UC project includes the main campus and satellite office locations in the Town of Blacksburg and the National Capital Region. The UC Applications project will provide Virginia Tech's faculty and staff with current-generation telephone, unified messaging, contact center, conferencing, mobility, and collaboration services.

NI&S is in the process of migrating users to the new UC system, with approximately 3025 phones converted during the reporting period. The National Capital Region, satellite office locations in the Town of Blacksburg and 40 buildings on the Blacksburg campus have been migrated. The telephony services where migrations are complete include the new Avaya technology and unified messaging service. New call center technology has also been implemented in many of these locations.

For more information on the UC topics above, contact John Pollard, jpollard@vt.edu

UC business model. A new service model was implemented on July 1, 2012, that reduced the total number of communications services in the NI&S portfolio from over 100 to approximately 20. This model is not only strategically aligned with the university mission, but it also promotes fiscal responsibility while facilitating the full realization of the technology investment. University affiliates have the opportunity to subscribe to essential communications services that include wired, wireless, and remote access to the Virginia Tech data network, in addition to unified communication (UC) voice service with unified messaging.

Additional changes to the model provided significant cost savings to departments through the elimination of charges for direct-dialed domestic long-distance calls and reduced costs for international long-distance dialing to most countries.

A multi-functional team continues to meet to refine the service model, as needed. This team also reviews and modifies the business rules for UC services in order to best meet the needs of the university community.

UC training. A course to train employees how to use Unified Communications services was developed in January 2013. University Computing Support (UCS) consultants adapted the in-class training materials to the university's online course system, Scholar, to support university employees unable to attend a classroom session, as well as those wanting to review in-class materials on their own. The course materials instruct employees about features of the commonly deployed Avaya 9611g VoIP phone.

UCS, in collaboration with other NI&S staff, developed and continues to maintain the Unified Communications Scholar site, which offers clear and concise information using text, images, and video. The site is updated as new phone features or services become available, so trainees have a single reference available at any time, to study basic and intermediate features of the phone service.

For more information on the above, contact Pat Rodgers, prodgers@vt.edu

Wireless network services

Vawter Hall Data Communications Pilot. Student Programs and Network Infrastructure and Services (NI&S) collaborated on the pilot deployment of an integrated wired and wireless data network system in the southern wings of Vawter Hall replacing the traditional 2 data and 1 analog phone jack. The new system provided the following services in each residence:

- 4 FastEthernet (100Mbps) wired data ports
- 1 Rolm telephone connection
- 802.11 a/b/g/n service in 2.4 and 5 GHz frequency bands

The underlying technologies involved in this pilot were recent developments and this deployment was an evaluation of the system as a whole. As such NI&S Research and Development worked closely with the equipment vendor to incorporate enhancements and improvements for a residential deployment. A number of these suggested improvements were implemented by the vendor in the summer of 2013 and resulted in an extension of the pilot for another academic year.

A survey of the residents confirmed positive assessments of the service and indicated a trend away from wired connections to wireless. Over 51% of respondents regularly used two Wi-Fi capable devices and 27% used three or more.

Wireless network enhancements. The demand and expectations for wireless services on campus continues to increase at a high rate. The peak number of devices seen on the network has increased by 250% over the past 5 years. In order to continue to provide a reliable, robust service, Research and Development (R&D) engineers have added additional wireless network controllers to the Wi-Fi services. These controllers provide more capabilities and features including support for IPv6, 802.11n and radio frequency enhancements, as well as a foundation for support of the latest Wi-Fi technology known as 802.11ac. Also known as Gigabit Wi-Fi, 802.11ac offers higher data rates by bonding more spectrum channels, supporting more spatial streams and utilizing more advanced modulation techniques.

As of the fourth quarter of fiscal year 2013, redesign and implementation of a new wireless network equipment was completed in eight buildings. The objective is to increase geographic coverage of wireless signals and improve service for high-density use areas. Pre-cabling was also completed in five buildings in anticipation of deployment of new or additional wireless access points when resources are available.

Classroom wireless applications.



R&D continued to provide high level, expedited technical assistance for wireless connectivity in support of the College of Engineering's use of collaborative instructional tools. R&D engineers provide diagnostic and consultation services to professors on site and in real time, when necessary. R&D continues to coordinate with wireless networking vendors to encourage development of improvements and efficiencies to support the unique requirements of large-group educational sites.

Network enhancements for Senate debate. On Oct 18, 2012, Virginia Tech hosted the final debate between U.S. Senatorial candidates Tim Kaine and George Allen at the Squires Student Center. In anticipation of the communications needs of the staff of each of the candidates, the event staff, the press corps, and law enforcement, NI&S Research and Development redesigned the wireless network and worked with Field Engineering to upgrade infrastructure in this critical location.

Athletics facilities wireless upgrades. The university's wireless network (Wi-Fi) service at Lane Stadium had problems that led to a degraded level of performance. Problems were attributed to the saturation of Wi-Fi radios by thousands of spectator mobile devices and excessive interference from other sources during the events. NI&S Research and Development engineers identified the problems and provided recommendations to the Athletics Department that included the installation of upgraded wireless hardware and explained the necessity of spectrum coordination. Based on these recommendations, NI&S installed temporary hardware in strategic areas of the stadium as a proof of concept. The concept proved successful and remained in service for the remainder of the football season.

During Spring term 2012, NI&S met with representatives from Virginia Tech Athletics, Virginia Tech Police Department, and the Office of Emergency Management to identify strategic locations within the stadium and Cassell Coliseum that would not only improve wireless services needed for athletic events, but also for emergency communication needs. NI&S funded and met these requirements in time for the ensuing football season.

Continued IPv6 support over wireless. While IPv6 support is available throughout the campus, wireless networks have not been able to leverage the full feature set due to the constraints of legacy hardware. Torgersen Hall and Newman Library were the first locations

on campus to receive implementation of full IPv6 capabilities. Over the past few months, these capabilities have been extended to an additional 17 buildings including Randolph, Derring, Engel, and Cowgill Halls. These capabilities include IPv6 captive portal support, DHCPv6 (dynamic host configuration protocol for IPv6) and first hop IPv6 security measures, such as RAGuard (Router Advertisement Guard). Other areas of campus will follow as older wireless hardware is replaced.

Cisco Systems IPv6 case study. Virginia Tech is a strong proponent of implementation and advancement of the next generation Internet Protocol known as IPv6, which has become an important component of wireless network activity. A production service on all campus networks, including wireless, Virginia Tech has one of the largest IPv6 deployments in the world. The university also serves as an IPv6 Beta test site and collaborates with vendors to develop IPv6 functionality in their network hardware. This experience with the protocol, in addition to providing real usage data and diagnostic capabilities, led Cisco Systems to write a case study based on the university's experiences. The study entitled *University Marks World IPv6 Day as Early Adopter* is available on the Cisco website at http://www.cisco.com/en/US/prod/collateral/switches/ps5718/ps708/case_study_c36-719825.html

For more information, contact Joe Hutson, hutsonj@vt.edu

Capital and renovation projects

Field Engineering (FE) designs and installs telecommunications distribution systems intended to support both interior building connections ("inside plant") as well as cable that interconnects buildings ("outside plant") to meet the university's needs through the next 10 to 15 years.

The Field Engineering team develops collaborative relationships with customers and vendors alike to provide high-productivity communication tools for the university community. FE works closely with project architects and engineers, as well as with University Planning Design and Construction teams during project development, to ensure communications cable pathways and spaces meet all industry and Virginia Tech standards. In the past year, FE has worked closely with the University Building Official to ensure that new installations for Unified Communications building upgrades and routine orders are code-compliant. FE also coordinates its activities with Facilities Services to minimize disruption of university operations and plans its work schedules to avoid disturbing classes in session.

Veterinary Medicine Instructional Addition. This building addition provided three new classrooms and teaching labs, a 7400-square-foot surgical suite, and several offices. CNS Field



Engineering coordinated with the building construction team to ensure timely installation of telecommunications cabling and network equipment necessary to support the instructional and research objectives for this facility.

Sigma Phi Epsilon at Oak Lane. In the Oak Lane section of campus, this building is the most recent addition to the on-campus Greek housing quad.



North End Center. Located just north of the Upper Quad and opened in late March 2013, this 141,000-square-foot building provides office space for many departments including Human Resources, Purchasing, Internal Audit, and the Controller. Completed after the UC project was well underway, it was among the first buildings to receive the new voice and data network services.

Southwest Chiller Plant. This project, located in the former parking lot adjacent to the Veterinary Medicine complex, provides chilled water for cooling current and future buildings in the southwest section of campus.

Building 1901. The first building constructed in the Virginia Tech Corporate Research Center's Phase II area, it houses Virginia Tech's Center for Space Science and Engineering and accommodates faculty, students and staff from the College of Engineering's Bradley Department of Electrical and Computer Engineering and the Department of Aerospace and Ocean Engineering.

Telecommunications infrastructure work is in progress in the following capital projects:

- Center For the Arts
- Signature Engineering Building
- Human Agriculture and Biological Building
- Davidson Hall Renovation
- VTTI Addition
- Propulsion Lab
- North End Center Parking Deck



Over the past year, FE has installed new cable infrastructure and migrated the following buildings to Unified Communications VoIP, digital, and analog services:

- Parking Services
- Wallace Annex
- Media Annex

- Wood Engineering Lab (and adjacent labs)
- Health & Safety Building
- Grounds Building
- Burchard Hall
- Hancock Hall
- Media Building
- Engel Hall
- Center for Molecular Medicine and Infectious Disease
- Randolph Hall

The University Planning Design and Construction has scheduled the following projects to start within the next two years, requiring comprehensive design consultation for the telephone and computing network services:

- New Classroom Building
- New Residence Hall, Upper Quad

For more information, contact John Pollard, jpollard@vt.edu.

Distributed antenna system/In-building cellular coverage

Construction has begun on the first phase of a distributed antenna system (DAS) on the campus of Virginia Tech. Phase I includes the installation of fiber, DAS equipment and antennas to improve cellular coverage and capacity within Lane Stadium. Coverage will include the stadium bowl, all interior and exterior levels, and the parking lots on the Northeast, South and West sides of the stadium. On game days, cellular coverage and capacity in particular is a problem. The DAS will enhance cellular service as a convenience to students, faculty, staff and visitors to the stadium while also enhancing public safety and security.



The DAS is a system of antennas that will propagate a commercial carrier's cellular signals throughout Lane stadium. The initial carrier is Verizon Wireless but the system is being built to accommodate multiple service providers. The cellular signal comes from the provider's base station, and a structure will be located on the east side of Lane Stadium, within the stadium's perimeter fence, to serve as the DAS headend and base station shelter. In the future, key components of the stadium system will be used to extend coverage and capacity to other parts of campus.

For more information, contact Richard Hach, rhach@vt.edu.

IP-based safety and security camera network

Network Infrastructure and Services continues to work with X7 Systems integration in Fairfax, Virginia, to assist the university in the implementation of an enterprise-wide Internet protocol-based video surveillance system. The surveillance system and the associated components are implemented consistent with university policy. As part of a comprehensive security plan, the safety and security cameras are in place to deter crime and protect the safety of the Virginia Tech community.

