Letter from the Vice President

I am pleased to present this annual report of the Office of Information Technology for the 2015-2016 academic year.

In the following pages, you will read about the important work that the department has engaged in this year in support of the major components of our long-range plan. This plan, first established at the start of 2015, describes a set of initiatives and processes that will transform the way the department serves the University. The plan calls for major investments in the computational support of research, new capabilities to serve our administrative clients and a major investment in information security.

We also recognized in this plan that IT organizations themselves are being transformed by advances in technology. To meet this challenge, we are redefining the way we do business as a department – creating an IT organization for the future that we call OIT 3.0. This organizational transformation embodies an emphasis on service management, cross-functional integration, and talent development. The ultimate goal of all of our work is to be able to provide technology services that enable Princeton to achieve its mission to advance learning through scholarship, research, and teaching of unsurpassed quality.

The work described in this annual report represents the collective effort of more than 300 OIT employees. What is not readily described in these colorful pages is the vitality, joy, and commitment that our staff bring to work each and every day. It is their dedication and passion for our mission and the University’s mission that makes the Office of Information Technology successful.

Jay L. Dominick
Vice President for Information Technology
and Chief Information Officer
OIT Mission Statement

OIT delivers information technology services and resources that enable Princeton to succeed in its mission to advance learning through scholarship, research, and teaching of unsurpassed quality. We achieve this through continual improvement and by aligning our services to the changing needs of our campus.

Our services are delivered with a commitment to:

- **Enabling innovation and research** at the frontier of discovery through centrally-provided, high-performance computing services and support resources;
- Delivering technology, tools, services, and applications that **support teaching and scholarship in and beyond the classroom**;
- **Supporting the effectiveness of University operations** through IT solutions and processes that align with campus priorities and strategic initiatives;
- **Relentlessly protecting the University's information**, while respecting the privacy of the members of our University community;
- Providing information technology services that **enrich the student learning and living experience**;
- **Delivering next-generation state of IT services** achieved through service management planning and practices that ensure responsible stewardship of University resources;
- **Fostering a diverse workforce and an inclusive culture** that leverages many perspectives in the creation and delivery of technology solutions and services for our campus community.
Administrative Information Services (AIS)
AIS provides implementation and support services for the University’s administrative systems.

Research Computing (RC)
Research Computing provides computing, storage, and software infrastructure and programming services to support faculty, professional staff, and students in their research.

Operations & Planning (OP)
O&P is responsible for overall organizational operations and planning efforts and for facilitating major initiatives that strengthen campus-wide IT services. O&P is also responsible for administrative initiatives that strengthen the OIT organization.

Projects and Technology Consulting Office (PATCO)
PATCO supports the University IT governance process, facilitates the annual campus-wide IT project selection process, and provides project management methodology and assistance to project managers to help ensure project success.
Academic Technology Services (ATS)

ATS supports University teaching and learning, and faculty and student use of instructional technology. ATS also builds, manages, and supports websites, applications, and related technologies that further the academic mission of the University.

Enterprise Infrastructure Services (EIS)

EIS manages the University’s data centers, server and storage systems, and collaboration technologies. EIS provides backup/restore, database administration services, authentication systems, and essential IT security services.

Support Services (SS)

Support Services provides front-line information technology support to all members of the University community.

Information Security Office (ISO)

The ISO addresses institutional issues of information security policy and practice, data governance, and risk assessment, as well as compliance requirements that span the University.
OIT began a multi-year initiative to transform from a technology organization to a service organization—a key to actualizing long-range plans unveiled in FY15. Though the means are involved, the goal is simple: to activate a culture of continual service improvement guided by the principles of Information Technology Service Management (ITSM). With the July 2016 launch of Services Now at Princeton, or SN@P (a service management tool and customer-facing platform), this goal is on its way to becoming standard operating procedure.

A new platform: Introducing ServiceNow.

More than a year in the making, ServiceNow is the centerpiece of OIT’s enhanced IT service approach. A revolution in how OIT does business, its launch required a significant time investment from many across the organization and beyond in the second half of FY16. All told, more than 160 staff contributed to this effort, including a significant portion of OIT, our new Service Offering Managers, the technical SCAD/DCS support community, a large group of user-acceptance testers, and trainers dedicated to getting us up and running in record time.

A single, modern platform for all aspects of service, from incidents and inquiries to service requests, ServiceNow will enable OIT to create smart, collaborative workflows. Over time, added benefits will include: improved problem management (identifying the root cause of service disruptions); and enhanced change management (determining changes, identifying affected business services, and implementing rapid remediation plans in the face of issues). Orchestration features will allow us to automate routine tasks over time.

- **Reduced downtime:** With automated maintenance and upgrades, the platform guarantees a 99.99% uptime.
- **Highly secure:** Data is stored across two data centers, while constant monitoring allows for fast error alerts.
- **Multi-instance architecture:** Princeton maintains control with its own application logic and database, supported across multiple instances.
- **Continual evolution:** Regular feature sets and enhancements cover everything from better security to new capabilities.
- **Innovation-friendly:** The ServiceNow community is encouraged to develop and share add-on applications, collectively enhancing the platform.

This data-rich environment bends the technology cost curve by providing real-time metrics that reflect our performance against ITIL benchmarks. Trends and needs can be seen as they emerge, from customer inquiries to recurring or persistent problems. As such, the adoption of ServiceNow marks a critical shift in emphasis from getting things done to truly understanding where our priorities and opportunities reside.

