Learning

Research

Experience

Effectiveness

Information Technology
Annual Report 2014-2015

VirginiaTech
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I am pleased to present the Information Technology organization's annual report for fiscal year 2015. As we implement our Strategic Plan, the Information Technology organization seeks to grow in our role as consultant and broker for those services, support, and infrastructure required by the university. Given the ever-changing nature of technology, we intend to be agile, yet compliant with the enterprise-level stability and security required. A theme running throughout our year's endeavors is empowerment of the users of the services provided. We seek to create and improve services to be intuitive enough so that individuals—faculty, staff, students, friends, and partners—can understand their eligibility for those services and can use them seamlessly.

For example, this year, the primary "help" interface—www.4help.vt.edu—was made both more user-friendly and user-controlled. Individuals may search for answers to their questions in a more targeted and integrated fashion, since entry of a short synopsis of their issue presents potential answers. They do not need to exit and find answers themselves in a separate database, or to establish their own search criteria. An example from the enterprise administrative area is the new architecture for business intelligence. With the MicroStrategy tool, individuals will be able to analyze their own data or data that has already been modeled for use with the tool.

Other major accomplishments in FY15 included:

- Pillar 1: Teaching and Learning
    - The selection of Canvas as Virginia Tech's next generation learning management system
    - The implementation of a structured grants program for faculty totaling over $461,000 in opportunities for course design, research, collaboration with other institutions, and innovation in teaching and learning
    - Doubling use of both WebEx and Echo360
    - The opening of the TLOS Learning Studio, a unique space for leading-edge teaching and learning
- Pillar 2: Research Computing
    - Achieving 85% utilization on BlueRidge, our primary production high performance computing system (HPC)
    - The purchase and implementation, completed August 2015, of a new 126-node compute cluster called NewRiver
    - A 100-Gbps upgrade to the MARIA network
    - The creation of an investment computing program for HPC
- Pillar 3: The Virginia Tech Experience
    - Substantial expansion of wireless capacity and coverage on campus, including an ongoing implementation of wireless in all residence halls
    - A full deployment of our new distributed antenna system in Lane Stadium and our six largest residence halls to improve cellular capacity and coverage
    - The near completion of the Unified Communications project, transitioning campus away from Rolm phones
- Pillar 4: Enterprise Effectiveness
    - The business information system (BIS) implementation for the Student Perceptions of Teaching survey reporting, using MicroStrategy tools
    - The selection and beginnings of a major project to implement Blackbaud as the next system for Advancement at Virginia Tech
    - Continued improvement in prioritization and resource management
- Pillar 5: Safety and Security
    - The completion of the Cybersecurity working groups and the beginning of improvement implementations for log archiving and analysis, training, and two-factor authentication

- ○ Improvements to our off-campus disaster recovery capabilities, including a new data backup capability at the Virginia Tech Carilion Research Institute in Roanoke
- Pillar 6: Improving Communication
  - ○ Expanded work of the new Information Technology Communications Team across all units
  - ○ Partnership with new groups on campus, including the newly formed IT Council of distributed technology leaders
- Pillar 7: Improving the IT organization
  - ○ Initiated a project to develop and implement a comprehensive service catalog for user-facing Information Technology services
  - ○ Developed and began implementation of three initiatives for InclusiveVT focused on recruitment, organizational environment, and accessibility

In addition to improvements in our approach to service and user empowerment, FY 2015 saw the continued evolution of our Technology-enhanced Online Strategies (TLOS) unit. After FY14's initial combining of the former Institute for Distance and Distributed Learning with Learning Technologies, this year TLOS focused on simplifying its organizational structures and clarifying the goals and work areas of the unit. Shown in the diagram below, TLOS has evolved a refined emphasis on high-quality learning experience design, promoting faculty digital fluency, and technology-enhanced learning environments. TLOS' work includes cross-cutting attention to support and documentation, accessibility, and leading-edge innovation.
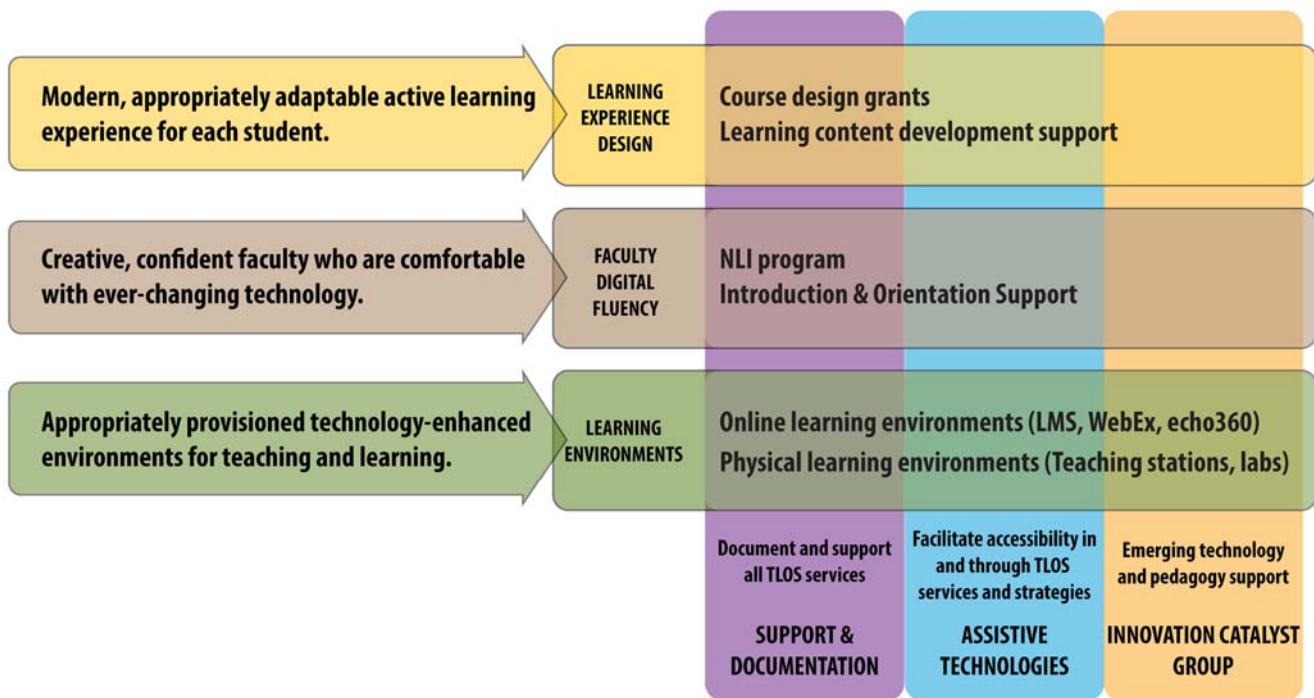
Information technology has never been more important to major research universities, including Virginia Tech. Properly conceived and applied, information technology presents exciting opportunities for Virginia Tech to achieve new levels of effectiveness and transformation in its teaching, research, and outreach missions. I am proud of the achievements and commitment to service of my colleagues in our 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
*October 1, 2015*

Information Technology provides enterprise services that are critical to the successful operation of the university, including many ongoing services and, each year, a select number of new services as additions or replacements. The Strategic Plan focuses on effectiveness of the service portfolio through 2018. The Strategic Plan takes more definitive shape through the Operational Plan for 2014-2016, and this annual report provides an opportunity to reflect on the work of the past year, and to assess our progress toward the goals and objectives of the Operational Plan.

This report is organized by the key points in the Strategic Plan and Operational Plan—the "pillars" upon which we build our endeavors. These are the following pillars that speak directly to the university's strategic plan, "A 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

The final three pillars focus attention on "how" more than "what" Information Technology will do to support the work of the first four pillars. These are the following:

Pillar 5: Ensuring the security and resilience of information technology resources
Pillar 6: Improving communications with customers and partners
Pillar 7: Strengthening the information technology organization
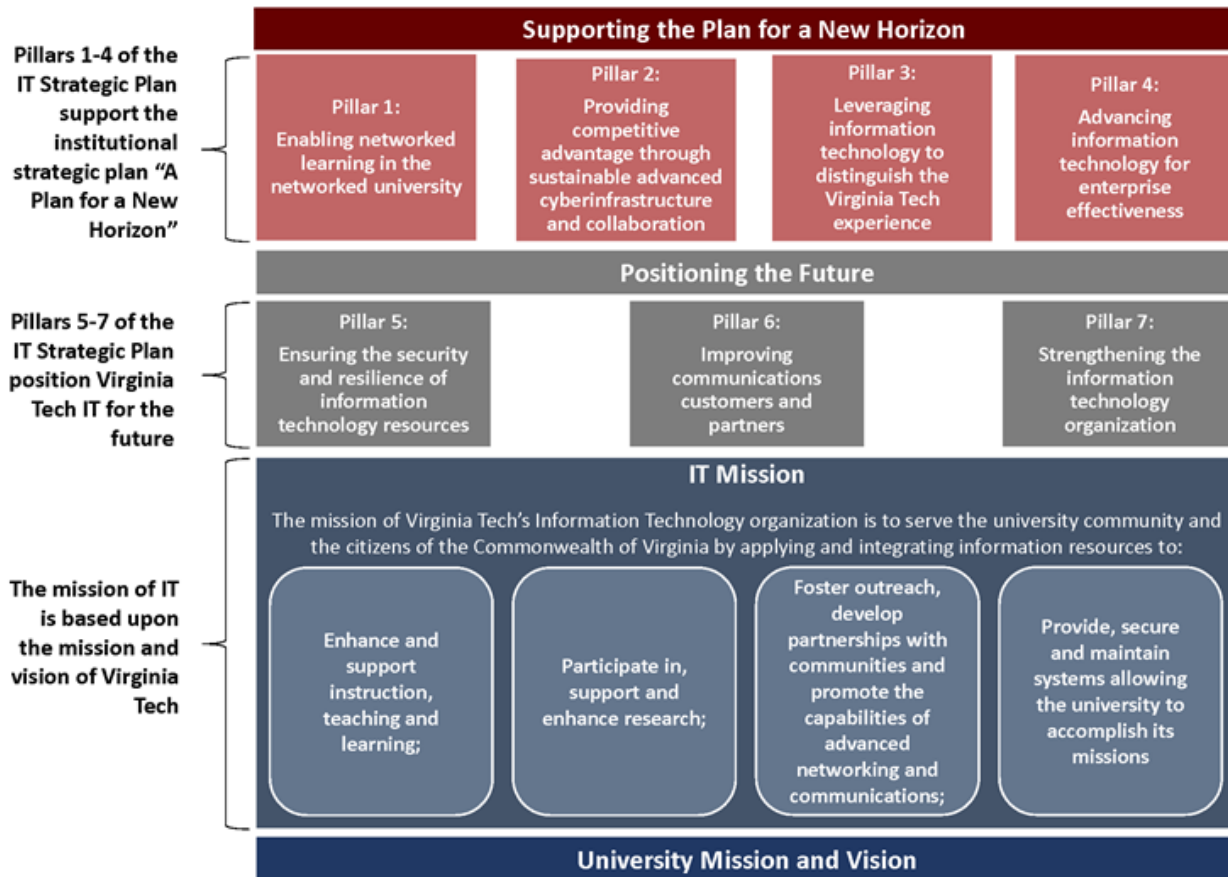
Pillar 1 Enabling networked learning in the networked university

Pillar 1 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

The organization supports online and technology-enhanced education through professional development, structured support, investigation into emerging technologies, and funded support for faculty.

Professional development and structured support

The offering of professional development and training help Information Technology continue to play a strong role in the development of digital fluency in faculty, staff, and student. In FY15, the Networked Learning Initiative (NLI) offered 324 unique courses with 612 total sessions. To improve the overall user experience, we added a new system specifically for registering for courses and tracking NLI course participation (along with the NLI hardware ordering). These sessions had 4777 in attendance, with 1836 unique participants. In partnership with the graduate school, the Graduate Educational Development Institute (GEDI) offered two graduate seminars to approximately 80 graduate students focused on Technology-enhanced Active Learning: GRAD 5114 and GRAD 5104.

612 NLI courses had 4777 participants in FY15

Innovation Space assisted almost 12,000 users in FY15

The Innovation Space new media lab provides opportunities for faculty, staff, and students to explore, implement, evaluate, and champion new technologies that allow for a truly networked university and digitally fluent faculty and students. From May 2014 to May 2015, the Innovation Space new media lab served 10,340 undergraduate students; 445 graduate students; 499 faculty; 389 staff; and 171 members of the general public. For student learners, the Innovation Space lab students conducted a total of 44 *iLearn* sessions.

lynda, our on-demand, online, customized method of support for faculty, staff, and students grew from 9,000 users in FY14 to over 13,000 in FY15. 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. From August of 2014 to August of 2015, 299,970 videos were viewed through *lynda*. FY14 saw 220,947 videos viewed, and in FY13, there were 182,562 videos viewed. These data indicate that *lynda* is growing in use but has room for additional growth as an asset—only 13,674 users have accounts, while the university is licensed for 37,000 users.

lynda.com usage grew by 5,000 users and almost 80,000 videos in FY15

FY15 also saw the expansion of efforts in course design and redesign assistance provided to faculty. Staff presented 35 sessions for Networked Learning Initiatives on topics including technology tools and effective pedagogy for assessment, managing group work, collaborative learning, establishing classroom learning communities, project and problem-based learning, and using WebEx for synchronous teaching and learning. Our instructional design group expanded and refined its approach to cohort-based semester-long professional development, structuring the course redesign and development projects for better alignment with quality assurance review process and to allow for integration of consultation on media development and advanced technology tools for teaching and learning. We have added additional options for faculty not desiring the full cohort process including faculty working groups for program development and structured individual consultation for course element design and development. The continued evolution of TLOS also led to the alignment of digital media services, digital imaging, and ePortfolio services under the new Learning Experience Design (LED) unit. This allows for better access and greater potential for development of rich media for interactive learning and authentic assessment tools and strategies. Internal reorganization of LED continues to build upon the initial redefining of positions, redirection of efforts and collaborative discussions on future endeavors. In total, our instructional design and development teams worked with 26 faculty in full cohort process and have 19 scheduled for Summer 2015. In addition, staff held 131 consultations with 81 faculty members either in groups or individually to guide the redesign of courses or course elements. We are moving to increase staffing and expand options for service to move individual consultations to full course redesign projects when appropriate.

WordPress sites grew by 5,000 accounts for a total of slightly over 9,000 blogs

To directly support technology-enhanced active learning, the Information Technology organization continued to provide tools and services that support instruction. See Pillar 3 for information on services for technology-drenched spaces, such as lecture recording via echo360, and online collaboration services such as WebEx. TLOS continues to provide the WordPress platform for blogs. In FY15, over 12,000 users had accounts—an over 5,000 increase from FY14. The number of blog sites held relatively constant at slightly over 9,000 sites.

Through the equipment loan facility, the Innovation Space makes available to faculty and students, iPads, 3D printing, photography and video creation and editing equipment, and an Oculus Rift Head Mounted Display. The Innovation Space continues to provide full class sets of iPads and is planning a special interest group around mobile learning and iPads to run either summer/fall or fall/spring. This would include a small group of faculty that are planning to use a class set of iPads and would meet regularly to read and discuss scholarship of mobile learning, as well as engage each other around their use of iPads for their courses.

During FY15, Information Technology continued support of existing ePortfolio implementations on campus, including developing training materials, building templates in Scholar, visiting classes, and consulting with faculty and administrators. Information Technology also promoted the use of ePortfolios and other digital media by students on campus by conducting six NLI workshops, and hosting the third annual 2015 Undergraduate Academic Technology and Extended Learning Showcase in May 2015. Beyond campus,

Information Technology participated in national conferences and events, including consultations with eight colleges and universities, two conference presentations, development of a network for ePortfolio efforts in the Southeastern United States (SEEN), and participation on the Board of the Association for Authentic, Experiential and Evidence-Based Learning, the international ePortfolio professional organization.

Emerging technologies

In addition to the provision of existing services and technology, the Information Technology organization continues to dedicate effort to the discovery, evaluation, and dissemination of new applications for emerging technologies and pedagogies. As part of the ongoing evolution of TLOS, in spring 2015 the new Innovation Catalyst Group was created to serve as the primary sandbox/skunkworks site. In the coming year, Information Technology will work to define and establish processes that keep this unit agile and nimble in determining which activities to sandbox or not and for how long; which to recommend move to pilot/prototype, etc. Tech Teams continued this year, producing a white paper on Air Server that can be found on the Tech Teams blog. Additionally, upcoming posts include topics of quadcopters for education, 3D printing, the use of styli and inking technologies, and the use of Oculus Rift for teaching and learning.

For faculty working on course redesigns, Information Technology groups work together to introduce new technology tools based upon the desired outcomes of courses under development and the interests and desires of faculty developing those courses. An overview and demonstration of new technologies has now been incorporated into the professional development guiding the cohorts redesigning and developing courses each semester. There is an informal referral process to move from inquiry to sandbox to implementation. In addition, LED sponsors (through NLI) Faculty Inquiry Groups (FIGs) to explore new technologies and pedagogy supporting the integration of those technologies. This past year, the FIG's focused on gaming for education and accessibility issues in online content. We would like to expand and add more formal structure to referral and implementation in the future and to have documentation of technologies available for sand-box efforts developed for distribution to faculty consulting and developing courses with LED.

Funded support

The organization provides financial support to faculty via a variety of grants. In FY14, Information Technology was preparing for the launch of the new Technology-enhanced Learning and Online Strategies-sponsored grant programs. In FY15, the program launched with three different grant programs that support teaching, learning, and research at Virginia Tech: Innovation in Learning Grants, Design and Development Awards, and 4-VA Grant Initiatives. As part of the rollout of this new program, Information Technology worked to develop a unified web presence for the grants program with complete information, showcase of recipients, downloadable documents, etc. As with all web sites, continual update and revision is ongoing but faculty users report satisfaction with the site layout and information.

TLOS Sponsored Grant Programs awarded over $435,000 in grants

Innovation in Learning Grants are intended to support the implementation and evaluation of new approaches to teaching and learning using technology. These small seed grants are allocated for working on integrative pedagogical and curricular projects that explore "leading edge" innovation with the potential to scale. Ultimately, the aim of this grant area is to advance the integration of new technologies in teaching and learning without limiting or prescribing the exploration of either the technologies or the curricular and pedagogical approaches that a viable project proposal ventures to explore, implement, and evaluate. In FY15, these grants were tied specifically to CLE/Pathways curricular and pedagogical redesign efforts. In total, $43,000 in Innovation in Learning grants was distributed. Grant work included the integration of ethics into a pilot computational thinking course, professional development support of new Pathways Scholars, and curricular/pedagogical redesign efforts.

