Information Technology

Annual Report

2013-2014

Reporting on the pillars of the Information Technology Strategic Plan

VirginiaTech

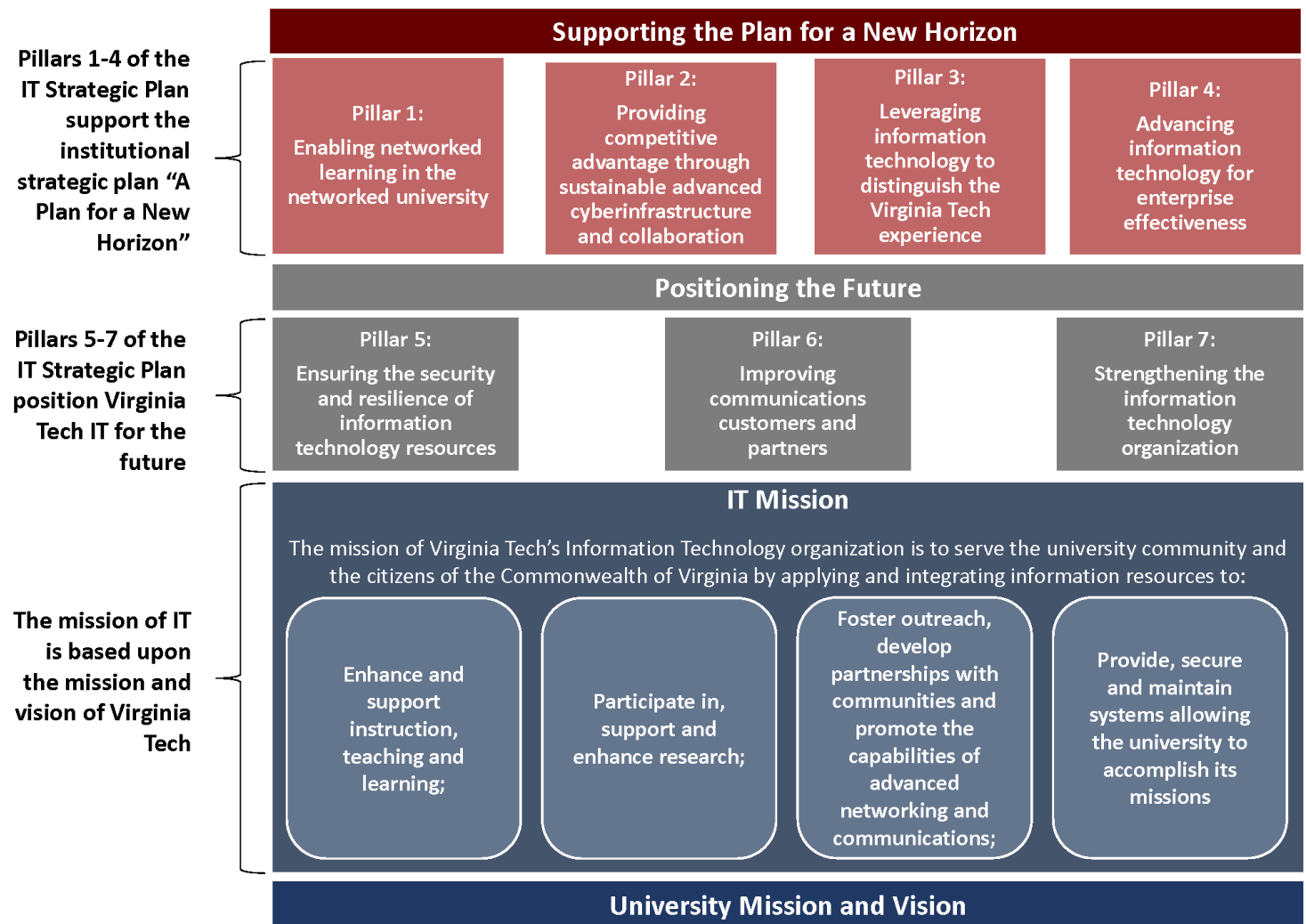# Table of contents

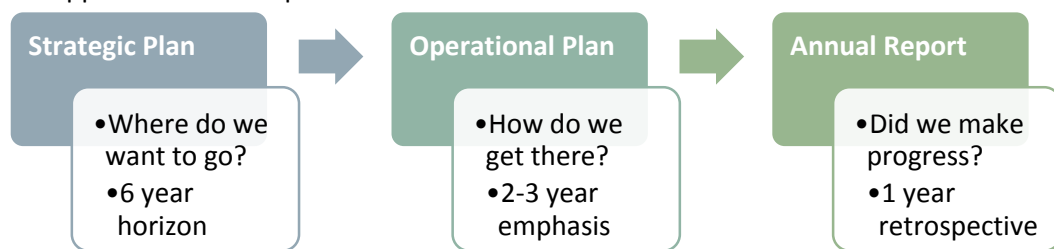# Message from the Vice President for Information Technology and Chief Information Officer

As we complete Fiscal Year 2014 and embark on the coming year, I am pleased to see the 2012-2016 Information Technology Strategic Plan move into its operational phases. As shown in the diagram below, the Information Technology Strategic Plan was designed to support the university's mission and vision, the mission and vision of Information Technology, and specifically to advance the university's "A Plan for a New Horizon: Envisioning Virginia Tech 2012-2018." The strategic plan presents four focus areas that serve as pillars to directly support "A Plan for a New Horizon" and continues with three additional areas that serve as pillars to support the long-term success of the Information Technology in addressing university plans.

Pillars 1-4 of the IT Strategic Plan support the institutional strategic plan "A Plan for a New Horizon"

Supporting the Plan for a New Horizon

Pillar 1: Enabling networked learning in the networked university

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

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

Pillar 4: Advancing information technology for enterprise effectiveness

Pillars 5-7 of the IT Strategic Plan position Virginia Tech IT for the future

Positioning the Future

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

Pillar 6: Improving communications customers and partners

Pillar 7: Strengthening the information technology organization

The mission of IT is based upon the mission and vision of Virginia Tech

IT Mission

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;
- Provide, secure and maintain systems allowing the university to accomplish its missions

University Mission and Vision

To ensure effective and systematic assessment of progress on the strategic plan, over the past year, the IT organization designed, collaboratively created, and implemented the first Operational Plan for Information Technology. The 2014-2016 IT Operational Plan provides a detailed set of goals, initiatives, and tasks to realize the seven pillars of the IT strategic plan and the "Plan for a New Horizon." Part of our aim was also to create a clear framework for defining a vision, implementing the vision, and assessing our progress towards that vision. The operational plan was intentionally designed to serve this purpose and functions as a living bridge between the strategic plan and the IT Annual Report, creating a logical and traceable flow among the three documents. This approach was an outgrowth of the Information Technology organization's assessment activities over the past three years, which three years ago were more loosely defined and emphasized system and service performance metrics. Although these metrics are extremely important for

the effective functioning of our organization, the implementation of the Strategic Plan in early 2012 demonstrated a need for the organization to more closely pair assessment with vision at both the organizational and institutional levels. The past three years, therefore, have seen a significant change in not only our organization's direction and vision, but in our approach to and implementation of assessment activities. We will continue to refine our approach to assessment as we move into the first full year of the operational plan, but the effects of these changes have already been felt.

Strategic Plan	Operational Plan	Annual Report
• Where do we want to go? • 6 year horizon	• How do we get there? • 2-3 year emphasis	• Did we make progress? • 1 year retrospective

Our focus on creating direct linkages between our vision and our assessment practices have also presented unexpected opportunities. We found that the creation of the operational plan was itself a major exercise in organizational assessment. As we sought to define how the organization would demonstrate progress, we also had to consider barriers to achieving the vision of our strategic plan in the current organizational environment. This process therefore enabled us not only to identify key assessment measures for ongoing progress on the strategic plan, but served as a major internal assessment opportunity to identify weaknesses and opportunities for improvement. This was particularly true for Pillars 6 and 7 of the IT Strategic Plan, which ask us to improve the way we communicate with each other, and evolve the ways in which we recruit and retain high quality employees. We found that we needed to assess and understand the weaknesses of our current environment to determine how to most effectively advance and achieve the aims for 2018 in these areas.

Despite the overlap of completing the operation plan and the ongoing work in the year, I am pleased that we have been able to advance our new strategic framework and focus this year's annual report around the completed and in-progress items in the operational plan. Moving forward, the annual report for Information Technology will assist in tracking and assessing accomplishment of operational plan objectives as well as gaps that need attention, and will give the university community detailed insight into our strategic plan progress and our ongoing efforts to advance the "Plan for a New Horizon."

In addition to these strategic changes, FY 2014 was a year of organizational change, with the reorganization of one unit and the creation of another. Although this is one area not addressed in the plan itself, organizational change facilitates many of the goals and objectives of the plan. The diagram to the right shows the nine major units of Information Technology at the close of FY 2014. The major change beginning this year was the creation of Technology-enhanced Learning & Online Strategies, or TLOS. Effective July 1, 2013, TLOS brings together the array of activities, services, and leadership in online and other technology-enhanced learning already in place at Virginia Tech. This new structure combines existing resources of the former Learning Technologies, the Institute for Distance and Distributed Learning, and Video Broadcast Services to position Virginia Tech as a national leader in online and technology-enhanced learning, and to provide "one-stop shopping" for development, support, and delivery of online and distance education content, courses, and programs. TLOS is the home to services for teaching and learning across the university, including distance learning programs, online content for on-campus courses, and hybrid courses. Dale Pike was named in January as the incoming Executive Director, effective March 3.
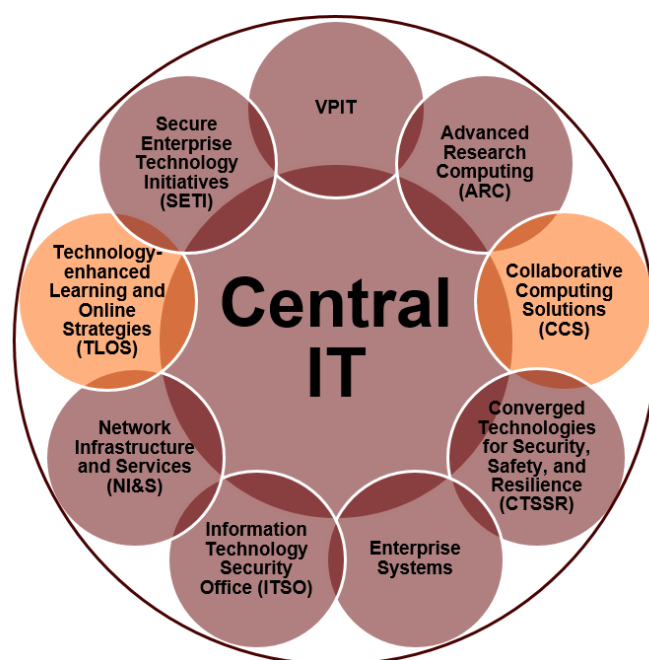
Another organizational change is the creation of Collaborative Computing Solutions (CCS). The group works to ensure that Microsoft Windows enterprise solutions are scalable, stable, and secure. This reorganization puts the vertical workflow supporting Microsoft-based solutions in one unit, increasing the effectiveness of managing and securing those solutions. One expected result of this change will be a timely rolling out of a revitalized on-premises Microsoft Exchange service and Microsoft's SharePoint Online during FY 2015.

The Information Technology organization must also respond to changes and needs that arise outside of our group. December 2013 saw the advent of the new winter session. A new academic session for the institution, the first winter session enrolled more than 1000 students from late December through early January in online courses, residential courses, courses with blended residential and online work, and study abroad opportunities. The session's opportunities benefitted both continuing Virginia Tech students and visiting students. Support was provided from throughout Information Technology, including additional help for students and instructors, systems maintenance, and direct systems support to administer the new academic term.

The list of new offerings from Information Technology that were newly available for FY 2014 reflects the hard work from throughout the IT organization and with our partners. They include moving the HokieSpeed high-performance computing cluster to production, new and easier ways to connect to VT Wireless, distributed scanning for exams and surveys, Going Google, InCommon Silver for federated authentication, a new risk assessment template, a research management tab in My VT portal, rolling out the Restricted Limited Access Network (RLAN) to selected departments, Time-Clock Plus, the introduction of WebEx conferencing and Echo360 lecture capture, and unified messaging.

FY 2014 also saw one of the organization's largest projects to date moving towards successful completion. The multi-year program of Unified Communications is a set of projects that figures prominently in Pillar 3, but which you will see in several places throughout the report. This program provided the impetus and resources for major upgrades of the on-campus network to help the institution meet twenty-first century voice and data needs. As we approach the end of calendar year 2014, the migration of services will be substantially completed. The program continues with upgrading cabling inside campus buildings and rolling out new features.

Information technology has never been more important to major research universities, including Virginia Tech. Properly conceived and applied, information technology presents exciting opportunities for Virginia Tech to achieve new levels of effectiveness and transformation in its teaching, research, and outreach missions. I am proud of the achievements and commitment to service of my colleagues in the IT organization. There are, of course, areas where we must improve our operations, grow our capabilities, and transform how we serve the institution. I look forward to working with the IT organization and our partners across the university and beyond to realize the goals of the IT Strategic Plan to help move the university toward the aspirations of "A Plan for a New Horizon" and positioning the IT organization for the future.

Scott F. Midkiff
Vice President for Information Technology and Chief Information Officer
September 3, 2014

Information Technology Financial Highlights

As a measure of the organization's responsible use of resources, as well as a means to convey basic size and scope of the organization, each year the annual report offers financial metrics. In FY14, Information Technology reflects 70% of what was formerly IDDL, including an operating budget of about $400,000 and operating expenditures of about $220K. The balance of budget and expenditures in this fund category are for building upgrades in the Torgersen museum and other spaces in Torgersen to accommodate the personnel moves associated with the reorganization.

Fiscal Year 2014

	Total budgeted	Total expenditures
Educational and general funds	36,444,884.20	36,074,898.62
Distance Learning-Degree (IDDL Ent)	1,222,315.89	613,363.76
Equipment Trust Funds	4,767,420.39	4,725,785.55
Auxiliary operations	22,549,934.00	20,914,993.26
Sponsored grants and contracts	2,940,163.48	1,782,658.98
Continuing Education Funds	65,230.90	9,747.22
Overhead funds	1,030,643.18	17,281.09
Other sources	208,558.57	162,289.71
Total	69,229,150.61	64,301,018.19

Fiscal Year 2013

	Total budgeted	Total expenditures
Educational and general funds	$31,356,693	$30,160,136
Distance Learning-Degree (IDDL Ent)	8,436	3,048
Equipment Trust Funds	5,307,883	5,099,323
Auxiliary operations	22,876,634	20,725,560
Sponsored grants and contracts	2,784,253	1,317,432
Continuing Education Funds	77,386	19,568
Overhead funds	965,217	42,516
Other sources	186,466	160,223
Total	$63,562,969	$57,527,808

Office of the Vice President for Information Technology: Unit Descriptions

Administration and Planning

The Administration & Planning group plays a variety of roles for the Information Technology organization (IT). Areas of responsibility include strategic planning for IT; policy development for information technology; communications within IT and with the university community; project coordination between elements of IT; project management; personnel services for IT; administrative requests; computer purchasing and software distribution (Information Technology Acquisitions); and coordination with the commonwealth's information technology agency.

Advanced Research Computing (ARC)

Advanced Research Computing (ARC) at Virginia Tech is an innovative and interdisciplinary environment advancing computational science, engineering and technology.

Collaborative Computing Solutions (CCS)

Collaborative Computing Solutions (CCS) provides the Virginia Tech community with stable, scalable and secure customer-focused systems, services and solutions.

Converged Technologies for Security, Safety, and Resilience (CTSSR)

Converged Technologies for Security, Safety, and Resilience (CTSSR) serves as a premier source of information technology expertise and applied knowledge, crafting solutions to emerging issues related to the security, safety and resilience of communities.

Enterprise Systems

Enterprise Systems provides the university community with information technology and support to complement its teaching, learning, research, and outreach as well as to serve administrative operations. Enterprise Systems supports

- Banner and other university-wide central administrative systems;
- core administrative information and services through database support and through operational software implementation, development and maintenance;
- web hosting projects, Filebox, content and knowledge management;
- data analysis and decision-making through data warehousing and decision support tools.

Information Technology Security Office (ITSO)

The Information Technology (IT) Security Office (ITSO) provides technology tools and services, education, awareness, and guidance necessary for all users to work towards a safe and secure information technology environment for teaching and learning, research, outreach, and the conduct of university business. The office is also responsible for the IT Security Lab, which focuses on **e**ducation and research in computer and network security. Faculty, staff, and students work cooperatively on a variety of projects to enhance the security of systems and networks.

Network Infrastructure and Services (NI&S)

Network Infrastructure and Services (NI&S) exists to enable Virginia Tech to succeed in its overall mission by providing and managing the university's information technology infrastructure and services. We accomplish this by

- identifying and incorporating solutions through the dynamic implementation and management of emerging technologies
- promoting sound fiscal management
- endeavoring to advance the capabilities of our existing information technology infrastructure and services
- broadly disseminating information regarding new technological developments
- providing network, system, and services management, maintenance, and support with emphasis on a high level of security, availability, and reliability
- supporting the teaching and learning, research, and outreach missions of the university, while embracing our role as a corporate citizen within the local, state, regional, and international communities
- remaining sufficiently flexible to pursue aggressive development and expansion of new services

Secure Enterprise Technology Initiatives (SETI)

Secure Enterprise Technology Initiatives (SETI) develops and supports secure, robust web applications, middleware, online directories, and authentication that integrate with teaching, learning, research, and outreach services throughout the university. Our mission is accomplished by

- developing Enterprise Directory middleware, based upon the Internet2 MACE architecture, to implement business logic for managing identities and provisioning the university's ubiquitous personal identifier, the PID;
- supporting authentication and authorization services including the Enterprise LDAP Directory, Central Authentication Service (CAS), and Shibbolet;
- providing a Public Key Infrastructure (PKI) to support the issuance of trusted digital certificates that can be used for authentication, digital signatures, and to facilitate encrypting information while at rest and in transit;
- ensuring quality software development and security through testing and verification for services developed and supported by SETI and other Information Technology departments;
- assisting with deployment planning, bug tracking, problem reporting and resolution.

Technology-enhanced Learning and Online Strategies (TLOS)

Technology-enhanced Learning and Online Strategies (TLOS) leverages an array of activities, services, and leadership in online programs and technology-enhanced learning to significantly benefit student learning with a range of high caliber, technology-enabled programs and activities. TLOS will collaborate with colleges and departments on advancing technology-enhanced learning by incentivizing and supporting highly effective distance learning programs, online content for on-campus courses, and hybrid courses.

Enabling Networked Learning

Pillar 1—enabling networked learning in the networked university—supports the university's strategic plan to reshape the educational landscape, by "creating unique opportunities to enhance classroom and online education" (p. 14). The university's long-range plan also recognizes the importance of providing faculty members 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" (p. 15).