To date, approximately 82 cameras have been deployed on the campus including the Perry Street Parking Garage, public areas and pedestrian walkways. NI&S will support the next phase of the deployment which will likely increase the number of cameras to 170. NI&S also provides the secure centralized storage of the surveillance records and expert support through personnel certified in the operation of the video management system.

X7 is an independent systems integrator. With its partners, X7 designs and deploys unique solutions for university personnel, departments, individual colleges, programs, or campus organizations who require the use of video surveillance equipment. In conjunction with Administrative Services/Facilities Services and Network Infrastructure and Services, X7 assists university personnel with camera implementation, operation and storage requirements in compliance with university policy.

For more information, contact Richard Hach, rhach@vt.edu

Campus fiber optic backbone improvement

The Field Engineering (FE) staff is currently in the third and final stage of a multi-year project to improve the campus network and communications infrastructure. A major infrastructure component, the campus's fiber-optic backbone cabling is being updated to accommodate current and future demands and to support the university's transition to Unified Communication services.

The third phase of this project involves interconnection of many of the campus's larger buildings to the new fiber ring. Each building will receive a new high-strand-count cable capable of providing reliable high-speed network connections and supporting future fiber-based services such as building management, public safety, and cellular telephony distributed antenna systems.

Construction commenced in January 2011. The project, inclusive of design, construction, and equipment, was forecast to cost \$2 million. Cost savings realized from efficient and effective use of materials and contract labor, will allow expansion of the project's third phase

objectives to serve roughly twice the number of buildings originally budgeted. The project is expected to complete during fall 2013.

The first two phases prepared the way for the current work. Phase one involved pathway design and construction to bring together existing facilities, such as utility tunnels, concrete encased duct banks, and newly constructed building penetrations—ensuring cable path diversity and redundancy.

The second phase of the project saw deployment of high-count single-mode fiber interconnecting the six campus switching centers to allow for network survivability in the event of a cut or damaged section of cable. Field Engineering has already completed splice work on the more than five thousand fiber connections in the main ring and is currently building circuits across campus utilizing the new fiber.

For more information, contact John Pollard, jpollard@vt.edu.

VT Google Apps

Following the successful implementation of the Alumni VT Google Apps for Education project, Virginia Tech Information Technology pursued the concept of offering an enhanced email service for all students, faculty, and staff. Google was chosen after comparison of several hosted services. By moving to VT Google Apps, Virginia Tech constituents received a larger mail store, along with access to calendaring, and Google Docs, Contacts, Talk, and Sites.

The move to VT Google Apps required extensive careful planning and execution from the university's email team, as well as major changes to documentation and the support model by University Computing Support staff.

Highlights of the effort include "Town Hall" information sessions, a dedicated website, and user-oriented online documentation. "Town Hall" style meetings for students, staff and faculty, were delivered by Kevin Davis, Manager of Student Programs and the Helpdesk. In September, three sessions provided information regarding VT Google Apps and addressed questions from the audience. A comprehensive website, designed to host announcements and to provide migration instructions and assistance, was developed by David Duckett of UCS. The site, dubbed "going.google.vt.edu," also hosted podcasts, videos, and other pertinent transition information. Julia Hurley, Content and Knowledge Manager, and members of the editing team, completed a major overhaul of content in 'answers.vt.edu' and 'computing.vt.edu.' William Dougherty, Executive Director of NI&S, was interviewed by University Relations and a podcast was developed to explain the reasoning behind the transition.

Open enrollment for the transition began in June of 2012. In October, mandatory transitioning of accounts began and all accounts were transitioned by the end of 2012. The total number of accounts migrated exceeded 60,000. The existing local mail servers will be decommissioned by the end of August.

VT Google Apps provides a private, secure email resource, where tools that mirror the publically available Google suite are available to Virginia Tech affiliates, yet governed by a negotiated contract that guards intellectual property rights of the university community. The contract also prohibits advertising. VT Google Apps is available at no cost to Virginia Tech and provides significant cost savings in licensing, equipment, and human resources required to run an enterprise-scale mail system.

For more information contact Ron Jarrell, jarrell@vt.edu.

University Computing Support

Fall move-in computing support. A pilot program established in August 2012 promoted a stronger collaboration between the 4Help Helpdesk, a year-around technology support group comprised primarily of students, and the Get Connected program which provides walk-in support during fall move-in, including assistance to students connecting to university's data network. The temporary relocation of the entire University Computing Support Helpdesk operation to an on-campus site (1100 Torgersen Hall) during move-in and the first week of classes was very successful. From this location, 4Help consultants and Get Connected staff, along with full-time UCS staff, were able to provide phone and email support to over 1300 constituents, as well as in-person support to more than 630 users. This service model change resulted in faster responses to users' computing issues at a very busy time of the academic year.

Get Connected Program. Get Connected (GC) was enhanced during fall move-in 2012 by dispatching individual staff members to specific campus locations to troubleshoot problems with setup and configuration of residence hall students' computers and/or mobile devices. The dispatch model enabled individual consultants to cover a larger group of residence halls than in prior years. Staff members were also charged with marketing the services of 4Help, while providing support to any of the on-campus population of approximately 8900 students they met during their shifts. During the four days of move-in and, while assisting the Corps of Cadets, 28 GC staff members provided in-person computing assistance to more than 640 students in the residence halls.

Captive Portal/XpressConnect. For nearly twenty years, University Computing Support has produced the VTnet software package. Distributed via CD-ROM and website download, the package automatically performed several critical security functions to ensure the safety of the

user's machine and of the university's network. Of paramount importance, it provided students (and faculty and staff) with a current version of antivirus software, provided educational information on best practices for using a computer at Virginia Tech, turned on a firewall and installed automatic software updates for the computing device's operating system. Invariably, the software package required updates between annual CD production dates, which could only be promptly applied to the online version. There were also costs associated with producing the CD-ROM version.



In December 2012, a project was initiated to replace the functionality of the VTnet CD and to simplify the process to register users for access the campus wireless network.

Project goals were

- to encourage all Virginia Tech users to connect VT-Wireless, the university's secure 802.1x wireless network;
- to create a service portal designed to have users agree to Virginia Tech's Acceptable Use Policy;
- to provide a web-based interface that quickly and easily authenticates the user and configures their wireless device;
- to provide a current version of antivirus software and access to educational information about best practices for operating a computer at Virginia Tech;
- to eliminate the need to produce CDs.

The project culminated during the summer of 2013 as Virginia Tech deployed [CloudPath's XpressConnect](#) software to simplify connecting to the university's wireless network. When a student, or a faculty or staff member connects a wireless-enabled device to the campus network for the first time, the XpressConnect wizard guides the user through authentication, device configuration and, quickly connects to the secure VT-Wireless network. After a device's initial configuration and connection, each subsequent connection to the VT-Wireless network is automatically authenticated and connected.

Gobblerfest: Raising awareness of computing and communication security. Virginia Tech's Gobblerfest is an annual festival designed to engage students in campus activities and help them connect with the surrounding community. Attended by thousands of students, faculty, staff and community members each fall semester, nearly everyone carries a mobile communication device to communicate and share information. Many students are not fully aware of risks associated with using mobile technology and may use it in ways that harm their communication devices, their data, and even their futures. Not surprisingly, incidents of computer viruses, malware, phishing, and social networking abuse continue to escalate.



Through a collaborative effort during the fall of 2012, the 4Help consulting staff and the university's Information Technology Security Office (ITSO) received a Parents' Fund Grant to promote students' awareness of computing and communication security issues. The goal was to help students at Gobblerfest understand cyber threats and to educate them about prudent ways to use mobile technology.

ITSO and 4Help set up games and gave away promotional items and informational materials to raise awareness of

- viruses, malware and how to prevent damage to computers and data;
- potential penalties and fines for illegally downloading and sharing music;
- sharing too much personal information online, which may lead to social networking abuse, identity theft, or even future employment issues.

4Help tweets. Last year UCS rolled out the 4HelpTweets project during new student orientation by advertising to incoming freshmen—quickly gaining a few hundred followers. As a follow-up, tweets updated information about technology resources and events. Prizes were given away during fall move in as staff continued tweeting relevant information. UCS plans to continue increasing the number of 4HelpTweets and to distribute information about the status of Information Technology services on a weekly basis. Project leadership was assigned to Dave Duckett who works in UCS's Special Student Programs group.

Patch management for departments and RLAN. An unfortunate trend has been the exploitation of vulnerabilities which facilitate compromise of computing systems and theft of data. Software developers publish updates and patches to mitigate the threat. However, research conducted by the IT Security Office confirms that departmental staff members have difficulty keeping up with timely patching, even for some of the most common third-party software. The result increased the university's risk of system compromises and data exposures. Machines with out-of-date software patches violate Virginia Tech's policy "7010: Policy for Securing Technology Resources and Services."

In the fall of 2012, University Computing Support and the IT Security Office explored solutions to solve the problem of timely patching of software on critical machines. As a result, the IT Security Office recommended that Virginia Tech obtain a system capable of identifying, reporting, and patching software. Information Technology purchased licenses for IBM's Tivoli Patch Management in the December of 2012 and began test deployments in coordination with a limited group of departments.

The project goals are to

- deploy a cost-effective patch management option that would be made available to university departments and used by Restricted/Limited Access Network (see below) clients;
- grant university departments access to the system to allow them to manage their own patching activities;
- develop scalable deployment plans, operational and system management procedures, and support documentation;
- develop a business plan to facilitate ongoing patch management operations.

By implementing a patch management solution, departments gain access to a powerful tool to help keep their systems patched to protect against vulnerable OS and client software. The patch management solutions addresses and should decrease the university's risk of system compromises and data exposures, as well as addressing the issue of unpatched software, a violation of Virginia Tech's policy "7010: Policy for Securing Technology Resources and Services."

Deployment by the end of fiscal year 2013 involved approximately 18 departments and over 900 machines and servers with supported unpatched software being quickly identified and appropriate remedial action applied. Various clients (Apple Mac and PC) were installed, and the Tivoli Patch management system can be expanded later to include mobile devices or system inventories. The service not only encompasses third-party applications but also supports Microsoft Windows operating systems, as well as other Microsoft products.

For more information, contact Pat Rodgers, prodgers@vt.edu.

Restricted/Limited Access Network

The Restricted/Limited Access Network (RLAN) was created to provide an additional layer of network isolation to machines used by university employees whose daily job duties are to process personal identifying information (PII). As the network name suggests, access is limited to specific, approved locations, as determined by departmental management and the university's Information Technology Security Office. Traffic on the RLAN network is segregated from other university networks and Internet access is restricted. This project is currently in pilot phase with three university departments enrolled. Once operational questions are answered and procedures developed, this service will be made available for other employees who process PII. RLAN service is an important part of the comprehensive program to protect the university's data assets.

For more information, contact John Pollard, jpollard@vt.edu.

Converged classroom

Video/Broadcast Services is currently involved in the design, development, and deployment of the next generation distance-learning classroom. The converged classroom employs an array of capabilities including multiple cameras, screen sharing, document sharing, interactive communication, presentation of images and graphics, annotation, and recording for later on-demand access. Additionally the classrooms will be equipped with a smart-board enabling real time collaboration between faculty and students at distant locations. The initial deployment is currently in progress for rooms at the Blacksburg and Falls Church campuses.

For more information, contact John Pollard, jpollard@vt.edu.