Design and Development Awards are funded by the Provost's Office and administered by Information Technology, and are designed to ensure investment in the quality of courses. These grants support development of high quality, technology-enabled and successful teaching and learning experiences in courses offered fully online, as blends of asynchronous and synchronous activity, hybrids of online and traditional classroom sessions, and courses utilizing a flipped classroom format. The purpose of the Design and Development Awards is to provide the means through which faculty developing courses appropriate for funding can dedicate the time and effort required for developing high-quality, successful courses that foster enrollment growth and academic success. For FY15, the Design and Develop Awards (formerly Enterprise Fund Awards) were completely redeveloped to be more efficiently managed and clearly conveyed. While extensive paperwork and management effort is still required, the process is now well defined and can be executed uniformly and efficiently, with two RFP cycles – one in Fall and one in Spring—each year. In FY15, $121,147.20 was awarded in Design and Develop grants.

The 4-VA Grants Initiative at Virginia Tech 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, Old Dominion University, 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. 4-VA strives to:

1. define instructional models, including the clear definition of instructional costs,
2. significantly expand access for all Virginians to programs preparing them for rewarding careers,
3. increase research competitiveness,
4. increase opportunities for and enhance the success of students in Science, Technology, Engineering, and Mathematics (STEM) courses and programs

The grants offer four types of funding opportunities through the mechanism of 4-VA, shown on the diagram below: shared courses, competitive research, collaborative research, and course redesign.

Shared Courses	Receive and offer shared courses from and to partner institutions; focus on language, STEM, or STEM-related courses $25,000 allocated
Competitive Research	Provide funding for pilot research that has potential to scale up; focus on technology and sharing and advance other 4-VA goals $100,000 allocated
Collaborative Research	Collaborative research between a PI at a 4-VA institution and a co-PI at VT $50,000 allocated $34,000 granted
Course Redesign	Supports course redesign in language, STEM/related courses in line with Pathways to General Education $250,000 allocated $82,163 granted

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. To further this aim, over the course of the 2014/2015 academic year, Virginia Tech began a project to identify and select a next generation learning management system (LMS). The project was prompted by a variety of both external and internal factors.

Key considerations and requirements for the next generation LMS

External Factors
Key contributors to Sakai (Scholar's platform) have departed, and the platform is moving in a different direction
The LMS market and associated LMS capabilities have evolved dramatically since 2010

Internal Factors
Scholar cannot currently meet many faculty and student requests for functionality
Scholar lags behind best practices for instructional design
Scholar has not kept up with industry trends for learning management systems
Scholar cannot address emerging priorities for a modern LMS

The current learning management system is locally branded as Scholar, and based on Sakai. Many of our former Sakai peers, and three out of four of the original founding institutions, have either implemented or are piloting a system by Instructure called Canvas, as have many other peer institutions. After comparing our known needs and emerging priorities to the capabilities of major LMS vendors, Canvas appeared most likely to meet our requirements.

A proof-of-concept was conducted in Canvas during the Spring Semester 2015 to determine whether it was a viable for selection as Virginia Tech's next LMS. This was not a comprehensive evaluation, but was intended to confirm evaluations from other institutions and to assess support and technical related issues. Faculty and students participating in the proof-of-concept were pleased with Canvas, particularly in comparison to Scholar. Concurrent with the proof-of-concept, the project launched a comprehensive community engagement initiative to gather requirements for the next LMS and the transition and understand needs, desires, and concerns from the university community. The Virginia Tech community was strongly supportive of the need to transition to a new LMS. No critical gaps between community needs and Canvas functions were identified, though as with any system, individual gaps exist. Finally, a detailed technical evaluation found that Canvas satisfactorily or exceptionally met all emerging priorities and key considerations in addition to offering a wide variety of additional capabilities that are not present in Scholar.

Based on these outcomes of the investigation process, Vice President for Information Technology Scott Midkiff and Executive Director for Technology-enhanced Learning and Online Strategies Dale Pike officially selected Canvas as Virginia Tech's next generation LMS. Virginia Tech began moving forward with the procurement and implementation of Canvas in May 2015.

In moving towards the next LMS, a program of activity is needed. Sakai is used for more than the management of course-related activity via Scholar. There are three major additional use cases:

1. Project sites: used by groups from search committees to research projects to manage documents and communication for ad hoc groups (including external participants)
2. ePortfolios: an important and growing specialized use case, allowing students to demonstrate their learning by curating a collection of evidence

3. SPOT—Student Perceptions of Teaching—Online, shown below in more detail: Scholar platform also provides the infrastructure for important projects such as SPOT Online (the role of Information Technology is to provide tools and development assistance to those deciding the best way forward)

In each of these cases, Scholar is used because it is relatively easy to set up and conduct appropriate activity and because there is a level of trust for privacy and security. We will be handling each of these as essentially separate projects, which roll into this Next Generation LMS Program. This program focuses on four projects that will result in the replacement of Sakai, which includes:

- Scholar, which serves as Virginia Tech's current learning management system (LMS) and project site solution
- The Sakai platform, which functions as Virginia Tech's ePortfolio provider and SPOT Online platform.

The program is driven by the need to implement replacements for all major aspects of Sakai and the total decommissioning of the system. To address the total replacement of Sakai, the Next Generation LMS Program will include the following, inter-related projects:

- **The Canvas Implementation Project**: focused on the implementation of Virginia Tech's next LMS and replacement for Scholar Course Sites, Canvas
- **Project Site Conversion Project**: focused on finding and implementing a replacement(s) for Scholar project sites
- **Next Generation ePortfolios Project**: focused on finding and implementing a replacement for ePortfolios
- **Student Assessment of Teaching Project**: focused on providing support for finding and implementing a replacement for SPOT Online

The implementation project to move us to a new LMS and decommission Sakai began in May 2015 and will complete in Spring 2017. During the transition, Information Technology continues to fully support the systems running on Sakai—Scholar, project sites, ePortfolios, and SPOT Online.

In addition to the transition away from Sakai, Information Technology is actively working on several additional fronts to enable 21st century learning environments. A key effort that will fully launch in FY16 began in FY15, when Information Technology began leading and populating an Online Learning Task Force Management Committee as a sub-committee of the TLOS Stakeholders group. The purpose of the Online Learning Task Force Management Committee is to serve as the investigative team sanctioned by the TLOS Stakeholders committee to identify issues with and challenges to successful online learning at Virginia Tech, seek out and compile information on ways to address those issues and challenges, and make recommendations for action based on that information. The core members of the Online Learning Task Force Management Committee are charged with:

- identifying key issues and challenges relating to online learning at Virginia Tech;
- recommending to the TLOS Stakeholders the issue and/or challenge to be addressed by a task force;
- inviting members to serve on a specific task force based on the issue and/or challenge to be addressed;
- managing the assembled task force with defined goals/objectives and periodic reports to TLOS Stakeholders;
- making recommendations to the TLOS Stakeholders committee for proposed action by TLOS and other areas of the university to address the focus of the task force.

Work on learning environments also included a focus on remote identity validation and guest account provisioning (see Pillar 5 for more detail).

Foster computational thinking across the university

In FY15, the Information Technology organization worked to foster computational thinking at the university through targeted infrastructure and services (see Pillar 3 for a discussion of unique spaces and infrastructure that support this aim), bringing students into Information Technology for learning and professional experiences, academic partnerships across campus, and events and outlets that publicize opportunities.

Working with students to promote computational thinking

Personnel from Information Technology taught or provided guest lectures in several courses across campus, bringing applied computational thinking capabilities to the classroom. Personnel taught courses in the Graduate School, and for the Departments of Computer Science, and of Aerospace and Ocean Engineering. A staff member also co-led "Connected Courses", a cohort of Virginia Tech faculty and graduate students, as part of a national/international Active Co-Learning seminar as part of the DML Research Hub course, http://connectedcourses.net. Team members provided guest lectures in a wide range of departments as well, including English, agriculture, the Honors College, computer science, electrical and computer engineering, engineering education, building construction, visual media, and instructional design. In the coming fiscal year, the LED group is developing a website offering topics of expertise and availability for guest lecture requests to further expand contributions in this area. Additionally, course contributions towards contribution occurred on a foundational level through professional development and consultations on course and course element redesign, which included references to and discussion about computational thinking in the structure of course, design of materials, assignments and assessment.

Promoting computational thinking works in two ways where students support students in the use of information technologies. The Get Connected program helps students get started with technology at the beginning of the academic year. This year's staff included 26 students, less than the 29 from last year, yet the group assisted with 758 incidents, up from 504 last year. Forty percent of incidents were resolved within 10 minutes, and nearly 80% were resolved within 20 minutes, the goal for resolution time. Configuring wireless connectivity was the most common issue.

Throughout the year, IT Support runs the help desk—4Help—that trains student employees to assist the campus community, including other students. Components of the support function include the Call Center, the Help Desk, the Network Operations Center (NOC), as well as the smaller functions of internal desktop support, and, for this year, the remaining Software Assistance Education Center on Torgersen Bridge. The Call Center handles password changes and is the gateway for a significant number of other requests. Together, the functions handled over 33,000 incidents during the academic year.

2014-2015 IT Support incidents
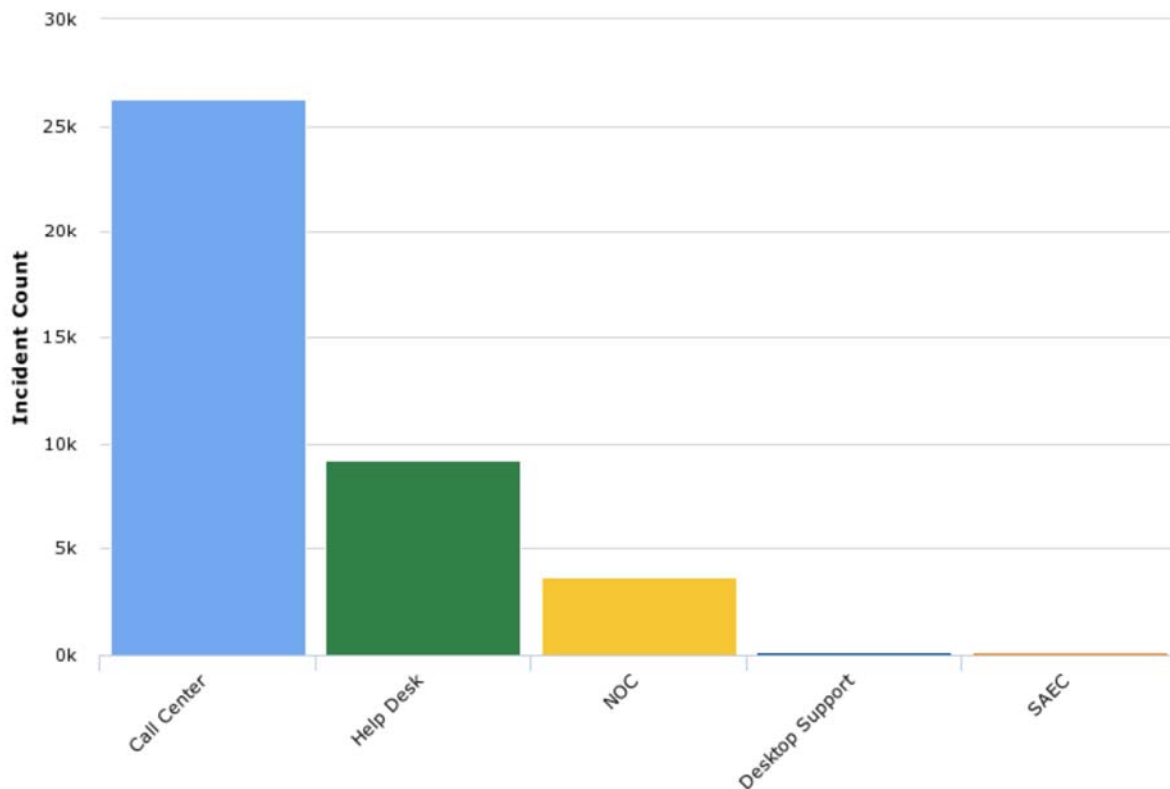
The community members served included approximately 40% faculty and staff, a fairly stable percentage year to year. Over half were students, and some alumni were served as well.

Support for computational thinking in applied environments includes yet other ways of engaging students with the organization. Information Technology staff engaged in a variety of mentoring and professional development activities during FY15. The organization continues to directly employ undergraduate students through groups such as 4Help and Innovation Space. In addition to Graduate School-funded GA's employed within our organization, we sponsored two GEDI graduate fellows, three NLI graduate fellows, and created two fellows for the coming fiscal year. Staff also assisted in other mentoring roles—serving as a faculty fellow in the new GTA Academy of Excellence; recruiting, guiding, and overseeing interns; and hosting student groups interested in learning about processes for instructional design for media rich, technology-enhanced courses.

Karen Herrington with Gino Manzo, lead instructor, and Luke Lester, department head.

One staff member served as a sponsor for an electrical and computer engineering (ECE) capstone course project for Fall and Spring semesters this year. Sixteen teams of upper-level engineering students completed a new capstone design course that paired teams with industry sponsors including Lockheed Martin, General Electric, BAE Systems, Northrop Grumman, Johns Hopkins, and also included one project from Information Technology—the first time an ECE capstone course selected a project within Virginia Tech for one of their sponsors.

Students completed a full business acquisition/deliverables cycle—responding to a request for a proposal, developing the statement of work and technical specifications, negotiating deliverables, designing and developing the technology, conducting initial simulations, and proceeding to a final turnover of the project. The course emphasized business process and professional development—including building leadership/team skills, listening skills, and identifying strengths and weaknesses.

Unique among the projects was designing a mobile single sign-on software interface, proposed by Identity Management Services. While most applications store passwords, creating security risks and poor user experiences, a single sign-on interface allows multiple services or applications to securely identify users over an open network, and allows users to sign in using just one password. Team members Zack Bubb, Christopher Dorick, Nathan McCloskey, and Cameron Spiller (pictured above) worked to develop a solution using open authorization to provide secure sign-on, keeping all authorization requests under the control of a token agent.

Karen Herrington (IMS), project sponsor, praised the work of the four-member team. "They worked hard and met all the goals we set for them, and came up with a solution that is workable and elegant. I really saw an evolution in their communication style and project management abilities over the duration of the project." Herrington mentioned that the students chose the project specifically because they wanted to work on a software challenge instead of a hardware challenge. Having had less experience in software development, two of the team members expressed an interest in taking additional mobile software design courses in the future. The single sign-on software interface project won the Best Paper Award, as voted by participants of the poster session and presentation.

Academic partnerships

Information Technology groups and personnel engaged in a wide variety of academic partnerships in FY15. In addition to those already named in other areas of this report, one major area of partnership was on general education—as with the past fiscal year, the organization continued its support for the evolution of general education at Virginia Tech during the transition from the Curriculum for Liberal Education to Pathways to General Education. As noted above, both Innovation in Learning grants and 4-VA course redesign grants dedicated funding to faculty members working on Pathways projects and courses. A staff member served as a member of the Provost's Pathways General Education Administrative Team, providing leadership and consultation on 21st-century pedagogies for the first group of Pathways Scholars; as the lead on the integration of "Intercultural and Global Awareness" outcome across general education courses; and as a keynote speaker for the Pathways Summer Institute and facilitator in and beyond the Institute. The organization's digital media services group participated in the creation of "course trailers" for

new Pathways courses. Footage in the classroom as well as student interviews were shot for three courses in Fall 2014, with follow up interviews with participating faculty in Spring 2015. To date one trailer is complete and has been released.

The organization also continued to evolve its partnership with Institute for Creativity, Arts, and Technology (ICAT), and in FY15 worked with ICAT to develop and agree upon the first memorandum of understanding that detailed contributions each organization will bring to the partnership. Additionally, ICAT and NLI have successfully completed two semesters of providing NLI credit to faculty who sign up for Field Trip to the Future events which involve attending an ICAT "Community Playdate" followed by a "backlot" tour of the Moss Center, particularly the ICAT studios and the cube. Participating faculty routinely comment that they have rarely, if ever, been engaged in the kind of cross-disciplinary atmosphere in these playdates, nor had any idea about the infrastructure and technology-enhanced learning and research capabilities built into the Moss Center. Incremental improvements are in the works, including trying to find a way to match up faculty members with Playdates involving areas of interest specific to them.

Additionally, the Innovation Space's UAV (drone) was used for faculty research projects in partnership with faculty in the School of Visual Arts and the School of Education for photogrammetry. The drone was part of an outreach event with Blacksburg High School where collaborators shared their process for digital media and game creation with over 400 students from Blacksburg Middle and High Schools. Work with faculty also included the presentation of results of funded research on augmented and virtual reality for inquiry learning at state, national and international conferences. Staff also met with representatives from Zambia and India to discuss and advise on the establishment of distance learning courses and programs.

Publicizing opportunities

Conferences, showcases, and events are another area of emphasis for advancing computational thinking by making community members aware of opportunities connected to computational thinking within Information Technology. In FY15 the organization offered six showcases related to teaching and learning, which included topics such as instructional design, broadcasting the work of faculty who participated in teaching and learning development opportunities through LED or NLI, celebrating leading edge technology-enhanced active learning work on campus, and debuting new spaces such as the Learning Studio (see Pillar 3). Information Technology also hosted a Distinguished Innovator in Residence speaker series through NLI.

Two units in Information Technology served as sponsors for the Society for Electro-Acoustic in the United States (SEAMUS) 2015 national conference hosted at Virginia Tech in March 2015. The conference is the largest of its kind and took place over three days, featuring over 20 hours of cutting edge electroacoustic music and audio-visual art from leading scholars and artists as well as student artists. The conference offered paper sessions and workshops and showcased the work of a number of Virginia tech faculty and students.

Staff also offered keynote speeches and conference presentations related to teaching and learning with technology at events across the country. As an example, a team member offered the keynote for Montgomery College's 2015 Innovation Forum. Staff also presented and led workshops at national and regional conferences for professional organizations including SITE, AECT, Educause, WECT, and OLC (formerly Sloan-C)—a presentation on technology and strategies for managing group work in online courses received award from OLC; a senior director was invited to lead workshops in their Mastery Series on Blended Learning and Leadership in Online Learning, both reaching national and international audiences; the senior director of LED was an invited lecturer for Online Learning Consortium (formerly Sloan-C) and facilitated OLC's online Mastery Series for Blended Learning; and staff members participated in international programs including the Institute for Emerging Leadership in Online Learning sponsored by OLC.

Pillar 2 Sustainable, advanced cyber infrastructure and collaboration

"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." Pillar 2 is designed to support and advance this area of the plan and to 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.

Leading edge institutional resources

In FY15, Information Technology invested in increased sophistication of data analysis and system structures; launched an Investment Computing Program to better meet the needs of super users, and significantly expanded our HPC infrastructure to address increasing demand for resources. More detail on our work in these areas is explained below.