"Networked learning" reflects the permeable boundaries between disciplines, among technologies—indeed, among people. It recognizes the interconnection of disciplinary expertise, pedagogy, and technology to improve the quality, effectiveness, and efficiency of teaching and learning. Networked learning also recognizes the interconnection of innovation, training, and faculty development. Networked learning includes the anytime, anywhere connectivity between students and course content, and between students and a learning community, knowing that this connectivity can benefit all of our students, both on campus and at a distance.

To support the "Plan for a New Horizon", Pillar 1 of the strategic plan seeks to help faculty develop technology-enhanced learning strategies, to enhance learning environments with current and emerging technologies, and to incorporate computational thinking into Information Technology activities. Throughout the report on Pillar 1, these goals inform the several initiatives that are being undertaken.

Supporting online and technology-enhanced education

A long-standing core element of Information Technology's support for instructional personnel—both faculty members and graduate teaching assistants—in years past has been the Faculty Development Institute. Beginning July 1, 2013, Networked Learning Initiatives (NLI) became the re-envisioning of that long-standing institute. NLI is a cross-discipline professional development program available to all Virginia Tech faculty and graduate students. Hundreds of sessions and special events throughout the academic year are offered, along with a limited enrollment program in the summer for participants in the computer refresh program. These offerings are designed and delivered by University Libraries, Advanced Research Computing, Technology-enhanced Learning and Online Strategies (TLOS), the Information Technology Security Office, and many more.

The new Networked Learning Initiative offers hundreds of classes, workshops, and other engagements throughout the academic year.

Structured support for teaching and learning

In the fall, NLI began to move away from the model of faculty development only in the spring or summer term that a faculty member was eligible for a new computer; instead, NLI focuses on faculty learning as an ongoing process. Faculty members explore technology-enhanced teaching, learning, research, and outreach/engagement as they earn their NLI 'computer credits' throughout their four-year computer refresh cycle. In addition, NLI now has a focus on technology-enhanced active learning (T.E.A.L.). During this first year of NLI, faculty members selected for computer refresh eligibility were encouraged to explore curricula in thematic groupings—engaging learners, research and discovery, visual media and web design, T.E.A.L. tools, securing your technology, programming and software, and online strategies and eLearning. Additional offerings are provided by Advanced Research Computing and field trip explorations of the Institute for Creativity, Arts, and Technology and of the Visionarium.

NLI also saw an overhaul of its enrollment system that enables faculty to register and instructors to track NLI offerings, replacing a dated system that was used for many years prior. This new system has a fresher, cleaner look and aligns with this new vision for NLI. In response to feedback, the sessions throughout the year were scheduled following the university's class schedule, to better fit with faculty members' calendars. Summer programming moved from broad, survey-type coverage for three days to topic-focused sessions scheduled for 1.5 days. TLOS colleagues also addressed faculty requests in the National Capital Region (NCR) for specific curricular/pedagogical redesign needs and created a unique TLOS in the NCR NLI cohort-based curriculum. TLOS staff made three trips to the NCR sites to work directly with individuals and groups of faculty members. In FY14, 25% of all faculty members participated in NLI sessions.

Support for graduate teaching assistants is structured primarily through GEDI—the Graduate Education Development Institute. In addition to orientation workshop for more than 650 new graduate students, 101 graduate students, including two in the National Capital Region, completed the Contemporary Pedagogy graduate seminar. Four students completed the Advanced Teaching with Technology independent project option for additional graduate credit. NLI also partnered with the Graduate School to support the Global Perspectives Program with GEDI courses, which provides a select group of graduate students with the opportunity to learn about and engage with higher education abroad.

Structured support is also available to faculty and graduate students for the use and advocacy of ePortfolios. ePortfolios offer opportunities to learn through reflection, along with capabilities to document learning. The ePortfolio project works to improve education, learning assessment, and student engagement by using collaborative online tools that take advantage of the latest technology. ePortfolios offer ways to showcase individual skills, student learning, and professional development. ePortfolios add digital technologies to the portfolio tradition, enabling video and multimedia presentations, as well as simplifying data collection. Portfolios have been used for decades in education as a tool for sharing and reflecting. ePortfolios re-enliven that process by adding to the mix the digital technologies that allow for multi-media presentations and easier data collection. ePortfolios are now used in every college across the university.

In 2014, the ePortfolio NLI curriculum focused on long-term adoption strategies for engaging students in active learning. The offering broadens the curriculum beyond "Overview of ePortfolios" to sessions on ePortfolios as catalysts for high-impact practices, digital storytelling, and blogs as reflective learning spaces. Also involved are showcase and brown bag sessions for faculty to share experiences in adoption.

Faculty participate in an NLI session

"Connect to Learning: ePortfolio, Engagement and Student Success" is in the final year of a 3-year project coordinated by LaGuardia's Making Connections National Resource Center in partnership with the Association for Authentic, Experiential, and Evidence-based Learning (AAEEBL), an emerging international professional association with 100 institutional members focused on ePortfolio practice. Funded by the Fund for the Improvement of Post-Secondary Education, the Connect to Learning project works with a dynamic national network of 24 campuses—community colleges, private colleges and research universities. Contributing to a structured matrix model of ePortfolio development, campuses develop and test the strategies for improved student learning outcomes.

This year, the model, "Catalyst Model for ePortfolios" outlined the necessary components of programs for the adoption and growth of ePortfolios at large scales.[1] Fourteen spring NLI sessions and a week-long summer faculty development seminar worked with long-term adoption and revision strategies for programs that have been using ePortfolios for several years.

In April 2014, the second annual Undergraduate ePortfolio Showcase gave 12 undergraduate students the opportunity to speak to an audience of approximately 65 faculty and students about their research, service, and learning, and about how the use of ePortfolios and other technologies have afforded them new perspectives and skills. The presented ePortfolios include two from each of the six award categories—leadership, mentorship, learning, professional growth, service, and research.

"Spreading the word" about e-portfolios were Marc Zaldivar and Teggin Summers (TLOS), invited as keynote speakers to the JaSakai Conference in March 2014 in Nagoya, Japan. In addition, they were asked to visit and present at Kumamoto University and Kyoto University to discuss adoption of ePortfolios at large-scale universities and to plan for future collaboration in the development of ePortfolio technology and pedagogy internationally.

Summers and Zaldivar in Nagoya

The Southeast Regional Conference of AAEEBL was hosted at Virginia Tech in November 2013. A regional offshoot of the larger international group, it had 85 people in attendance. The keynote was given by Jennifer Sparrow, a TLOS leader, and the most popular sessions were the panel of student adopters from architecture, English, SERVE (the service-learning living community) and education programs at Virginia Tech, as well as a student showcase of ePortfolios, where faculty got a chance to ask students directly about their efforts and interests in ePortfolio work. The

The president of AAEEBL reviews the ePortfolio of a Virginia Tech student

Networking Café at the conference hosted conversations and collaborations among all attendees. Presenters came from the University of Cincinnati, Stetson University, University of Michigan, and others, in addition to closer institutions of Radford University, University of Virginia, and, of course, Virginia Tech. Marc Zaldivar is also on the Board of Directors. In addition, Marc Zaldivar, Teggin Summers, and Jennifer Sparrow (all of TLOS) conducted a half-day pre-workshop session at EDUCAUSE 2013 called "Reimagining the 'E' in E-Portfolio: Emerging, Engaging, and Enriching Technologies for Teaching and Learning." Shelli Fowler (TLOS) was invited to serve as the keynote for the upcoming EDUCAUSE Connect session in Atlanta.

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[1] http://c21.mcnrc.org; http://vt.mcnrc.org

On-demand support for faculty, students, and staff

This year, 32 faculty members were involved in three cohorts for the development of 36 total courses.

The InnovationSpace fosters creativity in the university and public through multimedia by offering on-site state-of-the-art equipment, walk-in assistance, scheduled consultations, and equipment loans. This year, more than 10,800 students and 1,000 faculty and staff members utilized the InnovationSpace open lab which addresses discovery, incubation, and delivery of technologies. InnovationSpace provided approximately 40 student-led iLearn workshops with over 260 people attending, increasing student engagement and digital fluency.

Lynda is another on-demand, customized method of support. The lynda.com library is available 24/7-even from mobile devices. Entire courses or single tutorial videos can be viewed as needed, while exercise files let users practice, and bookmarks help track personal access. FY14 saw an increase to 220,947 videos viewed for a total of 15,444 hours of viewing time. In FY13, there were 182,562 videos viewed at 13,170 hours of viewing time. These data indicate that Lynda is growing in use but is still underutilized as an asset—only 9,000 users have accounts, and only 2,000 login each month, while the university is licensed for 37,000 users.

More than 10,800 students and 1,000 faculty and staff members used the InnovationSpace this year.

Teaching toolkit

Information Technology offers an array of supportive technologies broadly useful for instruction, as well as for other activities. Through structured or on-demand sessions, the university community can get support for these tools, although most are intended to be intuitive enough for immediate use. Below are thumbnail sketches of upgrades and usage statistics for these tools.

- The WordPress platform continues to grow in use and popularity. TLOS has over 7000 user accounts and over 9000 blogs sites.
- A new initiative implemented changes in support for the long tradition of test scoring. InnovationSpace distributed twelve Datalink optical scanners across campus to allow for easy instructor access and increased scoring flexibility.

Course redesign

FY14 saw a significant expansion of Information Technology's capabilities with respect to instructional design and assessment when the Institute for Distance and Distributed Learning (IDDL) joined with Learning Technologies to form Technology-enhanced Learning and Online Strategies (TLOS). Previously, IDDL specifically focused on course redesign for online environments, but broadened its focus and models as part of the reorganization to more generally support course redesign, particularly those featuring technology-enhanced learning. Lead responsibilities are within the TLOS group Network Learning Designs and Strategies (NLDS).

Based on past year's feedback and assessment, one of this year's changes was the introduction of a cohort approach for collaborative professional development that structures course development projects. This year, 32 faculty members were involved in three cohorts for the development of 36 total courses. All but six persisted to completion. The completing faculty members participated in a showcase event, with invitations to faculty members across the university. Faculty engaged in cohorts focused on developing courses are, upon completion of that development, featured in a 'Showcase' event to which departments and faculty across campus are invited. In addition, TLOS has been in active conversation and collaboration with the

library and continues investigation of different repositories, including the VTechWorks and Discovery Commons repository for housing learning objects created through the course development process.

NLDS offered certifications in Master Online Instructor, Course Interaction Design Specialist, and Technology-enhanced Course Design Specialist. These certifications were earned either through participation in cohorts completing full course development or attendance in a series of NLI sessions provided by NLDS. NLDS also hosted a focus group of faculty interested in the creation, identification and use of learning objects in their courses. The results of this faculty group will be used to guide the continued investigation and work in this area.

NLDS facilitated project-based learning communities focusing on flipped classroom design, strategies for technology-enhanced learning, and effective online teaching and learning. These communities included faculty inquiry groups in which panels of faculty members presented their outstanding work for discussion and brown bag lunches for open discussion of issues and trends in technology-enhanced teaching and learning.

NLDS instructional designers and instructional support specialists provided individual consultations to faculty members on a weekly basis at about an average of 5-7 consultations per week.

Advancing a new grant program to encourage innovation in instruction

The design and initial implementation of a wide-reaching TLOS grants program began in FY14. The grants program brings together initiatives in three areas, guided by the newly formed TLOS Stakeholders Committee with representation from academic leaders across the institution.

The Center for Innovation in Learning grants were re-launched as Innovation in Learning seed grants. These grants seek to stimulate, support, and assess innovation in teaching and learning. Criteria for funding were that the work has the potential to scale, is differentiated from existing core practices, and is intensely aspirational. Grants awarded this year included work that focused on using Google Glass for teaching and learning, attempts to measure how students intermingle their personal lives with the ways they understand learning and research, the creation of an e-portal for inquiry-oriented learning in linear algebra, and fostering collaboration in digital construction and manufacturing.

The Provost Course Development Awards were suspended for one semester (Spring 2014) but funded 12 projects in Fall 2013 and six in Summer 2014. All funded projects were completed on schedule with all awarded funds distributed. A new description of the awards, the request for proposal process and timeline was created for review by the TLOS Stakeholders Committee.

The 4-VA Grants Initiative was reconceptualized and refined with the assistance of the TLOS Stakeholders Committee. The initiative is intended to advance the mission and goals of 4-VA within the context of Virginia

Tech. The 4-VA Collaborative is a program between Virginia Tech, James Madison University, University of Virginia, and George Mason University. 4-VA's mission is to promote inter-university collaborations that leverage the strengths of each partner university in order to accomplish much more than any individual university could achieve alone. Prior to the reconceptualization of the program, 4-VA at Virginia Tech received several shared courses from partner institutions in foreign languages, funded a major course redesign effort in Math and Biology (www.vtnews.vt.edu/articles/2014/04/040114-science-activebioclass.html), and supported several collaborative research grants between researchers at Virginia Tech and partner institutions.

"A more active approach that mimics what biologists actually do is needed and it's a challenge based on the number of students. The scale of what we're trying to do makes this stand out; eventually we'll put 1,300 or more students per year through this program." Brenda Winkel, Biological Sciences Department Head

This grants initiative will fall into three categories, to be launched for FY15 as the academic year begins:

Competitive research grants are intended to improve research competitiveness within the commonwealth and at Virginia Tech by providing funding for faculty to engage in pilot research that could be used as a springboard for subsequent, major federal grants. Active dissemination of outcomes is a key requirement. The grant program issues a request for proposals.

Course redesign grants support the redesign of courses in STEM—science, technology, engineering, math—or a foreign language, connect to the Pathways to General Education program at Virginia Tech, and require the support of the applicant's department and college. Active dissemination of outcomes and materials is a key requirement to be addressed in the proposal.

Course sharing grants support the faculty interested in sharing a STEM or a foreign language course with 4-VA partner institutions and require the support of the applicant's department and college. Active dissemination of outcomes and materials is a key requirement. As with the others, a responsive proposal is required.

Sharing innovative strategies beyond the university

Information Technology supports the teaching and learning community through programs that encourage sharing of innovative strategies. In addition to programs noted above which shared strategies within and beyond the campus community (e.g., AAEEBL), the Distinguished Innovator in Residence program brings others to campus. The program was established by TLOS, and created a partnership with the University Libraries to bring innovators to campus every year. Jer Thorp filled that role during this year, talking with faculty and students about big data, data visualization, and computational thinking. On March 20, Thorp, an artist and educator known around the world for making the biggest data sets beautifully accessible, gave a keynote address, "Making Big Data Human," the in Graduate Life Center auditorium. Over the course of his two-day visit, he shared perspectives on data mining and data ownership and privacy with students and faculty in the Honors Residential College; spoke with the faculty involved in re-inventing general education on the Pathways to a General Education Curriculum; and, gave his keynote address on the topic of humanizing big data—all in effort to increase campus-wide awareness of data visualization and computation thinking as relevant to all disciplines. He also met with faculty and students in the master of fine arts in creative technology program at the Institute for Creativity, Arts, and Technology (ICAT), and provided one-on-one feedback to several computer science and creative technologies students' works-in-progress.

Assistive Technologies extended expertise beyond Virginia Tech through consultation with other higher education institutions on the production of braille texts, an area in which Virginia Tech has shown a strong leadership role. Assistive Technologies also met with the Virginia Department for the Blind and Vision Impaired to begin investigating whether braille materials produced at Virginia Tech could be made available to other vision impaired students. Assistive Technologies worked with programs for high school students, including planning for STEMability programming; participating in the Youth Leadership Forum, a Virginia initiative to encourage students with disabilities to take advantage of assistive resources; and supporting the Higher Achievement Organization, a group that seeks to encourage interest in post-secondary education for underprivileged middle school students.

Lujean Baab (TLOS) was selected as a recipient of the "Best-in-Track" award in the K-12 Online Education track for the 2013 Annual Sloan Consortium International Conference on Online Learning for 2013 for her presentation on managing group work online.

Defining an institutional approach to online learning

"The Plan for a New Horizon" calls on the university to "develop an appropriate infrastructure for e-learning", including a defined institutional approach to online learning. Information Technology is one of the lead units in fulfilling this charge. The changes made to programs to support faculty and graduate students outlined in the previous section form the basis for nurturing a culture of networked learning.

Emerging technologies

One of the tenets of an institutional approach to online learning is evaluating emerging technologies for applicability and effectiveness for teaching and learning.

InnovationSpace creates opportunities for faculty, staff, and students to explore, implement, evaluate, and champion new technologies that enable and support a networked university and digitally fluent faculty, staff, and students. The open lab is one setting for such opportunities. InnovationSpace continues to coordinate hands-on technologies for teaching and learning, such as its iPad long term loan program with over 200 loaned out for classes and research. The program is intended to increase digital fluency, student engagement, and access to mobile technology.

InnovationSpace and the Tech Teams Advisory Board this year launched the Tech Teams Initiative, a program to research emerging technologies and to create a sandbox environment for testing. The Tech Teams initiative created a sandbox template, with places to recommend advancement and discuss limitations, informing decisions on advancement or retirement of the emerging technologies tested in the sandbox. Tech Teams tested three emerging technologies this year—Beam TelePresence robots, Google Glass, and Lecture Tools. White papers summarize the results and are posted on the Tech Team blog (http://blogs.lt.vt.edu/techteams/). The projects implemented during the spring 2014 Tech Teams program modeled the phases of innovation, including pilot testing, assessing, communicating, and promoting successful use cases.

Google Glass, investigated by Tech Teams

Additional monitoring of specific emerging tools and practices can be seen through various projects facilitated by the Innovation Space team, such as development work with Google Glass, syndication support for Wordpress blogs, facilitation of the Division of Student Affairs mobile application, and promotion of the Beam TelePresence robots,

With the Tech Teams work, the Beam TelePresence project was launched with three Beam robots. One Beam robot has been loaned to the National Capital Region. Since its promotion at Virginia Tech, the Beam has been used to enrich distance learning courses and telepresence meetings. The Beam made its first appearance in the Northern Virginia Center during a March reception for then-future president, Timothy Sands. The Department of Human Development used the Bean for interviewing applicants, facilitating discussions about learning experiences, and other conversations that felt more intimate than less flexible technologies. (http://ncr.vt.edu/highlights/Highlight-070214.html).

The Innovation Space team has provided a significant amount of support and promotion for digital storytelling, which is an ePortfolio-related emerging technology that enhances and deepens the creation and curation of personal learning and also worked with and facilitated the TEDxVirginiaTech talks, in conjunction with the Institute for Creativity, Arts, and Technology (ICAT).

Faculty and staff are encouraged to engage with emerging technology through Network Learning Initiatives' New Media Faculty Seminar, a twice-yearly offering that brings together faculty members from across the institution to focus specifically on developing the digital imagination and cultivating interest on emerging technologies.

The XCaliber Award program adds to the visibility of successful emerging technology projects. This program "recognizes faculty, graduate teaching assistants, and teams (faculty/ staff/ students) who have made significant contributions to integrating innovative technology in teaching and learning in a course or in a significant technology-enriched project" (https://tlos.vt.edu/xcaliber_awards/)

Collaborative opportunities

Another facet of approaching online learning is collaboration. The richer and more varied environments of online learning require collaboration with new partners, well beyond the roles that facilitate traditional classroom settings.