4-VA TelePresence

The 4-VA TelePresence Initiative was expanded to support three language courses during the 2013 spring semester. The high quality, life-like video and audio experience of the TelePresence conference enables the instructor to provide facial expressions, so students at remote locations can readily see and understand key aspects of their language study. The Virginia Tech TelePresence rooms have also been used for a variety of ad-hoc conferences, allowing university members to leverage this advanced technology for communicating with colleagues at remote locations. Video/Broadcast Services is developing a service which will integrate TelePresence with the WebEx conferencing service to significantly expand the number of participants that may participate in a given conference.

For more information, contact John Pollard, jpollard@vt.edu.

Cable television infrastructure upgrades

Single master antenna television (SMATV) passive component replacement. The passive component replacement/upgrade is the second phase of the coax to fiber optic SMATV core upgrade, completed over the previous two years. Prior to the upgrade, many of the extant components within campus buildings only supported up to 400MHz of bandwidth. A plan and budget were developed this year to replace the cable television system's passive devices, faceplates, and F terminations in residence halls and offices, with quality new components that support up to 1GHz of bandwidth. This refreshment of components of the university's video distribution system was begun in June of the reporting year and, when completed, will yield sufficient bandwidth to support distribution of additional digital high definition programming across campus.

Through cooperation with the university's cable television programming provider, further installation of digital headend equipment is scheduled, which will support injection of high-definition (HD) programming on the university SMATV system.

The combined impact of the coax to fiber upgrade, the passive component replacement, and installation of HD programming headend equipment will provide a much improved instructional and entertainment experience for the students, faculty, and staff.

An additional benefit of replacing passive components is the reduction of radio frequency leakage which improves the cumulative leakage index (CLI) numbers reported to the FCC.

FCC compliance reporting for the university multichannel video programming distributor /SMATV system. The Federal Communications Commission requires that cable television system operators maintain minimal radio frequency (RF) emissions by analyzing leaks and annual reporting to the FCC of the system's cumulative leakage index (CLI). The university's cable television engineering team commenced a process to monitor, record, and report to comply with this requirement.

While the CLI reporting requirement has resulted in some operating overhead, we anticipate it to be mitigated as a result of the core to fiber optics conversion as fiber cables do not carry radio frequency. RF leakage risks are primarily located inside the buildings where we convert the fiber optics signals back into RF and distribute it throughout a building's passive devices and cable terminations. Our passive replacement and faceplate termination project will improve the university's cumulative leakage index.

For more information, contact John Pollard, jpollard@vt.edu.

High performance computing

Network Infrastructure and Services staff operate and maintain high-performance, large scale computing systems for university administrative, academic support and research endeavors.



BlueRidge Compute Cluster. BlueRidge is a 318-node Appro GreenBlade cluster. Each node is outfitted with two 8-core Intel Sandy Bridge CPUs and 64 GB of memory, for a total of 5,088 cores and 20.4TB of memory system-wide.

With additional funding provided by the HPC Investment Committee, BlueRidge is being upgraded with the addition of

260 Intel Xeon PHI (MIC) coprocessors, which will raise the processing core count on BlueRidge from 5,088 to 20,688 providing 22.4TB of system-wide memory. MIC refers to Intel's "many integrated core" architecture. Each MIC coprocessor has 60 cores.

Since BlueRidge's original purchase, the vendor, Appro, has merged with Cray, a founding business in high performance computing. The Advanced Research Computing group released the BlueRidge Linux-based compute cluster to general use in 2013.

HokieSpeed Compute Cluster. HokieSpeed is a graphical processing unit (GPU)-accelerated supercomputing cluster consisting of 204 compute nodes linked together using a quad data rate (QDR) InfiniBand interconnect. Each HokieSpeed node is outfitted with 24 GB of memory, two six-core Xeon E5645 CPUs and two NVIDIA M2050/C2050 GPUs.

As of November 2012, HokieSpeed was ranked No. 221 on the Top500 supercomputer list and No. 43 on the Green500 list of energy efficient supercomputers.

The Advanced Research Computing (ARC) group re-provisioned and initiated large scale testing of HokieSpeed in March of 2012. By August 2012, the cluster was released to the researcher named in the grant. The cluster has undergone incremental upgrades, being attached to new ARC storage, along with provisioning to comply with current ARC compute environment standards and management.

For more information, contact Tim Rhodes, tim.rhodes@vt.edu

Quality Assurance

Quality Assurance (QA) received part of a grant from General Motors provided to improve information technology processes and provide meaningful work for Virginia Tech students. The GM-VT Mobile Tickets project will produce a realistic and tested prototype using mobile devices to respond to and update network repair orders and computer support field service tickets. Three undergraduate students in Dr. Edward Fox's CS4624 "Multimedia, Hypertext, and Information Access" course designed a mobile ticket dashboard using a JIRA user interface, Python backend, and Twitter's Bootstrap. Two QA undergraduate interns have been evaluating NI&S work order processes for possible conversion to mobile apps, and have also worked on the implementation of NI&S' more accessible and secure wireless access service.

Another QA project which has involved interns, communication, and cloud-based collaboration tools is the SAMWise application, which will provide a web-based calendar, scheduling, and notification tool for maintenance events of the Information Technology organization. The SAMWise application is being developed by the QA team and is sponsored

by SAMS—Scheduling and Announcement of Maintenance Subcommittee, which has representation from all areas of the IT organization. Student interns evaluated and ultimately rejected off-the-shelf calendaring software, and are now developing a data model and user interface designs which attempt to address Virginia Tech's complex computer and network system dependencies, and make use of the VT Google Apps suite.

For more information, contact Kimberley Homer, kimberley.homer@vt.edu

Developing and evaluating emerging technologies

Towards a session layer for the TCP/IP protocol suite. Contemporary applications demand greater functionality from the network than was required when the transmission control protocol/Internet protocol (TCP/IP) suite was developed. For example, the ability for a networked device to seamlessly move between networks without interrupting ongoing communications is a requirement that was not a factor when TCP/IP was designed. Some researchers feel that completely new protocols will be required to achieve the requested functionality. Extension of the protocols to achieve increased functionality is the focus of the research. Results indicate that it is not only possible to extend TCP/IP to achieve the necessary functionality, but that it can be done without sacrificing backwards compatibility

The research produced the following publications this past year:

- Umar Kalim, Mark Gardner, Eric Brown, Wu-chun Feng, "Cascaded TCP: Big Throughput for Big Data Applications in Distributed HPC," in *International Conference for High-Performance Computing, Networking, Storage and Analysis (SC)*, Salt Lake City, Utah, November 2012.
- Umar Kalim, Mark Gardner, Eric Brown, Wu-chun Feng, "Seamless Migration of Virtual Machines Across Networks," to appear in *Proceedings of the International Conference on Computer Communications and Networks*, Nassau, Bahamas, July-August 2013.
- Umar Kalim, Mark Gardner, Eric Brown, Wu-chun Feng, "Cascaded TCP: Applying Pipelining to TCP for Efficient Communication over Wide-Area Networks," to appear in *Proceedings of the IEEE Global Communications Conference*, Atlanta, Georgia, USA, December 2013.

The personnel associated with the project from Virginia Tech are Dr. Mark K. Gardner (NI&S), Eric J. Brown (NI&S), Dr. Wu-chun Feng (ECE/CS), and PhD student Umar Kalim.

Analysis of IPv6 stability and security in large network environments. Virginia Tech has been a leader in the adoption of the IP protocol version 6 (IPv6). The university began experimenting with IPv6 networking in 1997. A Google paper using data collected from

September 2008 to September 2009 the university was third, globally, in overall IPv6 connectivity. With one of the largest enterprise IPv6 deployments in the country, it is natural that vendors would desire to partner with the university in investigating issues related to stability and security in a production environment.

The purpose of the research is to test methods which might mitigate the effect of attacks against IPv6 enabled computers. Internet control message protocol version 6 (ICMPv6) traffic data on the 802.11 Wi-Fi network at the university was collected and scrutinized to see if any such attacks occurred. A small number of possible events was observed. Along with the testing, an initial statistical characterization of the ICMPv6 traffic was performed. Attacks against a vendor-supplied Cisco router with firmware containing the mitigation measures were tested in the laboratory. Simple attacks against the router were successfully mitigated. More sophisticated attacks were still successful however. The final report was well received by the sponsor.

The personnel associated with the project are Dr. Mark K. Gardner (NIS&), Eric J. Brown (NI&S), and MS student Naresh Gudipudi (CS), along with Stephen Groat, a PhD student in the IT Security Office.

NSF Campus Cyberinfrastructure—Network Infrastructure and Engineering Program Grant: ASCED—An Advanced Scientific Collaboration Environment and DMZ. The Advanced Scientific Collaboration Environment (ASCED) and DMZ is a standardized infrastructure, based upon open source components, for building and hosting scientific communities. It is built upon the Science DMZ, an infrastructure for efficiently sharing data, by including a private cloud for hosting collaboration environments. It supports role-based access control, facilitates data management, and provides principal investigators with tools for abiding by regulatory requirements. It is a standard base upon which scientific communities can be built, allowing future proposals to focus on the specifics of their research. It is also envisioned that ASCED will be used as a platform for educators to engage students at all levels. And it can be a platform for engaging the public, both in the dissemination of results and in participating in research.

The project was initiated in January 2013. Hardware for the data transfer node (storage) has been purchased and the private cloud software (OpenStack) is being installed. Simultaneously, the data center is being prepared.

The personnel associated with the project are Dr. Mark K. Gardner (NI&S), Dr. Steven Ellingson (ECE), Dr. Keith Bisset (VBI), Dr. R. Benjamin Knapp (CS/ICAT), Eric J. Brown (NI&S), and Christopher Wolfe (PhD student ECE).

Advanced Research Computing storage. In January 2013, the Advanced Research Computing group deployed EMC Isilon storage to upgrade performance in support of the

compute cluster's home file system. This installation also enhances research storage capacity and positions ARC to expand capacity without the need for maintenance downtime. Additional funding has been secured to deploy high performance parallel file systems across all compute resources. The deployment is projected to complete by the end of 2013.

For more information contact Mark Gardner, mkg@vt.edu

Mid-Atlantic Research Infrastructure Alliance, Inc. (MARIA)

Virginia Tech co-founded a new non-profit corporation to promote the development and operation of high performance network and computing infrastructure to provide a competitive advantage for Virginia's research universities. Members include, in addition to Virginia Tech, University of Virginia, George Mason University, Virginia Commonwealth University, James Madison University, Old Dominion University, and the College of William and Mary.

MARIA contracts with Virginia Tech's NI&S department to provide high speed connector services linking the members to national research networks and other services through the NatCap Aggregation Facilities which are owned and operated by Virginia Tech. The Virginia Tech Operations Center (VTOC) provides 24x7x365 support to MARIA for research networking. MARIA also contracts with the NI&S business services group to provide business operations, accounting, audit, and reporting services for the non-profit corporation. MARIA's headquarters are located in the Virginia Tech Corporate Research Center.

For more information, contact Jeff Crowder, crowder@vt.edu.