Increasing sophistication in the use of data for planning and the birth of investment computing

In August 2014, Information Technology implemented automated reporting of usage of computational resources. Between July 1, 2014, and April 30, 2015, 405 users submitted a total of 84,069 jobs on high performance computing systems. In total, 363 new users were granted accounts on systems managed by Advanced Research Computing (ARC) between 1 July 2014 and 30 April 2015.
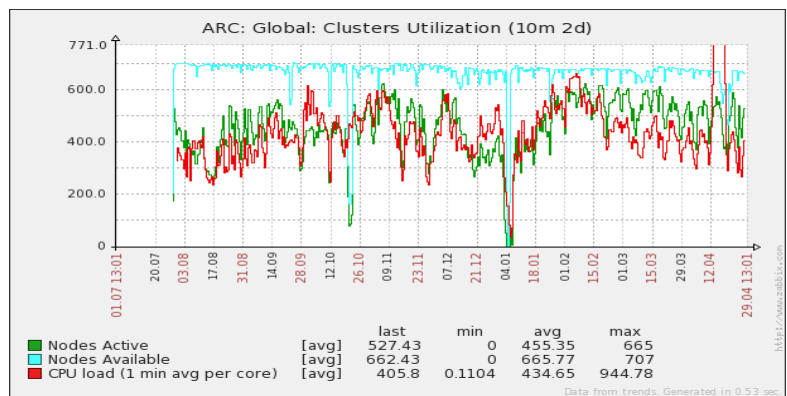
BlueRidge has served as the flagship HPC resource for Virginia Tech since it was brought online in June 2013. There are currently 109 research allocations owned by 85 different faculty members active on this system. BlueRidge had an average utilization of roughly 85% of the capacity available to production jobs[1]. The following figure shows total usage of ARC computational resources (green) against total resources available (blue).

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[1] Note that BlueRidge has several nodes that are reserved for interactive use or use by individual research groups, so utilization typically peaks at somewhat less than the total nodes available (margin between the green and blue curves).

An allocation system was developed when BlueRidge was initially brought online to help plan for and manage usage. This allocation system represents Information Technology's first effort to automate the tracking of faculty research on our systems. To use BlueRidge, faculty must describe their project, the software they require, and other relevant information, providing us with information about faculty needs, both in the form of faculty requests and actual usage. It also allows us to track the usage of the machine and associate each individual job with a particular faculty research project.

These usage rates then become data points to help Information Technology anticipate and plan for research computing infrastructure needs. Information regarding all approved BlueRidge allocations is provided in Figure 1. This graph shows the total number of allocations group by allocation size in core-hours. The most common allocation sizes requested are 200,000 system units[2] (SUs) and 1,000,000 SUs.
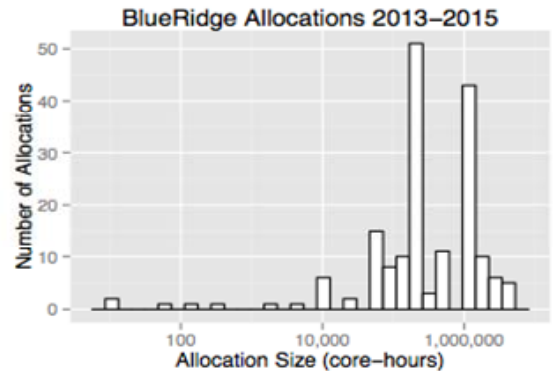

Figure 1. Summary of all allocation sizes granted to faculty for research performed on BlueRidge.

Yet, as shown in Figure 2[3], most faculty use fewer resources than they request. This graph shows the actual number of SUs used by individual allocations over a two year period. Comparing the requested allocation sizes with the actual system use demonstrates that the resources requested by faculty do not necessarily reflect their needs. Not surprisingly, faculty tend to request the maximum number of SUs possible given the amount of effort required. The "long tail of science" is clearly visible on this plot; while a small number of users require a very large number of core-hours to advance their research, most faculty have more modest compute requirements. Indeed, data suggest that two-thirds of research groups will require less than 100,000 core-hours to meet their annual needs. Centralized resources are relatively more valuable to these groups as compared to the large-scale users due to the fact that they have significant computational requirements that are nowhere near large enough to warrant dedicated hardware.

With the allocation system in place for two years, we increasingly have the opportunity to use this information to refine the system policies delineated by ARC to more effectively serve the needs of the faculty while advancing the strategic goals of the university and the department. In particular, this guidance can be useful in determining strategies that are likely to encourage faculty and departments to directly invest in ARC systems. As we learned from the data, while most faculty have comparatively modest needs that are effectively met without special accommodation, this group of super-users on our long tail have unique resource demands that previously might have required the purchase of dedicated hardware unique to their research groups.

In the interest of better meeting the unique needs of power users, the Cluster Investment Program was introduced this year to promote faculty investment in centralized computing infrastructure. The program allows researchers to purchase priority access to the BlueRidge cluster for five years, meaning that investor jobs will jump ahead of all non-priority jobs waiting to start. The program also works with investors to address other research requirements, such as specialized storage needs. In Figure 2 above, a horizontal line is included to show how many allocations have consumed at least 1.2 million core-hours over the two

[2] Allocations are granted for one year and must be renewed in subsequent years. Consequently, the number of core-hours should be interpreted as a measure of the annual needs of Virginia Tech research groups. Each system unit is defined as one core-hour

[3] Note that a log-scale is used for the number of core-hours in Fig. 2

year period from 2013-2015. This number is significant because it represents the smallest annual allocation of priority compute-hours that is possible within the Cluster Investment Program. Six faculty members participated in the Investment Computing Program for fiscal year 2015, yet, of the top thirteen allocations on BlueRidge, only one user is a Faculty Partner in the Cluster Investment program. While this distribution is likely to change as early career investors ramp up their research programs, the data point to a need to encourage investment from more well-established faculty that are most able to consume a large amount of resources. Departmental investments could provide an excellent mechanism for this, and the coming fiscal year will see Information Technology working deliberately with departments and faculty members with high computing demands to expand participation in the program.

Evolving infrastructure to expand access to resources

Information Technology is making a concerted effort to address the data needs of the Virginia Tech research community through a combination of hardware and software acquisition, user training, and collaborative efforts to improve the campus infrastructure. Focus areas for improvement are based on a variety of factors, including the demonstrated increase in usage and demand for resources. This year, Information Technology held a town hall meeting to solicit feedback on how we were meeting the needs of data intensive users. The town hall was supplemented by a questionnaire sent to users in September 2014 on data intensive computing needs. The questions were designed to gauge user needs prior to architecting a new hardware acquisition targeted at analysis of large datasets. After analysis of these data points, specific upgrades to capabilities from the past fiscal year included the following:

- Building a new storage GPFS system to support the data storage needs of the Virginia Tech research community
- Deploying Globus software for data transfer and dedicated data transfer nodes
- Providing access to DMF tape archive for the research community for long term archival (228 TB capacity)
- Opening the 90-node expansion of ARC's flagship cluster, BlueRidge, to users on June 20, three weeks after hardware arrival and less than one week after installation by the vendor
- Opening the 800 TB Lustre parallel file system to users on June 20 after its May 19 installation

Summer 2015 will see implementation of two new hardware offerings: a new 2.2 PB GPFS parallel file system and NewRiver. NewRiver is a stand-alone 126-node compute cluster. Clusters and storage system coming online this summer include these services:

- HPC general compute engine
- HPC large memory and large direct attached storage compute engine
- HPC large memory and accelerator compute engine
- HPC very large memory compute engine
- Interactive development compute engine
- General parallel file system (GPFS) storage

The new hardware will represent a 13% increase in total computational capacity and a 35% in CPU-only (the most in-demand) computational capacity. After these upgrades, the resulting visualization of HPC resources at Virginia Tech is shown below.

Information Technology also retired the Athena cluster in the summer of 2014, which involved migrating dozens of users to newer clusters. The migration started with announcement of the decommissioning and a meeting with users to talk about their use cases and needs. Staff then followed up with each user

directly to make sure that their software and workflow had been moved to other HPC resources prior to shutting down Athena.

Research network

In addition to major improvements to our HPC capabilities, Information Technology is working to upgrade our network for research by tenfold to enable 100-gigabit per second connectivity. This spring, Virginia Tech and other Virginia universities that are members of the Mid-Atlantic Research Infrastructure Alliance, Inc. (MARIA) increased campus connections to the Internet2 Network to 100 gigabits per second (100G). This upgrade delivers a tenfold increase in information-carrying capacity required to meet the rapidly advancing needs of high-performance, data intensive research and collaboration. The move puts participating Virginia universities among the best-connected institutions globally. Internet2 is the United States' largest and fastest globally connected research and education network.

MARIA is a non-profit corporation that brings together Virginia's major universities to facilitate access to shared technology infrastructure for research (cyberinfrastructure). In addition to Virginia Tech, MARIA members include the College of William and Mary, George Mason University, James Madison University, Old Dominion University, University of Virginia, and Virginia Commonwealth University.

A group of MARIA members are partnering with the Mid-Atlantic Broadband Communities Corporation (MBC) to invest in an upgrade to the MBC network spanning the Commonwealth of Virginia. The advanced technology required to deliver the needed 100G channels poses financial and technical challenges particularly for far flung areas outside the major metropolitan hubs.

The upgraded MBC network will deliver enormous initial capacity of 4 terabits per second (4Tbps), including 500 gigabits per second dedicated for MARIA research. Virginia Tech and Old Dominion University will be the first MARIA members to implement 100G channels over the research allocation. The new network became operational as the coming fiscal year began.

Radford University and the Virginia Tech Carilion Research Institute will benefit from Virginia Tech's 100G link. The MBC network is designed to reach additional MARIA members including Virginia Commonwealth University and James Madison University in a phased approach.

The MARIA 100G connections will land at the Mid-Atlantic Research and Education Exchange (MREX) operated by Virginia Tech at a strategic location in Ashburn, Virginia. The MREX provides an information exchange and shared access to Internet2, federal research networks, commodity Internet services, and content services serving as a regional hub for those activities. The Internet2 Network co-locates a major global interconnection point at the MREX location in Ashburn.

A known area of need, which will receive more emphasis in the coming year, relates to assisting researchers with data migration onto new systems. At present, most users who migrate external data to ARC systems rely on the local campus network. In the coming fiscal year, Information Technology intends to develop and implement a more formalized process.

Partnership and collaboration

As noted above, collaboration with researchers and organizations both within and outside the institution is crucial to effective and lasting expansion of our HPC capabilities.

National computing presence

Advanced Research Computing tracks the allocation of researcher time on two national computing programs: XSEDE and INCITE. The XSEDE program includes allocation on research cyberinfrastructure funded by the National Science Foundation (NSF). In the last year, seven Virginia Tech researchers have served as PI on XSEDE allocations. Allocations of supercomputer time on Department of Energy (DOE) resources are made through the INCITE program. These allocations require very large simulations and awards range from tens to hundreds of millions of core hours. Two Virginia Tech researchers are named on active INCITE awards, Edward Valeev (Chemistry) and James McClure (Information Technology).

Information Technology-assisted funding and publications

According to data entered by researchers in our tracking system, Information Technology systems and support staff enabled 61 academic publications from 25 different PIs across 48 different journals and conferences. Over $11,209,409 in funding was brought to Virginia Tech by projects using Information Technology resources. Projects are listed below.

Title	Byline	Funder	Award Amount
CDI-TYPE II–Collaborative Research: Using Algebraic Topology to Connect Models with Measurements in Complex Nonequilibrium Systems	M. Schatz, Mark Paul, K. Mischaikow	NSF	$1,850,000
Abiotic stress networks converging on FT2 to control growth in Populus	Amy Brunner, Jason Holliday	DOE	$1,430,447
Advancing Coal Catalytic Gasification to Promote Optimum Syngas Production	Francine Battaglia, Foster Agblevor, Michael Klein, Reza Sheikhi	Department of Energy	$625,388
Collaborative Research: SI2-SSI: Task-based Environment for Scientific Simulation at Extreme Scale (TESSE)	Ed Valeev	NSF	$600,000
Function of a male-specific gene in Aedes aegypti	Zhijian Tu	NIH	$410,000
Spatiotemporal Chaos in Fluid Convection: New Physical Insights from Numerics	Mark Paul	NSF	$400,000
Health Consequences of Disaster-Related Disruption in Home and Community-Based Supports	Yili Hong	DHHS-ASPR	$172,877
Integrated Controls for Convenience Stores	J.T. Borggaard, J.A. Burns, and E.M. Cliff	Department of Energy	$150,000
Augmented Reality Simulation for Design and Evaluation of Training Capabilities CGV: Small: Collaborative Research: Immersive Visualization and 3D Interaction for Volume Data Analysis.	Doug Bowman, Jake Socha	ONR, NSF	$ 1,144,697
IUSE: Wireless Communication Testbeds for Authentic STEM Learning	Dietrich, Polys, Beuhrer, Marovich	NSF	$ 626,000
Improved grape and wine quality in a challenging environment: An eastern US model for sustainability and economic vitality	Wolf, Sforza	USDA NIFA	$ 3,800,000
		TOTAL	$11,209,409

Direct partnership with researchers and departments

Between 1 July 2014 and 30 April 2015, Information Technology collaborated on 16 external proposals with a total value of over $20 million, $6.7 million of which would have been dedicated to Information Technology. These proposals included faculty from over 21 different departments across campus. In addition to direct collaboration, Information Technology assisted over two dozen researchers with proposal submission. We also led or assisted numerous collaborations on five internal institute level proposals (e.g. the Institute for Critical Technology and Applied Science, the Institute for Creativity, Arts, and Technology, and the Institute for Society, Culture and Environment) with faculty from eight different departments and personnel served as co-authors on four conference papers and five journal articles.

We assisted with 498 help requests and provided 82 researcher consultations over the course of the past fiscal year. As part of our researcher services, we seek to find efficiencies and improve outcomes. An outstanding example of this was our work with the Virginia Department of Environmental Quality (DEQ), which migrated simulations from Athena to BlueRidge. In the process, computational scientists in Information Technology enabled more parallelism in one of their main simulations, improving performance by more than two times. Additionally, FY15 saw Information Technology move from the FY14 initial procurement and configuration of a test cluster for Apache Hadoop—"an open-source software framework for storage and large-scale processing of data-sets on clusters of commodity hardware"[4] intended to enable more efficient and effective use of computational resources—to piloting the cluster with the Information Technology Security Office, to assisting researchers from several different areas as an initial validation of the model. Hadoop is now an official software offering from our Advanced Research Computing group.

The Information Technology organization also had an opportunity to begin piloting an entirely new partnership offering for systems administration and virtual infrastructure for researchers in FY15. The need for this offering became evident when a researcher, Dr. Laura Sands, needed to make the transition from another institution to Virginia Tech. A major area of Dr. Sands' research focuses on protected health information, which have stringent technical and environmental specifications required by the Health Insurance Portability and Accountability Act (HIPAA). The requirements for storing and accessing this data, in combination with the need for expertise to manage this infrastructure, created a physical, technical, and personnel resourcing challenge. As the first researcher attempting to work with HIPAA datasets at Virginia Tech, Dr. Sands' needs presented a unique opportunity for the Information Technology organization. The Collaborative Computing Solutions group (CCS) worked to understand and account for all HIPAA requirements, identified areas for improvement in other areas of the university that were also impacted by the expansion into HIPAA protected data. At the end of the fiscal year, the organization had implemented a plan to partner with Dr. Sands on a model to provide systems administration and virtual infrastructure for her research data. This pilot will soon scale to a university-level service offering, with potential to expand into other highly regulated data. This partnership saved the development of high-cost, localized, and non-sharable infrastructure and resulted in a service that will allow similar cost and time savings for other researchers on campus. The coming fiscal year will also see the formation of a working group focused on approaches for dealing with unclassified information in general to enable the institution to stand up better and more consistent models for institutional data in writ large.

Events, education, and training

Information Technology also dedicates effort to events, education, and training to get the word out about high performance computing and encourage new participation. One of the largest events from the past

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[4] http://en.wikipedia.org/wiki/Commodity_hardware

fiscal year was the second annual Virginia Tech HPC day. The event took place at the Inn at Virginia Tech in April 2015. There were sixteen $500 co-sponsors[5]. HPC day was attended by approximately 100 students, faculty, and staff. Featured keynote speakers were Sallie Keller, Rupak Biswas, and Cleve Moler, panel-discussions on "What Can ARC Do for You" and "HPC in Higher Education." The day ended with a judged poster-presentation session of forty posters.

Additionally, we work with the University of Virginia to facilitate, design, build, and staff the SuperComputing conference booth each year. In the coming fiscal year, we intend to expand this collaboration via MARIA with two more Virginia schools.

With respect to education, for the second time, ARC collaborated with the Department of Aerospace and Ocean Engineering to offer a graduate-level class in parallel programming. There are also a variety of courses where resources and HPC concepts are incorporated, including Computer Science—Virtual Environments; Information Visualization; Multimedia Storage and Retrieval; Psychology—Perception & Action; Mathematics—Linear Algebra. Information Technology hosts two VSCSE/XSEDE summer school programs that are attended by external users from the National Aeronautics and Space Administration and DEQ. The two courses were a three-day Intel Xeon Phi workshop and a two-day Visualization workshop.

Information Technology also offers short courses through NLI. Last year, 29 courses were offered with over 200 participants. In this fiscal year we also began recording all HPC NLI offerings and slides from trainings are made available online. Recorded events will soon also be available online. We are also evaluating ways to work with NLI to create a certificate for HPC/Viz. In the fall, we plan to make our NLI courses available via WebEx to external users.

We have just begun the process of selecting possible speakers for a sponsored speaker series. We will focus on highlighting how high-performance computing and visualization is making a big difference with its enabling role in research and development and a substantive impact in academic research projects and just as importantly in industry. We will also feature a speaker for diversity and inclusion.

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[5] College of Science, Department of Aerospace and Ocean Engineering, Department of Chemical Engineering, Department of Geosciences, Department of Materials Science and Engineering, Department of Mathematics, Institute for Creativity, Arts and Technology, Institute for Critical Technology and Applied Sciences, Interdisciplinary Center for Applied Mathematics, NI&S: UNIX Administration Services, Office of the Vice President for Information Technology, Office of the Vice President for Research, The Hume Center, Virginia Bioinformatics Institute, Virginia Tech Carilion Research Institute, Virginia Tech Transportation Institute

Pillar 3 Leveraging information technology to distinguish the Virginia Tech experience

Pillar 3 challenges the Information Technology organization to apply technology in ways that make the Virginia Tech experience unique. In partnership with other university units, we work to ensure that both physical and virtual spaces are infused with technologies to enhance learning, research, outreach, administration, and, notably for students, daily living. Creating these experiences requires collaboration with university partners to build the underlying infrastructure. Creating sustainable technology drench spaces, notably in residence halls and featured venues provides tools for a broad set of university activities.

Technology-drenched spaces

"Technology-drenched spaces" entails bringing technology into physical spaces, along with expanded virtual spaces in order to provide the advantages of interconnections with resources and people.

Construction and renovation of networking infrastructure

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.

To better inform the design process, Network Infrastructure and Services is enhancing the Cable Standard to include guidelines for use early in building design processes. The guidelines will address how many data connections should be included in preliminary designs according to the size and program of the spaces. The revamping of the Cable Standard is underway as this fiscal year closes. The organization is also working with other groups across the institution to highlight opportunities to incorporate Information Technology--primarily through the Network Infrastructure and Services unit--earlier in the planning process for new buildings.