Mobile applications are a facet of online learning that have increased and that require collaboration over a range of expertise—content, technical, and usability specialists, and also expertise in contracts and licensing. Information Technology and University Relations collaborate in seeing that these needs are met, including the required security for university data that could be used in mobile apps. Information Technology is the registration authority for apps that are issued in the name of Virginia Tech on Apple and Android distribution channels. This year, Information Technology assisted the Division of Student Affairs in the concept development for a mobile application. This effort served to advance digital fluency as students experience the university's Aspirations for Student Learning.

Considering how to effectively preserve, archive, and access a repository for learning objects has been the focus of a collaboration with TLOS, the CIDER—the Center for Instructional Design and Educational Research, and the University Libraries. Learning objects are reusable digital resources that provide learning resources. Creating a repository for learning objects is an essential component of being able to reuse them for flexible learning. Two key repositories were suggested and are being considered for defined use: the DiscoveryCommons and VTechWorks.

Collaboration with faculty members in Academic Advising, First Year Experience, the College of Agriculture and Life Sciences, and the Center for Instructional Development and Educational Research helped publicize the online teaching and learning best practices used in course design and development for Virginia Tech courses. TLOS collaborated with First Year Experiences and other faculty members to plan, film, produce, and deliver multimedia projects in support of University Honor Code.

Information Technology pursued several partnerships with ICAT in this space. TLOS faculty affiliated with the ICAT received seed grant monies and created two projects around virtual and augmented reality versions of local, historic landmarks and communities. The projects not only create hand-on opportunities for faculty collaborating across disciplines (technology, visual arts, history, education, computer science) but also provide much needed community outreach and visibility.

Information Technology helped reduce an equipment package price for the Moss Center for the Arts from $2,000,000 to $1,200,000.

These collaborations, and others, will continue to inform planning and implementation priorities in TLOS as well as priorities in the tools and environments TLOS supports.

Virtual learning spaces

Creating virtual learning spaces incorporates many domains. Content—whether instructor-created or the outcome of students' active learning work—must be produced, stored, secured, and managed. Channels of distribution and virtual space for engagement needs scalable technologies. And courses must be managed, by and for learners, instructors, assessors and accreditors, and managers of university records.

Digital citizens-digital campus

But first, students must be ready to be digital citizens in the 21st-century learning environment. TLOS has promoted and explored a 'digital campus/digital citizenship' initiative that includes the work with the Division of Student Affairs and facilitation of the Aspirations for Student Learning mobile application. Activities in the initiative also include Wordpress blogs—a research blog for the College of Science; blog syndication for the School of Architecture; and blog syndication for the Center for Leadership and Global Sustainability. These blogs promote a 'digital campus' and the networked culture of Virginia Tech. The InnovationSpace also developed and supported the virtual Graduate Life Center, as well as OpenLife, which has been used to create a virtual learning space for a digital photography course. Through the OpenLife and the course, faculty members and students were better able to understand the uses of virtual learning spaces. Learners' digital imagination is fostered when students to "walk" through a virtual art gallery.

Twenty-first century learning environments must meet the requirements posed by a varyingly abled population of learners. The Assistive Technologies group within TLOS has, as their mission, both providing services and helping everyone understand needs and available services as they relate to learning environments and endeavors. During the year, fifteen students and two employees were assisted on an individual basis, and NLI courses were offered on note-taking devices and accessible attachments. Educational efforts included both individual meetings, seminars, and events such as the Hokie Wellness Benefits Fair. Web accessibility was the subject of consultations with colleges, university administrative areas, and individuals. Research included the project, "Situated Touch Audio Annotator and Reader (STAAR) For Individuals with Blindness or Severe Visual Impairment," and work on three-dimensional manipulatives to enhance learning for blind students.

Creating and storing

Information Technology in FY14 laid the groundwork to increase its production of video and multimedia content production. Short security videos were created for NLI workshops. TLOS through its Digital Media Services (DMS) unit completed a two-year project to identify, specify, and budget for the purchase of new equipment for the television studio and newsroom for the Department of Communication in the Moss Center for the Arts. During the summer of 2013, DMS reviewed and revised equipment lists and specifications with broadcast engineering consultants and reduced the initial equipment package price from $2,000,000 to $1,200,000. DMS assisted the department and the Office of the Provost with purchasing

review, equipment receiving, and inventory control of the new equipment. DMS oversaw the change orders, equipment installation, and commissioning of the new facilities, assuring that the newly outfitted teaching environment was available in time for the start of Fall 2013 classes.

Content capture and video production for use in the teaching and learning environment was newly supported this year with the installations of Echo360. (See Pillar 3) Echo360 is supported by NLI workshops on content capture and one-on-one sessions with faculty. TLOS also emphasized the expansion of synchronous and asynchronous collaboration technologies via the implementation of WebEx (Pillar 3).

Securing

Part of preparing Virginia Tech for 21st century learning environments involves determining effective ways to remotely verify identity and engage in successful exam proctoring and online testing. TLOS began work in this area by conducting extensive benchmarking research and outlining key considerations in a white paper on the topic. In the coming year, a working group will take the first steps developed via the benchmarking process to develop a plan for how to effectively manage this increasingly important arena for the institution.

Managing

Ongoing support for the current learning management system, Scholar, was the primary work for FY14, with several regular releases during the year and fixing problems. Scholar experienced zero unplanned downtime the entire fiscal year—a major accomplishment for the organization. By improving FAQs, online help, training for faculty members, and the group's partnership with

Scholar had no unplanned outages and saw a 200% increase in FAQ usage for self-service questions.

4Help to help them be more effective, the need to escalate problem reports from 4Help is decreasing, resulting in more timely responses for the faculty members and students who have problems. Use of Scholar FAQs this year grew dramatically, up over 200%.

Fiscal year	Number closed by TLOS	Number closed by 4help	Total	Percent completed by 4help	Notes
2014	1026	1667	2693	62%	
2013	1095	1490	2585	58%	Scholar + SPOT + WordPress
2012	1560	1400	2960	47%	Scholar only
2011	2116	1949	4065	48%	Blackboard turned off Dec 2010

SPOT, the Student Perception of Teaching survey run through Scholar, continues to be used across the university and supported by TLOS.

The coming fiscal year will see Information Technology beginning to plan for Virginia Tech's next generation learning management system, to ensure that faculty and students continue to enjoy a high quality, flexible system with increased support for mobile devices.

The channels on the rise are those support mobile access and applications. Moving materials and processes online better enables mobile access. Online availability of original source materials is a type of infrastructure in support of e-learning. The Imaging and Archiving staff (TLOS) works to preserve and make materials available. They were recognized this year for their work on the project to preserve the Marshall Plan through painstaking digital imaging work. The George C. Marshall Foundation thanked the Virginia Tech personnel on October 3. Paul Barron, director of library and archives at the foundation noted, "The results achieved by the Virginia Tech group exceeded our highest expectations. The scans were completed without having to unbind the book or damage it in any way, and the completed volume is of excellent quality." Imaging and Archiving also launched a repository site for agriculture related to agricultural engineering and Project 10 in Virginia, a direct link to the Smith-Lever act establishing Cooperative Extension.


Scott Midkiff, John Baird, Anne Moore, Paul Barron (Marshall Foundation), Verner Plott; photo by Gary Worley, Director, Imaging and Repository Initiatives

Fostering computational thinking across the university

Computational thinking is notably advanced in the work of the Advanced Research Computing unit (ARC), in both curricular and co-curricular activities. In 2014, ARC and TLOS sought to advance usage of the Visionarium Lab through tours via NLI field trips to the future. ARC also offered in a wide variety of NLI courses to promote computational thinking. In Fall semester 2013. James McClure, Nicholas Polys, and Eric Paterson developed and taught AOE 5984: Introduction to Parallel Computing Applications, a graduate-level course in parallel computing targeted toward engineers and domain scientists. It enrolled 18 students from 7 different departments. Curricular efforts also included service by Nicholas Polys on the Undergraduate Core Curriculum Committee, a participant in the formulation of 'Computational Thinking.' Other co-curricular activities support computational thinking. One example is the Virtual School of Computational Science and Engineering XSEDE Data Intensive Summer School hosted by ARC.

Specific support for faculty includes ten different hands-on classes presented by ARC faculty through NLI, including Parallel Matlab at VT and PARFOR, Parallel Matlab and Single Program Multiple Data, Introduction to ARC Systems and User Environment, Shared Memory Parallel Programming in OpenMP, Parallel Programming in MPI, Programming for the Intel Xeon Phi Architecture, Python, Parallel R, Deep Media, and High-performance Visualization.

Campus partnerships on funded work to advance computational thinking is another strategic focus for Information Technology. TLOS Senior Director Shelli Fowler served on the Curriculum for Liberal Education (CLE) Executive Committee and their sub-committee on computational thinking to bring expertise on computational thinking to reform of general education at Virginia Tech. Nicholas Polys also served on this computational thinking committee. In addition to participating in and supporting this funded program for reimagining general education, TLOS has dedicated funding via the Innovation in Learning grants for the coming year to also support curricular and pedagogical reform in line with CLE goals. Information Technology also provided network support to the VT Hacks student hackathon initiative, which is the largest hackathon in the Southeast and was held for the first time in 2014 in Cassell Coliseum. Hackathons encourage students to think outside the box to quickly solve a challenge, promoting computational thinking and digital literacy.
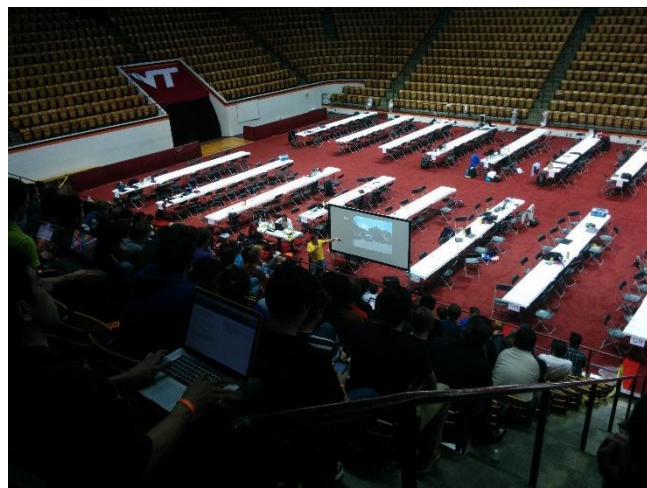
VT Hacks in Cassell Coliseum

Previously mentioned work on ePortfolios supports computational thinking in its activities, including the ePDN faculty network, the revised NLI curriculum, and the Undergraduate ePortfolio Showcase.

The Information Technology organization supports the application of computational thinking in real-world environments, in part, through dedicated projects and initiatives. In 2014, the hours of the Software Assistance and Education Center (SEAC) during the academic year to provide scaled up assistance for software installation to faculty, staff, and students. SAEC support is intentionally intended to help users effectively manage their own machines by giving them the tools and knowledge they need to do so.

The Software Assistance and Education Center saw a 43% increase in usage this year.

Fiscal year	Number served
FY14	1282
FY13	895
FY12	485

Support for computational thinking in applied environments includes engaging students with the organization. The InnovationSpace employs approximately 12 students during the school year and approximately six students during the summer. These students assist faculty, students, and the public in utilizing lab technologies and equipment. Some of these activities address computational thinking and all address digital fluency. Additionally, InnovationSpace student employees conduct iLearn workshops, which are free and open to all students and faculty. iLearn workshops cover a range of activities, often addressing skills and software for using digital media. Some elements of the iLearn workshops address computational thinking and all address digital fluency. The InnovationSpace student employees have a significant number of opportunities to work with and potentially be mentored by information technology leaders and faculty across campus. InnovationSpace student employees conduct consultations with faculty from every discipline and have opportunities to build relationships with these and other faculty in their industry.

This is the second year of four undergraduate interns—"eMentors"—serve as front-line help and guidance for student adoption of ePortfolios, blogs, and related technology. In partnership with Newman Library, the eMentors have a permanent table set up in a prominent space. Not only do they provide a clear place for students to find support, but also, the eMentors are often answering questions about what ePortfolios are and how (and why) students should start one. In that way, students are being brought to ePortfolios, digital storytelling, and blogging in order to express their own learning and professional development. NLDS

supervised four interns from the Education for Instructional Design and Technology program. NLI employs several graduate assistants to support courses. Collaborative Computing Solutions hosted two interns, and Secure Enterprise Technology Initiatives has an intern spot slated for the coming year.

Personnel from Information Technology taught or provided guest lectures in several courses across campus, bringing applied computational thinking capabilities to the classroom. InnovationSpace team members taught three courses and engaged in guest lectures, the Information Technology Security Office personnel taught two and provided guest lectures in several, Enterprise Systems personnel taught one, and staff in the Vice President for Information Technology offered multiple guest lectures.

Advanced Cyberinfrastructure

"A Plan for a New Horizon" recognizes that advanced computing – data-intensive, high-performance, and highly networked – is "crucial to facilitating advanced research" in areas of priority for Virginia Tech. Virginia Tech's long range plan notes that the "questions that can be asked and the methods and data sets that can be used to solve complex problems are being fundamentally altered by technology and the information sciences" (page 4). Pillar 2 is designed to support and advance this area of the "Plan for a New Horizon" and provide competitive advantage through sustainable advanced cyberinfrastructure and collaboration.

Cyberinfrastructure encompasses high performance computing (HPC), large-scale storage systems, visualization, HPC software and middleware, and advanced networking. Advanced cyberinfrastructure helps recruit top researchers, grow and sustain computational- and data-intensive research programs, and enable related graduate education.

To achieve these goals, Virginia Tech must scale up its cyberinfrastructure to support high performance computing, visualization, and other components of the Virginia Tech cyberinfrastructure at new levels. Information Technology must play a deliberate role in increasing the frequency and quality of collaboration in these areas, both within and outside the institution. Taking the lead on many of these efforts is Advanced Research Computing (ARC) for HPC and Network Infrastructure and Services (NI&S) for advanced networking. Advanced networking is reported on in Pillar 3.

Expanding access to cyberinfrastructure resources for researchers

During FY14, Information Technology expanded access to cyberinfrastructure resources both by increasing the resources available, and by seeking alternate means to expand access.

In recent years, leading edge HPC resources have been created in two ways. One method involves the computing resource itself being a research project investigating newer methods to advance HPC. For this reason, the stability and "uptime" of the computing resource remains an important strategic metric. Another method is to acquire high performance, stable computing resources designed for immediate use for research.

HokieSpeed is a GPU-accelerated supercomputing cluster. Each HokieSpeed node is outfitted with 24 GB of memory, two six-core Xeon E5645 CPUs, and two NVIDIA M2050/C2050 GPU. HokieSpeed follows the innovation path, notably pioneered at Virginia Tech by System X in 2003, for supercomputers designed to be faster, incorporating research ideas to create that speed. Engineering professor Wu Feng worked in collaboration with Information Technology's Advanced Research Computing unit and with the systems support area in Network Infrastructure and Services to initiate, test, and operate HokieSpeed as part of a research program. The goal was to move this research machine to production, available to all university researchers. That goal was achieved this year, with HokieSpeed turned over to university-wide access in March.

HokieSpeed supercomputer

In February 2014, the Intel Xeon Phi many integrated core architecture (MIC) was made available on BlueRidge. Computational capacity increased by 262 teraflops per second. Each of the 260 Intel MIC coprocessors on BlueRidge has 60 1.05 GHz cores and a theoretical peak performance of approximately 1 teraflop (double-precision) per second. The MIC is compatible with widely used multi-core CPU programming paradigms such as OpenMP and can be exploited in various ways to accelerate scientific

computations. In June, BlueRidge was expanded to 408 compute nodes, up from 318, and 18 high-memory nodes, up from 5. This expansion added more 30 teraflops per second. Several research groups and individual researchers migrated to the improved platform in 2014, including researchers from the Departments of Geosciences, Civil and Environmental Engineering, and Forest Resources and Environmental Conservation. June also saw the rollout of the Lustre Parallel File System, an 800 terabyte parallel file system dedicated to BlueRidge. Lustre allows larger and faster jobs at rates four times those of its predecessor.

An often overlooked but nonetheless critical task in maintaining HPC resources is decommissioning older service. This year saw the decommissioning of the Athena cluster, and migration of researchers from Athena to newer resources.

Available computing in production increased to 650 teraflops per second, up from 229 teraflops per second last year.

The resulting capacity of these changes is that research computing available in production through the Advanced Research Computing group is now 650 teraflops per second, up from 229 teraflops per second last year.

FY14 also saw a 40% increase to the storage system that houses ARC users' home directories and a simplification of the computing environment to improve stability and performance for the parallel file system.

Refinements to ARC's user environment included the following:

- Creation of groups and shared storage for labs and allocations
- Addition of in-memory mount for running jobs
- Addition of scratch-local storage mount for running jobs access to local hard drives
- Creation of location (/work/common) for fast access to shared input data
- csh/tcsh support

The second element of expanding access to high performance computing is to find better ways for researchers to make best use of the resources. The ARC Investment Computing Program was initiated this year in pilot model. The program implements a recommendation from the High Performance Computing committee, a presidentially appointed group that provides direction and helps consolidate university resources for research computing. Once fully launched, the program will allocate priorities and dedicated resources to researchers in the program, even when systems are at capacity. The model supports new university researchers by allowing start-up funds to purchase this capacity. Initial use is a trial by Kevin Wang, Assistant Professor, Aerospace and Ocean Engineering. His help with prototyping the concept this year has led to refinement and tuning of the program.

Dr. Troya's lab

In another example of research using HPC resources, Diego Troya, associate professor of Chemistry, uses over a million CPU hours a year on BlueRidge in his lab. He noted, "BlueRidge is many times faster than the prior computer we used to operate. A lot of problems that we couldn't tackle before BlueRidge have now become tractable." His lab is trying to carry out simulations of the molecular dynamics of collisions between the gases of the low-Earth orbit atmosphere and models of the polymers that are used as thermal blankets or protective paints on the spacecraft surface.

Dr. Diego Troya uses over a million CPU hours a year in his Chemistry lab.

ARC has added five new positions over the past five years to improve support and to scale up high performance computing efforts at Virginia Tech. Information Technology continues to seek an ongoing base budget for research computing needs. Currently, the High Performance Computing Committee identifies

needs to move the university forward each year, resulting in yearly funding assistance. The eventual—but not yet realized— institutional goal is to allocate 5% of externally expended research dollars to support high performance computing.

To seek more efficient use of resources, ARC also procured and launched a test cluster for Apache Hadoop in 2014. Hadoop is "an open-source software framework for storage and large-scale processing of data-sets on clusters of commodity hardware"[1] that will enable more efficient and effective use of ARC computational resources. Testing of the cluster will occur in 2015, with the potential for larger investment if successful.

Developing deeper infrastructure layers

In addition to managing and extending access to high performance computing, Information Technology manages the infrastructure underpinning the HPC resources. One effort is to create a new data center. A data center for the university has been placed on the 2014-2020 capital plan. Over the course of Fall 2013 and Spring 2014 semesters, a University Data Center Working Group documented needs and requirements, and propose alternative approaches to meet those needs. The group engaged in benchmarking activities, visiting multiple data centers, consulted with external entities with expertise in data center design, and conducted a preliminary survey of university researchers to better understand needs and interest. The working group prepared a needs report based on their findings. FY15 work will be the development of specific plans and design options.