National Capital Region fiber ring

Virginia Tech owns and operates a fully diverse, dark fiber ring interconnecting the NatCap nodes and other strategic locations including the Virginia Tech Research Center in Arlington, Virginia. The university's network operations center operates an advanced packet optical network integrated with a DWDM—dense wavelength division multiplexing—system capable of delivering Metro Ethernet Forum standard carrier Ethernet services or dedicated channels at 1–10 Gbps. Transport services can be tailored to meet specific requirements. Secure dedicated or shared access to any network or resource at NatCap McLean or NatCap Ashburn (Equinix) can be provisioned, including access to multiple service providers. The system is upgradeable to deliver 100 Gbps channel capacity in the future.

For more information, contact Jeff Crowder, crowder@vt.edu.

National Telecommunications and Information Administration Grant

Network Infrastructure and Services is providing program management and project monitoring and compliance for a fiber construction project funded by the US Department of Commerce—the National Technologies and Information Administration’s (NTIA) Broadband Technologies Opportunities Program (BTOP). The original proposal was developed by NI&S with strong support from the university’s eCorridors program, resulting in a \$5.54 million award to the Virginia Tech Foundation (VTF). Use of this funding will extend Virginia open access fiber, operated by the Mid-Atlantic Broadband Cooperative (MBC), from Bedford to Blacksburg.

Coverage will span over 110 miles through rural underserved communities. NI&S is contracting with the VTF to provide program management as well as grant compliance and oversight for the complex project. This fiber will improve high performance access for Virginia Tech, put the university “on-net” for state-funded fiber statewide, and extend broadband access to communities in the region. Virginia Tech provided support for additional successful BTOP proposals amounting to over \$130 million statewide. Construction for the project was completed on time and under budget. Virginia Tech requested a modification to the award to use surplus funds to extend the network to Roanoke to reach the Virginia Tech Carilion School of Medicine and Research Institute and to establish an MBC point of presence in the downtown area. The university will submit the project final report to NTIA by September 2013.

For more information, contact Jeff Crowder, crowder@vt.edu.

Local multipoint distribution service

Local multipoint data service (LMDS)—beneficial for wireless backbone links and for alternate backup routes—has been managed by NI&S for over a decade. The FCC-licensed areas cover about 16,000 square miles across most of Southwest Virginia and a small area in Tennessee and were successfully renewed through 2018. Current equipment supports speeds up to gigabit Ethernet over distances of a few miles.

Three LMDS links provide service in the Blacksburg area. One from Slusher Hall on campus to the Town Centre on Main Street to support classrooms and faculty offices, one from Slusher Hall to the Post Office on Main Street to support University Mail Services and a third from Slusher Hall to the Corporate Research Center Building 14 to provide a backup route for network data.

LMDS service is also important in promoting rural broadband infrastructure development. LMDS links were installed in Danville, Martinsville, and Wise County by university partners.

A primary backbone link also operates in Danville between their network hub site and a business center to provide high-speed Internet service. The City of Martinsville has an alternate path backbone link over a distance of about four miles between a site in downtown Martinsville and a Henry County node. The University of Virginia College at Wise uses three links on their campus to provide alternate backup routes in case of fiber-optic cable cuts.

For more information, contact Richard Hach, rhach@vt.edu.

Strategic Initiatives

NetworkVirginia. Virginia Tech's NetworkVirginia program delivers broadband services to rural and underserved communities throughout the state and provides access to the world's most advanced research network infrastructure for regional universities and laboratories.

Internet2. Since 1998, Virginia Tech has provided high performance access to Internet2 for member universities and K-20 participants in Virginia, Maryland, and the District of Columbia. Individuals using the Virginia Tech network automatically connect to Internet2 resources.

The Quilt. The Quilt provides a dynamic forum where leaders from throughout the advanced research and education network community build on the intellectual capital and best practices of network service providers worldwide. As a founding member of The Quilt, Virginia Tech represents the commonwealth via the NetworkVirginia, Mid-Atlantic Terascale Partnership, and NatCap programs. The university realizes deep volume discounts from the national aggregation of Internet capacity using Quilt contracts for commodity Internet service.

For more information, contact Richard Hach, rhach@vt.edu

Digital Millennium Copyright Act activities

The Digital Millennium Copyright Act (DMCA, 1998) addresses the protection of copyrighted content that may be stored, played, copied, or transmitted in a digital format. The DMCA represents, in part, a legislative response to the proliferation of file-sharing or "peer-to-peer" software, which is a widely popular method for obtaining and sharing music, movies, and other digital content. In FY13, the number of notices received by the university decreased notably, compared to historical data.

The Kestrel Internet Copyright Infringement Case System, developed by the NI&S Applications Development group, is used by the Public Relations group (PR) to administer cases and process most of the analysis and referral work. PR coordinates as needed with the

university's Office of Student Conduct to address student file-sharing cases and when asked, communicates with appropriate student groups about Internet infringement issues.

Housing and Residence Life—special service offerings

Network Infrastructure and Services collaborated with Housing and Residence Life (HRL) to identify their special telecommunications needs and provided services to meet them.

Premium sports programming. Premium cable television sports programming was made available during the fall semester to HRL. This offering provided telecasts of National Collegiate Athletic Association football and National Football League game broadcasts to 51 residence hall lounges. The premium sports programming was provided to encourage on-campus residents and their guests to socialize in public residence hall spaces.

Summer conference services. Internet access and telephone services were provided to thousands of HRL summer conference guests. Guests not directly affiliated with Virginia Tech reside on campus while participating in sports camps or other special events sponsored by the university. While staying in residence halls, guests had access to the university's network, the Internet, and in-room phones.

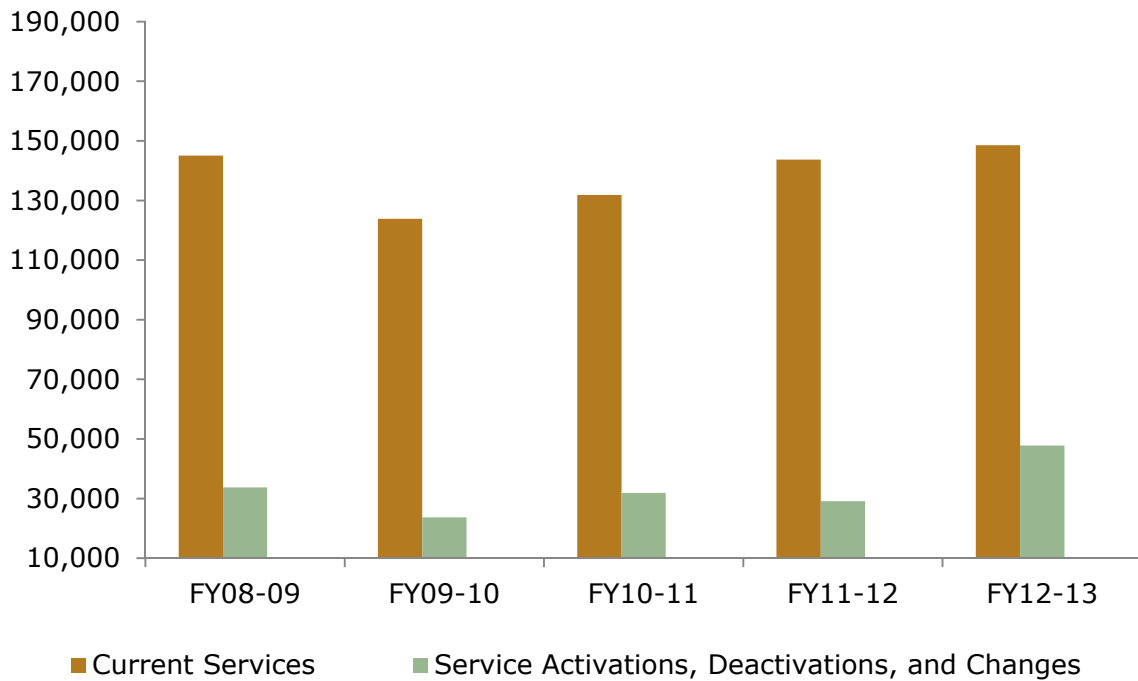
For additional information, contact Richard Hach, rhach@vt.edu.

Metrics

Business Operations

Increasing activity in changes to current services is primarily attributed to the Unified Communications transition. Adding to the increases is greater use of wireless and cellular services.

Services overview



The graph depicts, by fiscal year, the number of current services billed to customers, and the number of service activations, deactivations, and changes.

Service activations, deactivations, and changes are often a result of departmental moves to new or renovated office space and the resulting domino effect when another department relocates to the space previously vacated. The numbers vary year-to-year, but over a small range. This year's numbers, greater than in any of the previous four years, shows the impact of the UC transition from legacy voice and data services.

Engineering Operations

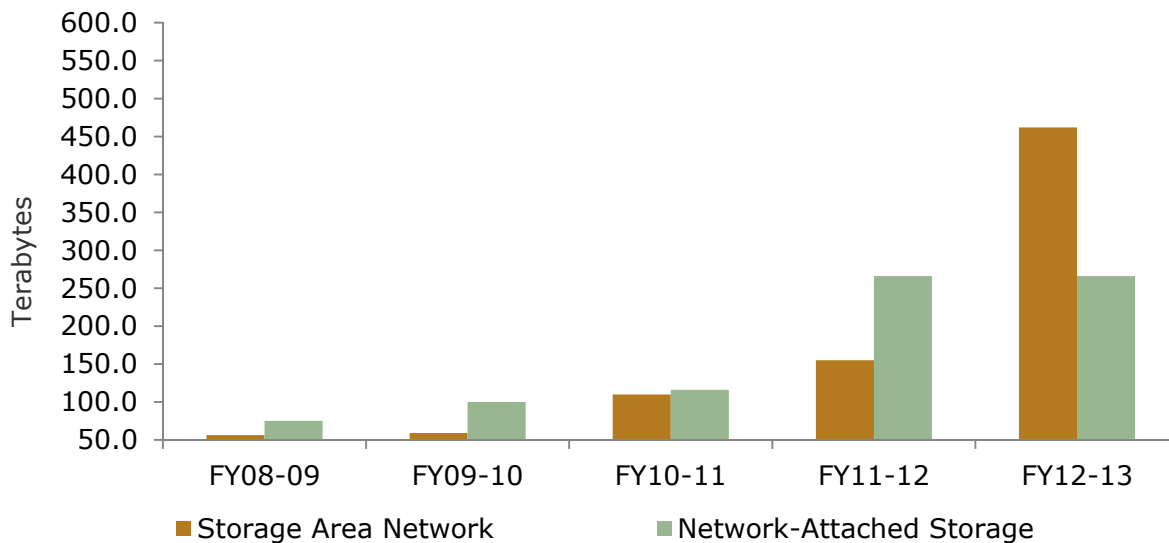
	FY09	FY10	FY11	FY12	FY13
Number of on-campus buildings with Wireless LAN Service	162	170	193	192	193
Total number of deployed wireless access points	1,769	1,898	1,978	2,146	2,728
Total number of Wireless LAN subscribers	32,089	35,995	36,012	45,082	49,825

Network Engineering continues to improve and expand wireless local area network (WLAN) coverage. In FY13, the total number of deployed wireless access points increased considerably as NI&S accommodated locations with large numbers of users and higher demand for the service.