This year, Information Technology had an opportunity to collaborate with the Office the Provost, University Design and Construction, and others to ensure that the coming new classroom building has the infrastructure required for the anticipated learning technologies to be incorporated. Expectations for a learning environment required higher performance cabling than what was initially slated. Information Technology staffers were also able to advise on requirements for renovation of space in Newman Library that would serve learning in the arts. Faculty from cinema, music, and the visual arts will be using newly renovated space on the first floor. Proper placement of power and communications raceways and ports, server room configurations, placement of projects and screens, furniture specification, and the visual arts studio pipe grid upgrade were issues where technology-informed input was vital.

Wireless expansion

Outdoor. In fiscal 2015, wireless expansion was a major initiative. Wireless epitomizes a "technology drenched" environment, permitting access wherever it is available to ubiquitous mobile devices. While students, faculty, and staff experience online access transparently, the "hard" infrastructure enabling wireless takes collaboration. University architects and VT Electric were essential partners to enable the university's first outdoor wireless deployment. Establishing wireless zones in Dietrick plaza, the New Library plaza, and the Squires/Graduate Life Center plaza was funded in part by the Hokie Parents Fund.

Residence halls. While students have had high quality wired access in the residence halls, this summer's comprehensive, high-performance, wireless network expansion--the Residential Network Upgrade project--uses technology designed to support speeds up to 850 megabits per second. In addition, a single, wired, 1 gigabit per second Ethernet connection continues to be provided in each room. Many public areas will also have wireless coverage by Fall Semester 2015 move-in.

Housing and Residence Life is a sponsor and key partner. The project includes the design, planning, and installation of approximately 1,800 wireless access points in 34 residential buildings and the upgrade of all Ethernet access switches. Most residential buildings receive at least a tenfold increase in speed on the link between the building and the university's core network.

As a separate project, landline phones are being removed from residents' rooms since students have fully embraced "bring your own device" for telephone service. Emergency phones on each floor of the residence halls are being installed. Resident Advisors and live-in staff will continue to have access to conventional telephone service.

Responsiveness. As an ongoing process, Information Technology monitors wireless capacities and investigates reports of poor wireless network performance. Where additional wireless access points will improve service, they are installed. Planning for the future of yet more reliance on information technology has, as noted above, led to new standards. A "Category 6A" cabling solution was standardized for capital buildings and other spaces that require inside plant cabling systems capable of supporting up to 10 gigabit per second wired network service. The system was installed in Goodwin Hall and in the Moss Arts Center.

Other work to prepare for the future was the completion of the major upgrade to the structure fiber optic cable plant connecting the six primary campus cabling/switching centers, the core, and individual campus buildings. The new system is based on ribbon fiber, rarely seen in campus systems. The system positions Virginia Tech well for the future. The new ring interconnecting the cabling centers was upgraded to 864 single mode fiber strands. Some cables as small as 6 multi-mode and 6 single mode fibers were upgraded.

Beyond Blacksburg. While the Blacksburg campus is the heart of students' undergraduate residential college experience, the full range of Virginia Tech experiences extends throughout Virginia, notably the National Capital Region, and on to Switzerland and beyond. Providing equivalent network access depends on partners in physical design and network capacity. The Northern Virginia Center in Falls Church, the Virginia Tech Richmond Center, the Language and Culture Institute in the National Capital Region, the Virginia Tech Carilion Research Institute in Roanoke, and, since June, the Marion duPont Scott Equine Medical Center in Leesburg all have data infrastructure managed by Network Infrastructure and Services where wired and wireless access has been made equally robust.

Federated network access. *eduroam* was made available across the Virginia Tech campuses this year beginning January 2015. This federation of authentication servers was developed by use by the education and research communities in which all participating institutions have agreed to provide network access to each other's members. By joining the federation, Virginia Tech can offer visitors an easy-to-use option for gaining network access, along with providing our own students, faculty, and staff with wireless connectivity

locally and around the world. Virginia Tech students, faculty, and staff are encouraged to use the eduroam wireless network, which also enables Internet access at other participating universities and institutions.

With the IEEE 802.1x authentication standard used by Virginia Tech wireless networks, there is no need to manually authenticate with each access to the wireless network once the initial configuration has been completed. VT-Wireless and *eduroam* are equivalent in terms of performance and functionality. *eduroam* is now the preferred network and ensures that a user is configured to access *eduroam* at other participating institutions.

RAS-VPN

The Remote Access-VPN service work culminated in a July 2015 production date. The service allows university employees to access university network services as if their computer were connected to the Virginia Tech network on campus, even while connected to the Internet miles or continents away. Limiting access to university services exclusively to university IP addresses restricts the scope of exposure. For those university services which restrict access to campus network addresses, the Remote Access-VPN service is a way of selectively re-opening services that would otherwise be unavailable only to physically present members of the university community.

Collaboration with the Center for the Arts and the Institute for Creativity, Arts, and Technology

As a result of sustainable engagement practices among Network Infrastructure and Services, the Center for the Arts, and the Institute for Creativity, Arts, and Technology (ICAT), the Moss Center "Cube" received support from the National Science Foundation to fund infrastructure support research in big data visualization and auralization. ($671,000 grant) Underway is an agreement to support bandwidth for remote access to the Cube for inter-instructional research collaboration. Other agreements with ICAT involve sharing personnel and video engineering support.

In April, we completed an agreement for closer integration and collaboration between the Technology-enhanced Learning and Online Systems unit and ICAT. Provisions included reciprocal time commitments of personnel in each organization; a grant of 100 hours of TLOS video engineering support for Moss Center experimental/start-up events and activities; the creation of an opportunity to purchase system administration support for the Mirror Worlds project; and an agreement to collaborate on joint grant-making to faculty relative to proposals and project of mutual interest to TLOS and ICAT. Additionally, bandwidth required to support remote access to the Cube for inter-institutional research collaboration will require assistance from Network Infrastructure and Services for networking, facilities management, and systems administration. An additional agreement between the Moss Center and NI&S is in progress.

These engagement efforts clarified and solidified by memoranda of understanding constitute a solid start on building a mutually beneficial relationship with ICAT. A goal for the coming fiscal year is for senior leadership, along with the Provost and President, to continue building this partnership for the future.

Physical environments for teaching and learning

In FY15, the organization worked with physical spaces across campus to create opportunities for technology-enhanced active learning (TEAL) in the physical world.

Herman Miller partnership. The partnership with Herman Miller continues as part of the company's learning spaces research program to work with students on effective classroom design. In FY15, personnel engaged in initial data collection focused on the use of configurable furniture in the TLOS Learning Studio.

The collection took place in three undergraduate and four graduate student classes using a Herman Miller survey tool.

Consultations around campus. In FY15, Information Technology assisted other groups around campus with the planning and design of spaces for TEAL. A staff member provided consultation to the Division of Student Affairs on the addition of collaboration tools to the informal learning spaces they are creating in their residence halls. He also consulted with Mechanical Engineering on the creation of a collaborative work space open to all students in Randolph Hall, next to the Computer-Aided Design Lab. Innovation Space is working on a project with a faculty member from veterinary medicine to discuss and consult on a skills lab learning space. TLOS is in early consultation with Pamplin on the design of their new business school building, and with the Provost's Office on exploring potential roles and contributions for the new classroom building. To encourage additional partnerships, Innovation Space conducted a "Field Trip to the Future" around flexible learning spaces.

TLOS Learning Studio. FY15 saw the completion and launch of the new TLOS Learning Studio in the former Torgersen museum space. The infrastructure includes

The new Learning Studio was opened for Fall 2014.

- fixed and patchable fiber and CAT6A cabling;
- Airplay capabilities to all display screens, a movement toward "bring your own everything" or "BYOE";
- production switcher controlling multiple PTZ cameras, border microphones, and portable lavalier microphones to allow trained staff to "produce" a live event with near-studio quality;
- interfaces via the switcher from all cameras and microphones to WebEx and Echo360; (See below for more information on these tools.)
- infrastructure supporting interface/doorway to ICAT Mirror Worlds and other remote virtual land cross-real learning spaces.

Version 1.0 of the studio is considered complete. The NLI Studio will need adjustment in its access to personnel and budget to continue incremental upgrades to equipment and software. As noted in Pillar 1, an internal Showcase for the Studio was held Friday, April 17, 2015, featuring interactive demonstrations by units within TLOS. We also partnered with the math department to host 3D-a-thon workshop for pre- and in-service math teachers. The Graduate Education Development Institute offered two graduate seminars in the space, and faculty fellows have been granted access for leading-edge courses.

Innovation Space. The Innovation Space classroom continues to serve as a testbed for faculty interested in technology-enhanced active learning. In FY15, staff met with faculty interested in using the space to share ideas and strategies for leveraging the tech-enhanced, flexible learning classroom. From May 1, 2014 to May 1, 2015, the 1120 classroom held 262 regular classes, 73 meetings, 32 NLI sessions, and 51 special events. Examples of classes held in the space included math education; "Rhetoric in Digital Environments," an English honors course; "Feminisms and Rhetoric" (Communication Studies); and "Agriculture, Leadership, and Community Education." The Innovation Space also developed a plan and received approval to complete technology enhancements in the classroom in order for it to fully support web conferencing, digital video, and multimedia capabilities. These upgrades are in progress and will be complete by the beginning of FY16.

Innovation Space also spent the last part of the year redesigning the Innovation Space media lab in a way that is more conducive to both individual and group work, allowing greater engagement in 21st century skills while retaining core functionality. The newly designed and refreshed media lab will also be available at the beginning of FY16.

The Innovation Space continues to provide full class sets of iPads and is planning a special interest group around mobile learning and iPads. This small group of faculty members who are planning to use a class set of iPads, will meet regularly to read and discuss scholarship of mobile learning, and to engage each other around their use of iPads for their courses.

Instructional design spaces in Torgersen

Over the past year, we designed and executed a complete renovation of the working space in Torgersen 3120, 3060 and 3064. The newly renovated space allows for comfortable, inviting and productive interaction with faculty onsite and online in large and small groups as they develop and revise programs for technology-enhanced learning. The space has been fitted with technology that allows for collaboration and exploration of the use of a wide range of technology for teaching, learning and assessment including multi-monitor and shared screen capability, interactive whiteboard with web-based access and large monitor web conference and technology exploration lounge. Frosted and clear glass maximizes light without sacrificing privacy, and promotes the connected space flowing from one room to the next. Included now in the space are collaboration spaces, a media lounge seating twelve for meetings connected via WebEx; a 'low tech' planning room with movable whiteboards for brainstorming, storyboarding, graphic and media design, and project planning; a video review and editing room; conversational space with four comfortable chairs; and a visiting faculty desk.
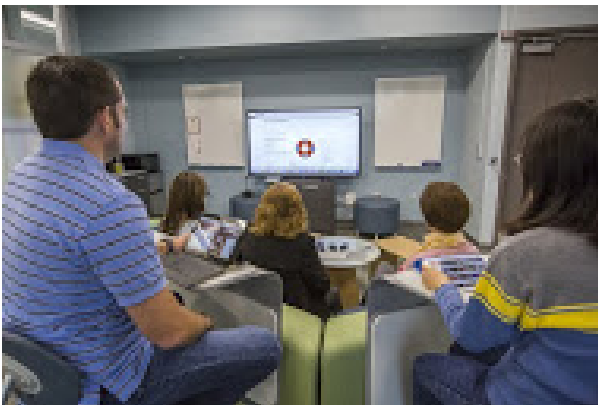
The space and technology contribute to the advancement of digital fluency for those faculty working with staff in the Learning Experience Design unit. Room 3064 has been renovated to become a video consultation room in which faculty can review and receive assistance in creating and editing video created on computers or in our organization's studio.

TelePresence rooms

We continue to equip, support, and provide two high-quality TelePresence rooms for use on campus. In FY15, we provided bridging and room support for 37 events and eight classes in these rooms. We facilitated participation and provided support during a virtual town hall event hosted by the governor at TelePresence sites across the Commonwealth of Virginia. While these rooms are primarily leveraged for 4-VA collaboration and course sharing purposes (see Pillar 1 for more information on 4-VA), a goal for the coming fiscal year is increasing usage of these rooms for other university needs.

Visionarium

The Visionarium provides space and services for computational thinking on the research front. The Visionarium was promoted through six course offerings on visualization—such as field trips to the future—with a total of 56 attendees. Additionally, Information Technology offered introduction to computational thinking courses via the Networked Learning Initiatives program.

The organization worked with ICAT this year to provide high performance computing and visualization infrastructure in the Create Cube and Mirror Worlds that is complementary to and interoperable with the VisCube. The Visionarium supported dozens of projects by faculty members and graduate and undergraduate students.

Virtual environments for teaching and learning

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. This year, we expanded the scope and types of virtual learning and collaboration spaces available to students, faculty, and staff at Virginia Tech.

WebEx

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 conferencing capabilities began in July 2013. The system has grown to over 2100 registered host accounts, which is more than double the number from last year. We also continued work on web conferencing platforms to explore remote support capabilities, and held visits and conversations with information technologists in the National Capital Region to explore emerging possibilities for high-end video infrastructure. Additionally, Canvas, the new learning management system, has built-in web conferencing capabilities, making it even easier for students and faculty to collaborate regardless of physical location.

Echo360

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. The system is fully integrated with both Scholar and Canvas, allowing for live streaming of classes and on-demand playback for students to watch classes.

In FY14, Echo360 was implemented in ten classrooms in Blacksburg and six in Falls Church, supporting 70 class sections. An additional 14 rooms were added in early FY15. While overall usage of the product has stayed at 60-75 course sections per semester over its two years of usage, more than 4500 students and 300 instructors have now used it, a doubling over the first year of use.

VT Office 365 and Exchange

A major area of work in FY15 that enables a quantum shift in virtual communications and collaborations capabilities for campus was the dramatic expansion of Microsoft offerings. In the past year, Information Technology rolled out Office 365 Pro Plus. Back-end integration work enabled single sign-on using Hokies credentials, connected Virginia Tech interfaces to Microsoft, built licensing managers so that users could

self-provision for these services, and developed a one-stop landing page with information on these new services.

For students, Office 365 Pro Plus means being able to communicate and collaborate more efficiently from full versions of familiar applications such as Word, Excel, and PowerPoint on multiple devices, including mobile devices. This change moved students to a cloud licensing, increasing their flexibility and reducing their costs.

Faculty and staff members who activate their accounts now have access to a wide variety of new, cloud-based services. These include SharePoint Online, Office Online, Skype for Business, and OneDrive for Business.

Microsoft SharePoint Online is a cloud-based service hosted by Microsoft that enables an organization to create and manage custom, team-focused and project-focused sites for collaboration. It is a tool for collaboration and project management that allows subscribed users and departments to create SharePoint sites that can range in use from a simple webpage to a complex workflow system, allowing data exchange with an on-premises SQL database. SharePoint can be used to provide wiki, blog, document management, or intranet services. Both individual and departmental accounts are available.

Office Online (formerly known as Office Web Apps) opens Word, Excel, PowerPoint, and OneNote documents in your web browser. Office Online makes it easier to work and share Office files from anywhere with an Internet connection, from almost any device. VT Office 365 customers with Office Online can view, create, and edit files on the go.

Skype for Business (formerly known as Lync Online) is a hosted next-generation cloud communications service that connects people in new ways, anytime, from anywhere. Skype for Business provides intuitive communications capabilities across presence, instant messaging, audio/video calling and a rich online meeting experience including PC-audio, video and web conferencing. Skype for Business also enables scheduling, screen sharing, and remote desktop capabilities.

OneDrive for Business (formerly SkyDrive Pro) is personal online storage space in the cloud, useful for storing work files securely across multiple devices. Shared files can be edited collaboratively in real time with Office Online. OneDrive for Business provides 1 terabyte of online storage and provides synchronization of files and folders between all Office 365 applications as well as desktops, laptops, smart devices, and the cloud.

The coming fiscal year will also see the fully cloud-based, multi-device model for Microsoft Office made available to faculty and staff. We also intend to expand support and offerings within SharePoint Online, which has a wide variety of additional collaboration and knowledge-sharing tools that could be of use to campus. In anticipation of this effort, our Collaborative Computing Solutions group began a SharePoint Users Group which meets monthly for interested university members. Meetings are simulcast via Skype for Business and a recording is available online.

Significant upgrades made to Exchange this year improved the end user experience. We upgraded from Exchange 2007 to 2013, increasing the quota from 50MB per user to 10GB. Information Technology also investigated options for best addressing the needs of users of classified and controlled data. The decision was made to keep Exchange on premises rather than moving fully to the cloud in order to best meet our data security requirements.

/devSpace

A team made up of staff from across the organization continued development of a plan to offer "/devSpace," an infrastructure for collaborative programming, backup, and code management for informal learning. We identified the equipment and software required to startup the offering, held discussions with Virginia Tech Intellectual Properties to discuss intellectual property implications for students involved in this university-focused creativity incubator, and are in the planning stages to have a soft roll out of /devSpace lasting throughout the summer and moving into a proof-of-concept state in the fall.

An offshoot was the Innovation Space's support of the spring 2015 VTHacks event. The Innovation Space facilitated the involvement of the IT Security Office with VTHacks, allowing us to test the concept of providing a project for students to work on while supporting a major student event on campus. The Innovation Space also provided a space for secure storage during the event.

Campus partnerships for virtual environments

Information Technology provides Active Directory, Exchange, and learning management system support and services to the Virginia College of Osteopathic Medicine (VCOM), which saves VCOM time, personnel, and expenses that they would otherwise have to cover on their own. To better facilitate this partnership, in FY15 we developed a defined service level agreement for Active Directory and Exchange services.

A Virginia Tech prepares for closer ties with the Virginia Tech Carilion School of Medicine and Research, Information Technology personnel are actively working on the information technology infrastructure. In FY15, this effort involved discussions about the school's setup and requirements.

Groups within Information Technology actively partner with one another and with faculty to introduce new technology tools based upon the desired outcomes of courses under development and the interests and desires of faculty developing those courses. An overview and demonstration of new technologies has now been incorporated into the professional development guiding the cohorts redesigning and developing courses each semester. The Learning Experience Design (LED) unit of TLOS sponsors Faculty Inquiry Groups (FIGs) to explore new technologies and pedagogy supporting the integration of those technologies. This past year, the FIGs focused on gaming for education and accessibility issues in online content. We would like to expand and add more formal structure to referral and implementation in the future and to have documentation of technologies available for sand-box efforts developed for distribution to faculty consulting and developing courses with LED.

Emergency notification technologies

After last year's solicitation for a new emergency notification vendor, the contract was awarded to Rave Mobile Safety. Information Technology assisted the Office of Emergency Management in migrating services to the new system, and transitioning continuing service to the desktop alerts service and campus electronic signage system. VT Alerts (www.alerts.vt.edu) is Virginia Tech's emergency notification system that includes the university homepage (www.vt.edu), broadcast email to all accounts, electronic message boards in classrooms, the weather/emergency hotline, campus sirens and loudspeakers, VT Phone Alerts, and VT Desktop Alerts.