Another critical support for HPC is the coordination between the Advanced Research Computing team and the Unix Administrative Services team (NI&S). The teams meet together three to four times each month to prioritize and coordinate activities for HPC. This year included initial use of task management software to enable documentation and tracking.

Increasing cyberinfrastructure-related collaboration

Collaboration between Information Technology and others both at Virginia Tech and elsewhere, takes forms of both information sharing sessions, shared resource use, and research collaboration.

This year, Virginia Tech hosted an inaugural day-long event to connect the campus community in a "computational commonwealth." The program included tours, short research talks, keynote addresses, and a poster session. The Virginia Bioinformatics Institute hosted a series of 12 minute talks by their faculty to introduce the campus to the many ongoing projects and ARC hosted an open house tour of facilities the Visionarium lab in Torgersen Hall and of the Andrews Information Systems Building. A keynote was given by Rick Stevens, University of Chicago and Argonne National Labs on how computational methods are revolutionizing biology. A panel of Virginia Tech faculty and Stevens discussed breakthrough applications of High Performance Computing and visions for the future. Student work and research labs were showcased with a plenary talk, a poster session, and reception.

The Office of Science in the Department of Energy (DOE) awarded nearly six billion core hours on two of America's fastest supercomputers dedicated to open science. The INCITE—Innovative and Novel Computational Impact on Theory and Experiment—program provides access to DOE's computing facilities at Oak Ridge and Argonne national laboratories. James McClure, computational scientist in Advanced Research Computing, was part of the team with Cass Miller (Environmental Science) and Jan Prins (Computer Science) of the University of North Carolina. They were awarded 60 million processor hours at Oak Ridge

Virginia Tech researchers were awarded 60 million processor hours at Oak Ridge National Laboratory.

[1] http://en.wikipedia.org/wiki/Apache_Hadoop

National Laboratory. Their project focuses on directional flows of fluids through porous materials at macro-, meso-, and microscales.

Information Technology personnel participated as principal investigators in varied sponsored research projects, generally in collaboration with university or industry partners. These include the following:

- National Science Foundation: US Ignite: FitGENI - The Impact of Video Fidelity on Fitness Efficacy
  Mark Gardner (Network Infrastructure and Services)
  $299,930.00
  This NSF project will assess the effectiveness of live fitness sessions broadcast via gigabit networking. Participation in regular group fitness programs and access to personal trainers is a way to improve the health of individuals, thus increasing lifespans and reducing the overall cost of healthcare.

- National Science Foundation: Campus Cyberinfrastructure—Network Infrastructure and Engineering Program: MARIA 100G—Accelerating Science for All Virginia Universities
  Mark Gardner (Network Infrastructure and Services)
  $323,774.00 award
  The MARIA 100G project addresses a known bottleneck point in the NatCap network aggregation facility operated by Virginia Tech on behalf of the research and education community in Virginia, including the research institutions who are members of the Mid-Atlantic Research Infrastructure Alliance (MARIA). The project is upgrading the aggregation link to the Internet2 national research network, from a 2x5 gigabit per second capacity shared by all institutions in the commonwealth to a 100 gigabit per second capacity. The removal of the bottleneck paves the way for the unimpeded exchange of dramatically growing data sets in the course of scientific discovery.

- National Science Foundation: Exploring the potential of mobile augment reality for scaffolding historical inquiry learning.

  Todd Ogle (Technology-enhanced Learning and Online Strategies), Co-PI
  $549,039.00
  This trans-disciplinary grant is designed to explore the use of augmented reality technologies in a way that explicitly teaches inquiry strategies and engages students to practice in an augmented real-world context, while scaffolding their progression while studying the history of Christiansburg Institute.

- American Battle Monuments Commission: Transatlantic Teacher Scholars Program: Change of Time and Place in the Meuse Argonne American Cemetery.
  Todd Ogle (Technology-enhanced Learning and Online Strategies), Co-PI
  Total: $350,000—Virginia Tech subcontract: $58,916.00
  This grant is a collaborative partnership between UNC-Chapel Hill and Virginia Tech. The goal of the grant is to build curriculum materials (digital book) that support the themes of ABMC and use this as a portal into preparing teachers to learn to teach about World War I.

Additionally, Marc Zaldivar (Technology-enhanced Learning and Online Strategies) was part of a 25-institution collaboration for the national grant "Connect 2 Learning," funded by the Fund for the Improvement of Post-Secondary Education. This project is developing a model, "Catalyst Model for ePortfolios," for successful adoption and growth of ePortfolio initiatives at large scales, resulting in a large compilation of research. Jeff Crowder is the principal investigator on the US Department of Commerce National Telecommunications and Information Administration: "Allegheny Fiber: Extending Virginia's Open Access Fiber Backbone to the Ridge and Valley."

Expanding cyberinfrastructure outreach

Collaboration and outreach came together in activities shared between Virginia Tech and the University of Virginia in high performance research computing. This year, the two institutions shared a booth with at SC13, the International Conference for High Performance Computing, Networking, and Storage Analysis, in Denver. The display highlighted work done by Advanced Research Computing staff and by Network Infrastructure and Services staff to support high performance computing at the university. The conference was attended by over 15,000 people from more than 50 countries.

Information Technology continues to support Mid-Atlantic Research Infrastructure Alliance (MARIA), a non-profit corporation co-founded by the College of William and Mary, George Mason University, James Madison University, Old Dominion University, the University of Virginia, Virginia Commonwealth University, and Virginia Tech. MARIA enables collaboration for development and sharing of high performance networks, computing systems, data storage, visualization, and other cyberinfrastructure to create a competitive advantage for research in the commonwealth. As noted above, 2014 saw a major National Science Foundation grant awarded in support of MARIA activities.

Through the mechanism of 4-VA, a collaborative of Virginia Tech, the University of Virginia, George Mason University, and James Madison University, Information Technology has increased the number of grants available to Virginia Tech faculty. FY14 saw a pilot of several collaborative research grants with 4-VA partner institutions, and FY15 will see the release of a comprehensive grant process with opportunities for reciprocal funding from 4-VA partner institutions. See http://blogs.lt.vt.edu/tlosgps/4-va-grant-initiatives/ for additional information.

4-VA is a collaborative of Virginia Tech, the University of Virginia, James Madison University, and George Mason University

Leveraging Information Technology to Distinguish the Virginia Tech Experience

"A Plan for a New Horizon" calls for Virginia Tech to create superior research, learning, and workplace environments essential to attract the best students, post-doctoral scholars, faculty, and staff. For example, a principal strategy for e-learning is to "continue to investigate, develop, and utilize current and emerging technologies to enhance traditional classrooms, provide mobile access, and expand high-quality distance-learning opportunities," and another is to "identify opportunities during construction and renovation to create flexible classroom spaces that fully support e-learning components" (page 16).

As an organization, Information Technology works with other units to enable these aims of the "Plan for a New Horizon" and distinguish the Virginia Tech experience in both its physical and virtual forms. Information Technology can provide innovative technology-drenched spaces, capitalize on the availability of highly capable mobile devices, and leverage converged technologies for the physical safety, security, and resilience of the university community throughout its several locations.

Through the goals of Pillar 3, Information Technology seeks to directly advance the "Plan for a New Horizon" to make Virginia Tech an institution with a competitive technology-enhanced environment in its physical and virtual spaces. Information Technology must also elevate the experience of people who use technology to work and study here by taking steps to embrace and enable the Bring Your Own Everything (BYOE) movement.

Creating financially sustainable, technology-drenched learning spaces

Components required in order to create sustainable, technology-drenched learning spaces, whether physical or virtual, begin with connectivity. The university's network for voice and data communications includes connections between Virginia Tech and the world, as well as connections throughout the campus.

The network

A requirement for bringing online technologies into classrooms and for serving virtual spaces, both locally and at a distance, is a high-capacity network. Major enhancements to both the network connections between Virginia Tech and the world, and within the university campus were made this year.

With the now-complete fiber optic construction project led by Virginia Tech and the Mid-Atlantic Broadband Communities Corporation (MBC), the region including Montgomery, Giles, Craig, Botetourt, Roanoke, and Bedford counties, has gotten a major boost in Internet bandwidth. The fiber is accessible and available to support any type of service delivered by any number of competing providers on equal footing rather than being monopolized by a single provider. It brings enormous capacity to the region and has generated enough revenue to cover the costs MBC expended. The project helps support data-intensive scholarship within the university, as well as the benefits it brings to the region. For example, this year a new link connecting to this network supplied the University of Virginia's research station at Mountain Lake with high performance networking, and, in one of the underserved communities the project was designed to help, the local telecommunications provider used the network as well. Negotiations in the fiber collaboration space produced an estimated $2 million in value to the institution and the region at no additional cost to Virginia Tech.

> **Information Technology negotiations on fiber collaboration produced $2 million in value to the institution.**

From cables to connections, the network needs to be robust. In the spring, Virginia Tech created a new high-performance data network exchange facility in Atlanta, Georgia. The new exchange improved reliability and capacity for access to national and international networks. The facility, named the Mid-Atlantic Research and

Education Exchange Atlanta, streamlines access to major centers throughout the southeastern United States, notably to research centers. The new facility complements another data network exchange already operated by Virginia Tech in the metropolitan area of northern Virginia outside the District of Columbia. With that rebuilt primary aggregation facility, both aggregation points support transfer speeds to 100 gigabits-per-second. The Atlanta facility also provides geographic diversity, backup connectivity, and direct peering connections with major research institutions such as Oak Ridge National Laboratory and the Centers for Disease Control. Virginia Tech partnered with the Georgia Institute of Technology to house the new facility and to establish the regional peering connections. Having two connections, one going north and one south, greatly enhances reliability and availability.

Connecting the Blacksburg campus to these high-performance networks is the infrastructure supporting the campus's core and border. This upgrade of equipment at the core of the university's data network and the switches which connect the campus network to the Internet occurred in early August 2013. This upgrade positions the university to conduct network maintenance with higher reliability, shorter resolution times, and minimal service impacts. Adding the diversity of network pathways similarly helps maintain connectivity. In addition to connections between campus and the world that had been housed only in the Andrews Information Systems Building, another connection was created in Hillcrest Hall, extending the redundancy of network connections.

Academic and residential spaces must also have high performance networks inside buildings. Information Technology collaborated with groups across campus to design or refresh academic and residential spaces. The heart of infrastructure starts with planning for new construction and major renovations. During the year, the staff in Network Infrastructure and Services worked with construction teams and Capital Design on new

Information Technology coordinates planning and deployment of the network infrastructure in new buildings, including the Signature Engineering Building.

buildings—the Signature Engineering Building, the North End Center, Human and Agricultural Biosciences Building 1, Southwest Chiller Plant, work on Rasche Hall's replacement, and several smaller projects. Early involvement with the design of new and renovated spaces helps ensure that cable pathways, placements of network connections, including wireless access points, and spaces for equipment can be fully integrated into the building or renovation design. Network Infrastructure and Services staff has begun meeting regularly with Capital Design staff to ensure appropriate collaboration before and during planning and construction. The Center for the Arts, opened in FY14, is an example of enhancing the technology capabilities within a structure from early planning and ongoing onsite inspections.

<u>Unified Communications</u>

The Unified Communications (UC) program provided the impetus and resources for major upgrades of the on-campus network. The network carrying the converged voice and data traffic must meet twenty-first century needs. The program comprised four projects: facilities, cable plant, network, and applications. The first, facilities, provides upgrades and construction for equipment and cable pathways. The cable project called for upgrades to at least 40 campus buildings where cabling was not up to current standards. The network project included the core-border upgrade, as well as creating aggregation segments to serve campus buildings. Improving wireless coverage and capacity (below) was another element of the network project. The application project is the most visible to the user community with its goal of migrating telephone equipment and service from the legacy ROLM system to the new Avaya system phones. Approximately 10,500 phones were to be migrated over the life of the project. As FY 14 closed, telephone migration was over 80% complete, with the remainder to be completed during the 2014 calendar year.

Renovating and creating new facilities in FY14 focused on the creation of new pathways where indoor cables would need to run. Project staff worked closely with colleges and administrative areas, and with departments, to keep the disruption of construction as low as possible. Close connections with Facilities and the University Building Official was also necessary to move the facilities projects forward. Pathways and/or equipment rooms were being worked on this year in Burruss Hall, Derring Hall, Holden Hall, Lane Hall, Litton-Reaves Hall, Pamplin Hall, Wallace Hall, and Whittemore Hall. Experience has reduced the number of equipment rooms required. For example, Derring was originally planned to have twelve rooms, but now planning is for three. Fewer rooms means at least as much, if not more, investment in pathways. Approval was received for equipment room construction as the fiscal year closed.

The standard for new copper station cabling is Category 6 cable or "Cat 6," a standard that offers higher performance than the previous Cat 5e. Cat 5e supports gigabit Ethernet; Cat6 is capable of supporting higher bandwidth, although the technology to provide Ethernet service at speeds between gigabit Ethernet and 10 gigabit Ethernet does not exist yet. It has always been the practice of Network Infrastructure and Services (NI&S) to install the best possible cabling systems, at reasonable price points, in order to future proof expensive and time consuming station cable installations. This approach has served the university well over
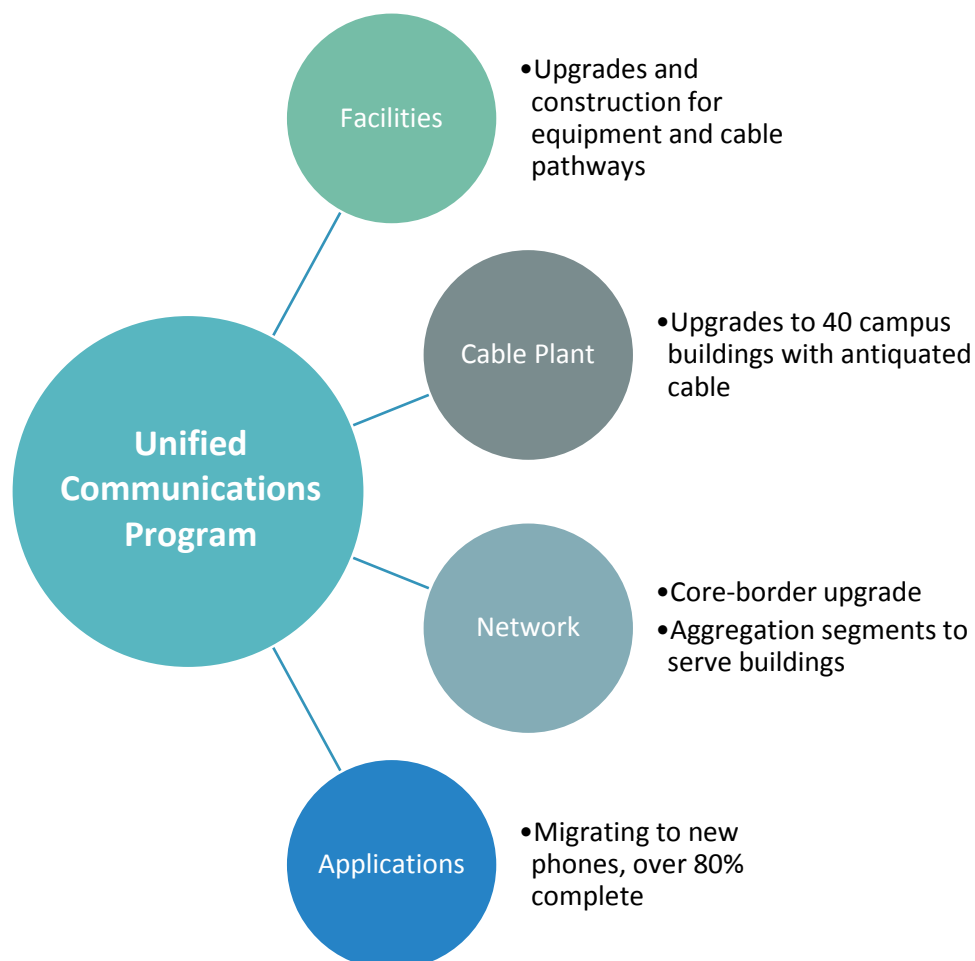
Underpinning even wireless network connectivity are many wires and equipment, such as this router.

the decades and, as networking technologies improve, has allowed us to utilize older cabling to support higher bandwidth services, significantly extending the useful life of the cabling. Selected buildings have Cat 6a, a cabling standard that currently supports up to 10 gigabit Ethernet. 10 gigabit Ethernet switches are becoming available, but are still very expensive. Buildings with Cat 6a cabling include the renovated Davidson Hall, the Signature Engineering Building, the Center for the Arts, and ICTAS II.

Cabling proceeds more slowly than some of the other components of the Unified Communications program. Older buildings are difficult to re-cable. The UC schedule shows the cable timeframe (www.nis.vt.edu/uc/schedule). An innovative solution, using ADTRAN, Inc. equipment, is being used to provide non-converged UC voice service over the older cables while the re-cabling project continues.

Part of the project will decommission about 100 antiquated Ethernet access switches. These are being replaced with Gigabit Ethernet switches that support power-over-Ethernet, and a feature set that better supports voice and video applications.

Migrating away from the aging ROLM phones and supporting equipment is the final and most visible component of the Unified Communications program. As the campus shifted from "majority ROLM" to "majority UC," users who had not yet migrated had more sources of information about the system, and enabling supports such as the Discovery Center for demonstrations were used less this year than in the previous years of the project. Even as the migration process continued, additional features continued to be provided. This year saw the availability of the mobility package that enables continuity of calls regardless of location. Significant work in FY14 led to the deployment in early FY15 of a new VPN—virtual private network. Remote Access-VPN provides remote access that "looks" like on-site Virginia Tech access, limiting the exposure of university resources. Remote Access-VPN is provided by the newly converged network. Other services expanded in the year include additional offices using the voice contact center features of the Avaya phones—information technology support in the office of the Vice President for Administrative Services, the Center for the Arts, and Squires ticket office, among others.

Physical learning spaces

"Technology-drenched spaces" entails bringing technology into physical spaces, along with expanded virtual spaces. Wireless service is one increasingly critical technology that needs to be present in physical spaces.

Wireless access points increased from approximately 3000 to 5000.

The UC project supports improved wireless access which is being upgraded in parallel with some of the cabling upgrades in academic and administrative buildings, and additional resources to upgrade wireless are being dedicated outside of the UC program. The wireless technology being deployed supports 802.11n and 802.11ac standards. The 802.11n will move from 1462 access points to 1671 and 802.11ac from 1019 to 2425 connections, or 51% of the access points. Simultaneously, 691 outdated 802.11g access points are being decommissioned. This older standard has contributed to recent performance problems with wireless service. The wireless design and installation team is working to upgrade wireless in centrally scheduled classroom identified as the highest priorities for improved service. In all, approximately 60 academic and administrative buildings are in the process of being upgraded, and the number of wireless access points increased from around 3,000 to 5,000 on campus. The majority of the effort occurred in FY14, with the project to be completed by December 2014.