Year	Peak number simultaneous devices	Total number of unique devices	Terabytes of traffic
2010	9,000	19,000	2.0
2011	9,900	26,000	3.8
2012	14,000	32,000	4.2
2013	15,500	40,000	5.7
Growth since 2010	172%	210%	285%

Systems Support

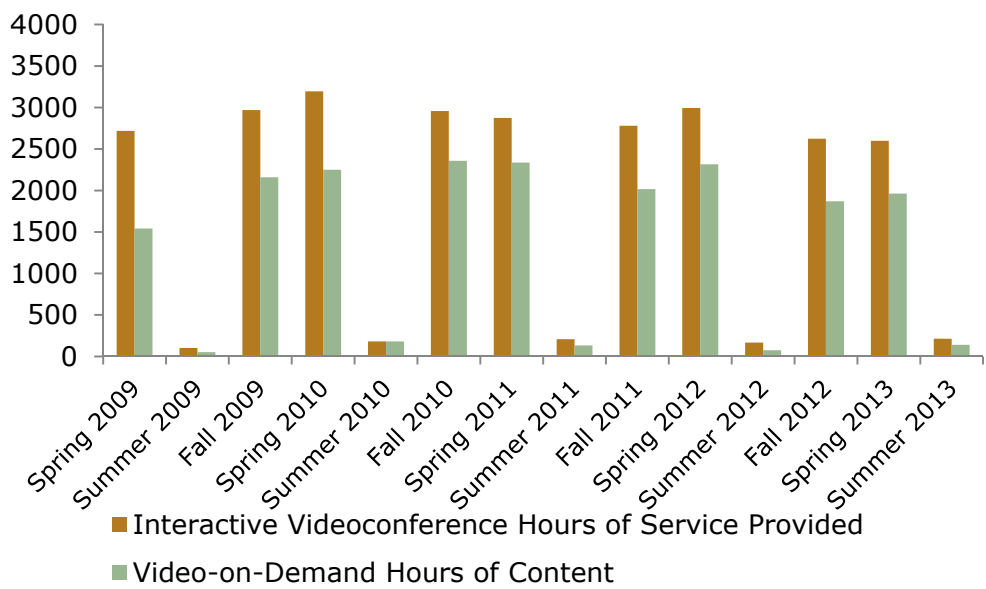
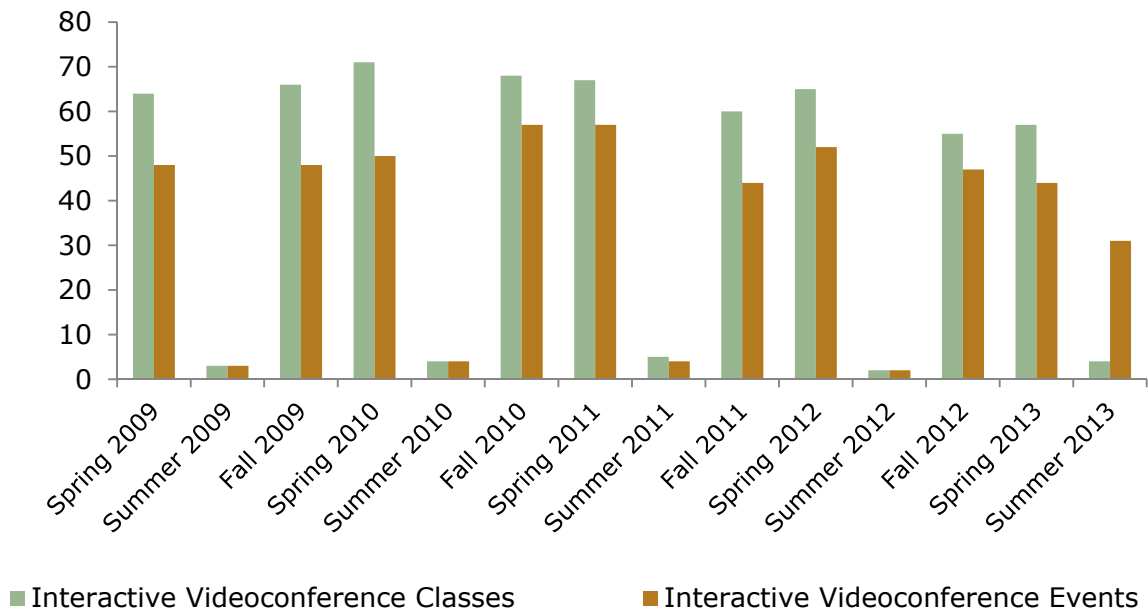
The purchase of another EMC VNX5700 to support the safety and security camera project increased the capacity of the storage area network (SAN). The SAN and network-attached storage (NAS) support virtualization, the Unified Communications project, Enterprise Systems Database and Application projects, System Development and Administration projects, and Learning Technologies' projects.



The NAS also provides file level storage to support faculty/staff personal and departmental shares.

Video/Broadcast Services

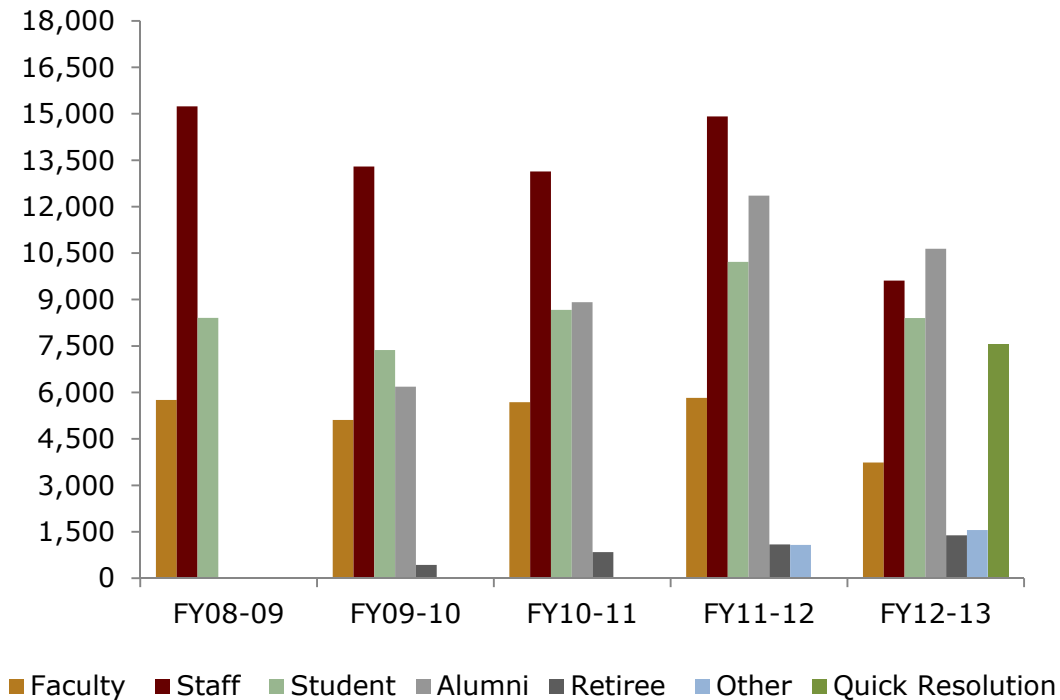
The graph depicts both interactive videoconference classes and events that are supported by Video/Broadcast Services. VBS maintains and operates 32 interactive videoconference (IVC) classrooms throughout the commonwealth. The unit coordinates the scheduling of on- and off-campus IVC classrooms, provides video bridging services, and hosts class lectures as video-on-demand files.

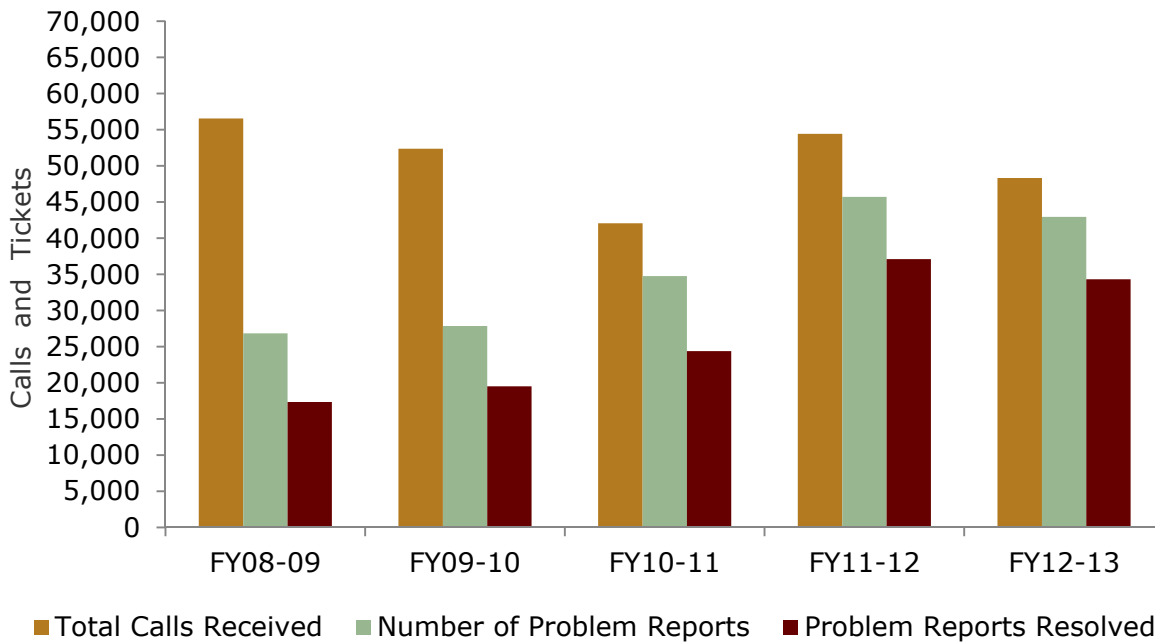


VBS' interactive videoconference classrooms have the capability to broadcast two separate channels of information simultaneously (dual video). VBS developed the process to capture and stream dual video content in a single video-on demand file. VBS continues to provide streaming and rich media support. VBS has increased its trans-coding processor capability in order to deliver all its streaming classes in high-quality, high-definition H.264 video format.

Virginia Tech Operations Center

This graph depicts the distribution of the majority of problem tickets received in the VTOC by caller affiliation. Calls by students showed a slight decrease this year, as did other over-all ticket counts. The “Quick Resolution” category, added this year, represents calls not related to basic services—questions about paying bills, service requests for Network Virginia, or misdirected (non-network/computing) inquiries. The number of tickets generated by retirees increased following the Virginia Tech Google Apps project and the deprecation of the modem pool and termination of the subscription modem pool service.