Situational awareness

In the ongoing effort to make campus safer, Virginia Tech is supporting the development and use of technologies that provide better information on threats and vulnerabilities, improve response times for emergency personnel, facilitate communication between citizens and police, and even predict outcomes for a variety of emergency scenarios.

Information Technology's Converged Technologies for Security, Safety, and Resilience unit (CTSSR) explores and collaborates with university researchers and practitioners on projects that merge information science, computer networking, and geospatial modeling and simulation technology with traditional forms of communication to support emergency managers and first responders.

As part of the collaborations with university researchers and practitioners, CTSSR hosts an annual Showcase for Security and Safety Technologies which highlights some of the latest technologies innovations that are being used on campus. This year, the Showcase included information about LiveSafe, available for all Virginia Tech community members to download free of charge. The app, purchased and managed by the Office of Emergency Management, can be used on Android and IPhone devices. It allows students, faculty, and staff to send tips and messages to Virginia Tech Police, share their location with friends or family as they walk on campus, find buildings on campus, and access emergency preparedness information.

Broadband deployment for public safety network is another CTSSR collaboration this year. Wireless@VT is testing a new broadband system utilizing long-term evolution (LTE) over 3.5 Ghz band spectrum to improve coordination and interoperability for public safety, to allow device-to-device communication, and to improve reliability. CTSSR engages with Wireless@VT for a number of broadband and public safety related activities.

Interior space data management, visualization, and system integration. The Enterprise GIS unit of CTSSR collaborates with Administrative Services on multiple ongoing initiatives pertaining to interior space data. Interior space data consists of the floor plan drawings for all campus buildings and associated attribute data maintained by Facilities Services. This spatial data is useful for situational awareness and emergency response, as well as space planning and management, and serves as the critical reference layer for any project aimed at mapping things that exist or occur inside of buildings.

Enterprise GIS worked with Facilities Services and an external consultant to develop an automated extract, transform, and load process to convert floor plans from CAD to GIS. This process, implemented as a set of scripts that run as a recurring scheduled task, error checks the CAD drawings, creates multiple GIS representations of the features on the drawings (e.g., room polygons, points which will be useful for future projects to develop interior routing applications, and floor polygons), and loads the updated information into the Enterprise GIS geodatabase infrastructure.

Once interior space data has been loaded into the GIS back-end systems, a user interface is needed to allow exploitation of this data by a broad audience of stakeholders, including emergency responders, space planners, and facilities personnel. A web-based tool was desired, since not all stakeholders are intensive GIS users. Facilities Services purchased the Invision FM web-based floor plan viewer for this purpose. Enterprise GIS is hosting and configuring this application. When fully implemented, multiple targeted instances of Invision FM will be made available to visualize and query interior space data for various workflows, such as emergency response, space planning, and facility operations.

Interior space data consist of both geometry (the physical representations of spaces as imported from CAD) and attributes (descriptive data from other systems such as capacity, ownership, and use). Enterprise GIS worked with the database administration unit within Information Technology, and with the information technology staff in Administrative Services to set up linkages between the geodatabase backend that stores the geometry and the systems of record for the attribute data, such as the "HokieServ" database maintained by Administrative Services. Enterprise GIS then created views that fuse the external attribute data to the extracted geometry for the spaces, thus creating a unified data product useful for visualization, situational awareness and planning.

Automated GIS data sharing for regional 911. Virginia Tech, the Town of Blacksburg, the Town of Christiansburg and Montgomery County are working to integrate their respective 911 systems into a regional 911 center. CTSSR worked with Facilities Services to identify the necessary campus GIS layers to share with our regional partners, then deployed a "geodata service" using its ArcGIS Server infrastructure to securely make the necessary layers available to an automated system developed by the Center for Geospatial Information Technology that harvests and merges each member jurisdiction's layers into a seamless map for use by dispatchers in the regional 911 center.

Campus population modeling. This initiative involves the creation of a function that enables the Office of Emergency Management to determine the general movement of campus populations around the physical campus, visualizing active WiFi links within each WiFi-enabled building on campus on a campus map in real-time. This data provides emergency managers and responders with an estimate of the number of people likely to be in each location. The application is updated in near real time, enabling mapping of general population shifts and areas of congestion without identifying or tracking individuals.

Geospatial data governance and promotion of interoperability. The Enterprise GIS unit of CTSSR solidified its long-standing informal role of GIS data coordination by adding "advocacy for interoperability" as a component of its core mission. A number of initiatives kicked off during the current reporting period that advance this objective.

Through its leadership of the GIS Stakeholders Working Group, CTSSR began development of a "Geospatial Data Sensitivity Standard" that seeks to address business process ambiguity surrounding the classification of certain GIS datasets, especially in the Administrative Services area, as "sensitive," and the subsequent decision of whether or not to share such datasets.

Through a collaboration with University Libraries, Enterprise GIS developed a data discovery system architecture and provided guidance to the library on the development of a geospatial metadata repository. The Library chose the open-source GeoBlacklight platform as the metadata repository user interface. Implementation of the system is currently underway.

Also with University Libraries and the GIS Stakeholders Working Group, Enterprise GIS has been developing an institutional geospatial metadata standard. University Libraries convened a Geospatial Metadata working group to solicit academic stakeholder input, and through this group, Enterprise GIS has recommended an approach for the encoding of the metadata standard, as a profile of ISO 19115/ISO 19139.

In partnership with Information Technology Acquisitions (ITA), Enterprise GIS manages the cloud-based "ArcGIS Online" subscription for the university. ArcGIS Online enables faculty and students to develop self-service web maps, perform cartography and conduct spatial analysis within a web UI. It is becoming very popular for introductory GIS courses. To support ArcGIS Online, Enterprise GIS worked with ITA and the Middleware team to integrate authentication and authorization with the cloud provider's identity federation systems, and has begun the development of an ArcGIS Online governance document to help faculty and students better understand the system's account provisioning procedures, identify acceptable uses, and ensure the availability and performance of the cloud platform as a shared resource.

In the coming fiscal year, these activities will enable data stewards to better understand the safety and security implications of geospatial data sharing (and, we hope, share more data with reduced uncertainty regarding what is and is not "sensitive"), facilitate the creation of descriptive metadata for GIS data resources, improve the ease with which our customers can find and make informed decision regarding the use of geospatial data resources, and increase the effective adoption of the ArcGIS Online cloud platform. All these activities are envisioned to lower barriers to the use of GIS, reduce process uncertainty, and "grow the pie" of GIS integration into both academic and administrative use cases.

"Bring your own everything"

This initiative in the Strategic Plan refers to the environment in which users provide their own resources for computing and communications, with systems and devices expanded beyond early concepts of "bring your own device." Ensuring that university services are prepared for the myriad of mobile devices used by students, faculty and staff, and visitors is part of the charge to Information Technology.

Distributed Antenna System initiative

The Distributed Antenna System initiative (DAS) at Virginia Tech is provided for the convenience of students, faculty, staff, and visitors and to enhance public safety and security in key parts of the campus. To date, work on the DAS has resulted in the construction of a head-end and a two-tier carrier equipment shelter, purpose built to integrate carrier base transceiver stations with the DAS and accommodate the needs of multiple cellular carriers. The initial carrier participating on the DAS is Verizon Wireless.

DAS equipment and antennas have been installed throughout Lane Stadium, and system coverage includes the stadium bowl, all interior and exterior levels (including 15 luxury suites, a high-tech media center and press area) and the parking lots. The DAS serves the largest stadium in the Commonwealth of Virginia, with a seating capacity of 66,233.

Key components of the stadium system have been used for expansion of the DAS, which has now been extended to six residence halls to improve cellular coverage and capacity. Cellular improvements in these six residence halls now reach 35% of the on-campus students. The DAS serves Miles, Pritchard, Harper, New Hall West, Cochrane and Ambler Johnston residence halls.

Generally speaking, cellular service customers from all major carriers report that they have usable cellular signal walking or driving on campus, but they very often have no service available within buildings on campus. The DAS addresses the need for enhanced in-building coverage. With all the devices and applications from Virginia Tech-provided devices to what students and visitors bring with them, the network challenge is more than coverage. Demand for data has been growing exponentially. This summer a project began to upgrade the portion of the DAS within the North End Zone stands to improve coverage but more importantly, capacity.

Tech Teams

Tech Teams brings together a small group of people from across the university for rapid evaluation of emerging technologies that have potential for use in teaching and learning at Virginia Tech. The scope of a Tech Team can be very narrow—for example, vetting a specific software—to fairly broad—for example, focusing on classroom flipping or examining a range of technologies classified under an umbrella like "student response systems". One white paper was produced by the initiative this year on AirServer. A portion of the white paper is discussed below. (https://blogs.lt.vt.edu/techteams/2015/02/12/air-server-up-your-classroom-collaboration/)

AirServer is an application that acts as an AirPlay receiver for Mac and PC. It allows you to receive AirPlay feeds so you can stream content or mirror your display from your iOS devices. It facilitates collaboration and discussion in a classroom by allowing multiple device screens to be mirrored to one location.

Sue Hagen, Senior Instructor, Mathematics, used AirServer in her Fall 2014 course, Secondary Math with Technology. Below are some of her thoughts on using it in the classroom:

> I wanted the students in class to have a more active role in the course. I had used an
> AppleTV in classes, but only one student's work could be on the screen at a time. AirServer

allowed multiple students to display their work simultaneously. We were able to compare and contrast solutions to problems together rather than look at one at a time. Most of the time displaying two students' work at a time was all we needed; however, there were times when we found displaying three or four screens useful. We used AirServer on a daily basis, to share work using whiteboard programs or other apps on the iPad.

With the increase of bring your own device popularity, this simple solution allows content sharing across multiple devices and operating system platforms. Many times device type can inhibit collaboration if a user's device is not compatible with the existing hardware or software in a given place or group. AirServer addresses almost all issues without the need for extensive adjustments on the user's part to share with a larger, typically non-compatible, device group. Once Android (Miracast) functionality is improved, this application will be a one-stop solution for multiple-device, multiple-OS wireless display mirroring at a low price.

Pillar 4 Advancing Information Technology for Enterprise Effectiveness

The university's long-range plan states that "as the university prepares to move into the next planning period, we will be challenged to continue to meet demands for increased productivity and efficiency without sacrificing quality." The long-range plan also states that "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." Leveraging information technology through enterprise systems for automation and collaboration is important to achieving organizational effectiveness, much as it is for achieving operational effectiveness.

Prioritization and resource management practices

Information Technology must be responsive to support the university's information technology needs. In the arena of enterprise administrative systems, Information Technology has worked with the administrative offices of the university to identify "next steps," and to plan for appropriate resources to support required changes. In years past, estimates of schedule, costs, and scope relied on the experience and expertise of the personnel within both Information Technology and in the partner administrative offices. The experience and expertise remains strong, but the environments for new initiatives are increasingly complex. Resources must be deployed to best achieve enterprise effectiveness.

Project management practices help propel us toward the goal of the standard and universal method of undertaking new initiatives. Two new positions and one replacement position were hired as project managers, with initial focus on key projects for the coming fiscal year.

In recent years, a much more careful focus on effective and well documented **resource management practices** allows work to proceed making best use of available resources. Beginning in 2010, Enterprise Systems has used Team Dynamix, a comprehensive project and resource management tool, to manage the group's project portfolio. Documenting time spent on projects is one element, providing data on the effort of various components of project work that complements the experienced-based intuition of experienced developers and managers. In 2014, Enterprise Systems implemented time tracking for its employees in an effort to more effectively utilize project management standards. This process has led to better development of project plans and more accountability for project budgets and schedules.

Another feature of Team Dynamix is the ability to provide requesters and stakeholder groups with timely information on the status of requests for work to be done. Not only can requesters inquire, but key notifications are pushed to the requesters about project outcomes. Better tracking of resource usage and project statuses also enables a data driven approach to prioritization of work—stakeholders can now be provided with comprehensive information on existing work and time commitments to assist with the prioritization of new requests in the context of existing work.

This increased emphasis on effective resource management and data-drive prioritization processes has enabled a similar expansion into the facilitation of better defined and more active governance for enterprise projects. In addition to the success of the BI Steering Committee (see below for more information), which has worked since the inception of the project to provide guidance on how to best meet institutional needs—and in what sequence--in the coming fiscal year the Information Technology organization will be launching an Enterprise Systems Steering Committee focused on assisting with the determination of the schedule for and impact of major enterprise projects, with a particular emphasis on the upgrade to Banner 9—the next generation of our Banner ecosystem.

Anticipating needs and implementing systems–preparing for the future

One of the desired outcomes for the Strategic Plan is to create a roadmap for the future directions of Virginia Tech enterprise systems for the next 5 to 10 years, and part of the role of collaborative decision-making is to anticipate needs for the future. The collaborative process to decide on the 5 to 10 year future of administrative enterprise systems also speaks to the Operational Plan initiative to focus on competitive advantage in sourcing enterprise systems. A common theme across the majority of the new systems discussed below is the transition from custom coded, locally hosted systems to the procurement of cloud-based, flexible, and robust systems that expand the capabilities of our enterprise systems. Given the rapid pace of technological change, strategic sourcing of opportunities also has the broader net effect of freeing our personnel to enable a broader range of new systems and capabilities rather than on development cycles for the creation of custom products with a limited shelf life.

Banner 9

Enterprise administrative applications tend to change slowly for a few years, and then make larger leaps responsive to accumulated needs. Ellucian, the provider of Banner, recently announced that a new version of its offerings—Banner 9—was on the horizon. The new Banner 9 is intended to substantively improve the web-based user interface—providing a newer and more mobile-friendly look and feel—and update processes to improve ease of use. The new version is intended to feel like a modern web system for the end user, including greatly expanded functionality and responsive design.

In anticipation of major changes to the Banner system by the vendor, Ellucian, university stakeholders were engaged to better understand the proposed changes and to decide whether the changes we will experience should be the changes to Banner or in moving to an alternate source. University leadership expressed support for staying with the Banner system's coming version for finance, human resources, and student systems. One evaluation criteria for advancement was timing. The needed functionality for the next major fund-raising campaign would not occur in time with the Banner system. Instead, advancement will shift to Blackbaud (see below for more detail).

On the recommendation of Ellucian stakeholders outside of advancement, Enterprise Systems entered an agreement to serve as one of a handful of institutions across the country to pilot and test the coming release for Banner 9. During FY15, Information Technology installed and tested beta software, provided feedback to Ellucian, and participated in the final iterations of development. The decisions and analysis completed in fiscal 2015 will continue with implementation work in the coming year.

Blackbaud

Blackbaud addresses the increasing need for data-driven fundraising and engagement strategies.

One of the final recommendations from the campaign consultant at the conclusion of the Campaign for Virginia Tech: Invent the Future was that Virginia Tech needed to "assess whether Banner Advancement can support your next campaign." Work with two Ellucian consultants over a two-year period determined that Banner Advancement no longer meets Virginia Tech's database needs. The technology to be implemented is Blackbaud CRM, which was purchased by the Virginia Tech Foundation in December 2014.

With Blackbaud's state-of-the-art constituent relationship management system (CRM), the university and the Virginia Tech Foundation are addressing the increasing need for data-driven fundraising and engagement strategies. The system, designed around advancement industry best practices, will serve as a tool to enable more strategic, data-driven fundraising, alumni relations, and engagement efforts.

Implementing Blackbaud CRM will provide integrated tools for efficient and effective management of advancement data; and will provide enhanced data visualization, drill-down, and data management capabilities to support nimble advancement strategies. The project will integrate the existing on-line giving site with the core advancement database to provide better tools for Virginia Tech's online donors, and integrate existing event registration tools with the core advancement database to provide better tools for external constituents.

In addition to meeting an urgent institutional need, the Blackbaud CRM Implementation Project is directly tied to aims outlined in the Information Technology Strategic and Operational Plans—particularly in Pillar 4's focus on enterprise effectiveness. The work completed under the Blackbaud CRM Implementation Project will advance this strategic goal by:

- providing integrated tools to efficiently and effectively manage advancement data;
- providing enhanced data visualization, drill-down, and data management capabilities to more quickly enable nimble advancement strategies;
- integrating and enhancing the existing on-line giving site with the core advancement database to provide better tools for Virginia Tech's online donors;
- integrating and enhancing existing event registration tools with the core advancement database to provide better tools for Virginia Tech's external constituents;
- implementing state-of-the-art technology that is in use by peer and aspirational peer schools that have completed $1 billion and larger fundraising campaigns.

Virginia Tech will undertake a best practice implementation of Blackbaud CRM using higher education centric processes and minimizing the customization of vendor delivered capabilities. The project to implement Blackbaud runs until spring 2017, after which Blackbaud is anticipated to be fully operational and in use by the institution. Ultimately, Blackbaud CRM will support Virginia Tech's new advancement model and position it for growth by providing state-of-the-art constituent relationship management tools that allow for data visualization, data drill-down, and other enhanced data handling capabilities. This state-of-the-art technology will be consistent with President Timothy Sands' goal that "Virginia Tech will be one globally interconnected campus, linked by the best technology available." Other schools using this system have indicated that the system allows for more transparency and more accountability.

Canvas

In selecting the Canvas Learning Management System (LMS) by Instructure to replace Scholar as the university's primary platform for course management, the university anticipates evolving needs and is acting now to ensure that these needs are met in a timely manner. Key factors in the selection of Canvas are its responsive design for mobile access, and media integration and ease of adding video, audio, slideshow, and other graphic content to course modules. Key factors also included the ability to work for large courses, and learning analytics. For more on the Canvas program, see Pillar 1 and the program website. (www.tlos.vt.edu/NextGenerationLMS/)

Research administration: Summit

Since the fall of 2014, the Comprehensive Research Enterprise Solutions Team (CREST) has been developing software providing technology support for business workflows in the administration of sponsored research proposals and associated grants. The pre-award phase is the first area of focus for the software named "Summit."

Summit is a web application that provides the ability for a principal investigator (PI) or a grant administrator to initiate the pre-award process. The software facilitates communications between the Office of Sponsored Programs (OSP) to communicate with the PI, grant administrators, and other members

of the proposal team to gather all of the information needed to submit the proposal. The intent of the software product is also to ensure that critical business requirements surrounding compliance, conflicts of interest, and export control are properly tracked and addressed.

Since February 2015, Summit has been deployed in a pilot, and since March, pre-award associates in OSP have been using Summit to support the pre-award workflow for *all* sponsored research proposals for the university. As the fiscal year ended, use of Summit was expanded for use in computer science and chemistry, as well as in two centers—the Virginia Bioinformatics Institute, and the Virginia Tech Transportation Institute.

Ensemble

A new system to support the university's Ensemble content management system was selected in December 2014. After a thorough procurement process, University Relations and Information Technology will implement Adobe Experience Manager. Reasons for the selection included the ability to edit pages with phone/tablet/desktop, supporting the mobile-ready goals of the Information Technology plan. Adobe's product was also selected for its ease of uploading images, and the ability to share content. Overall, the new content management system is expected to dramatically improve the user interface and experience in managing institutional websites.