In FY14, wireless capacity in the residence halls was also expanded, and in collaboration with Network Infrastructure and Services (NI&S), the Division of Student Affairs is planning a systematic upgrade of wireless access for the residence halls, spaces that traditionally relied on wired service only. Collaboration

with Facilities Services led to planning efforts in FY14 for outdoor wireless access in selected gathering points at entrances to the Drillfield. The planning led to a grant of funding from the Parents Fund for implementation in FY15.

Another technology in learning spaces is upgraded cable television service serving classrooms and residence hall rooms. The new system has more than 80 channels, the majority of which are in high definition. The transition to digital distribution from analog was made at the end of spring semester, along with a change in service providers. The bandwidth capabilities expanded from a 450MHz system to a 1GHz distribution system allowing for future expansion and programming capabilities.

Keeping existing spaces current with technology is an ongoing effort, and Information Technology invested in significant upgrades to formal and informal learning spaces. The spring of 2014 presented a unique opportunity to transform the Torgersen museum into a special technology-enhanced learning space. Under the sponsorship of Technology-enhanced Learning and Online Strategies (TLOS), design and construction of "The Learning Studio" began in January. It will open in Fall 2014 as the primary sandbox, exploration, and workshop space for the Networked Learning Initiative (NLI). The academic space of the 1120 InnovationSpace classroom was refreshed with flexible furniture, an interactive whiteboard, and an implementation of the Echo360 lecture capture system. TLOS was also involved in the design and deployment of two next generation distance-learning classrooms. These converged/networked classrooms (Burruss 123A and Room 219 at the Northern Virginia Center) include several capabilities such as multiple cameras, screen sharing, document sharing, interactive communication, presentation of images and graphics, annotation, and recording for later on-demand access. The initial deployment of these rooms occurred during

The new NLI Learning Studio was planned in FY14 and opened for Fall 2014.

Summer and Fall 2013. The rooms became available for production in Spring 2014 and were used for 12 classes that semester. Finally, TLOS began the process of renovation of two rooms in Torgersen. Construction is scheduled to be completed by start of fall semester 2014. In addition to office space, this renovation includes a media lounge area for web conference, training and demonstration, a large and small collaboration space with integrated technology for shared computer screens, media review and web conferences, a planning room for storyboard layout and project planning, and a media editing room.

Information Technology also collaborated with partners across campus on learning spaces. The Institute for Creativity, Arts, and Technology (ICAT) was a major collaborator. As the library continues its renovations, University Libraries, TLOS, and ICAT worked together this year to establish library learning studios for animation/visualization, music/sonification, and cinema. This collaboration around the fundamental elements of digital media increases cross-disciplinary student access to technology-enhanced active learning experiences. TLOS staff are assisting ICAT with the installation of equipment supporting Mirror Worlds, a major grant project from the National Science Foundation researching "human interaction by studying behavior and emotion in both the physical and virtual environment. Sensors placed around the Moss Arts Center track people in the physical space and then generate a digital version of those people at those same locations in a virtual building" (www.icat.vt.edu/impact/project/mirror-worlds). Upon completion of the project, NLI will leverage it as one of a number of "field trips to the future" in which faculty experience emerging, technology-based and/or immersive learning environments and related tools. NI&S worked with ICAT to assist in planning and design for the new Center for the Arts.

TLOS consulted with groups during their initial stages of remodeling spaces for learning environments by touring existing facilities, suggesting consultants, and proposing learning space options. For example, TLOS worked with Civil and Environmental Engineering on creating a multimedia learning studio and consulted with Housing and Residential Life to add technology to common spaces in residential buildings.

A Learning Space Research Program grant from Herman Miller is collecting data on how the configurable learning space affects faculty and student active learning and use of emerging technologies. TLOS ended the fiscal year in the data analysis phase. Preliminary findings suggest improvement of student engagement and positive responses toward flexible and collaborative learning spaces. The new NLI Learning Studio will participate in the grant as well, with research on experiences in that space beginning in the fall.

TLOS manages teaching lab computers around campus, with responsibilities for their technical currency. FY14 saw upgrades to the computers in six classrooms and the Math Emporium—over 250 computers. TLOS assumed responsibility for the Newman Library public computers and for the public computers at the library's satellite locations. At the end of the year, TLOS was exploring assumption of management responsibilities for the Port Digital Research Commons in Newman Library. Port is the library's destination for individual scholars and project teams who need above-average technology and collaborative space to explore data, create knowledge, and develop interesting ways to express information. TLOS continued to implement wireless displays and presentation systems using inexpensive components, including installation of a large screen display and AppleTV to provide for cross-platform wireless display.

Finally, in 2014, TLOS and the Office of the Vice President began articulation of a creativity incubator or "CoLab" concept. This concept for Virginia Tech originated from Duke's Co-Lab, which "is a creativity incubator, focused on exploring how new and emerging technologies can fundamentally reshape the research, academic, and service missions of the university."[1] The incubator at Duke brings together university employees with students from all disciplines with wide-ranging skillsets to identify and meet institutional needs using technology. The creation of a creativity incubator serves as a strategic enabler. Institutional needs are identified and addressed, students receive valuable real-world experience, and the institution has the opportunity to foster innovation that carries well beyond the boundaries of the institution. In addition to these broad benefits, the concept of a creativity incubator also supports several strategic priorities of both Information Technology and Virginia Tech as a whole in areas such as computational thinking and creating a networked university. In addition to benchmarking practices at Duke, Information Technology personnel met with leaders from collaboration spaces on campus such as the AMP Lab, NuSpark, TechPad, and the inVenTs community to understand existing venues and build out concepts. The initiative will continue to move forward in FY 2015.

Virtual learning spaces

Until recently, many of Virginia Tech's distance-learning classes were limited to classroom-based interactive video conferencing. Students needed to travel to a designated classroom at a prescribed time to participate in person or through a two-way audio and video exchange. Newer software takes advantage of the ubiquity of webcams to create virtual learning spaces that support students located nearly anywhere, interacting in real time with students and faculty in other settings. These tools can also support asynchronous interactions, with a learner scheduling their engagement with the class at a time that best fits their needs. The combined tools of WebEx and two components of Echo360's Active Learning platform, LectureTools and lecture capture, extend the richness of interaction. As part of the ongoing expansion and implementation of these tools, TLOS is working with faculty to identify the appropriate types of support for these platforms, from course design to troubleshooting and course delivery assistance. This support will be a key focus in FY15.

WebEx enables online multimedia interaction, and can integrate with video transmissions. It can connect multiple locations during live course sessions; help blend online and "seat time" experiences in a single course; and can record content for students to view later at their convenience. Cisco WebEx online for web

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[1] https://colab.duke.edu/about

conferencing capabilities began in July 2013. The system has grown to over 900 host accounts in one year. Of these, up to 200 individuals are quite active, hosting at least one event per month. During Fall semester

WebEx has grown to more than 900 host accounts.

2013, the College of Engineering participated with Information Technology in a pilot project for WebEx OneTouch. WebEx OneTouch extends TelePresence and interactive video conference meetings to WebEx users. The six weeks of the pilot were extended by some of the faculty who found the hybrid options valuable for their courses. Another session of pilot use occurred in spring term, with eight classes using OneTouch. To successfully enable WebEx OneTouch, Information Technology invested in significant upgrades to underlying interactive video bridging hardware and management tools to eliminate single points of failure and scale up availability.

During Spring 2013, TLOS reviewed lecture capture products to find a system that would integrate into 14 origination sites in Falls Church and Blacksburg and provide a cost-effective approach to making lecture capture available on a large scale. From the results of those reviews, the Echo 360 System was approved for purchase. Echo360 permits video capture of the classroom session for current or later viewing online. With this tool, instructors can tell if students are repeatedly revisiting material, possibly indicating difficulty with the material. Instructors can download Echo360 Personal Capture onto their computers to create online lectures. By allowing lectures to be created once, saved, and potentially re-used, this option is a fitting tool for a class that flips lectures and homework, students can view the lectures before class, so that class time can be devoted to collaborative workshops focused on exercises and applying class concepts. In FY14, Echo360 was implemented in ten classrooms in Blacksburg and six in Falls Church, supporting 70 class sections. Information Technology will be adding 14 rooms in the early months of 2015. Cabling and hardware mounting plans were produced for the construction teams. Final equipment installation and testing in these additional rooms will be completed in time for Fall 2014 classes. There will be video network capabilities to capture and record still other classes that have not yet been upgraded with hardware. From the initial implementation in the cloud, Information Technology has since moved Echo360 operations onto campus. The system is fully integrated with Scholar, allowing both for live streaming of classes and on demand playback for students to watch classes.

Semester	Number of interactive video course events	Number of interactive video courses	Hours of support	Video-on-demand hours of content
Fall 2013	92	55	2584	1947
Winter 2014	12	1	86	4
Spring 2014	89	55	2530	1891
Summer 2014	30	1	179	27
Total FY 2013-2014	223	112	5379	3869

With Echo360's LectureTools, instructors can upload videos or text presentations so that students can follow along in class, seeing the same images on their own computers. LectureTools works in concert with lecture capture to provide an improved learning experience in and outside the classroom. Students have additional space to take notes or flag material for questions. 2014 saw initial testing and piloting of LectureTools to limited groups on campus. The coming year will see extensive rollout of LectureTools to campus.

Emergency notification technologies

Maintaining a leadership position in emergency notification technologies supports the security and safety of our campuses, our students, our employees, and our visitors. In FY14, a procurement process was begun to refresh the mobile alerts components of the emergency notification system. Collaboration among the Office of Emergency Management, the Virginia Tech Police Department, and Network Infrastructure and Services within Information Technology was managed through Information Technology Acquisitions. The

procurement strove to acquire a mass notification system that rapidly disseminates emergency information through multiple delivery methods, including telephone calls, texts, and email. The procurement is now being finalized as the fiscal year closes to be implemented in fiscal year 2015.

The emergency notification system also includes an integrated initiator interface, along with mechanisms for on-site alerts such as classroom digital signs and desktop alerts. During the spring, Virginia Tech-developed source code was released as open source so that other institutions could adapt these resources for their own environments.
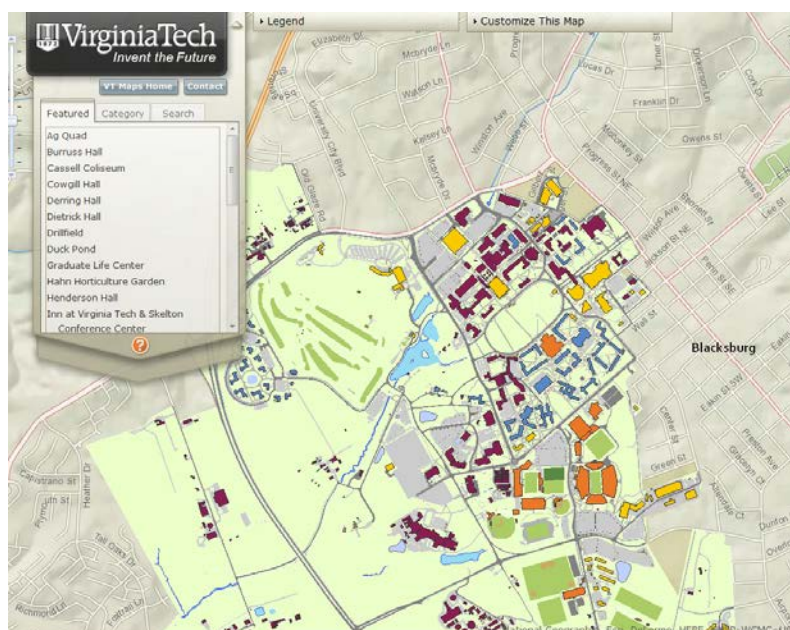
Advancing situational awareness

Situational awareness speaks to emergencies, the prevention of emergencies, as well as to wayfinding and other situations of everyday life. Converged Technologies for Security, Safety, and Resilience (CTSSR) is the lead unit within Information Technology in integrating geospatial information into applications that assist both safety professionals as well as everyday users of the information. As a unit, CTSSR employs best practices in coding and user interface standards to generalize a set of reusable components that can be deployed quickly for new situational awareness applications.

One application, Game Day, was noted this year by the chief of police for contributing to enhanced security and reduced costs during football games and other events in Lane Stadium by informing deployment of police officers. This fiscal year saw enhancements to the analytic tools available.

The campus populations project is an ongoing development effort to use GIS to visualize the rise and ebb of a variety of data sources that correlate with population as it shifts throughout the day as classes begin and end, mealtimes bring people to dining facilities, and other reasons for movement. The data sources are used to estimate the number of people likely to be in a building at a given time of day or day of week. The data are aggregated to offer a visualization of the degree of occupancy of buildings at specific times, useful in the event of a rapid evacuation. FY14 saw a refresh of existing data and planning for the addition of new data in FY15.

CTSSR worked with Facilities Services to build a secure, online repository of campus building floor plans, making this data available to anyone with a university credential. Electronic copies of floor plans are desired for a number of use cases, including students who wish to map their route to their classes throughout the day, or to university event planners who need to determine the size and layout of a meeting room for a special event. The groups worked together on business process analysis to determine how to best leverage geospatial interoperability and data transfer among systems; on documenting data flow and data sources; and on content design.

The Office of Emergency Management, the Virginia Tech Police Department, and University Relations collaborated with Information Technology to produce the Interactive Campus Map (www.maps.vt.edu/interactive/).

Enterprise GIS worked with Facilities Services and University Relations to design and launch an interactive campus map with CTSSR taking the lead on development. The map was launched in August 2013 to foster situational awareness, with information and data that are usable for other applications. For example, it also served as the basis for the Unified Communications services map. In 2014, Enterprise GIS stood up a

Pictometry server that provides web access to high resolution imagery of campus buildings which provides an oblique perspective, suitable for integration with various applications.

Embracing the "Bring your own everything" movement

"BYOE"—bring your own everything—began as "BYOD"—bring your own device. The BYOE concept recognizes the increasing seamlessness of 21st-century life. People use the same devices regardless of whether tasks are for work or personal life, blurring the distinctions between spheres. Hybrid classrooms blur distinctions between physical and virtual presence, and between synchronous and asynchronous learning. Both research and outreach take Virginia Tech personnel to locations around the commonwealth and around the globe, and bring global participants to the university campuses. Practicalities of BYOE mean that services, policies, and practices must not only be agnostic regarding devices, but agnostic regarding ownership and location of devices.

Robust connectivity is essential to support the emerging network economy and ubiquitous computing devices that individuals and businesses rely on. Information Technology engaged in a wide variety of networking and infrastructure collaborations in the region for expanding connectivity and facilitating affordable access. CTSSR works with service providers to assist them in developing expansion plans that promote economic development objectives for Virginia communities. CTSSR's eCorridors group led the Accelerate Virginia broadband speed test campaigns throughout the state. These campaigns serve to introduce residents and businesses to the need for awareness about broadband connectivity, competition, and pricing issues and contribute to the State Broadband Initiative and statewide map of broadband access. The eCorridors staff participated in a series of regional broadband strategy workshops throughout the state conducted by the Center for Innovative Technology. The workshops focused on helping communities in the commonwealth overcome obstacles to broadband access, and introducing the tools developed by Virginia Tech to help communities obtain the information they need to develop plans for enhancing access to broadband infrastructure. Many of these tools have been designed so that communities beyond Virginia can take advantage of them. Additionally, the initiative enables Virginians to complete connection speed tests to help the state identify underserved areas. Residents can use the information to investigate other options for improved service to their region. Virginia Tech is the only state institution participating in this initiative. More than 10,000 speed tests have been run from locations in 132 of the 135 counties and independent cities in Virginia. The broadband speed test tool was developed by eCorridors in 2006 and has positioned the group to obtain research funding of $1.5 million over the past five years. The data from these funded projects are made available to the National Telecommunications and Information Administration and to the Commonwealth of Virginia as part of their national participation in this space.

More than 10,000 speed tests have been run from locations in 132 of the 135 counties and independent cities in Virginia.

2014 also saw a transition for Virginia Tech's collaborations with the Mid-Atlantic Research Infrastructure Alliance (MARIA), "an alliance of institutions in Virginia established to promote the development of shared advanced network and other cyberinfrastructure resources to serve the commonwealth and the Mid-Atlantic region." In 2014, MARIA began contracting with NI&S for its support services and world headquarters. Virginia Tech continues to operate all the network infrastructure supporting MARIA.

Services in university locations other than the main campus in Blacksburg should be on a par with Blacksburg services. In the National Capital Region (NCR), the Language and Culture Institute in Fairfax was provided with standard voice and data services this year. The new Remote Access-VPN brings this objective closer, since individuals should be able to take advantage of services as though they were local to the Blacksburg campus. Differences continue to exist since local Internet service providers, not Virginia Tech, supply the network's external connectivity. TLOS loaned a Beam TelePresence robot for use in mobile, interactive video conferencing between the NCR and other locations. The president's office in Richmond was upgraded in time for the legislative session in Richmond. New routers and switches were installed, shifting from the older

ATM—asynchronous transfer mode—to Ethernet. This office has Virginia Tech phones and network connections, as well as VT Wireless.

A technology critical to supporting communications everywhere is cellular connectivity. When walking and driving on campus, the Virginia Tech community tends to have good coverage, but the neo-gothic architecture can make it difficult for radio frequencies to penetrate. As a result, both Virginia Tech and

cellular service providers to the region had a strong interest in investing in improved coverage and capacity—both to improve our ability to communicate and to enhance safety and security on campus. In 2014, Verizon became the initial carrier in a partnership to enhance cellular service on campus. The university experienced improved cellular coverage at the spring football game this year, thanks to the completion of the first permanent phase of the distributed antenna system (DAS), an upgrade from last season's temporary stadium coverage. The DAS improves the cellular coverage and capacity within Lane Stadium, including the stadium bowl, all interior and exterior levels, and the parking lots on the northeast, south and west sides. On game days, cellular coverage and capacity in particular is a problem. The DAS

The first permanent facility created as a result of the DAS expansion effort

enhances cellular service as a convenience to students, faculty, staff and visitors to the stadium while also enhancing public safety and security. The improved DAS also supported the increased demand in the stadium during commencement, and will be used at full capacity during Virginia Tech's first football game in 2014.

The distributed antenna system began operation in Lane Stadium with the 2013 football season and is currently being expanded to six residence halls.

The DAS provides usable in-building coverage through a vendor-neutral integrator, Longent LLC. DAS equipment and antennas are installed within Lane Stadium with a permanent head-end and shelter completed in early 2014. The next goal is to expand capabilities in the residence halls.

To improve guest experiences on campus, Information Technology laid the groundwork to enable guest wireless access in the Center for the Arts, which will launch in fall 2014. Eduroam, another pilot project, offers wireless credentialing. Guests from institutions that also use Eduroam can to obtain wireless access when on campus, and enables Virginia Tech personnel traveling to another institution with Eduroam to use the network at that institution.