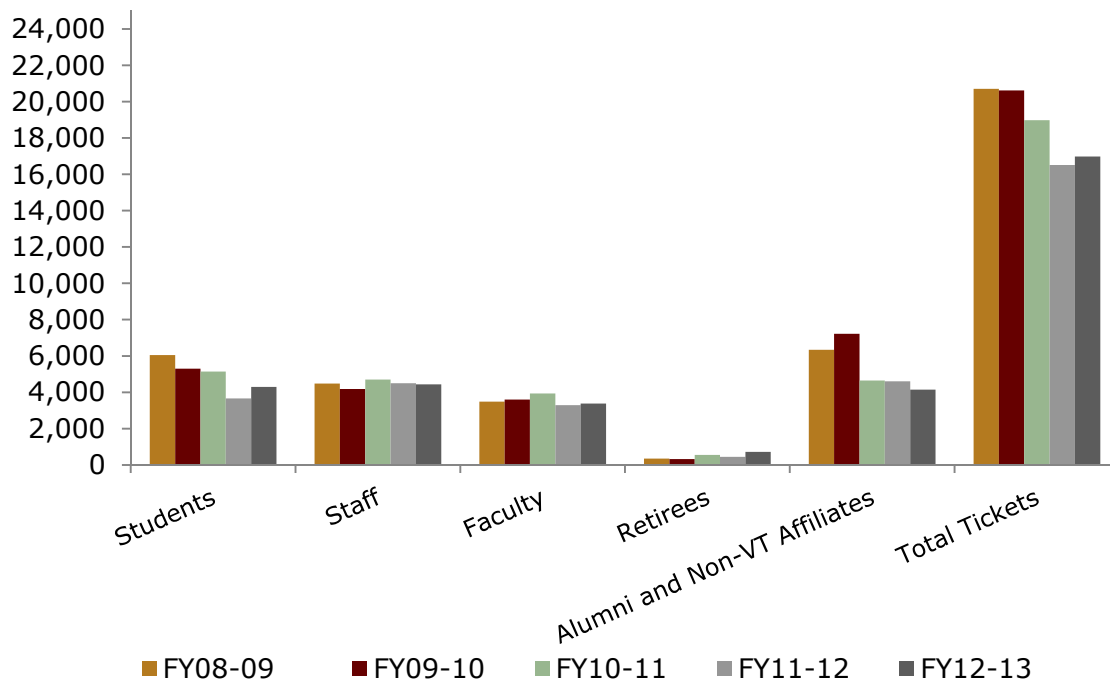
The graph above depicts calls received by the VTOC, the number of Remedy trouble tickets created, and the number of trouble tickets resolved. Support calls for Video/Broadcast Services are not included.

VTOC technicians receive questions and trouble reports from constituents and provide information and technical assistance as required. Trouble tickets are created, as necessary, and resolved if possible. If the problems cannot be resolved because of the need for additional data or a higher level of technical expertise, the trouble tickets are escalated to University Computing Support or other appropriate unit.

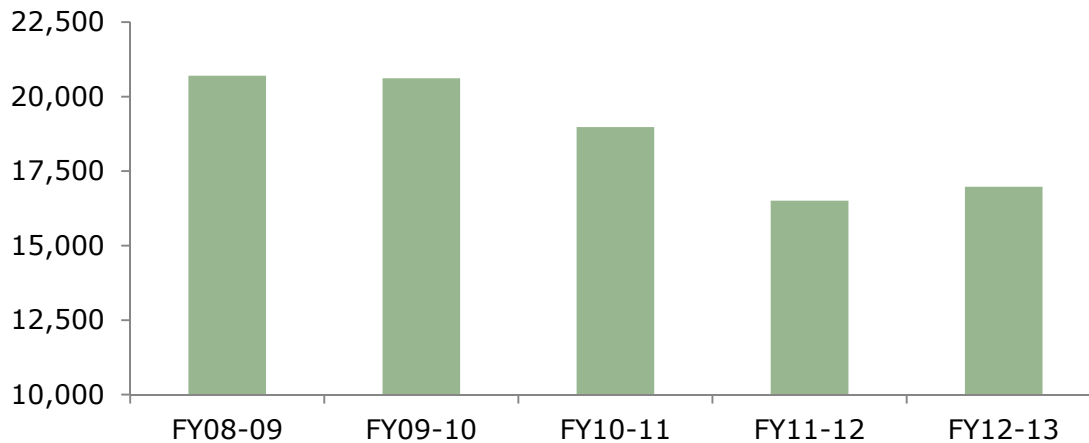
There was a slight decrease in both total calls received and number of problem reports entered and resolved.

University Computing Support

The number of trouble tickets based on the role of the users is relatively stable, with the active campus population of students, faculty, and staff accounting for over 70% of all problems reported this year. The event-driven nature of problems is demonstrated in the spike in alumni tickets in FY10 when alumni email was converted to Google.



There was an increase in student tickets, primarily due to the VT Google Apps project, as well as an increase in retiree tickets, due to the transition to VT Google Apps and the deprecation/termination of VT Modem Pool services. The number of alumni tickets decreased significantly since the completion of the VT Google Mail for Alumni project's conclusion.



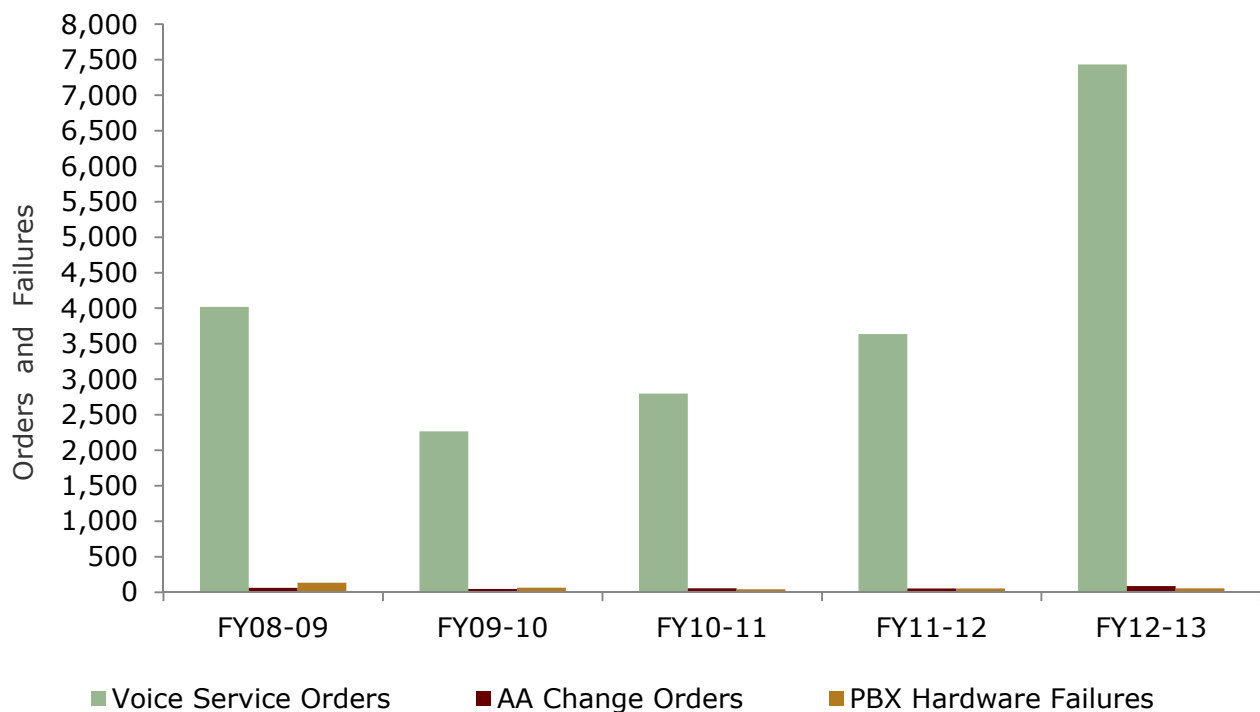
The total number of tickets for the past year increased due to the introduction of several new services, including transitioning all Virginia Tech affiliates to Virginia Tech Google Apps. The decrease during FY 2011-2012 is attributed to concluding implementation of the Virginia Tech Google Email for Alumni project, and a decrease in the number of calls related to Scholar implementation as users have become more familiar with the online course system.

Applications Administration

The *voice service orders volume* (7,433) depicted here represents the total number of move, add, and change orders for telephone or voice messaging services. These data track hardware, software, and cable plant activity that typically affects a single telephone user. The increase in work order activity in FY13 relates to completion of new buildings and to Unified Communications program.

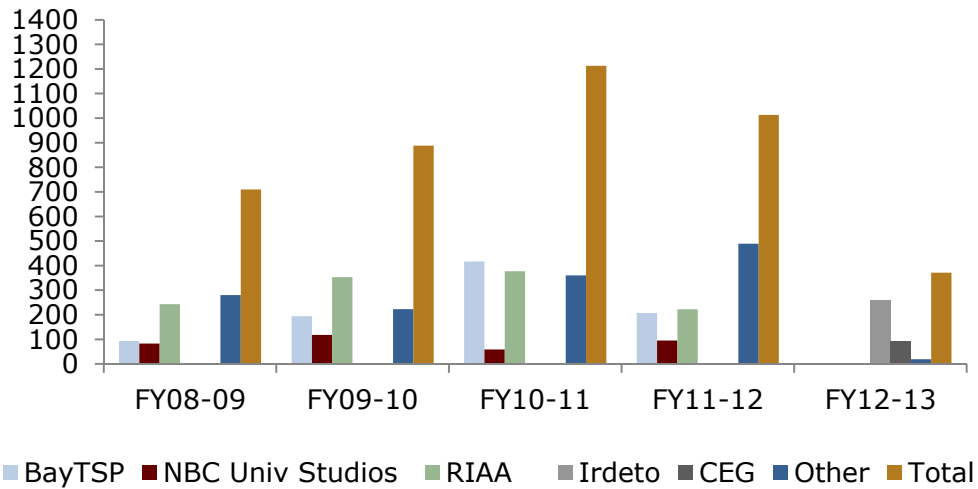
Applications administration (AA) change orders volume (86 this year) represents changes to campus telephone or voice messaging systems' capacity or functionality. This statistic tracks hardware or software activity affecting large groups or all users of the telephone system.

The PBX (Private Branch Exchange) hardware failures (56) represent the total number of electronic circuit packs replaced in response to service-impacting failures of a node of the university's PBX.



Internet copyright infringement cases

The volume of cases received during the year dropped significantly (62%) compared to prior years. Irdeto, an "anti-piracy" agency based in Netherlands, acquired nearly all Internet copyright infringement tracking and reporting agencies that communicated with Virginia Tech.



Copyright Enforcement Group, LLC, (CEG) has been included in the "other" category for several years. With the increase in CEG’s infringement referrals this year, it is included as a separate referral agent above. CEG offers to preempt legal action by settling out of court for a sum less than a “probable” court assessment. It has steadily referred cases over the last three years, accounting for a quarter of this year’s total. Previously, the typical type of infringement complaint was an agent demanding that copyrighted files and file sharing software be deleted.

During 2008-2012, the principal originators of infringement complaints forwarded to Virginia Tech in conformity with the Digital Millennium Copyright Act were BayTSP, the Entertainment Software Association, NBC Universal Studios, MediaSentry, and the Recording Industry Association of America (RIAA).

For more information, contact Richard Hach, rhach@vt.edu.

Secure Enterprise Technology Initiatives

The Secure Enterprise Technology Initiatives (SETI) department develops and supports infrastructure services that enhance the university's ability to secure its online resources. SETI's development activities are most closely aligned with Strategic Plan Pillar 5: Ensuring the security and resilience of information technology resources. Three units within SETI—Enterprise Middleware and Authentication Services (Middleware), Microsoft: Secure Infrastructure Services (M:SIS), and Secure Information Exchange Services (SIES)—support services that provision account credentials and secure the authentication environment for students, faculty, staff, and visitors. The software developed in these units ensures data privacy and leverages identity management strategies for authentication and authorization. Enterprise applications are integrated with SETI's services to enable appropriate access to online resources. SETI's Quality Assurance & Verification (QA&V) group performs testing to ensure quality software is developed and deployed into production.