25Live

25Live is an active area of work for the organization. This system offers campus-wide event scheduling, calendaring, and analysis on a web-based platform. The implementation is ongoing, and was made available for use by summer camps in 2015. Selected to address compliance issues with summer camp experiences for minors, the software will have greater usefulness throughout the university. The software service enables searching of dates and venues, scheduling of resources, and posting of events to calendars and electronic displays. 25Live will replace Schedule 25 for academic class scheduling by 2017.

Leave Reporting System

In collaboration with the Department of Human Resources, Enterprise Systems is working on an enhanced leave reporting system that will allow departments to enter and submit leave reports electronically. The system is being rolled out across the university in a phased approach. All employees are expected to be using the new system by January 2016. The system replaces the current system launched in 1998. The new system incorporates the hours and time worked report, and will eliminate a paper signature process used by many departments at the university. The interface is optimized for mobile devices.

Cashiering

The new cashiering system from Higher One Inc. manages payments, including the budget-tuition plan. The Bursar's Office implemented the new cashiering system, CASHNet, in the spring, and rolled out the system to departmental users at the start of the 2016 fiscal year. This web-based cashiering application replaces paper-based processes with automated systems and allows real time accounts receivable posting, as well as streamlines the departmental deposit process.

The evolution of My VT

In FY15 Information Technology started the process to look at the next phase for myVT by engaging in an assessment for how we would replace myVT with better functionality, and beginning the acquisition process based on the outcome of that assessment. OneCampus has been selected as an interface that is search oriented and allows us to categorize and describe services and applications that are readily

searchable and organized in ways that facilitate finding services, applications, and opportunities across the university. OneCampus is intended to serve as a one-stop "app store" for the institution. Work on implementing and testing OneCampus will begin in FY16.

Financial reporting

Enterprise Systems is working to adapt the university's financial reporting to the state Cardinal system. Replacing the Commonwealth Accounting and Reporting System (CARS) from the 1970s, Cardinal has been phasing in state agencies, and during this reporting year, included higher education agencies. CARS is a COBOL-based system that stores information in a non-relational database. Upgraded in 1986 and again in 1999 for Y2K compliance, the system has aged while technologies used locally in agencies have advanced. Agency systems have had to upload accounting data to CARS through non-industry-standard interfaces. All agencies are scheduled to be included in Cardinal by February 2016.

Business intelligence and the data-driven university

To support access and analysis of university information, Information Technology has been working to implement an enterprise-wide business intelligence solution. The result delivers data analytics across diverse information sources, informing university decision making.

During FY 2015, the Business Intelligence Services group of Enterprise Systems established the MicroStrategy business intelligence tool as a replacement and extension of existing enterprise data reporting. The tools in use prior to the project were being de-supported, and the university had needs for greater reporting in support of data-driven decision-making. The new system fills the need to replacing aging systems, and expands the use of reporting and analytic tools to wider university communities.

The first phase of the new MicroStrategy business intelligence tool was completed December 15, 2014. This on-time and within-budget completion successfully met the expectations of Virginia Tech's first major project, as defined by and reported to the Virginia Information Technologies Agency.

Existing users of the Jaspersoft reports for Student Perceptions of Teaching were the first to access data with the new system. A community for these users was created, the BI Hub user community, and any user may access the dashboard capabilities of MicroStrategy. The new tool enables greatly expanded control and analysis capabilities.

Training and support is a shared responsibility with the university areas responsible for the data. The training and support plan for the system is currently being developed by the various functional areas in collaboration with the Business Intelligence team. Staff have been assisting with data modeling to more rapidly enable analysis by teams in finance and human resources, two groups that have also moved some data into the new tool. As part of the efforts in FY15, Information Technology contracted with a consultant who assisted the institution in improving data reporting processes for data within the tool. Rather than duplicating reports from previous systems, the new process allows the institution to take separate reports in the last system and convert them into a dashboard with multiple views and drill-down functionality. This provides both greater efficiency and a significant process improvement, and has potential for widespread implementation as new data sources are added to the tool.

The University Data Initiative Steering Committee defines the roadmap for business intelligence and prioritizes efforts. The immediate roadmap has been determined but work remains to reach the goal of a data-driven university. The coming year will be largely focused on assisting campus in developing ideas for how to use the tool effectively. Future iterations of the program for other data sources will involve assisting colleges, administrative units, and the rest of the university community in figuring out how to engage in strategic data analysis, driven by members of the Steering Committee.

Pillar 5 Security and resilience of Information Technology resources

Supporting the security and resilience of information technology resources is the intention of Pillar 5. Security and resilience encompass the protection and control of identities and physical spaces, as well as the safekeeping of networked information and resources. Data privacy and integrity are increasingly important given the growing number and sophistication of cyber-attacks.

Protect and ensure the resilience of infrastructure, data, and research

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. As noted last year, 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.

FY15 saw the organization conducting a gap analysis within each unit to determine how fully Information Technology has implemented the controls. A composite profile of the organization based on the outcomes of the gap analysis will be produced in FY16. Additionally, the Cybersecurity Task Force—originally constituted in spring of FY14—continued their work on investigation of specific security practices related to the controls. The Cybersecurity Task Force in FY15 confirmed their recommendations in three areas of emphasis and investment.

Cybersecurity Task Force recommended
One-time passwords
Logging
Training

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. This effort ramped up under the auspices of the 2 Factor Authentication Project (2FA—see in later section of this Pillar).

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.

Logging needs are also closely related to work done on Control 1 in FY15, which focuses on identification of both authorized and unauthorized devices using Virginia Tech networks. Attempts to more fully implement this control in FY15 helped the organization to identify challenges with how we identify network devices, particularly for devices using our wireless network. The investigation process showed that logs for devices accessing the network were stored for a short period of time, after which—due to the volume of log data—they were overwritten by newer logs. Thus, in the event of an incident, the accuracy of our log data over time went down significantly over time, which makes root cause identification and tracking a major challenge. Improvements to log archiving will also assist in the implementation of Controls 4, 5, 7, 11, 13, 14, 16, 17, and 18, which are focused on continuous vulnerability assessment; malware defenses;

wireless access controls; port security; boundary defense; maintenance, monitoring, and analysis of audit logs; account monitoring and control; data protection; and incident response and management; respectively.

The log analysis and archiving project is underway to address these issues. In FY15, the Information Technology Security Office (ITSO) engaged in a proof-of-concept for log archiving and analysis improvement on ITSO systems. The successful proof-of-concept has evolved into a pilot project focused on the entire Information Technology organization, which has included the procurement of hardware and software that significantly expand capacity. Initial work on the pilot involves the incorporation of critical systems as defined by the organization's risk analysis, after which all other systems will be folded in. After the pilot, the intention is to iteratively expand these new capabilities to the entire university. Improvements are focused on three areas: centralized logging, centralized data collection, and a web interface for data access and analysis.

The third recommendation is to provide new training resources for systems administrators. Systematic training contributes to both performance generally and secure practices specifically. FY15 continued the offering of the "SANS Securing the Human" online training program. Last spring, the organization also conducted a SANS class on continuous monitoring that attracted around 110 attendees from a wide variety of locations. The organization also began a formal mentoring program for systems administrators in the Information Technology organization and is transitioning to use of the NLI training tracking system to identify and track training participation and develop an understanding of each participant's skill sets over time that can be used to create a "keyword" database on common skills and types of focus among systems administrators. Work to expand effort in this area will continue in FY16.

110 attendees participated in spring SANS class on continuous monitoring

FY15 also saw specific measures undertaken to implement other controls. Control 3, focused on secure configurations for devices—including workstations and laptops—was one focus. In FY15, Information Technology successfully developed, tested, and moved into production System Center Configuration Manager (SCCM) and is continuing to work on deploying it into the full production environment. SCCM allows us to manage PCs and servers, keep software up-to-date, set configuration and security policies, and monitor system status[1].

Control 4 focuses on continuous vulnerability assessment and remediation, which means looking for areas of weakness on a consistent basis and seeking to rectify any identified weaknesses. ITSO runs vulnerability scans against critical assets at least once a week for centrally managed systems, and also offers this capability to departmental units that wish to scan and remediate their own equipment. Currently around 12 departments take advantage of this service, and the goal in FY16 is to increase this number. In FY15 the organization also upgraded vulnerability scanning hardware to replace aging equipment.

Control 13, focused on boundary defense, involved the installation of new network sensors designed to detect intrusions. The organization was able to use these new sensors to bring new networks—such as those in the National Capital Region—under our sensor wing, to improve network security in areas that were previously not covered.

Control 17 emphasizes the importance of data protection. Roles and responsibilities for data trustees, stewards, managers, and users have been defined in University Policy 7100, and each year the data

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[1] http://www.microsoft.com/en-us/server-cloud/products/system-center-2012-r2-configuration-manager/

administration standard is updated when new personnel have taken on responsibilities for a domain of data (http://www.policies.vt.edu/7100.pdf). FY15 saw the creation of a document that clearly delineates responsibilities and obligations of data trustees called "Things a Data Trustee Should Know". This includes a ten step data protection plan, and data trustees are asked to complete the included checklists and signoff on the document. ITSO is conducting roadshows with data trustees to familiarize them with the document, and this is expected to be completed in FY16.

Control 18, incident response and management, also was an area of work this year. Internal Audit conducted an incident response audit, the recommendations from which led to the creation of an incident response checklist that received feedback from groups around the university and is in the process of finalization.

In an overarching effort to improve security operations this year, Information Technology consolidated and integrated security resources into a security operations center. Within the Information Technology Security Office, a security operations center (SOC) monitors and alarms when information technology security events are detected. SOC analysts submit tickets in the incident management system, which, in turn, sees to the notification of relevant parties. Initial work was completed to automate the process, emphasizing reducing and eliminating false-positives. The automation process is continuing, and at year's end, an SOC analyst remains involved.

The SOC/NOC integration procedures include work with the Call Center, 4Help, the Network Operations Center, monitors of abuse@vt.edu, individual departmental information technology support, and external parties while performing SOC functions.

Cybersecurity outreach and education

Reaching out to the several communities of the university creates mutually beneficial exchanges that advance security. ITSO continues to offer security reviews and assistance with security improvements based on the reviews for individual departments. In the past year, six departments requested these reviews.

The Information Technology Security Office hosted the Eastern Regional US Cyber Challenge (www.uscyberchallenge.org) camp for the fifth year in a row. 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. Approximately 40 campers ranging from 18 to 50 years old participated in the event. Our security officer runs the camp and develops the curriculum for campers across the nation.

Working towards the organization's eventual goal of a true "teaching hospital", ITSO continued efforts to expand the number of students working in the IT Security Lab and hired a new leader for the lab in FY15. The lab received a $200,000 grant from NSA to support one year of a doctoral and master's student to conduct cybersecurity research. Those positions will be hired for FY16. The lab also continues to support assistantships for two master's students.

The lab continued its engagement with the Army's Advanced Civilian Schooling program, providing hands-on cybersecurity experience in the ITSO lab. ITSO hosted four students in FY15—two from the US Army and two from the US Air Force. FY15 was the first year that students from a non-army branch of the military participated in the ITSO lab.

ITSO worked with Dr. Joseph Tront to advance the "Scholar for Service" program at Virginia Tech in its second year. This is 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. A total of 52 students will be funded

through this program, and 14 students at Virginia Tech have gone through as of the end of FY15. In FY16, three more students will work in the ITSO lab under this program.

The security lab also continues to support undergraduate research experience. The lab hosted three undergraduate students for Research in Engineering for Undergraduates (REU) Program in summer of 2014 to work on log projects. The students were so successful in their REU research that the lab hired them to continue working throughout FY15.

The security office maintains a program of education and awareness to the university community and beyond. In FY15, ITSO hired a new staff member specifically for the purpose of conducting trainings across the university. The chief information technology security officer is an associate professor of practice in Electrical and Computer Engineering (ECE) and continues to teach two courses each year, one in the masters of information technology program on security and trust and one in ECE on network security and fundamentals. The new lab director, Dr. David Raymond, will also offer ECE courses as an adjunct in the department.

ITSO and University Computing Services teamed up to engage students at GobblerFest and to interact with employees during Staff Appreciation Day. The annual Gobblerfest welcomes students to campus, and engages them in campus activities and connects with the surrounding community while inspiring curiosity, civility and self-understanding. Staff Appreciation Day is held each spring to celebrate the dedication of the insitution's staff. For both events this year, Information Technology's booth focused on computer security. The event engaged more than 650 staff members in playing Plinko or spinning the Prize Wheel. Our prizes included jar openers, insulated bags, cups, hand sanitizer, and water bottles, all with this year's new design "security.vt.edu: KEEP YOUR COMPUTER CLEAN, KEEP YOUR COMPUTER WORKING 4help.vt.edu". We distributed flyers and bookmarks from ITSO, and engaged many attendees in conversations about "not clicking the shiny" and distributing "Don't Get Hooked" stickers referring folks to our phishing information site.

Publicity efforts also included the creation and release of a Windows security best practices blog by the Collaborative Computing Solutions group.

Information technology risk assessments

Information Technology helps the university community identify and mitigate risks due to internal and external threats to its critical information technology infrastructure and data assets. Converged Technologies for Security, Safety, and Resilience (CTSSR) coordinates this process. CTSSR maintains and promotes the university-wide risk assessment documentation and ensures that it adheres to standards and best practices. CTSSR has received 80 completed risk assessments for FY15.
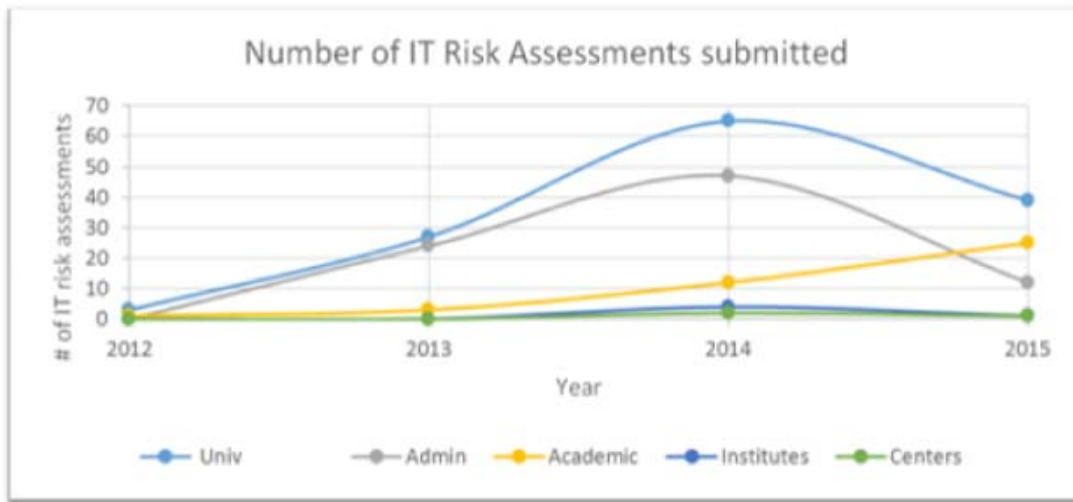
Number of IT Risk Assessments submitted

On-site training for completing the risk assessments is available upon request. Since July 2014, CTSSR has responded to 15 separate requests for training, with requested follow-up meetings bringing the total number of training events to 18. These are in addition to numerous telephone consultations. Written feedback is often provided and serves as additional training for those who have submitted initial drafts of their department's assessment.

The information technology risk assessment process and template includes best practices aligned with the National Institute of Standards and Technology Special Publication 800 series. The template is reviewed and updated annually to introduce incremental enhancements. An additional step was added this year that requires an evaluation of critical security controls from an organizational perspective. These controls are considered the most effective measures for detecting, preventing, responding and mitigating the most common information technology security risks. Other updates seek to improve risk response reporting and monitoring previously proposed solutions.

Recoverability and resilience of infrastructure and data

Key to the resilience and recoverability of critical systems is the work to establish a backup facility at the Virginia Tech Carilion Research Institute in Roanoke. By year's end, work was complete to confirm the IP address range, and to have Banner and Scholar backups running, as well as the NetApp storage that supports those systems. Work continues to document and verify requirements and dependencies throughout Information Technology.

The Enterprise Directory (ED) directories (LDAPs) are already redundant at the Blacksburg campus with 6 replicas. Another ED LDAP is located at the University of Virginia. Redundant LDAPs are planned for the Carilion Disaster Recovery facility. These facilities provide off-site redundancy. The SAN provides some redundancy for the ED Registry Oracle data base. Redundancy of these services relies on load balancing, now configured to use the new F5 load balancers. The Middleware group within Secure Enterprise Technology Initiatives continues to work with Network Infrastructure and Services (NI&S) on remaining challenges to managing the load balancing configuration. Middleware and NI&S are testing the F5 load balancing service before using it in preproduction and production.

Continuity of operations planning

Business processes to recover from infrastructure issues are also critical. The interrelationships between risk assessment and continuity planning are investigated collaboratively with individual units and the CTSSR group. The risk assessment process identifies the technology resources supporting the essential functions of an organization. Essential functions are those organizational business activities and services that must be continued under all circumstances. This important step relates the risk assessment directly

to continuity planning. The assets identified as mission critical are used to inform the departmental continuity planning sections: essential functions worksheets; critical resources, vital records, and databases and files.

Once the mission critical technology resources have been identified, threats and vulnerabilities that pose risk to those resources are considered and prioritized. The risks are then assessed to determine what actions can be taken to minimize risk to mission essential technology assets. Together, the ITRA—information technology risk assessment—and COOP—continuity planning—processes work to enhance the resilience and recoverability of university wide critical information technology systems.

In January 2014, CTSSR conducted a survey of technology representatives from 37 university departments asking them to identify, in order of restoration priority, the most mission essential five Information Technology services. Based on the results, it was decided to continue to plan for the following services to receive priority restoration in the event of a COOP incident: Banner, Scholar, the university website, email services, and the university communication network. Ongoing discussions with the Office of Emergency Management continue to improve our ability to identify priorities for disaster recovery and COOP.

In August 2014, a new continuity template was adopted that reflects the Virginia Department of Emergency Management documentation resources.

Since July 2014, CTSSR has facilitated two exercises—a tabletop exercise for the call center procedures used when an activation of the Emergency Operations Center is requested, and an unannounced drill of the activation of the Emergency Operations Center in collaboration with the Office of Emergency Management, both in March 2015. While these events did not exercise the continuity plan, they did exercise Information Technology's readiness to provide an essential emergency support function for the university.

Advance identity management capabilities

Industry organizations that Virginia Tech looks to for identity management best practices include Internet2. A recent initiative of Internet2 is Trust and Identity in Education and Research (TIER). Information Technology has worked with the TIER initiative, and through Secure Enterprise Technology Initiatives (SETI), we are implementing one of the TIER core products—Shibboleth Identity Provider, version 3. The CAS protocol handler in this version was developed by SETI's Middleware unit

Information Technology contributes to national discussions on identity management. For example, a staff member from Identity Management Services served as Virginia Tech's subject matter expert for Identity and Access Management on the Internet2 ServiceNow Identity track. This work included the submission of Virginia Tech's use case for authenticated role-based views of the ServiceNow service catalog. The requested authorization capabilities are under consideration for implementation by ServiceNow (Pillar 7).