Information Technology made efforts to engage faculty and students with emerging technologies and use of BYOE devices. As mentioned in Pillar 1, members from InnovationSpace and a Tech Teams Advisory Board launched the Tech Teams initiative, a research and development program of emerging technologies, and a sandbox environment to test such technologies for the purpose of teaching and learning. Three emerging technologies were tested in the spring of 2014. White papers discussed the experience, along with advantages, disadvantages, and future implications. http://blogs.lt.vt.edu/techteams/).

The successful iPad long-term loan program continued with more than 200 iPads loaned to classes and groups doing research, increasing digital fluency, student engagement and access to mobile technology. TLOS is in the process of developing a system for evaluating use of the iPads for teaching and learning.

The InnovationSpace team engages faculty and students with emerging technologies relevant to BYOE through NLI sessions, faculty consultations, and in-class visits. As noted in Pillar 1, approximately 16 NLI sessions, four Field Trips to the Future (opportunities for faculty to engage with interesting emerging technology spaces and opportunities on campus), and five lunchtime discussion groups were conducted last year. Many of the iLearn workshops were relevant to BYOE. InnovationSpace and Enterprise Systems assisted Student Affairs with the design and development of a mobile application to support Virginia Tech's Aspirations for Student Learning. In conjunction with the InnovationSpace's work with the Division of Student Affairs mobile application, members of the Innovation Space team conducted student focus groups

investigating student expectations for mobile delivery of Virginia Tech online services. Finally, Enterprise Systems also hosted a student focus group centered on understanding student expectations for MyVT, particularly for the mobile experience.

Enterprise Effectiveness

"Our goal is to ensure 'quality, innovation, and results' by reviewing and revising our current business practices for opportunities to optimize efficiency, flexibility, and accountability without sacrificing our ability to remain innovative and competitive." So reads a portion of *A Plan for a New Horizon, 2012-2018* (Organizational efficiency and flexibility, p. 7). Information technology offers automation and collaboration towards achieving this goal, particularly for enterprise-level systems.

Pillar 4 advances enterprise effectiveness through (a) expanding capabilities in support, services, and systems, and (b) positioning enterprise systems for a future that will be defined by rapid change, constrained resources, and significantly expanded external options.

Establishing prioritization and resource management practices

A major effort over the coming years is to find more effective and consistent ways to prioritize work, focusing on the needs of the institution as a whole. Initial progress was made in FY14 for the Business Intelligence (BI) project. Run through Enterprise Systems, the project created a stakeholders committee to recommend the priority and order of initial and long-term activities for the BI project. Enterprise Systems is also implementing a unit-wide personnel management tool for projects and operations that will help document and understand resource use, thus informing prioritization of incoming requests.

Overall effectiveness and efficiencies for the university come from improved resource management practices, such as acquiring software that can be shared. This year, Information Technology Acquisitions (ITA) processed procurements from existing Virginia Tech and state contracts, and also from eligible cooperative contracts with the Virginia Association of State Colleges and University Procurement Professionals (VASCUPP), the Virginia Information Technologies Agency, the US Communities national cooperative purchasing program, and the federal General Services Administration Schedules 70 and 84. ITA manages the Esri geographic information software contract for all of Virginia's educational institutions. ITA joins with other Virginia institutions at the annual Software Summit to help educate vendors on the directions for software in higher education, including the university's capacity to manage licensing, our needs with regards to compliance responsibilities, and options we see available to us. Within the university, Information Technology units also strive to collaborate on procurements. For example, Enterprise Systems worked with University Libraries on mutual use of Team Dynamix. ITA also engages university departments through the semi-annual Departmental Computing Support Symposium, the New Student Orientation planning team, the Computer Requirements Committee, and through ad hoc communications to promote effective software procurement.

The Hokie Bird checks out some of the available computer options for faculty going through computer refreshes in 2014.

Rapid and flexible responses to ongoing and emerging needs requires setting directions for enterprise systems and tools that can add sufficient value if they

are created and managed in-house, or, to the contrary, if they are acquired in the marketplace. Email is available in the marketplace, a commodity that can meet many university needs without in-house provision. Once crafted largely internally, software testing has expanded the use of external tools. Security Enterprise Technology Initiatives implemented automated testing this year using an open source product called Selenium. Selenium can emulate a number of browser sessions, and facilitates regression testing, automating a process that was previously highly manual, and improving overall use of personnel and technology resources.

In another case, Enterprise Systems launched a project last year to evaluate and redesign the My VT portal, with the goals of upgrading underlying software, redesigning navigation, updating the look and feel to provide better consistency with the VT brand, and improving integration with other applications like Hokie SPA. A few months into the project, Indiana University launched a new portal called OneIU. Indiana re-envisioned their university portal as an app store. It changed the way we saw My VT moving in the future and resulted in developing an app store concept for My VT. Recently, OneIU has been licensed to be offered as a cloud-based service called OneCampus. Options for buying the service instead of building it ourselves are being evaluated.

In other services was the completion of the rollout of VT Google Apps, with analysis of lessons learned, and account transitions. Increased storage, collaboration tools, and ubiquitous access characterize this offering available to all faculty and staff members and to all students. The year also saw testing for the coming implementation of Office 365—a cloud-based anytime, anywhere approach to the suite of Microsoft Office offerings. Through town halls with campus constituents and extensive discussion with institutional stakeholders, the initial implementation is centered on SharePoint Online. The goal for this phase of the project is to improve availability, scalability, and accessibility of Microsoft cloud-based communication and collaboration technology. Service will initially be available to faculty and staff, as evaluation continues regarding the value provided by maintaining an in-house version of premium email and collaboration tools in order to meet regulatory and confidentiality requirements.

Policies and procedures for enterprise applications

Project management discipline is an important requirement for enterprise applications. Project management helps ensure value and maintain consistency in the development, implementation, and support of enterprise applications. The project management policy and standard have been in place, and continue to gain acceptance and compliance. Ongoing project management practices have included explicit discussions of projects' connections to Information Technology's strategic goals at internal project management meetings, holding monthly project information meetings with the leaders of each unit in Information Technology, hosting monthly project planning meetings for Enterprise Directory work, and the facilitation of monthly Communications and Collaboration Technology Steering Committee meetings.

Project management expertise within Information Technology has been expanded with two employees gaining certification. With project management certified personnel, Information Technology has been able to improve not only our internal project management, but as we collaborate with groups across the university, they are better able to see the relationship between progress and adherence to standards.

Communicating and promoting information technology project management standards came through work with Veterinary Medicine, University Libraries, and the technology group in the Office of the Vice President for Administrative Services. Projects to develop and enhance enterprise services and systems also brought together Information Technology personnel and other campus units, notably in the Enterprise Systems work. For example, the newly purchased event management system brings information Technology's staff together with

the interested campus offices in Athletics, Student Affairs, and others. The project management discipline that is visible and useful to these stakeholders cultivates both an appreciation for the standards and a model for them to adopt in their own projects.

We experienced the effect this year in the initiation and/or completion of other ongoing projects undertaken by Enterprise Systems.

- Working with the Office of the Controller, enhancements to the travel and expense system enabled campus-wide use beginning in August 2014.
- In collaboration with Human Resources and with Payroll, Time Clock Plus automates non-exempt employee time and attendance and leave reporting.
- Improvements to degree planning resulted from collaboration with the Office of the University Registrar on a new system.
- The current faculty activities reporting systems were enhanced with work on new systems in conjunction with the Office of the Provost.
- Support for a new event management system upgrade is ongoing work with Athletics, the Alumni Association, and others.
- The university continued a project supported to enhance the Leave Entry and Reporting System, with goals of realizing a more secure, efficient, and cost-effective process.

Project management was essential to organizing and planning the work done in the multi-year Unified Communications (UC) program. With its four separate but interconnected projects—construction of rooms for equipment and pathways for cabling in critical locations throughout campus, running new cables to support more capable transmissions, installing the network electronics to support the system, and migrating the telephones to voice-over-IP, the UC effort required the planning and documentation of project management to keep the diverse efforts working together.

The Business Intelligence (BI) project (see next section) is the university's first information technology project that Information Technology has categorized as "major." Major projects require a greater level of project management, reporting, and accountability than other projects. Part of the increased requirements involve going through independent verification and validation process (IV&V), which requires a third party to essentially conduct a comprehensive project audit at different stages. The IV&V process reviews the project from multiple perspectives, evaluates progress, and identifies potential risks and mitigation opportunities. Moran Technology Consulting was awarded the contract for this independent assessment. The initial visit was completed in FY14. The structure and approach for IV&V will be translatable to future major project efforts. Along with the IV&V process, the BI has prompted an increased focus and effort on project management. As noted above, BI has facilitated the development of initial approaches to project prioritization, and has also led to the implementation of improved reporting and tracking tools. Enterprise Systems is in the process of transitioning to a comprehensive project and resource management tool, Team Dynamix, to enable more robust project management. The BI program provides monthly status reports to evaluate progress, as well as a quarterly report to the commonwealth. An assessment technique being used to determine project effectiveness is through the mechanism of earned value management, a technique that combines measurements of scope, schedule, and costs. Stakeholders on the BI program have noted that the increased documentation and new assessment techniques have helped them more clearly see the connection between documents and action.

FY14 saw Information Technology begin the first project classified as "major" by the organization.

Technology-enhanced Learning and Online Strategies conducted a unit-wide activity inventory to better understand projects and operational activities for all groups after the reorganization, and implemented a weekly project and operational activity review meeting to discuss sticking points and outstanding needs, and to raise issues. ARC ramped up project management, prioritization, and coordination in its meetings with the Unix Administrative Services team, including the implementation of JIRA to enable defined progress and task documentation and tracking.

Network Infrastructure and Services used assessment and redesign of workflow processes for project-related services and tasks. Phase one of this assessment and redesign involved introducing a new Service Provisioning Team with consistent workflow for requests coming into the project. This new team assesses requirements, assigns resources centrally, and does initial configuration work where possible. The team then documents the work through a new task management system that tracks progress and transitions work to an implementation team. Phase two of this redesigned approach will occur in 2015 and will involve aggregating a dispatch function so that the project teams also have consistency, repeatability, and predictability in how teams are sent out to complete the work requested.

Providing business intelligence tools and support to university units

As noted above, the Business Intelligence project was fully underway in FY14. This program addresses the demand for accessible methods to analyze institutional data that may reside in many different source systems. BI aims to provide the community with a consistent resource for university data, easier data analysis and reporting. This year, project teams formed and the agreements for the governance of the project were established. MicroStrategy Business Intelligence System was awarded the contract at the end of the calendar year. Other planning work in FY14 was the implementation plan, analysis of the security and functionality of the tools, and establishment of tool standards. Configuration and development work continued as FY15 began. The first implementation is the pilot, data for the Student Perception of Teaching instrument (SPOT). Aspects of the program are expected to be made available to the community in the coming year.

Improved ability to analyze data is a significant anticipated contribution of the Business Intelligence project.

Related to the BI project under the umbrella of the University Data Initiative is a university-wide approach to information governance. The information governance project planned for intensive information gathering, including the use of focus groups consisting of stakeholders from around the university that will occur in FY15. Once this project moves out of the planning phase, it will also enable progress towards clear data governance and data modeling practices.

Improving acquisition processes for enterprise applications

Acquiring software for enterprise activities can be achieved through "buying" or "building." Much of the "buying" is handled through Information Technology Acquisitions (ITA). FY 14 continued the increasing complexity of buying as software vendors seek to expand their exposure to potential customers, notably students; to fight piracy; and to find new market niches. This year saw procurements of "free" software that, despite the zero-pricing, still must support university compliance with state and federal regulations and laws;

"leased" software that is partially or fully off-site, "in the cloud;" and relatively fewer of the older, perpetual software license.

Procurement processes are similarly changing. Buying from existing contracts promotes efficiencies when requesting parties have a precise understanding of their requirements. This year, ITA processed procurements from existing Virginia Tech contracts, and also from eligible competitively-awarded contracts with the VASCUPP. In contrast, the more complex process of requesting proposals from vendors (the RFP process) fits when requirements are more broadly defined. RFPs can lead to discovery of available functionality, better pricing, and a better fit with the Virginia Tech environment. This year, RFPs were used to acquire major project components—for the Business Intelligence program, for e-commerce cashiering, and for emergency notifications. ITA works to ensure that state-recognized small businesses and women- and minority-owned businesses participate fully in the procurements.

Collaborative software procurement, both within the university and among universities, enhances overall effectiveness and efficiencies. Virginia Tech participates in VASCUPP whenever possible and joins with other Virginia institutions at the annual Software Summit to help educate vendors on the directions for software in higher education, including the university's capacity to manage licensing, our needs with regards to compliance responsibilities, and options we see available to us. Within the university, Information Technology units also strive to collaborate on procurements. For example, Enterprise Systems worked with University Libraries on mutual use of Team Dynamix. Information Technology Acquisitions also reaches out to university departments through the semi-annual Departmental Computing Support Symposium, New Student Orientation planning team, the Computer Requirements Committee, and through ad hoc communications to promote effective software procurement.

Similarly, "building" software is gaining in complexity. While buying software that has matured to a broadly useful commodity can be a low-cost alternative, building software for specialized functions or unique environments often provides higher levels of effectiveness, translating to lower costs in ongoing operations.

An example continuing from FY14 into FY15 is the new approach to meeting needs in research grant submission and administration. Various software products exist that do a portion of the requirements needed, but an integrated approach for the university environment was lacking. The new project takes a hybrid approach, crafting new software to meet the needs of the university for an intuitive, integrated experience, while taking advantage of vendor-supplied and/or open source products that fit. This approach allows the developers to work first on the areas where there is the most value to be gained for the institution. The initial focus is on pre-award communications and approvals.

Open source software can itself be "buying," "building," or both. This year, Information Technology contributed software to higher education open source in emergency notifications through the Virginia Tech-based uAlert initiative. Source code was posted to GitHub in the spring. Secure Enterprise Technology Initiatives made significant contributions to the Open Source CAS and Shibboleth projects.

Security and Resilience

Knowledge and information are gathered, created, and analyzed as mainstays of the university. The institution must protect that knowledge and information and the infrastructure supporting their use. The university must ensure the integrity and appropriate privacy of information, an increasing effort as privacy requirements associated with sponsored research projects change, other statutes and regulations that seek to maintain individual privacy are adopted, and as the frequency and sophistication of cyber-attacks increase. Successfully addressing these issues requires participation by the entire university community.

Pillar 5—ensuring the security and resilience of information technology resources—encompasses goals of establishing a level of security that protects and ensures the resilience of university infrastructure, data, and research; engaging the community in ensuring security through research collaboration, education programs, and community outreach; and enhancing Virginia Tech's ability to effectively manage access to facilities, services, and online systems.

Achieving these goals requires the participation of the entire Information Technology organization, with leadership from the teams in the Converged Technologies for Security, Safety, and Resilience (CTSSR), the Information Technology Security Office (ITSO), and Secure Enterprise Technology Initiatives (SETI). Within the university structure, Information Technology takes the lead on managing cybersecurity and information technology risk assessment, and participates in university procedures for disaster recovery and continuity of operations planning. This section of our 2014 annual report focuses on the key activities undertaken in the past year to make Virginia Tech resources more secure and advance the fifth pillar of our strategic plan.

Creating an information technology security strategy

Virginia Tech's security strategy, based on defense-in-depth, combines tools and strategies to provide an overarching structure that works every hour of every day and includes the university community. Robust standards, practices, policies, and controls are required. The framework of the security strategy builds on the SANS 20 Critical Security Controls (www.sans.org/critical-security-controls). The controls date to 2008, when the U.S. National Security Agency began an effort that took an "offense must inform defense" approach. The approach prioritizes controls that have the greatest impact in improving risk posture against real-world threats. Recommendations for what became the Critical Security Controls were coordinated through the SANS Institute and subsequently transferred to the Council on CyberSecurity, an independent, global non-profit entity committed to a secure and open Internet. The controls focus on "what works"—controls that have demonstrated real world effectiveness. With the operational plan of the Information Technology Strategic Plan, Virginia Tech has adopted these controls as our framework.

Randy Marchany, Information Technology Security Officer, addressed "The 20 Critical Controls" at the EDUCAUSE Security Professionals conference in 2013, and discussed the issues in a subsequent podcast (http://www.educause.edu/sites/default/files/marchany.mp3). The controls

are "quick wins" that allow for rapid improvement in cybersecurity without major procedural or technical change. International cybersecurity experts developed the 20 Critical Controls to be the most effective and specific set of technical measures to counter the most common and damaging computer attacks. The controls address the root causes of these attacks. Marchany discussed how Virginia Tech is implementing the 20 Critical Controls as part of its overall security strategy. In FY 2013, Information Technology conducted a comprehensive gap analysis to determine present state capabilities and desired future states. The data collected in FY14 are being used to set priorities for control implementation work in the 2014 and 2015 fiscal years.

People continue to be a primary element of our security strategy. The continuing focus on education about threats has led to over 6200 enrollees in the "SANS Securing the Human" online training program. Roles and responsibilities for data trustees, stewards, managers, and users have been defined in University Policy 7100, and each year, including FY14, the data administration standard is updated when new personnel have taken on responsibilities for a domain of data (http://www.policies.vt.edu/7100.pdf). Periodic reviews of requests for access to ED-ID—the authorization component that provides greater personal information to university-based services— provide data stewards an opportunity to approve or deny access to data about students and employees for online services. New this year is the document "Guidelines for the Acquisition of Information Technology Hardware, Software, and Software as a Service" (www2.ita.vt.edu/purchasing/guidelines/index.html). The guidelines provide practical advice on safeguarding university data when acquiring a new system, along with a revamped procurement questionnaire.

> **Information Technology's offering of the SANS "Securing the Human" education program had over 6200 enrollees in 2014.**

Cybersecurity Task Force

With the strategy built on the SANS 20 Critical Security Controls, specific security practices were scrutinized by the Cybersecurity Task Force, appointed by Vice President Midkiff in the spring. In part a reflection on issues contributing to fall 2014 breaches, the task force sought to identity and understand the deeper causes that would enable the institution to better avoid impacts of cyber-attacks, and better recover when they occur.

The sensor networks in place on university networks have helped security experts conduct forensic analysis to determine the timeframe of attacks. In one case, event log monitoring had been exploited by attackers so forensic analysis of logs was not possible. The implementation of monitoring as a response means that alterations to logs will be apparent. Analytics abilities were tested and expanded as Secure Enterprise Technology Initiatives worked with the IT Security Office to pull information and report in detail on all servers within the vt.edu domain during one of the breaches, allowing the university to identify potential targets and make needed security updates to prevent further exposure.

A major outcome of the work done in the aftermath of these breaches has been a much closer partnership with senior management in the colleges on information technology security as well as increased collaboration between Information Technology personnel and departmental system administrators.

The Cybersecurity Taskforce recommended three areas of emphasis and investment. The first is to increase the security of digital credentials by implementing a one-time-password multi-factor authentication solution. Relying only on passwords can lead to security incidents. Even well-trained, security-minded employees can get caught up in the press of workload and forget to change passwords or to employ a difficult-to-break password. And even the best passwords can have vulnerabilities. Requiring multifactor authentication—both "something you know" and "something you have"—moves the university to an authentication practice with fewer elements left to personal behavior. With multifactor authentication, a poor password or shared secret practices are not the sole element of the authentication process. To support the implementation of this recommendation, the Information Technology organization submitted and was approved for critical needs funding in 2015.