SETI supports the goals of Pillar 4, advancing information technology for enterprise effectiveness, by providing and utilizing virtualized computing platforms, developing integration and provisioning methods for cloud services, and contributing to open source development projects. Ongoing technical support and operational improvements improve the effectiveness of SETI's enterprise services. To the extent possible, SETI promotes and preserves energy efficiency on desktop and server computers under the department's control.

SETI actively engages in efforts to improve the Information Technology organization—Pillar 7. SETI personnel participate in the IT Perspective program and support the IT Intern program by hiring student workers to make significant contributions to specific projects.

Highlights



InCommon Silver Certification. SETI management and staff played leading roles in the project to certify Virginia Tech as the first InCommon member to achieve Bronze and Silver certification under the [InCommon Identity Assurance Program](#).

Google Apps for everyone. Middleware developed software to provision Virginia Tech Google accounts and groups through integration with the Enterprise Directory. QA&V tested

all affiliations and many platform and browser configurations, and made many suggestions about documentation, workflow, and user interfaces.

Global Qualified Server Certification Authority. To prepare to issue globally trusted SSL certificates only to authorized Virginia Tech domains, SIES worked to comply with technical requirements of the CA Browser Forum, which will allow the Virginia Tech Certification Authority (VTCA) to function as qualified certification authority within the GlobalSign Trusted Root program.

Office 365. M:SIS began leading a project to implement Microsoft Office 365 cloud services, with initial plans to deploy on Exchange Online.

Automated testing. QA&V initiated the use of automated testing to improve efficiency and use of resources.

Pillar 5: Ensuring the security and resilience of information technology resources

InCommon Silver certification. In collaboration with Internal Audit and Identity Management Services, SETI implemented updates to software, policy and procedures, collaborated with national higher education consortiums, contributed documentation to the InCommon community, and satisfied criteria in the InCommon Identity Assurance Profiles Bronze and Silver version 1.1 that resulted in InCommon Bronze and Silver certification for Virginia Tech. The InCommon Silver project began in fiscal year 2012 and culminated with the audit submission to InCommon. InCommon approved the submission and certified Virginia Tech on September 10, 2012. To support InCommon identity assurance, SIES implemented a new version of the Token Administration System (TAS.) Middleware ensured that both the Central Authentication System (CAS) and Shibboleth infrastructure elements adhered to InCommon security requirements and would properly identify a Bronze or Silver user during the authentication process.

ADAdmin. Active Directory administration is the main self-provisioning portal for end users to interact with Windows based central IT resources, including network storage (My Store) and Exchange (Outlook) email. Version 1.1.5 was developed and released during this report time frame; it includes the following functional improvements:

- eToken personal digital certificate (PDC) login for self-service password reset
- Allows end users to control third-party password reset permissions on their accounts
- Bug fixes and user interface (UI) updates

M:SIS has begun working on the 2.0 release of ADAdmin to support new servicing roles including OU (organizational administrator) and child domain roles. These roles will extend ADAdmin into a full service web application portal for departmental administrators. Additionally a student intern position was made available to assist with developing account lockout and client log correlation that will be folded into ADAdmin 2.0.

VT WSUS. Virginia Tech Windows Software Update Services (VT WSUS) is an M:SIS client/server application that utilizes the Microsoft WSUS solution to provide timely patching of Windows operating systems and applications. During this report time frame, M:SIS was sponsored by University Computing Support to upgrade VT WSUS to a 3.0 release, which includes the following:

- Upgrade to desktop client to support Windows 8
- Remove faculty and staff authentication requirement when installing client
- Remove yearly timeout of services
- Add functionality to allow silent remote installs of clients via Windows Group Policy
- Remove support for Windows XP and Microsoft Office 2003
- Upgrade existing WSUS servers to latest version and data base patching
- Bug fixes and UI updates

VT WSUS has been downloaded over 450 times since its release on January 22, 2012.

Active Directory. M:SIS manages, maintains, and administers the VT Active Directory. This service supports Windows authentication, authorization, domain naming services, and AD forest infrastructure support. After a successful Microsoft Premier AD health check, M:SIS extended the infrastructure to support Windows 2008 R2 servers and Exchange 2010. New virtual and physical domain controllers were put into production to support the root (Hokies) and the University Services child domain, which M:SIS manages. Development and pre-production mirror AD environments are also maintained by M:SIS to support development and testing of M:SIS and third-party application and services. In fiscal year 2014 M:SIS will be demoting and removing redundant Windows 2003 and Windows 2003 R2 domain controllers to reduce administrative overhead and reduce support burdens.

Collaboration. M:SIS hosts the VT Windows Users Group and the SharePoint Users Group bi-monthly meetings. M:SIS staff also assisted other units within the Information Technology organization with security, virtualization, eTokens, Active Directory, Windows authentication \ authorization, O365 services and software licensing and evaluation. M:SIS helped evaluate Shibboleth/CAS integration for SharePoint and worked with the office of the Vice President for Administrative Services (VPAS) on Windows forest trust project planning. M:SIS supported IMS' evaluation of the IdentiKey and eToken mutli-factor requirements for the Virginia Tech Police. M:SIS worked with the School of Architecture + Design, the Division of Student Affairs, and VPAS on active directory migration questions. M:SIS assisted NI&S in

opening up a Microsoft Premier Support case in regard to OpenRadius and Windows 8 issues with VT-Wireless. M:SIS worked with several Information Technology units in discussing the problems and potential solutions with the Office of Export Control and Secure Research Compliance regarding secure communication and collaboration in an ITAR—international traffic in arms regulations—research environment. M:SIS worked with the IT Security Office on integrating their SIEM system with Windows server event logging. Two M:SIS employees were trained on Configuration Manager at the Microsoft Charlotte location in Microsoft System Center 2012.

Token Administration System (TAS) updates. The SIES unit developed and deployed a new TAS v3.3 release in August 2012. TAS v3.3 implements technical controls requiring TAS administrators to authenticate using eToken PDC credentials that meet minimum Medium Silver or higher level of assurance. Additional security enhancements were introduced to enforce more secure registration requirements for TAS registration authority administrator and certification authority (CA) administrator roles and to automatically send email notifications to alert IMS personnel whenever changes in TAS administrator roles are detected. In January 2013, TAS v3.4 was released to accommodate the issuance of eToken PDCs with Bronze assurance level for subscribers who don't possess acceptable forms of photo identification, but instead rely on their department head to vouch for their identity.

Soft Personal Digital Certificate project. The SIES unit continued its work on the Soft Personal Digital Certificate (SoftPDC) project. SoftPDCs are stored as files on a computer's hard drive or other storage media (flash drives, CDs) as opposed to storage on a smart device such as a smartcard or hardware eToken. In April 2013, SIES updated the SoftPDC web interface to use a development Virginia Tech Global Software Token User CA to enable testing of SoftPDCs using GlobalSign's qualified subordinate CA environment. Pending approval of GlobalSign's Subscriber Agreement by the Virginia Tech public key infrastructure (PKI) Policy Management Authority (PMA), SIES plans to work with GlobalSign to complete production key signing for the Virginia Tech Global Software Token User CA in the coming year.

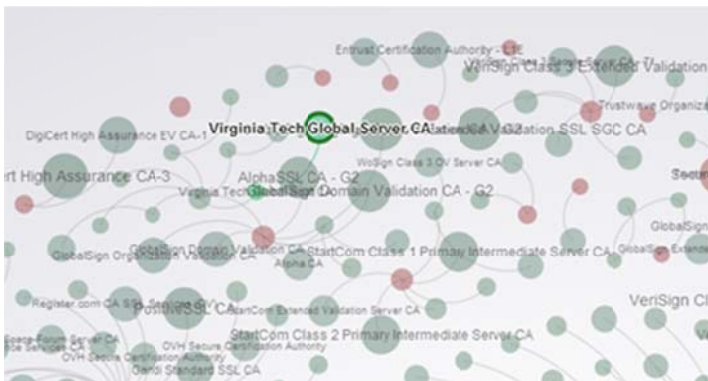
Virginia Tech Global Qualified Server CA project. In October 2012, the SIES group began working with GlobalSign on the VT Global Qualified Server CA project to enhance security for operation of the university PKI. The newly developed qualified subordinate CA provides a highly secure operational environment by implementing technical controls to insure that SSL server certificates can only be issued to authorized domains. The SIES group has worked closely with members of the Virginia Tech PKI PMA to help develop a certification practice statement for the VT Global Qualified Server CA and is tentatively planning a production deployment during August 2013.

Virginia Tech Hardware Token User CA project. In April 2013, the SIES group began testing a qualified subordinate CA operating within GlobalSign's trusted root program. The VT

Global Hardware Token User CA project will provide a more secure CA operational environment by implementing technical controls to restrict the domains used for certificates issued to users on their eToken smart devices. PDCs that are issued by the new Hardware Token User CA will be issued onto the next generation of eToken 5100 smart USB devices and inherit automatic global trust by chaining with GlobalSign's trusted CA hierarchy. Pending approval of GlobalSign's subscriber agreement by the Virginia Tech PKI PMA, SIES plans to work with GlobalSign to complete production key signing and deployment of the Virginia Tech Global Hardware Token User CA in the 2014 fiscal year.

Secure USB Research Initiative. In an effort to increase the strength of credentials used to access the InCommon Identity Management System Operations infrastructure elements, the SIES group led a research initiative to evaluate various encrypted USB devices to support secure storage of Secure Shell (SSH) keys. Encrypted USB devices can be used to store data like standard USB flash drives but allow the data to be encrypted so that is not readable by others if lost or stolen. After evaluation of several options, the SIES unit identified the Aegis Secure Key USB 2.0 Flash Drive as the best choice. The Aegis Secure Key USB drive which meets FIPS 140.2 Level 3 criteria uses AES 256-bit CBC hardware encryption and provides a built in keypad for secure PIN entry.

Virginia Tech certificates



Virginia Tech Global Server CA depicted in the [International Computer Science Institute's Tree of Trust](#)

SIES tracks the number of certificates issued by the Virginia Tech certification authorities. The number of SSL Server certificates that were issued this year increased over last year by about ten percent. The increase could be attributed to the fact that the Virginia Tech Global Server certificates are more useful to the university community now that they are globally trusted.

The number of certificates (PDCs) issued onto eTokens by the User CA in fiscal year 2013 doubled compared to fiscal 2012, possibly because the two-year certificates issued in fiscal 2011 expired and were re-issued in 2013 to employees who use them to sign leave reports. Some increase could also be attributed to acceptance of graduate plans of study that are

digitally signed with the PDC on the eToken by the Bradley Department of Electrical and Computer Engineering.

Middleware certificates are used by ED-ID services to connect to the Enterprise Directory. We would expect the number of these certificates issued each year to vary based on expiration dates, while the number of certificates in circulation should be roughly correspond to the number of ED-ID services currently in use.

Virginia Tech certificates issued and in circulation

Certificate type	FY 2012	FY 2013
Server (issued)	346	382
Server (in circulation)	638	702
User (issued)	153	489
User (in circulation)	828	553
Middleware (issued)	46	23
Middleware (in circulation)	69	62

Network password. Middleware developed business logic components to manage the network password in the Enterprise Directory, and implemented that logic in web services. Support for managing the network password was added to the Directory Administration Tool (DAT), and the network password attribute was added to the LDAP services.