SETI provides support for Shibboleth Identity Provider (IdP), a required service for the use of federated credentials. The service releases attributes about individuals to federated service providers according to an attribute release policy that is more restrictive for students than for faculty/staff. In FY15, SETI collaborated with Identity Management Services, with the Shibboleth sponsor, and with the associate vice president for research computing to create a process by which students could explicitly grant permission to release the core federated credentials to InCommon service providers, thus enabling graduate students to access InCommon. Work continues on this project.

2-Factor Authentication Program

The Multi-factor Authentication Working Group completed its study of one-time password technology (OTP) during August-December 2014, including identification of at least one major service that is a prime candidate for one-time password requirements. As part of the working group, services that should utilize OTP technologies were mapped to credentials. As the project got underway later in the fiscal year, it was decided that two factor authentication should be required of all services. The existing multi-factor authentication technology is personal digital certificates on eTokens. Deployment did not extend throughout the university, in part because of the requirement for locally installed software that was burdensome to both users and support personnel.

With goals of universal deployment, the University 2-Factor Authentication Program was initiated in the first half of calendar year 2015, including finding a technology vendor. Windows login environments and the Shibboleth IdP for CAS-enabled applications were identified as the initial services to be enhanced.

The Shibboleth IdP is being enhanced to support 2FA and to support the existing eToken implementation as an InCommon Silver credential technology solution.

InCommon Silver-compliant password storage in the Enterprise Directory is included in ED 4.0, which is being tested in pre-production. ED 4.0 will be in production early in FY16.

Affiliate identities

While core identities of faculty, staff, and students, along with those for alumni and retirees, are well defined according to established business processes, the varieties of transient and temporary affiliations are less well defined. As the proof-of-concept learning management exercise with Canvas was underway in the spring, there was a need to integrate guest or transient students. Identity Management Services proposed a delegated model enabling class instructors to sponsor guest accounts. The plan anticipates that the model will scale to multiple classes as Canvas is implemented.

Information Technology engaged the topic of "Remote Vetting of Identities" at the 2014 Internet2 Technology Exchange, Identity Services Summit. Multiple approaches were discussed and proposed including creating a point system where different IDs (social, high school email, driver's license) would be collected for an individual and added to reach the documentation threshold, use certified postal mails that are sent to a home address, use the parents/college to vouch for the children, ask students "security questions," or upload a notarized document or copy of a photo ID and verify with video conferencing.

Information Technology contributed to the Internet2 External Identities Working Group. The purpose of this group was to gather knowledge and facilitate decisions on making external identities useful and sufficiently trusted in a variety of use cases in higher education. External identity providers were evaluated based on criteria such as account management policies and identity proofing. Risk factors were identified, and a final report was issued in the latter part of FY15. See
https://spaces.internet2.edu/display/EXTID/Home.

Identity Management Services continues work on a proof-of- concept model of an automated affiliate management system using Bonita workflow technology. When completed, the Virginia Tech Access and Identity Management Service will provide the capability to appropriately provision/deprovision non-core Virginia Tech affiliates in a more timely and effective manner. Additionally, staff worked with representatives from Human Resources to customize an automated Banner workflow process for the distributed entry and approval of some types of affiliates.

The organization also continues to support affiliate identity needs of partners across campus. In FY15, Identity Management Services worked closely with the Language Culture Institute (LCI), Hokie Passport Services for physical access, and the Schiffert Health Center, a service provider, to enable the distributed entry and appropriate provisioning/deprovisioning of LCI identities in the VT Identity Management System.

Strengthen the security and privacy of the identity management Infrastructure

Continuing to strengthen the privacy and security of the identity management infrastructure, access to the ED-Auth service was restricted early in FY 2015, better securing use of this authentication system. Other security improvements included upgrading the Global Qualified Server certificate chain to use the SHA-256 algorithm, in compliance with CAB Forum requirements, and planning to replace the hardware security modules. Looking to the future, research on using external certificate authorities for personal certificates began in FY 2015. Ensuring the security of these infrastructure changes involves extensive testing, conducted by SETI's Quality Assurance & Verification unit. The staff expanded their automated testing capabilities in FY 2015 with enhanced logging for the Selenium grid.

Evolving identity needs

As part of the expansion of Office 365 (see Pillar 3), significant upgrades were needed for our Active Directory. A major part of this needed evolution was the incorporation of students into Active Directory for provisioning of Office 365. Until FY15, students had never been included in the Active Directory—moving them in required defining appropriate affiliations, creating a security structure that would give students the access they needed while safeguarding their identities and information. Changes to Active Directory (AD) also involved a major upgrade to ADAdmin's infrastructure. This upgrade ensures that identity services using this infrastructure will continue to be robustly supported by strong infrastructure. Other work on student identities in FY15 included defining identity processes to produce a consistent view of student identities between Banner and the Identity Management Person Registry and ongoing work to create a process for correctly identifying Virginia Tech undergraduate fellows for authorization to appropriate services.

In addition to infrastructure work on ADAdmin, new services in ADAdmin were rolled out to campus in FY15. The organization created an MOU for new inter-forest trusts in the AD forest for the Office of the Vice President for Administrative Services (VPAS) and the Division of Student Affairs (DSA). This inter-forest trust allows VPAS and DSA to use central authentication mechanisms for their systems, which improves security and simplifies functionality for end-users, who do not have to maintain multiple identifiers and passwords. After initially testing the inter-forest trust concept, the DSA made the decision to further streamline and economize their efforts in this space and transitioned to a child domain under Information Technology—eliminating the need to maintain a separate domain entirely. FY15 also saw the development of a "VT AD external application integration document" for third party applications that need to integrate with AD. The document explains and simplifies the process for integrating applications with the centrally managed AD domain. The move to Office 365 also required the creation of a sponsored role in ADAdmin that allows higher-level privileges for sponsored users that oversee identities in their departments or units. Finally, the 2-Factor Authentication Program will result in an upgrade to our AD in FY16 to support two-factor authentication.

The Business Intelligence project (Pillar 4) also led to the expansion of identity services. In FY15, the organization worked to design and implement an authorization structure for Microstrategy (our Business Intelligence solution) that automatically populates Enterprise Directory groups based on institutional roles and/or Banner classes present for a user. Other systems that required identity integrations included 25Live (Pillar 4), Gobbler Connect (CampusLab's platform for tracking student involvement activities), and ServiceNow (Pillar 7).

Pillar 6 Improving communications with customers and partners

Information Technology is working to improve communications with customers and partners. Mindful that communications is interaction, not a one-way blast of information, the organization is pursuing different types of communications to fit different circumstances and needs. We communicate to persuade—for example, to persuade faculty, staff, and students to NOT click on suspicious links in email. We communicate to *be* persuaded—what services does our community need and how do they need them to work. We communicate to educate from our base of expertise—how to recognize "phishes," how to acquire Information Technology services. And we communicate to assist the Virginia Tech community in understanding the role of information technology in university experiences.

Culture of information sharing

Information technologies underpin nearly all of the work of the university, making communication throughout the university and beyond essential. Creating a culture that enters into communications easily is a culture change, from days that technologists were back-room specialists, either innovating for the sake of technology or dutifully crafting code to someone else's specifications. Today's challenges demand good communications to provide the technology that the university needs and to demonstrate the possibilities as those technologies continue to evolve.

Communications Team

In the second year of operations as a team, Information Technology Communications Team includes skills that range from branding and vision, customer support, web design, marketing, and writing. Most units within Information Technology are represented, and members of the team are assigned to organizational units so that each unit has a resource person to call upon.

One of the key channels of communications to reach the entire university population are the channels controlled by University Relations. VT News captures significant events of the university for widespread distribution and for archiving for posterity. This year Information Technology had 14 VT News articles run, including announcements of new senior hires. Campus Notices are shorter announcements to inform the community of opportunities and changes. Both VT News items and Campus Notices are run in the weekday Daily News Email and selected items are in the weekly Student News Email. In Jun 2015 alone, Information Technology-provided information for the Daily Email on 12 days of the 22 days of publication. These included Campus Notices items announcing the Two-Factor Authentication program, new Skype service, information on Avaya phones, and security alerts. In June, the selection of Canvas as the new learning management system was announced as a VT News item.

One of the charges to the Communications Team is to inventory the communications channels. Initial work was completed in the year, highlight these channels maintained by University Relations, along with web interfaces under the control of Information Technology and used routinely by the community. The Scholar learning management system is key among these systems, with the ability to post a 'message of the day" that everyone using Scholar for courses or projects would be able to view.

The old "high tech-high touch" maxim remains very much with us as well, with critical changes for the university requiring multiple opportunities for in-person communications. For the learning management decision that ultimately selected Canvas, Information Technology engaged in extensive personal conversations with the community (see below). The effort involved in these communications helped develop an evolving catalog of ad hoc communications (town halls) as well as a list of existing organizations and groups that can be engaged in a conversation.

The Communications Team is also the driving force behind a re-imagining of the organization's web presence. In FY15, this effort involved undertaking an audit of the organization's web presence, identifying best practices for organizational web presence, producing a recommendations report based on the assessment and the best practices findings, and creating wire frame mockups for potential web presence changes. In FY16, the aim is to implement a new design and approach to content for www.it.vt.edu, in conjunction with other efforts such as the Service Catalog (Pillar 7).

Highlights of Information Technology in the university news for FY15

July
- How to manage spam
- 4Help seeks feedback
- New remote access service

August
- Technology-enhanced showcase
- Extended computer assistance available

September
- 4-VA grants
- VT Office 365 info

October
- Exchange upgrade
- Filebox notice
- One-time password town hall

November
- Enhanced 4Help website
- Run a speed test
- Software Distribution relocated after flood

December
- New eduroam wireless access
- Digital repository for Kenyan law
- Recognition for NI&S engineer

January
- Learn more at lynda.vt.edu
- Course design grant workshop
- Telephone safety notice

February
- Exchange public folders end
- NI&S opens online suggestion box
- Get involved with plan for LMS

March
- Call for early phone, network orders
- Unified Communications survey
- New deputy CIO

April
- 100 gigabit/second network
- Prevent identity theft
- Listserv being replaced by Google
- VT Office 365 available

May
- Skype for Business available
- New director, high performance computing

June
- Canvas to replace Scholar
- Phone upgrade
- 2 factor authentifcation announced

Internal communications

Building relationships throughout the Information Technology organization is a planned objective that was addressed this year through a variety of communications and events. The now long-standing newsletter, the ITELL, included issues this year of added length and remains available on the organizational website (www.it.vt.edu/itell).

Make information about Information Technology services and plans readily available

As part of the onboarding of the organization's new Deputy CIO, Dr. Scot Ransbottom, each unit and major sub-group in Information Technology have held informational meetings to provide context, acquaint new senior leadership with their work, and discuss challenges and opportunities. One outcome of these discussions were the two human resources focused town halls (see Pillar 7), which were held in the spring and provided the community with the opportunity to provide feedback, share ideas, and discuss opportunities for improving the organization's approach to recruitment and retention.

Additionally, in October 2014 the Vice President hosted a series of three town halls for the Information Technology organization focused on revisiting organizational goals and considering the focus for the coming year. These town halls included a discussion of the IT Strategic Plan and IT Operational Plan, an update on the budget, a discussion of the organization's cybersecurity working groups, and gave personnel an opportunity to ask questions and share feedback.

Enhance communications processes between Information Technology and the university community

The IT Council, an advisory group to Information Technology, is formed from representatives of senior management areas around the university, both academic and administrative. The council has become, even in its early days, a standard means of engaging knowledgeable audiences from the university. Council members have been generous with their time, agreeing to work on specific projects (for example, the "project site" aspect of Scholar that needs thoughtful solutions for after the Canvas conversion), and pointing Information Technology to other customer segments that may be particularly interested in one or another initiative.

Build awareness of activities and accomplishments

Communications to the university community and beyond are essential to effectiveness of the projects, initiatives, and operations that Information Technology undertakes in support of the university's strategic directions. Some of these communications activities are highlighted below. Note that most are connected to work described at greater length in the cross-referenced pillars.

The annual **Showcase for Security and Safety Technologies**, is described in Pillar 3. Topics for 2014 included an update on the Regional 911 center, broadband deployment for public safety, spatial data and imagery for campus safety, LifeSafe mobile safety app, stadium evacuation simulation, campus population modeling.

Virginia Tech and the Roanoke-Blacksburg Technology Council hosted a town hall information and discussion meeting of the **Virginia Cyber Security Commission** on February 24 in the Holtzman Alumni Center's Assembly Hall. This event, the first in a series, introduced the public to the mission of the commission established by Governor Terry McAuliffe in 2014. The commission brought together experts from the public and private sectors to develop recommendations that will help position Virginia as a leader in cybersecurity.

As a host, Information Technology was afforded an opportunity to showcase university talent. Speakers included Randy Marchany, information technology security officer, along with individuals from the commission, and the FBI. The remote attendance abilities of the university were also critical to the meeting's success. In total, the event—arranged and hosted by Information Technology—attracted around 260 participants, 140 via WebEx and 120 in Alumni Assembly Hall. Cyber Security Virginia held similar meetings in Martinsville, Harrisonburg, Charlottesville, and Norfolk.

Extensive communications with the community surrounded the development, decisions, and initial use of the university's new **learning management system**. The system is described in Pillar 1. Leadership sought to reach as many members of the university community as possible to gather feedback on needs, desires, and challenges for the next generation system. The project sought input through open town halls; NLI sessions; and dedicated meetings for colleges, commissions, undergraduate and graduate students, academic leaders, administrative leaders and their teams, remote workers, and Virginia Tech community members in the National Capital Region.

The majority of these discussions were led by the Vice President for Information Technology and the Executive Director and Associate Provost for TLOS. These feedback gathering events resulted in involvement from hundreds of community members, who shared their perspectives with the project team. The graphic below provides a high level summary of the different ways in which we sought to speak with Virginia Tech students, faculty, and staff. A listing of most events demonstrates the diversity of settings and the attempt to reach as many members of the university community as possible.

Open sessions

Virtual Town Hall via WebEx, March 24
In person Town Halls, Blacksburg, March 19 and 25, and specifically for students, April 14
Town Halls, National Capital Region, April 30—one for faculty and staff and one specifically for students
NLI sessions: 6 overview sessions between March 30 and April 27; 2 sessions on course redesign, April 27 and 28.

College and Academic Leadership Meetings

Department Heads Council Executive Committee: February 3
College of Agriculture and Life Sciences: February 15
College of Agriculture and Life Sciences NLI discussion: March 10
College of Architecture: March 3
College of Science: March 4
Department Heads Council: March 16
College of Business: March 17
Virginia-Maryland College of Veterinary Medicine: March 20
College of Liberal Arts and Human Sciences: March 24
College of Engineering: April 2
College of Natural Resources and Environment: April 2
Faculty Senate: April 28

Commission Meetings

Faculty Affairs: March 6, 2015
Graduate Studies and Policies: March 18, 2015
University Support: March 19, 2015
Undergraduate Studies and Policies: March 23, 2015
Student Affairs: April 16, 2015

Student Meetings

Student Government Association: March 17, 2015
Graduate Student Association: April 23, 2015

Administration Meetings

Professional Development Practitioner's Network: March 23, 2015
IT Council: March 26, 2015
Technology-enhanced Learning and Online Strategies Stakeholders Committee: March 27, 2015

Social media was another avenue of conversations regarding the future of learning management systems, with a Twitter contact, https://twitter.com/NextGenLMS, as well as email, nextgenerationlms-g@vt.edu.

In FY15, the organization offered six **showcases related to teaching and learning**, which included topics such as instructional design, broadcasting the work of faculty who participated in teaching and learning development opportunities through LED or NLI, celebrating leading edge TEAL work on campus, and debuting new spaces such as the Learning Studio (see Pillar 3). Information Technology also hosted a Distinguished Innovator in Residence speaker series through NLI.

Two units in Information Technology served as sponsors for the **Society for Electro-Acoustic in the United States** (SEAMUS) 2015 national conference hosted at Virginia Tech in March 2015. The SEAMUS conference is the largest of its kind and took place over three days, featuring over 20 hours of cutting edge electroacoustic music and audio-visual art from leading scholars and artists as well as student artists. The conference offered paper sessions and workshops and showcased the work of a number of Virginia tech faculty and students.

Identify conferences with strategic advantages. Conferences, showcases, and events offer opportunities to disseminate the work of Information Technology, and to learn best practices and innovations from others. Staff offered keynote speeches and conference presentations related to teaching and learning with technology at events across the country, including the keynote for Montgomery College's 2015 Innovation Forum, and workshops at national and regional conferences for professional organizations including SITE, AECT, Educause, WECT, and Online Learning Consortium (OLC; formerly Sloan-C). The presentation on technology and strategies for managing group work in online courses received an award from OLC. A senior manager was invited to lead workshops in the their Mastery Series on Blended Learning and Leadership in Online Learning, both reaching national and international audiences, and another invitation led to an invited lecture for OLC and to facilitating OLC's online Mastery Series for Blended Learning. OLC sponsored programs such as the Institute for Emerging Leadership in Online Learning where TLOS staff members participate.

Pillar 7 Strengthening the Information Technology 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

One major aim identified in Pillar 7 is to create tools and processes to help the Information Technology organization understand the services and activities that are taking place, identify the services and activities that should be in place in the future, and evaluate services and activities that should be retired. In FY14, the effort 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. ServiceNow offers a service catalog, knowledge management, and integration with key university systems, along with a comprehensive set of supports for incident management. In FY15, ServiceNow was implemented for ticketing, and the organization began to explore expanding the use of ServiceNow in these other areas of capability, particularly with respect to its service catalog capabilities.

Service catalog

In FY15, the organization launched a project to create a new, unified service catalog for Information Technology services. This project was identified as a task from the Operational Plan to move the aims of better understanding services and activities forward. The desired outcome of this project is a single, easy-to-use, well-organized online catalog for all user-facing services provided by the organization. Currently, various units have separate pages and catalogs, resulting in duplication and confusion. The Service Catalog Project was divided into three "tracks" across two phases. The project is slated to run through the end of Spring Semester 2016.

Phase 1. Track one in FY15 focused on a pilot with the three largest units--NI&S, Enterprise Systems, and TLOS—as well as Identity Management Services to gather or create documentation that would be used in this service catalog. The output of phase one of track one was a "Master Matrix of Services," a spreadsheet with information on over 100 services, and hundreds of subservices. For each service, the following was documented (when possible): service name; sub services; brief description; features and

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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

benefits; service owner; level of support for service; eligibility to use; cost; how to get the service; Service Supporter; Documentation.

Track two focused on visualizing and designing the Information Technology Portfolio platform, including the design (look and feel) of the solution. While Track 1 emphasized the "what and how" of what we do, Track 2 focused on how we represent what we do to others. The following process was used to establish these VT service catalog preferences:

1. Staff consulted best practice recommendations, peer institutions, ServiceNow, and Evergreen resources, including webinars and documentation, to establish understanding of Service Catalog best practices.
2. Over 100 current university service catalogs were analyzed, and a matrix was created to document the following information for each catalog: category names, options for categorization, number of categories, images and icons, number of webpages to reach service, format grade, service status options, request service options. A point system was established to evaluate these components for each catalog in the matrix.