Cybersecurity Task Force Recommendations

| Implement a one-time password solution | Improve event logging and analytics | Provide new training resources |

Multifactor authentication is not new to Virginia Tech, as it is already used in select sensitive applications. Earlier in the year, multifactor authentication was newly required for accessing the Enterprise Directory query tool, the DAT. The report recommended wider use. While the task force was still putting its recommendations together, a multifactor solution was adopted for administrative access to Information Technology-run enterprise Linux servers. The solution investigated and adopted is now also used by other groups on campus for server administration, with about 30 users. The solution uses a high security USB device that meets federal information processing standards for a high level of assurance (level 3) and does not require client software installation. Information Technology also continues to support the Multifactor Authentication Cohortium of Internet2 to share, evaluate, and consider development for multi-factor solutions

A critical needs request was approved to support multifactor authentication efforts in FY15.

The second recommendation is to improve logging and analytics. Centralized event logging would systematically forward event information for storage, analysis, and response. Analytics are key to helping understand when events threaten our systems, as is (near) real-time observation. Centralized event logs prevent the situation experienced in one of the intrusions in which logs are saved only to the local file system, and then deleted by an intruder. If logs are transmitted to a centralized logging server in near-real-time, analysis could identify the intrusion, and remediation can begin immediately.

The third recommendation is to provide new training resources for systems administrators. Systematic training contributes to both performance generally and secure practices specifically.

Each recommendation has been assigned to a working group to work towards implementation in the coming year.

Identifying and mitigating risks to critical infrastructure and data

Managing risk to information technology infrastructure and to Virginia Tech data is a shared responsibility over various offices and roles within the university. Information Technology takes the lead in providing policies,

standards, and procedures, along with training materials, to guide the university in the information technology risk management.

The information technology risk assessment process is handled by Converged Technologies for Security, Safety, and Resilience (CTSSR). Revisions to the process this year incorporate best practices as recommended by the National Institute of Standards and Technology. The risk assessment process focuses on business impact analysis to identify mission-critical assets. Once the critical assets are identified, potential threats to those assets can be better anticipated, planning for the most likely events and most serious impacts. Finally, mitigation strategies are identified and resource needs are documented in a Risk Assessment report. Reports are maintained in each department and also archived with CTSSR to ensure continuity and retention of this critical information.

During the year, CTSSR worked with units within Information Technology to identify critical assets and risks, resulting in the FY14 risk assessment with reports from 13 Information Technology units.

Additional one-on-one training sessions were conducted with colleges (3), departments (1), research centers (2), and administrative offices (2). In addition to the assessments from Information Technology, 20 information technology risk assessment reports have been received during the fiscal year.

CTSSR staff worked with offices including the Bursar, the controller, Internal Audit, and the Office of Export and Secure Research Compliance to better understand university information security compliances processes and requirements. These interactions provided deeper understanding of federal, state, and university compliance responsibilities, helping identify university units in most need of information technology risk review. These units are then contacted by CTSSR staff and encouraged to get started on the risk assessment process. Templates, sample completed risk assessments, and training resources are provided on the CTSSR website.

Provide effective threat defense

Defending against threats to information technology infrastructure, data, and services must respond to the moving target posed by attacks and vulnerabilities. The Information Technology organization takes steps to minimize disruptions and failures at all locations. Virginia Tech facilities are distributed beyond Blacksburg, Virginia. As part of our continuous monitoring enhancements, network sensors were implemented or upgraded at three locations in the northern Virginia region this year—the Northern Virginia Center in Falls Church, the Virginia Tech Research Center in Arlington, and the Washington Alexandria Architecture Center. Much of 2014 was focused on refining our upgraded sensor systems and on establishing sufficient capabilities to store network data necessary to provide security through continuous monitoring. As sensor and storage capabilities mature, the IT Security Office is now focused on enhanced analysis of complex events.

At https://red.cirt.vt.edu/ users can get a real-time geographic view of network threats and activity.

RLAN—the restricted/limited access network—is one method of mitigating risk to exposure of personally identifying information. RLAN was created by the IT Security Office and Network Infrastructure and Services. It is designed as additional protection for employees who must work with larger volumes of personal information—

The restricted/limited access network completed 106 connections by the end of FY14.

employees in offices such as those of the controller, the registrar, admissions, financial aid, and police. It segments a portion of the network for advanced traffic monitoring and filtering, and separates that segment from the external Internet. Early in the fiscal year, all 106 connections in the pilot were completed. Users in the pilot program have begun to use RLAN more. The next phase, in progress, is aimed at improving the user experience and supporting IPv6, while continuing the robust logging and monitoring of events on the segmented network. This phase will add more departments to the program, as well as more users in pilot departments, with a goal of 220 connections.

A new initiative in 2014 tracks security logs and allows identification of device lockouts. The tool was created as part of a student internship program. The tool has been helpful in providing analysis of lockouts, both routinely and during episodes of malware attacks. One consequence of having this tool in place is the analysis it enabled, leading to a more generous lockout practice for individual users.

To ensure the security of credit card transactions that involve Virginia Tech, Information Technology has begun the analysis phase to implement the new version of the security standards of the payment card industry, PCI 3.0. Efforts will scale up in 2015.

A wireless audit in 2014 also helped Information Technology identify areas for improvement. 2015 will see work to improve wireless device control, and two measures have already been implemented to improve wireless security. First, Information Technology launched the "Connect to VT Wireless" program to provide users with clear and secure options for accessing the network for the first time. Second, Information Technology transitioned to required use of a network password for accessing the Internet, retiring the use of an older password protocol that was retired after upgrades to wireless security.

Personal safety

Information Technology also serves as a partner on the recently expanded camera surveillance efforts on campus. Led by the Office of Emergency Management, Virginia Tech currently has nearly 20% coverage on walkways and throughways, with an eventual goal of 95% coverage to improve public safety. Information Technology assists in this effort by running the camera servers, providing data storage, and providing restricted access to the stored data. Three major camera projects were completed in 2014 by Information Technology, offering new cameras for walkways and additional building coverage.

As noted in Pillar 3, Information Technology also supports physical security through the mechanism of VT Alerts. 2014 saw the procurement of a new system and the sharing of open source code for use by other universities. The Distributed Antenna System project (see Pillar 3) is another effort to improve safety and security by extending the strength and availability of cell phone signals on campus so that users have enhanced access to receipt of emergency notifications, the ability to contact authorities, and communications abilities in the event of a disaster.

To ensure that new contracts such as this VT Alerts agreement meet our institutional security needs, in 2014 Information Technology implemented a comprehensive security procurement questionnaire that all future

vendor applicants must complete to move their applications forward. The same requirement was also implemented for groups developing software in-house.

Improving recoverability and resilience of information technology infrastructure and data

Establishing a disaster recovery site at the Virginia Tech-Carilion Research Institute in Roanoke was proposed and funded this year through the university's critical needs process. Equipment has been purchased, ready to be implemented in FY15. While Virginia Tech works toward this new facility to enhance redundancy and backup,

Virginia Tech Carilion Research Institute and School of Medicine, Roanoke

select functions have increased their redundancy. This year, Active Directory services added a hot backup site in a location other than the Andrews Information Systems Building.

Reducing single points of failure for network services was a focus for 2014. The Unified Communications project (see Pillar 3) standardized on an aggregated design that would prevent any single point of failure from impacting more than 48 users at one time. Information Technology also put in new technology to eliminate a single point of failure on the border network taking traffic off campus. Previously Virginia Tech relied on a single path, but in 2014 added path diversity.

Another effort to improve redundancy involved piloting an improved application for load balancing across the university. Systems like VT Alerts, servers, email traffic, and web traffic all impact the availability and response time of one another based on system bandwidth. The pilot application for load balancing will improve our ability to analyze configurations and evaluate performance in order to streamline how these systems and tools leverage the network and ensure access is as efficient and streamlined as possible.

Risk assessment, disaster recovery, and continuity of operations planning (COOP) all relate to planning in the face of risks. Converged Technologies for Security, Safety, and Resilience (CTSSR) worked closely with the Office of Emergency Management to facilitate consistency of procedures and policies and also with the Office of the Controller regarding their business compliance survey. Responses to the business compliance survey along with information from Internal Audit and from the Information Technology Security Office are often used to identify departments that utilize sensitive data and are therefore at greater risk.

COOP and disaster recovery plans seek to document processes necessary to put university units back in operation. Information Technology conducted a COOP/disaster recovery exercise by taking advantage of a schedule network maintenance event in August 2013. Equipment upgrades to the network core and border (See Pillar 3) required the temporary disabling of incoming and outgoing Internet traffic to the Blacksburg campus. The exercise tested the readiness and capability of provisioning an identified critical information technology service at an alternate facility in the event of such a major outage.

Information Technology units completed their own COOP documents by March 1, 2014.

Interacting with the Virginia Tech community and beyond

Reaching out to the several communities of the university creates mutually beneficial exchanges that advance security. The Information Technology Security Office (ITSO) hosted the Eastern Regional US Cyber Challenge (www.uscyberchallenge.org) camp from June 6 to 20, 2014. Attendees are the top scorers in national cyber competitions and are invited to attend the camps. Four days of intense classes are followed by a capture-the-flag competition.

ITSO worked with Dr. Joseph Tront to implement the "Scholar for Service" program at Virginia Tech, a US CyberCore grant that provides a stipend and funding for students interested in cybersecurity in their junior and senior years. Selected students agree to complete a master's degree and work for a federal or state agency for three years after graduation. 2014 saw the first two students enrolled in the program, with another seven accepted for the coming year. A total of 52 students will be funded through this program.

The security office continued its engagement with the Army's Advanced Civilian Schooling program, providing hands-on cybersecurity experience in the ITSO lab. Two students participated in the past year. ITSO has been participating in the program for over a decade, and is planning to expand security lab opportunities to other service branches in the coming year.

The security lab continues to support undergraduate research experience. Three undergraduates participated this year. They were subsequently hired as wage employees for the year through a Northrup Grumman scholarship program.

ITSO continues partnerships with external organizations such as the Virginia Alliance for Secure Computing and Networking, EDUCAUSE, the Research Education Network Information Sharing and Analysis Centers, and Infraguard. The IT Security Lab has relationships with General Electric, SANS, SERC—the Security and Software Engineering Research Center, and other corporate and educational entities.

Training and outreach activities address human-based information security needs. Information Technology implemented an expansion of the Securing the Human program. It will be offered as part of the Network Learning Initiatives (NLI) curriculum available to all faculty in the next fiscal year. The security office continues to offer trainings through NLI and has worked to extend the impact of outreach functions through security reviews with interested university units. In coming years, Information Technology will make ongoing security reviews a requirement.

Booth at Staff Appreciation Day

The security office maintains a program of education and awareness to the university community and beyond. ITSO and University Computing Services teamed up to engage students at GobblerFest and to interact with employees during Staff Appreciation Day. ITSO staff taught two NLI sessions to educate faculty members on data management and computer security.

Advancing identity management

Identity management at Virginia Tech secures access to information resources, and requires clear efforts in understanding the relationships between digital identities and 'real world' identities, and ensuring that online

systems appropriately implement those identities. The core system--the Enterprise Directory system-- is based on eduPerson collaborations and has evolved into the components needed by the university.

<u>Personal digital identities and credentials</u>

The major personal digital identity at Virginia Tech is the "PID," used by many online applications. Other personal digital identities generally share the character string of an individual's PID. A component of identity management is the creation of clearly defined roles of individual people that can be used to determine appropriate access to services when using the PID credential. Virginia Tech accomplishes much of this task through affiliations, or roles that individuals have with the university—employees, enrolled students, alumni, and more. A new affiliation, worked on in FY14 and rolled out as the fiscal year closed, marked the role of students newly admitted to an undergraduate, graduate, or professional program. The affiliation persists through the beginning of the semester for which the student has been admitted. It is useful not only to facilitate engaging newly admitted students as soon as possible, but also to terminate services to former students by better distinguishing them from long-ago attendees.

With the world's discovery of the Heartbleed malware this year, the university undertook a precautionary campaign of mandatory password changes for the PID. Earlier efforts to ensure that passwords are changed routinely had already provided the infrastructure that was used to mandate the password changes. An enhancement to mandatory password changes created this year was to enable notification of impending password expiration through email and via the Central Authentication System (CAS).

Additional security-related measures this year included moving many Information Technology services to using CAS for authentication and affiliation-based authorization, offering better protection of passwords. In FY14, the directory made specifically for authentication and role-based authorization checks (ED-Auth) was restricted to known Virginia Tech IP ranges. This restriction limits the exposure of the personal information required for authentication and authorization. Availability was improved this year with 99.999% service uptime for the Enterprise Directory directories, increased from last year.

Authenticating individuals in online services relies on individuals using only their own credentials. In most cases, individuals benefit from knowing their credentials are secure from use by others. The benefit erodes in the context of distance learning, where there can be temptations for a learner to want an impersonator during an exercise or exam for which the learner lacks confidence. These situations challenge the security of credentials used for online learning. As Virginia Tech expands distance learning, implementing effective mechanisms for identity verification of remote students is an increasing need. FY14 saw the early stages of biometric identity verification with the production of a white paper on remote identity verification. Work continues in FY15, likely looking for hybrid solutions of in-person proctoring and multifactor authentication. Solutions may include biometrics—"something you are"—as a complement to the "something you know" and "something you have" components of multifactor authentication.

Learners at the Language and Culture Institute represent the kind of relationship with the university that the new affiliate system will serve.

An affiliate system for persons associating with the university for more temporary purposes is planned to enable appropriate online access to data and online services. In FY14, work was

concentrated on researching a business process and workflow platform that will serve as the core of the developing affiliate system.

Separate from PIDs, in FY14 work began to reframe guest wireless access on campus. A new system is to be piloted in the Center for the Arts. Planning in FY14 prepared for a Fall rollout. This pilot will help decide whether to expand this option to more places on campus.

Federation and collaboration

An increasing effort in higher education is to federate personal digital identities among identity providers such as Virginia Tech and service providers, be they other universities, organizations, or vendor-provided services. Federation allows digital credentials issued at one member institution to be honored by other members, while protecting the integrity and privacy of the credentials themselves. Virginia Tech is a member of the InCommon Federation. InCommon is the leading body for higher education's federated identity management. This year, the university's "Silver" status with the InCommon Federation was upgraded with a new identity profile. Secure Enterprise Technology Initiatives (SETI) analyzed the encryption algorithms used throughout Virginia Tech's identity provider operational infrastructure, and made changes to ensure use of federally approved algorithms. Staying current with the university's "Silver" status positions Virginia Tech for increasing requirements of identity assurance will be beneficial as we engage with other institutions and government agencies.

The InCommon Assurance Program, and the framework and standards surrounding the program were described by Mary Dunker at the fall meeting of VASCAN, the Virginia Alliance for Secure Computing and Networking. Building on the experience of Virginia Tech in securing "Silver" status, she offered information on how schools may work to achieve an InCommon Assurance Certification.

Shibboleth is the protocol that enables most federations, including InCommon. Secure Enterprise Technology Initiatives staff contribute to the open source community for Shibboleth, as well as for its related authentication system, CAS—Centralized Authentication System. In 2014, SETI assisted with the development of prototypes for plugins, contributed to an API, and contributed documentation, among other activities. SETI and IMS assisted University Libraries in integrating the ILLiad interlibrary loan service with Shibboleth. Other InCommon service providers use the federated service, requiring intervention by Virginia Tech only when they request specialized personal attributes other than those opaque identifiers that are routinely granted. Work resumed in FY14 to investigate uApprove, an open source add-on that lets individuals elect to share personal information with specific InCommon service providers. uApprove had undergone significant enhancements that may make it more workable than when previously considered.

InCommon provides guideposts for security standards through its involvement with federated authentication. InCommon criteria for cloud security was mapped to a cloud control matrix developed by the Cloud Security Alliance. SETI contributed to the effort through its collaboration with Internet2 Net+. Compliance with new InCommon Assurance Program requirements led to updates to TAS--the system that issues Virginia Tech digital certificates on tokens.

One of the additional set of credentials used widely in the university is the Hokies ID and password. A system separate from the PID is required because of proprietary differences for Microsoft products where the Hokies ID is used. Federation in this sphere is through ADFS—Active Directory Federated Services—to support using Hokies authentication to access Office 365 cloud resources. Using the newly established federated service

eliminates the need to share university IDs and passwords outside the university. Additional planning for Office 365 continues for planned implementation in the coming year.

<u>Server identities, certificates, and credentials</u>

Another effort in identity management is to have secure and well-documented means for "nonpersons" to authenticate. Services and servers also need to have clearly defined digital identities and means to authenticate. Certificate-based authentication has been the method available for services to authenticate to the Enterprise Directory. Work in FY14 will lead to rollout in early FY15 of the ED Service Account, which can include a password. The Service Account and its accompanying Service Manager web application provide the "next generation" of the ED-ID service. The Business Intelligence System and the Enterprise Systems Jira instance will be able to take advantage of Service Account infrastructure enhancements.

The university has had an agreement with GlobalSign to provide the trust for university-issued digital certificates, allowing them to be recognized and trusted beyond the university. In FY14, work to upgrade security and procedures created the new Virginia Tech Global Qualified Server Certificate Authority implemented new security requirements from GlobalSign. Yet more security-related efforts included installing a new file monitoring system on the servers for Virginia Tech's certificate authorities.

Virginia Tech issued 460 server certificates in FY14.

The Middleware Certificate Authority was enhanced for FY15 deployment in both a functional way--allowing entry of alternative names during enrollment, and to improve security—using a newer hashing algorithm.

For FY14, Virginia Tech issued 460 server certificates and 51 Middleware certificates. There were also 362 certificates issued to persons. The public key infrastructure had no unplanned downtime during the year.

Improving Communications

In a "networked university," students, faculty, and staff operate in a world of increasingly permeable boundaries. Information Technology strives for teamwork and coordination across those boundaries, both within the Information Technology organization and with customers and partners.

As the newly developed Information Technology Operational Plan specifies, the primary direction for the near term is retooling the organization's approach to communications, promoting information sharing and partnership. The areas describe below constitute our 2014 focus for Pillar 6 of our operational and strategic plans.

Fostering a culture that supports and promotes information sharing

Fostering a culture that supports and promotes information sharing requires significant work internal to the Information Technology organization. This work is in two parts: first, to adopt a communication approach involving all units within the organization; and second, ensuring that communications within the organization—up and down management levels, across units, and within working groups—continue to improve.

Communications approach

During FY14, a major component of communications work for the organization was building the operational plan itself. The method of creating the operational plan was to interview unit directors, propose a draft plan, then host discussions within the organization before arriving at a plan that offers "stretch" but achievable goals for the two-year period. Of course, one of the pillars in the Strategic Plan (and operational plan) is communications. The overall internal process for the operational plan creation built buy-in among the unit directors for the communications-centered Pillar.