LDAP—Lightweight directory access protocol. Changes were made to the Enterprise Directory LDAP to enhance privacy by ensuring that information about deceased people is suppressed in ED-Lite, the directory used by People Search. SSHA512 password encryption and bcrypt password encryption technologies have the potential to increase LDAP security and are being evaluated on an ongoing basis by the Middleware group.

Shibboleth. Middleware provided support to bring several new Shibboleth service providers online this year, including Lynda.com. Work was done to refine the concept of the Hokies federation to support Shibbolized services internal to Virginia Tech. Virginia Tech’s Shibboleth identity provider was also updated to include the Bronze and Silver identity assurance qualifiers after Virginia Tech achieved InCommon Assurance certification.

Pillar 4: Advancing information technology for enterprise effectiveness

Cyber Security Desktop Initiative. Cyber Security Desktop Initiative (CSDI) is a pilot project developed to enable a centralized highly secure and maintainable virtual desktop infrastructure utilizing Microsoft technology. During this timeframe, several departments (Human Resources, VPAS, Internal Audit, and the Division of Student Affairs) and over 40 end users were enrolled in the pilot program to test and evaluate the suitability of the service.

Additionally, several security-hardened zero-touch thin clients were lent out to these departments to provide end-to-end encryption, managed access, and always-“evergreen” guest images. M:SIS has learned a great deal from this project and as the pilot ends has developed a cost/benefits analysis on how this technology and knowledge can be used to help departments and how the university benefits by having a more manageable and secure desktop computing environment. For CSDI to be run in a production environment and support departments customers, additional budgetary funding and staffing will be required.

Virtual Dedicated Widows Services (VDWS). VDWS is a set of services that M:SIS runs to support virtual Windows and Linux server class systems for central and departmental information technology units. This service consists of seven clustered Microsoft Windows 2008 R2 Servers running Hyper-V back ended with 100Mb iSCSI storage attached network (SAN). The service offers customers a very low cost hosted server solution with the option to run in a highly available configuration. The service currently supports guests from 11 central Information Technology departments and 19 departmental groups. This customer base represents a total guest population of nearly 100 guest servers. For fiscal year 2013, the services have generated over \$27,000 in yearly service fees. These fees are, by contract, only used to improve the VDWS service. In fiscal year 2013, 100% of previous paying customers re-enrolled in the services, and for fiscal year 2014, 95% of paying customers have renewed. Based on increasing customer participation and an increasing infrastructure administrative burden, M:SIS requested and received permission to increase the base cost of a guest from \$200 to \$250 to be implemented in fiscal year 2014.

M:SIS has also begun working on the next version of VDWS, called VDWS^ (VDWS Next) which will be a 20+ cluster of Windows 2012 Hyper-V nodes with a 10Gb iSCSI SAN backplane network. Efforts are also under way (if critical needs funding is available and allocated) to provide VDWS^ with a geographically highly available and disaster recoverable virtualized environment for the use of the IT organization and for other university departments.

Microsoft Office 365 (O365). M:SIS leads the development and deployment of Microsoft Office 365 (O365) cloud-based and hybrid services and applications. With the kickoff of the project several pieces of necessary Windows infrastructure needed to be enabled. M:SIS has deployed ADFS (Active Directory Federation Services) and directory synchronization within the development and test (pre-production) Active Directories to support O365 integration and single sign-on. Currently, over 65 test users have access to the following offerings within the test O365 tenant (vatechtest.onmicrosoft.com):

- Exchange Online
- SharePoint Online
- Lync Online
- Office Web Apps

- Skydrive Pro

The first phase of the project will most likely be deployment of Exchange Online, enabling authorized employee user populations to migrate their mail and calendaring into the cloud. New mail workflow, automatic on-premises vs. cloud mailbox migration and extending ADAdmin to support self-service provisioning of these services will be necessary.

SIES technical support. The SIES unit continued to provide support for its PKI web services, Token Administration System, eToken RTE Installers, and the VTCA PKI infrastructure including the VT Root, Global Server, Middleware and User CAs. SIES assisted the TAS administrators in the Student Network Services and Information Technology Acquisitions offices to insure a successful TAS 3.x deployment and provided training for their TAS operators. SIES provided training for new TAS system administrators and TAS operators in the VTOC who will be performing eToken PIN resets and PDC (Personal Digital Certificate) revocation. In addition, SIES has provided technical support for operation of GlobalSign's Code Signing certificate service which is administered by the IMS (Identity Management Services) office.

Enterprise Directory. Middleware programming code implements the business logic to provision an email account for a person whose identity information is in the Enterprise Directory (ED.) As part of the project to provide Google Apps for all university constituents, Middleware was tasked with reworking the provisioning and de/provisioning code for the cloud based environment. The new code takes into account restrictions on where email can reside for individuals whose email falls under ITAR compliance restrictions. That email is restricted from being transmitted outside the Virginia Tech on-premise computing environment.

Groups in the Virginia Tech Enterprise Directory existed independently of groups in the Google Apps system; more integration was needed to improve the usefulness and management of Google groups. Middleware developed a method—Virginia Tech Group Manager Tool—to be used to request creation of a parallel group in the Virginia Tech Google Apps system. This effort represents the first phase of support for Google group integration.

One of the drivers behind migrating to Google email was the ability to decommission the aging iPlanet mail server and its related outdated hardware. Middleware's directory replication code was changed to redirect the replication process from the iPlanet mail server to directory a newer Linux server. This change to replication paves the way for the elimination of the MiraPoint routers.

LDAP. Operational enhancements were made to the LDAPs to use shared memory keys to avoid disk I/O issues. The development and pre-production LDAPs were moved behind the

Network Infrastructure and Services load balancer to improve the testing environment. Evaluation of the mb database is ongoing.

DAT. DAT enhancements included support for display records from external data sources like Active Directory and Google. This functionality was requested by 4Help and should also aid IMS in answering questions regarding identity management information. Support was added for Google groups, and improvements were made to the mail creation interface used by IMS.

Central Authentication Service (CAS). Middleware improved the effectiveness of their production support this year by developing the following for CAS:

- a new Git-based deployment process with enhancements for QA&V testing;
- an application health monitoring facility to provide analytics into system components as a measure of overall system health; and
- a dashboard to report on authentication statistics.

Middleware infrastructure. Code versioning and software repositories are integral to any development unit's processes. Many open source projects are transitioning from older source code management systems to one based on Git. This year, the Middleware group evaluated GitHub Enterprise and GitLab, and then selected GitLab for enterprise use. The Middleware projects were moved from Subversion to Git.

Middleware maintains extensive documentation, and was one of the first areas at Virginia Tech to use a wiki. This year, www.middleware.vt.edu was upgraded to the most current version of DokuWiki.

Open source. SETI units implement enterprise class open source products including, but not limited to Open LDAP, CAS, Shibboleth, and EJBCA—Enterprise Java Bean Certificate Authority. Developers contribute to existing open source projects and offer other products and libraries to the open source community.

This year, Middleware contributed a new open source LDAP application programming interface (API) called [ldaptive](#). Ldaptive is a simple, extensible Java API for interacting with LDAP servers. It was designed to provide easy LDAP integration for application developers.

Middleware staff continued to make key contributions to the CAS project this year. A next-generation authentication API was created for CAS 4.0 that provides native support for multi-factor authentication. A new LDAP subsystem based on [ldaptive](#) was contributed for CAS 4.0 with a number of new features that dramatically improve performance and reliability. Documentation for CAS 4.0 was also contributed.

Middleware's contribution to the Shibboleth project was for IdPv3 authentication and storage subsystems.

During the past year, the open source community continued to download M:SIS-developed software available at <http://opensource.w2k.vt.edu/home.php>. DictionaryFilter_v2.1, Selfservice_2.3, ADPasswordfilter_v1.0, and VTWSUS_v1.0 were the most popular, based on the number of times they were downloaded.

Quality Assurance and Verification

Quality Assurance and Verification provides functionality and usability testing for SETI applications and services. Staff members also support the deployment process, providing input regarding schedules, standards, and documentation for production implementations.

QA&V provided testing support for SETI deployments of EJBCA 4.0.1, ADAdmin v1.0.0, VT eToken, VT PKI Website, WSUS 3.0 beta client, ED 3.5 (including support for Google Apps,) CAS 3.5.1 and 3.5.2, CSDI, VT Global Qualified Server CA and VT HW and SW User CAs. Usability testing was done for ADAdmin, DAT, and CAS. Testing is underway for the Office 365 Exchange deployment.

QA&V sent outdated equipment in the test bed to surplus and set up newer computers using virtual machines, resulting in running installations of all operating systems supported by 4Help. A library to store test plans was created, and there are ongoing efforts to extract information from older JIRA issues which will be helpful in future testing.

Selenium WebDriver was successfully introduced for automated testing. The first use of automation was to test concurrency issues for CAS 3.5.2.1 which would have been difficult to test by hand. There is an ongoing task to provide regression test scripts for SETI Web Apps.

Other testing was performed for the following collaborative initiatives within Information Technology.

Committee work. QA&V participated in the redesign of computing.vt.edu, the Data Quality committee, and the SAMS committee, which coordinates Information Technology system maintenance.

Assessment: How are we doing?

SETI has set a goal of 99.9 percent uptime for the services we support. Uptime is a measure of service availability. The following statistics show that this year's uptime compares favorably with previous years.

Service	Percent uptime		
	2011	2012	2013
Central Authentication System (CAS)	99.975	99.971	99.986
Shibboleth	99.975	99.879	99.985
Enterprise Directory LDAP (ED-Id)	99.975	99.987	99.993
Enterprise Directory LDAP (ED-Auth)	99.975	99.993	99.993
Enterprise Directory LDAP (ED-Lite)	99.975	99.963	99.993
Middleware Messaging Services	not reported	99.898	99.986
Directory Access Tool (DAT/web apps)	99.935	99.965	99.977
Public Key Infrastructure (EJBCA)	100.000	99.999	100.00
Hokies Active Directory and University Services Domains	100.000	99.830	100.00
ADAdmin	99.960	99.890	99.978
Virtual Dedicated Windows Servers			
Non-M:SIS guest services	99.970	99.930	99.967
Non-M:SIS High Availability (HA) guest services*	not reported	not reported	99.843

* The HA guest VDWS service experienced storage area network (SAN) failures that will be remedied with hardware improvements next fiscal year.

Quality Assurance and Verification's assessment goal was to have less than one percent of JIRA issues resolved as 'incomplete,' 'cannot reproduce,' 'invalid,' or 'rejected.' The purpose of this metric is to make the best use of developers' time in fixing problems that are relevant to our customers.

QA&V created or updated 95 issues this year, resolved as follows:

Completed	58
Open	24
Fixed/fix verified	7
Won't fix (by developers)	3
Withdrawn (by QA&V)	1
Invalid (by developers)	1
Duplicate	1

Total incomplete, cannot reproduce, invalid, and rejected: 1/95 or 1.05%

Many of the open issues are long-term projects, such as using PKI certificates internally and creating test plans, which never will be “completed.”

Information Technology

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