**Track 1: Master matrix of services
Track 2 Designing the portfolio platform
Track 3: Technical implementation**

3. Participating personnel each analyzed the catalogs in the matrix and assigned points and rankings to the catalogs as they saw fit.
4. A compilation of the scorings of catalogs was completed, to establish a consolidated ranked list of "Top 5 Service Catalogs."
5. These top service catalogs were then more thoroughly analyzed on a number of components by each participant. Regular group discussions on these analyses were held, and all preferences and concerns were documented.
6. These preferences and concerns based on other universities' catalogs were combined with Service Now "best practices" to form a document of recommendations.

The recommendations document coming out of Track 2 was presented at the conclusion of phase one. Track 2 completed with the production of the recommendations report.

Track 3 was not active in phase one, as this area of work is primarily focused on the technical implementation of the service catalog.

Phase 2. Phase 2 is a continuation of the work established by Tracks 1 and 2 during Phase 1 of the portfolio project during spring semester 2015. Phase 2 specifically focused on the documentation and implementation of a user-facing service catalog for most-requested/most-queried services.

To prepare the organization for a full scale documentation and implementation effort, we offered training sessions on key service catalog concepts with opportunities for hands-on practice. Topics within these training events included the following:

- What is a service catalog?
- How does a service catalog fit into the overall concept of information technology service management?
- What is the point of a service catalog, and how will this practically benefit my work?
- How do we understand what constitutes a "service"?
- Hands-on exercise to identify and practice documenting services

The pilot group from Phase 1 was expanded to include all groups within Information Technology to gather or create documentation. The first priority for Phase 2 of this track is to document and gather information on user-facing services prioritized for the first iteration of the service catalog. Building the catalog will

iterate from top-requested services based on 4Help data. The documentation effort will include identification and documentation of opportunities for improvement, and the expansion of self-service for the user community. This track was just getting underway at the conclusion of this fiscal year.

Track three specifically focuses on the implementation of the portfolio itself using the outputs from the Documentation and Visualization/Design tracks and additional organizational requirements for the service catalog. Track three has only become active in phase 2 of the project, which is currently in progress. Track 3 in FY16 will work closely with others efforts in the organization to implement the catalog in a manner consistent with Information Technology's next generation technology architecture.

Expanding understanding of ITIL

The service catalog effort has been closely coupled with an emphasis on expanded understanding of information technology service management in general. ITIL—Information Technology Infrastructure Library—is a set of best practices for information technology service management that the Information Technology organization is using to guide discussions about other areas of improvement based on best practices. In FY15, 20 Information Technology employees took the ITIL Foundations Course and passed an ITIL Foundations certification exam. This effort is assisting the organization in developing a common vocabulary about service management to allow us to better talk together about how we all support information technology services for Virginia Tech. Since the Foundations course, other personnel from across the organization have participated in series of ongoing conversations about ITIL. These conversations will continue in FY16, with the intention of implementing new practices based on the outcomes of these discussions.

Improving the organization through inclusion and diversity

"On June 30, 2014, Virginia Tech adopted a new organizational structure for inclusion and diversity. This new framework, called InclusiveVT, resulted from the efforts of a Task Force on Inclusive Excellence which was charged to consider successful analogous structures at peer institutions...As part of the new InclusiveVT framework, 86 initiatives were solicited from 28 senior management areas."[2] It "is a framework that creates active, intentional engagement of Virginia Tech communities."[3]

The Information Technology organization crafted and began work on three of these 86 initiatives, in areas that had already been identified as priorities in our 2014-2016 Operational Plan[4]. Indeed, Pillar 7 of the 2012-2018 Information Technology Strategic Plan and 2014-2016 Operational Plan are directly relevant to the priorities identified in the 2013-2018 Diversity Strategic Plan. This pillar focuses on making the organization stronger and more capable. Indeed, Information Technology had identified several work areas that closely match the priorities of the Diversity Plan, the most urgent of which have become the three major diversity and inclusion initiatives we defined for the coming years.

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[2] http://www.inclusive.vt.edu/resources/publications/reports/past-pres-fut.pdf

[3] http://www.inclusive.vt.edu/resources/faq/index.html

[4] To ensure effective and systematic assessment of progress on the 2012-2018 Information Technology Strategic Plan, over fiscal year 2014 (FY14), Information Technology designed, collaboratively created, and implemented its first Operational Plan. The 2014-2016 Operational Plan provides a detailed set of goals, initiatives, and tasks to realize the seven pillars of the 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.

Initiative 1 specifically arises from a need identified in the operational planning process, and within the initiatives and tasks of Pillar 7, to better understand and comprehensively improve recruitment strategies, structures, and practices. As a result, Initiative 1 of our InclusiveVT Implementation plan calls for the Information Technology organization to take on recruitment as a major effort, with a clear and deliberate focus on inclusion and diversity. To accomplish the aims of this Initiative, FY15 focused explicitly on conducting a current state assessment to identify areas for improvement and extant needs, while FY16 will primarily emphasize best practices benchmarking/confirmation of direction and implementation of improvements.

Three initiatives connect Information Technology with Inclusive VT: recruiting, retention, and online accessibility.

Initiative 2 also arose from a need identified in the operational planning process, and within the initiatives and tasks of Pillar 7, to enhance retention of employees by focusing, in part, on improving the workplace environment. As a result, Initiative 2 of the InclusiveVT Implementation plan calls for us to take on the organizational environment as a major effort, with a clear and deliberate focus on inclusion and diversity. To accomplish the aims of this Initiative, FY15 focused explicitly on conducting a current state assessment to identify areas for improvement and extant needs, while FY16 will primarily emphasize best practices benchmarking/confirmation of direction and implementation of improvements.

Initiative 3 came from a need identified in the operational planning process, and within the initiatives and tasks of both Pillars 1 (enabling networked learning in the networked university) and Pillar 7. Both pillars call for actively engaging the university community in advancing accessibility, via mechanisms such as the web, universal design of course materials, and assistive technologies to promote a supportive and inclusive experience for individuals with disabilities. As a result, Initiative 3 identifies accessibility in information technology as a strategic need, both for both Information Technology as an organization and the institution as a whole. To accomplish the aims of this Initiative, we recommend a two-pronged approach. The first area of emphasis is seeking a university-wide improvement in web accessibility. The second area of emphasis centers on improving accessibility for other Information Technology-provided services. In FY15, we focused on conducting a current state assessment to identify areas for improvement on web accessibility and recommendations for best practices for improvement, while FY16 will primarily emphasize the implementation of improvements and the beginning of an assessment of accessibility for other Information Technology-provided services. FY17 is then expected to focus on continuing implementation of web accessibility improvements as well as the beginning of improvements in these services and the completion of the assessment of accessibility for Information Technology services.

More detail on each initiative and progress to date is provided below.

Initiative 1. Initiative 1 focuses on improving recruiting in order to advance diversity and inclusion goals. The major goal for FY15 was to launch a holistic assessment of our current employment environment to identify areas of weakness and establish a baseline for improvement in subsequent fiscal years. To date, we have made significant progress on our FY15 goals, and have also begun work on our FY16 goal of implementing improvements to identified areas of weakness. Work relates both specifically to diversity and inclusion in recruiting and also to improving the recruiting process and structures more broadly because improving our overall recruiting ability will also help us to more effectively recruit specifically for diversity and inclusion.

For FY15, our accomplishments included:

- Analyzing existing data on known challenges, areas of weakness, and barriers to improvement based on operational plan development discussions
- The production of a report based on these findings
- The vetting of this report with Information Technology leadership

- The use of the identified challenge areas in this report to develop an initial list of targeted leaders in the Department of Human Resources and elsewhere with whom to discuss the known challenges, potential amelioration measures, and identify outstanding peers from whom we might borrow successful ideas
- Meetings are in the process of being scheduled, and the outcomes of these discussions will be used to craft an updated report detailing the findings of these investigations with a list of top priorities for improvement in coming years
- We are in the process of establishing baseline metrics on our other measure areas, but do not have defined reports or findings yet (e.g., demographic profile of hiring pools, dollars allocated to strategic recruiting, number of recruiting zones). As noted below in "unexpected insights" one finding from the process of analyzing our climate data was that we needed to improve our organizational infrastructure in Banner, which we are in the process of correcting, and which will be vital to correct for effective production of many desired metrics. We anticipate that it will be feasible to have this completed and our desired measures for this initiative completed by the end of the FY per our original goal communication of Information Technology's perspective on inclusive recruitment. This training program is expected to launch in July 2015

As noted above, we also made progress on our FY16 goal of implementing improvements to identified areas of weakness. Because we had already identified some areas of weakness through the operational planning process and incorporated these into our operational plan, work was planned and has subsequently begun on improvement opportunities in several recruitment-related areas.

<u>Immediate improvements to talent acquisition management</u>. Due to the operational planning process, there was a known desire to provide more centrally organized management support for individuals with hiring authority and responsibilities, and to offer a closer relationship between hiring managers and human resource functions. The human resource area within Information Technology is well into the development of a training program targeted at mid-level managers to provide an overview on the recruiting process, including both attraction and retention of talent.

<u>Developing standard classifications and skillsets for talent acquisition</u>. A known impediment to effective recruitment were position descriptions, skill set requirements, and classifications that were overly tailored and exacting. Specific to InclusiveVT, as many researchers[5] and industry peers[6] note, a key component to effective recruiting for diverse applicants involves casting a wide net and ensuring that position descriptions and job postings are able to appeal to a broad pool of applicants and are not so narrowly tailored that they restrict a sense of "fit" for applicants. This effort is directly intended to address the InclusiveVT diverse recruiting goal as well as addressing previously identified known recruiting challenges by changing how we look at recruitment through more general position descriptions and job postings that emphasize broad skillsets and the ability to learn on the job

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[5] For example:

- Trautvetter, L.R., Knight, D.B., & Kinoshita, T. (2014, April). Recruitment and retention of female and underrepresented engineering faculty: The influence of organizational context. Research presented at the annual meeting of the American Educational Research Association, Philadelphia.
  - NOTE: Knight is a faculty member at Virginia Tech and Kinoshita is a graduate student at Virginia Tech
- Smith, D.G., Turner, C.S., Osei-Kofi, N., and S. Richards. (2004). Interrupting the usual: Successful strategies for hiring diverse faculty. *The Journal of Higher Education*, *75*(2), 133-160.

[6] For example: NC State: http://oied.ncsu.edu/oied/hiring/OEO_Recruitment_Guidelines.pdf; Harvard: http://hr.fas.harvard.edu/files/fas-hr/files/recruiting_for_diversity_9.17.13_0.pdf

Expanding into new recruiting venues. As part of "casting a wider net" described above, Information Technology is also seeking to expand its footprint into new, non-traditional recruiting venues such as job fairs. Our previous recruiting strategies have been overwhelmingly web-based. In-person recruiting events were extremely rare. Yet, industry experts[7] note that high-touch, personal recruiting is exponentially more effective for diversity recruiting. Information Technology's strategic expansion into in-person recruiting events, which will occur more frequently in subsequent fiscal years, targets both our specific diversity goals and our general need for larger applicant pools

Creating a visual identity. Work has recently begun on creating a visual identity with marketing materials specific to Information Technology at Virginia Tech to better articulate who we are as an organization, with the intention of making the recruiting materials more personalized and deliberate. This effort supports the others to create a coherent identity so that recruits can more easily envision what it means to be part of Information Technology.

Expanding student employment opportunities. Work continued this year to expand the program for graduate and undergraduate employees/interns. The eventual goal is to develop a true rotation program and form relationships with colleges to recruit participants. Drawing from our diverse population on campus to encourage participation in the organization, and attempting to build a pipeline to post-graduate employment with us will help the organization make progress on our diversity goals

Because Initiatives 1 and 2 are closely related, the initial analysis efforts for these initiatives were combined. A major part of our goal for FY15 was establishing a baseline for subsequent metrics reporting. In the process of analyzing data so far, we discovered that our organizational structures in Banner are seriously outdated and need to be recalibrated to accurately reflect the present state of the organization and the employees within it. This parallel effort is currently in progress so that we can complete our reporting goals, but may have implications for our timeline goals if structures cannot be adapted by the end of the fiscal year.

Initiative 2. Initiative 2 focuses on improving the workplace environment in order to advance diversity and inclusion goals. Our major goal for FY15 was to launch a holistic assessment of our current employment environment to identify areas of weakness and establish a baseline for improvement in subsequent fiscal years. To date, we have made progress on our FY15 goals, and have also begun work on our FY16 goal of implementing improvements to identified areas of weakness. For Initiative 2, it is particularly important to note the close connection with Initiative 1. While improving recruitment for diversity and inclusion (Initiative 1) is a crucial goal for the organization, retaining that talent once it enters the organization is equally important. As a result, much of the work in Initiative 2 will initially focus on improving the overall environment for employees in order to improve retention. The byproduct of this is directly applicable to diversity and inclusion, because improvement in our ability to recruit diverse employees will be negated if we cannot retain these employees.

For our FY15 goal, our accomplishments to date include:

- Analyzing existing data on known challenges, areas of weakness, and barriers to improvement based on operational plan development discussions
- Assessing existing climate survey data and climate survey format to understand recent organizational feedback and generate ideas for off-year survey options
- The production of a report based on these findings

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[7] For example: http://money.usnews.com/money/blogs/outside-voices-careers/2014/10/08/trends-in-diversity-recruiting-us-employers-weigh-in

- The vetting of this report with the CIO, Deputy CIO, and leaders from each unit
- The use of the identified challenge areas in this report to develop an initial list of targeted leaders in the Department of Human Resources and elsewhere with whom to discuss the known challenges, potential amelioration measures, and identify outstanding peers we can learn from

Meetings are in the process of being scheduled, and the outcomes of these discussions will be used to craft an updated report detailing the findings of these investigations with a list of top priorities for improvement in coming years.

We are in the process of establishing baseline metrics on our other measure areas, but do not have defined reports or findings yet (e.g., an organizational baseline, number of employees providing input). As noted below in "unexpected insights" one finding from the process of analyzing our climate data was that we needed to improve our organizational infrastructure in Banner, which we are the process of correcting, and which will be vital to correct for effective production of many desired metrics. We anticipate that it will be feasible to have this process completed and our desired measures for this initiative completed by the end of the year.

We are behind on setting up structures and processes for exit interviews, but are currently working with University Organizational and Professional Development to obtain information on best practices and current exit interview structures from which we might be able to build a model; obtain exit survey data to assist with the development of our organizational baseline; and to determine whether we may wish to add Information Technology-specific questions to the exit interview survey sent to the organization's employees.

As noted above, we also made progress on our FY16 goal of implementing improvements to identified areas of weakness. Because we had already identified some areas of weakness through the operational planning process and incorporated these into our operational plan, work was planned and has subsequently begun on improvement opportunities in several recruitment-related areas.

Implementation of awards and recognition programs. Information Technology is actively working to create two new award and recognition programs that will be managed out of the vice president's office. The first will focus on acknowledging excellent contributions, and includes a nomination process and selection of awardees by the Vice President. The second celebrates certifications and other professional accomplishments (e.g., degree attainment) for the organization's employees. Both awards are still in development, but the second is expected to launch at the latest by July 1. The desire for awards and celebrations of achievement was articulated as a desire by employees during the operational planning process to help improve the workplace environment.

Members of the Information Technology team were recognized for successful completion of the university's Employee Certificate Development Program. These nine people are some of the 125 employees recognized for their commitment to professional development.

Immediate improvements to talent acquisition management. Due to the operational planning process, there was a known desire to provide more centrally organized management support for individuals with hiring authority and responsibilities, and to offer a closer relationship between hiring managers and human resources. We are well into the development of a training program targeted at mid-level managers to provide an overview on the recruiting process from advertisements, to attraction and retention of talent, to explicit discussion and communication of the organization's perspective on inclusive recruitment. This training program is expected to launch in July 2015. This is also listed as an accomplishment for Initiative 1, focused on recruiting, but it will benefit the workplace environment as well because it brings a focus on diversity and inclusion directly to those with hiring authority

Creating a visual identity. Work has recently begun on creating a visual identity with marketing materials specific to our organization to better articulate who we are. A clear visual identity is also listed as an accomplishment for Initiative 1. This effort supports the others to create a coherent identity for Information Technology, which will help current employees better identify with the organization as a general overall benefit to workplace environment.

Creation of an annual organization picnic. The Information Technology organization hosted its first annual picnic on July 15th, 2015.

Hosting organization town halls to solicit feedback. On June 3, the organization hosted two town halls to solicit feedback on human resources plans, to understand where we have opportunities to reach out to the best new talent to help our teams, to ensure everyone on the team has the knowledge, skills, and abilities to reach full potential and to grow as part of the organization.

Initiative 3. Initiative 3 focuses on improving accessibility in Information Technology. Our major goal for FY15 was to conduct a current state assessment to identify areas for improvement on web accessibility and recommendations for best practices for improvement. Initiative 3 is behind schedule. The major outcome of these challenges has been the identification of the need to adjust the proposed approach, scope, and timeline of Initiative 3. A revised version of Initiative 3 is in progress. Accomplishments to date on the original plan for Initiative 3 include the following:

● TLOS personnel assisted University Relations as accessibility and functionality experts on the selection of the new content management system;
● The Communications Team began a web presence project focused specifically on the organization's websites that included a high-level review of industry best practices for web accessibility, peer benchmarking on web presence, and running 39 websites through WAVE, a web accessibility evaluation tool, to establish a baseline understanding;
● Assistive Technologies has pulled together and reviewed historic information from a similar accessibility initiative in 2004;
● An initial plan for addressing each of the aims for Initiative 3 was developed and is in the process of being updated based on bandwidth;
● Receipt of a matching funds request from the Provost's Office to purchase and pilot additional software for expanded campus accessibility tools.

Some progress has been made on the FY16 and FY17 goals of assessing accessibility of other services and the implementation of improvements. Accessibility as a focus in Information Technology's teaching and learning support has been a key area of progress. Both the Networked Learning Initiative (NLI) and Graduate Education Development Institute (GEDI) have incorporated a strong focus on inclusive pedagogy and the curricular integration of inclusive pedagogy. GEDI involves 90 or more graduate students each

year, who receive the inclusive pedagogy education. It is an integral component of the GEDI and NLI sessions focused on inclusive pedagogy have run multiple times through the year. NLI sessions on inclusive pedagogy have reached a variety of faculty. Summer 2014 involved nine participants in a focused seminar on the topic. Additionally, a team member served as a presenter and facilitator for first Pathways Summer Institute focusing on inclusive pedagogy for Pathways courses implementing Ethical Reasoning and Intercultural/Global Awareness.

TLOS sponsored a Faculty Inquiry Group (FIG) to explore the challenges and opportunities related to course accessibility with the intended outcome being the production of a graphic representation of best practices for incorporating universal design in course design and development. There were 18 FIG participants, including from TLOS, University Relations, faculty, and other university employees.