The first step to carry out the operational plan for Pillar 6 was to convene an Information Technology Communications Team. The team is composed of employees with responsibilities for communications, both directly and through management responsibilities. By sharing time and expertise, the new team is able to provide professional communications capacity to units that have not had these resources for communications in the past. The cross-organizational team has established a liaison to each major area within Information Technology, and is in the process of creating tools and templates that all parts of the organization can use—independently or in collaboration with the team—to interact with faculty, staff, and students, as well as with friends and peers.

A draft operationalization is completed for each pillar

The draft operationalizations are shared with each unit leader

Discussions and editing occur with each leader and designated staff to build out the drafts, make edits, and establish assessment measures

Changes and updates are reviewed and approved, process iterates until parties agree version is complete

As a working group, the emerging team developed an initial plan for Information Technology communications activities and carried out activities as the year unfolded. For example, the new liaison to the Information Technology Security Office assisted in disseminating critical information after the world discovered the Heartbleed vulnerability in the spring, and the team set the stage for communication regarding service decommissioning. This initial plan is a building block for a more comprehensive approach in the coming year.

Testing the Beam
TelePresence robot

Another area of work by the team was to inventory and document existing communication channels. These include channels managed by University Relations—VT News, Campus Notices, Daily Email (faculty and staff), and Weekly Email (students), and others managed by Information Technology—Scholar, My VT, and websites, including computing.vt.edu and the Information Technology organizational website. Some units are using social media sites as well. Work also began, to be completed in the coming year, on inventorying existing communications channels internal to the Information Technology organization.

In addition to the work of the Communications Team, Information Technology units and groups tested new communications channels—social collaboration spaces, Twitter, instant messaging programs, and emerging technologies such as Beam TelePresence robots for remote meeting participation.

Internal communications

As part of its restructuring, the new Technology-enhanced Learning and Online Strategies organization (TLOS) implemented an initiative to understand existing communications practices across groups and locate areas for improvement. TLOS discussed communications needs within and outside the organization at its yearly retreat, and then developed a series of strategic documents, including a new Communications Framework for communications within TLOS and a series of Communications Action Plans for implementing the framework. Working groups were formed to focus on key areas. The net impact in 2014 has been improved and more consistent communications across groups within TLOS, with a stronger focus on documenting and discussing activities, dependencies, and issues.

Ongoing work in Network Infrastructure and Services for organizational branding grew out of the Unified Communications program. The magnitude of concentrated work during the UC projects meant that informal communications that had sufficed for previous work needed to be formalized. Several related concerns came together—the new magnitude of work, the need to rework processes, and the overarching goal of organizational change to become more responsive and collaborative with service users—meant that the organization needed to also become more responsive and collaborative with internal customers; that is, with one another. Brand training events involved all the unit's full time staff, allowing more openness in internal communications. The employee blog, developed in FY14 and announced at the start of FY15 (see Pillar 7), allows employees to comment and discuss organizational issues.

Actively engage our communities

This fiscal year provided an opportunity to establish a baseline, documenting long-standing efforts to engage our community. These include the twice yearly Departmental Computing Support Symposium (DCSS) that attracts about 130 attendees from throughout the university to presentations on new services, best practices, and shared solutions; specialized email lists, notably Techsupport, the open university membership list for announcements and discussions of information technologies, and the network liaison list for announcements of changes to the network infrastructure; two centrally produced online publications—The *IT Reference Guide* and *IT Connection*; and occasional "Town Hall" discussions.

The Departmental Computing Support Symposium attracts 130 attendees twice a year from throughout the university.

Although FY14 was a "baseline" year, communication activities have already increased. The Town Hall format was used more this year than in the past, with discussions of a vulnerability and remediation, and two addressing new directions for email services, the last one just after the fiscal year

closed. By supporting more areas within Information Technology with Communication Team members' expertise, the number of VT News stories tagged with Information Technology was up to 25 this year, compared to last year's 11. Some of these news items garnered the attention of regional media. Roanoke television (WSLS10) covered the work done in Digital Imaging to bring the Marshall Plan online (December), and the collaboration of Virginia Tech and the Town of Blacksburg to join US Ignite in efforts to bring faster broadband to the region (August). WDBJ7 covered the robotic technology of the Beam telepresence (July). Information about planned outages and temporary service degradation was better distributed this year by improving access to the maintenance calendar, publishing a link to it on the main navigation bar of www.computing.vt.edu. Work for next year will include greater focus on external media, from the close-at-hand Collegiate Times, to regional media, to higher education outlets, and more social media.

Community engagement also occurs more formally through the use of advisory groups. Some advisory groups have been in place, also a part of the baseline. In FY14, two major new groups were formed. The TLOS Stakeholders Committee provides feedback on the coming comprehensive grants program, and a representative, campus-wide advisory group was formed for the Business Intelligence System. In addition to the four prior Information Technology advisory groups—Security, Enterprise Systems, Technology-enhanced Learning and Online Systems, and Network Infrastructure and Services, the presidentially appointed High Performance Computing committee offers comment and advice on directions for technology implementations for Virginia Tech.

The Unified Communications program entailed major community engagement as service users were advised about schedules and consulted to identify equipment and service needs. Migration of individuals to the new service proceeded building-by-building, providing unique target audiences for communications. Oversight of the installations requested were handled through institutional channels, with request for orders funneled through departments, while in-person training was handled directly with service users. Face-to-face meetings, emails, phone calls, and—towards the end of the year—freestanding outdoor signs all alerted and informed individuals to the decisions they needed to make about the opportunities the new technology would bring.

Surveys also provided feedback on needs and stakeholder desires. The Identity Management Services group used the feedback obtained in a stakeholder survey to re-conceptualize and re-launch their web presence.

Building awareness of Information Technology's accomplishments

In addition to improving internal communication and better engaging with the university community, Information Technology explicitly intends to raise awareness of accomplishments within and beyond the university. Opportunities include onsite gatherings organized by Virginia Tech personnel, this year including the annual showcase for Converged Technologies for Security, Safety, and Resilience (CTSSR) and HPC Day (see below).

The annual showcase sponsored by Converged Technology for Security, Safety, and Resilience was well attended in August 2013.

Annually, prior to the start of the new academic year, CTSSR hosts a showcase of technology initiatives that impact physical security and safety. The campus community is invited. In August 2013, topics included VT Alerts, geospatial tools and processes, identity management, hazard mitigation, security and safety infrastructure, and the coming regional emergency 911 center.

Presenters at the CTSSR Annual Meeting included Kevin Foust (Chief, Virginia Tech Police Department), Ron Jarrell (Email Manager, Network Infrastructure and Services), William Dougherty (Executive Director, Network Infrastructure and Services), Mike Mulhare (Director, Emergency Management), Seth Peery (Senior GIS Architect, CTSSR), Carl Harris (Chief Technology Architect, Information Technology), Karen Herrington, (Director of Identity Management Services, CTSSR), Scott Midkiff (Vice President, Information Technology), and Sherwood Wilson (Vice President, Administrative Services).

In April 2014, Advanced Research Computing and the Virginia Bioinformatics Institute sponsored "High Performance Computing and Bioinformatics Research Day, popularly known as "HPC Day." It was the first of several planned events to connect the campus community in a computational commonwealth. The program included tours, short research talks, keynote addresses, and a poster session.

Technology-enhanced Learning and Online Strategies held several showcase and outreach events, including the second annual Undergraduate ePortfolio Showcase, a Hokie Wellness booth for assistive technologies, a course redesign showcase, the annual faculty computer showcase, and a collaborative venture with Advanced Research Computing to produce "field trips to the future" in which faculty experience emerging, technology-based and/or immersive learning environments and related tools. Advanced Research Computing also held several events in addition to HPC Day, including a series of Visionarium tours that reached a wide variety of groups on campus; and hosting an Emerging Technology Showcase in the National Capital Region with over 45 attendees from government, academia and industry mingled over presentations, demos and a reception.

As noted in Pillar 1, the Association for Authentic, Experiential, and Evidence-Based Learning Southeastern Regional Conference was hosted at Virginia Tech in November 2013 with 85 people in attendance. The keynote address was presented by a TLOS employee. Additionally, two TLOS employees were invited keynote speakers to the JaSakai Conference in March 2014 in Nagoya, Japan. They were asked to visit and present at Kumamoto University and Kyoto University to discuss adoption of ePortfolios at large-scale universities and to plan for future collaboration in the development of ePortfolio technology and pedagogy internationally.

Additional opportunities to raise awareness of the work of Information Technology at Virginia Tech involve external conferences. Personnel from Information Technology attended, served in leadership roles for, and presented at several higher education and/or technology conferences that represent both broad and specialized audiences. Information Technology employees were involved in several types of conferences:

Meetings unique to Virginia government

- The Virginia Information Technologies Agency security meeting

User groups of vendors whose services and software we use or intended to use

- Open Apereo, Mid-Atlantic Banner Users' Group, Ellucian Live, Microstrategy World, Rosetta MiniCon, JaSakai

Professional organizations

- EDUCAUSE, Association of Collegiate Computing Services of Virginia, Association for College and University Technology Advancement, Common Solutions Group, Virginia Alliance for Secure Computing and Networking, HPC User Forum, Southeastern Universities Research Association, IEEE Virtual Reality, Web3D, NextMed/Medicine Meets Virtual Reality, SIGGRAPH 2013, Conference on Higher Education Pedagogy, Association of American Colleges and Universities, Higher Education Data Warehousing Forum, SC13, Coalition for Academic Scientific Computation, Scientific Computing Group, Internet2

Strengthening the Organization

Pillar 7 of the Information Technology Strategic Plan focuses on making the organization stronger and more capable. The process of creating the Operational Plan over the course of fiscal year 2014 prompted an iterative and highly participative discussion of areas for potential organizational focus and improvement. The outcome of these operational planning sessions was two major goals. The first is to improve our understanding, planning for, and documentation of the varied services offered by the units within Information Technology. Better understanding is the first step to understanding linkages and dependencies, preventing unnecessary overlap, and providing the service portfolio that Virginia Tech needs from the organization. Second is to improve the support provided to personnel inside the organization, preparing leaders of the future, and recruiting, hiring, and retaining excellent staff.

Improving organization-wide understanding of Information Technology services

The major effort this year in promoting understanding of offered services rested on the procurement of a replacement for the trouble ticketing system that supported the Information Technology help desk. The procurement resulting in acquisition of ServiceNow, an enterprise solution based on industry standard frameworks.[1] ServiceNow offers not only a trouble ticket replacement, but also a means of better integrating and publicizing the varied services of the organization.

Purchased from an existing competitive contract, ServiceNow offers a service catalog, knowledge management, and integration with key university systems, along with a comprehensive set of supports for incident management. As the year closed, staff members were learning the system in preparation for implementation.

The implementation of ServiceNow will help Information Technology better integrate and share information on services.

In addition to managing the organization's portfolio of ongoing services, decommissioning those no longer needed is an important task. While the decommissioning of Athena (research computer), Filebox (storage and webpage space for individuals), and legacy VPN—virtual private network— will not occur until FY15, planning was well underway in FY14 for shutting them down. The formation of Collaborative Computing Services (CCS) in 2014 also prompted a holistic review of services and agreements that fall within the new group. As a result, Information Technology decommissioned a domain, began the review and evaluation of existing memoranda of understanding, and began work to reduce redundant services and overhead. The year also brought a focus on retiring interactive video classrooms that had reached end of life.

Hiring and retaining a well-qualified and diverse workforce

Information Technology's ability to effectively hire and retain personnel is undergoing a shift: more external competition for high quality employees, impending retirements, and a more mobile workforce. Recognition of impending change prompted a focus on identifying areas that merit attention in coming years, as well as attempts in FY14 to gather a statistical baseline by which to measure the success of future efforts. Key areas of concern are competitive salaries, turnover, student employment, and diversity. The Institutional Research

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[1] ITIL, formally known as Information Technology Infrastructure Library, a set of best practices for information technology service management; and ITSM—Information Technology Service Management, a process-based practice that aligns information technology services with the needs of the organization

baseline data of September 30, 2013, showed 105 faculty members employed, 30 percent women, and 12 percent nonwhite. Staff members totaled 239, with half (120) in technical/professional jobs. Thirty percent of the staff were women, the same as for faculty. However, 18% of the technical/professional personnel were women. Five percent of the staff were nonwhite, including 7 percent of the technical/professional personnel. Turnover rates were approximately 11% for salaried personnel, a number that is in keeping with metrics from higher education generally.[2]

241 student workers were employed in FY14.
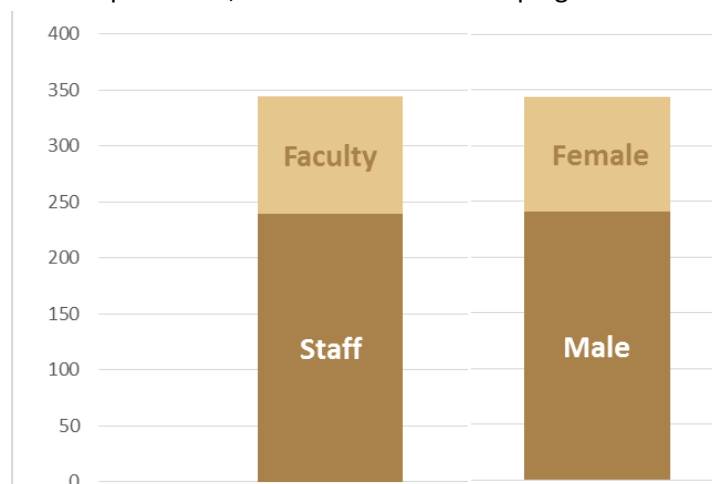
The continuing IT intern program funded by the Office of the Vice President was used well during the year, with 26 student internships funded, and 30 graduate assistantship positions filled. Overall, Information Technology employed a total of 241 unique student workers during the fiscal year.

Recruiting was aided this year by the ability to connect to the university's job postings from the Information Technology website (www.it.vt.edu). Retention efforts included dedicating a portion of the monthly internal newsletter to human resources issues.

The branding work initiated this year in Network Infrastructure and Services (NI&S) serves to improve the quality of the work environment. This comprehensive effort reached most full-time employees within the unit, and sought to recognize, support, and enhance excellence in customer service throughout the unit. Near year's end, a survey of the unit's employees provided information on the perceptions of the branding efforts, notably as to whether employees are engaging in and witness more collaborative work. Detailed results are still being analyzed. A related effort was the development of the "Feedback for NI&S" blog which will be announced to employees in early FY15. The statement of purpose for the blog emphasizes both better service and a better place to work: "We've created this feedback blog because we—Network Infrastructure & Services—want to be better. We want to better serve our customers, better fulfill the university's mission, and be a better place to work" (http://blogs.lt.vt.edu/feedback4nis/).

Create career opportunities and career planning mechanisms

This year, Information Technology continued and expanded the IT Perspectives that is designed to extend the knowledge of mid-level managers about the university and about higher education. Participants are recommended by their area managers, and attend workshops led by the vice president, with invited speakers from key offices around campus. This year, 17 Information Technology managers participated in the workshops dealing with Internal Audit, Student Affairs, and Research, with leaders of the respective offices offering their perspectives. After the restructuring of Learning Technologies with portions of the Institute for Distance and Distributed Learning into TLOS, the program was able to include two managers new to Information Technology.

In FY14, 17 Information Technology managers participated in the IT Perspectives Program to expand knowledge about the university and higher education.

Information Technology participates in the Executive Development Institute, a program to identify and groom future leaders that will serve the university. The Executive Development institute is prepared by

[2] Virginia Tech Human Resources metric: "Average percentage turnover rate should trend with College and University Personnel Administrators ("CUPA")-Human Resources ("HR") benchmark, which is approximately 11%" (www.vt.edu/restructuring/authorities.html)

University Organizational and Professional Development (UOPD) for Virginia Tech. During FY14, one of the major unit leaders participated in the program.

The Management Academy is another offering through UOPD. This program focuses on "leading from the middle." It is a cohort-based learning experience designed to assist managers with the development of skills necessary to effectively lead, manage, and support their respective teams, processes, and projects. Again this year, Information Technology supported a manager to participate in the program.

Information Technology is also striving to develop a stronger approach for optimizing expertise and abilities across the organization. In 2014, this effort included a strong focus on training, notably across traditional roles, for staff working on the Unified Communications project to streamline workflows, prevent resource dependencies, and improve succession planning and knowledge transfer capabilities. Units also increased the use of cross-functional teams to bring together and share expertise in order to tackle challenges. The newly formed Communications Team is one example, bringing together communications experts from across the organization to focus on overarching goals for communications (Pillar 6). Tech Teams (Pillar 1) is another. This year, participants came from three management areas within Information Technology, and also from several other administrative and academic units across campus such as the Office of Assessment and the College of Engineering. Finally, the organization experimented with new approaches to filling both professional advancement and organizational needs. For example, two units were able to work together to provide career advancement opportunities for an employee while creating a clear transition plan that gave both groups and the employee a satisfactory outcome. Information Technology continues to actively support the dual career program at Virginia Tech.

Individual recognitions

Special recognition from the university level this year was awarded to two individuals. Lylah Shelor was named Extraordinary Employee for January 2014. Her nomination and selection reflect her commitment to and passion for her work as facilities manager for the Andrews Information System Building and 1770 Forecast Drive, including the university data center. John D. Nichols of Blacksburg, retired information technology manager for Network Infrastructure and Services received a university 2014 Staff Career Achievement award. Nichols retired from the university in 2013 after 38 years of service, and the award recognizes his exemplary performance and service as an advocate for technological advancements across the university.

Lylah Shelor

Jennifer Sparrow

Finally, individuals garnered some very special recognition from beyond Virginia Tech this year. Jennifer Sparrow, Director, Emerging Technologies and New Ventures, Technology-enhanced Learning and Online Strategies (TLOS) was selected as a 2013 "Rising Star" by EDUCAUSE. Her work was recognized for demonstrating excellence in faculty support, collaborative leadership in the institution, and a promising future in higher education information technology. The EDUCAUSE Rising Star award is intended to recognize an information technology professional who, while early in his or her career, demonstrates exceptional achievement in the area of information technology in higher education.

James McClure, Computational Scientist, Advanced Research Computing, has been selected as one of six XSEDE Campus Champion Fellows for 2013-2014. The announcement comes from XSEDE—Extreme Science and Engineering Discovery Environment—part of a program funded by the National Science Foundation to facilitate national-scale supercomputing. McClure has extensive experience in heterogeneous parallel programming, particularly on systems equipped with accelerators, and is interested in developing approaches that utilize the Intel Xeon Phi architecture to accelerate large-scale simulations. He will apply this knowledge to accelerate Rosetta, a macromolecular modeling software package used to predict protein structures. Researchers use Rosetta to better understand treatments of infectious diseases, cancers, and autoimmune disorders. Further applications involve the development of vaccines, new materials, targeted protein binders, and enzyme design. McClure worked with principal investigator Jeffrey Gray from Johns Hopkins University

James McClure

and Frank Willmore, a research associate with the Texas Advanced Computing Center at the University of Texas-Austin (TACC), on a project that will optimize Rosetta on TACC's Stampede, currently ranked #6 on the Top500 list of the world's fastest supercomputers.