Services Now at Princeton (SN@P): Bringing it all together.

Part of our mission in rethinking technology at Princeton is to make it easy for users to access what they need, when they need it. Enter SN@P, the customer-facing portal for ServiceNow. Greatly streamlined, it is a key component of the ServiceNow experience. With a design informed by user experience (UX) best practices, it significantly simplifies the process of requesting services, reporting and tracking incidents, or seeking information.

**Process consolidation:** Hundreds of service request and inquiry forms and processes from disparate sources are now consolidated and accessible in one place. This achievement reflects tremendous effort, and will streamline the service ecosystem, minimizing the effort required from our customers. Optional workflows will also accelerate the movement of a task within OIT, and we are assessing automated processes in FY17.

**ITIL-based incident management:** When users access the portal, they are guided through the process of making inquiries, service requests, and incident reports. At the same time, those fulfilling requests can access contextual data for rapid troubleshooting or escalation. IT support by email and phone continue to be available.

**Real-time metrics:** Previously, disparate service-delivery mechanisms made it difficult to discover—or better yet, anticipate—trends. With SN@P-enabled reporting, we are now able to see which services encounter the most incidents, or which Knowledge Base articles are most requested at particular pulse points in the academic year. This will allow us to be proactive in delivering service.

Looking forward

SN@P, which has replaced the legacy issue ticketing system, OPM, after two decades of service, encompasses more than a new way to engage OIT. It supports a revitalized, forward-looking foundation for our organization in the face of ever-increasing technology demand, helping to...
minimize service disruptions and to associated productivity costs. With this piece of the foundation in place, continual service improvement for IT at Princeton is becoming a reality.

The portal will empower OIT to approach service delivery as a unified team, guiding investment toward quantifiable results. It will help us think about technology the way our customers do, resulting in new roles and the evolution of existing roles to include new responsibilities around evolving needs. Performance can be fine-tuned to increase service satisfaction while driving down or avoiding costs. In short, Service Management will be the engine by which OIT will be able to plan creatively and purposefully for goal-aligned technology investment for years to come.

**ITSM Priorities:**
- Standardize services
- Automate where possible
- Improve efficiency
- Maximize value
- Continually improve

**Into the Cloud: Embracing Platform as a Service.**

The move to ServiceNow marks OIT’s largest enterprise cloud project to date, and the benefits of this particular Platform as a Service (PaaS) are many. For one, the cloud offering enables OIT to prioritize strategy over maintenance of servers and systems, which places us in the position to efficiently analyze and implement new features. Multiple redundancies also support high availability. While our initial engagement is focused exclusively on the Service Management solution, an expanded set of integrated products may also prove beneficial to a broader audience.

Given our long-time reliance on OPM, the process of getting up and running in the new ServiceNow system was incredibly smooth.

Moving into FY17, we anticipate rapid realization of another benefit related to cloud contract and vendor management. During our launch window, ServiceNow was working to finalize a deal with Internet2 NET+, a research-and-education (R&E) collaboration which tailors cloud solutions to meet the unique needs of universities, select non-profits, and other R&E institutions. While we initially negotiated separately to save time, converting to the NET+ contract will simplify contract management and costs.

**Better information: Insight into technology.**

Platforms don’t improve service on their own. Clearly cataloging the services OIT offers and defining relevant knowledge articles provide the gateway for our customers to more easily access service and support from us.

**Service Catalog:** The first step toward the launch of ServiceNow was a comprehensive assessment of the entire OIT service portfolio, conducted in close partnership with our department IT colleagues, SCAD/DCS. With more than 500 offerings and applications to review, a notable allocation of time and resources was required. The assessment uncovered nearly 160 ways to access technology services, which in the next phase will be greatly streamlined and simplified for our customers.

Throughout the course of this project, services were identified and categorized. Redundancies and support groups were noted. Highly iterative, the effort has simplified the process by which customers can discover and request technology solutions and services. Moving forward, we will be able to continually and proactively rethink and hone our service offerings in tandem with the evolving IT landscape.

**Knowledge Upgrade:** To support our customers, a significant overhaul of the Knowledge Base system has commenced, with an initial focus on incident-related content. In the new system, Service Offering Managers (SOMs) will take responsibility for keeping knowledge about their services current. As a result, fulfillers and customers will have more, and more relevant, information at their fingertips, including self-service suggestions where appropriate.

**New major incident process: Prioritizing what matters most.**

When it comes to major IT incidents, OIT aims to minimize impact to the University. With that goal in mind, we have formalized a Major Incident Response Framework in FY16. These enhancements codify the chain of communications within the organization, creating high visibility to support a swift, coordinated response across our entire organization.

**A major incident is a significant disruption or degradation of an IT service with a severe and urgent impact on University business.**

**Threat detection:** Based on severity and impact, the Support and Operations Center (SOC) determines major-incident status. Such incidents have potential to disrupt or threaten:
- Human or animal safety
- Our teaching and learning mission
- Princeton’s reputation or public perception
- The ability to perform work for many people or a particular group at a critical time
- Security or legal compliance
- University revenue

**Coordinated response:** Upon designation, major incidents take priority above all other work. This is supported through immediate escalation up management levels and continual communication from an assigned Major Incident Owner, who provides regular updates. Clear lines of contact are established to effect high awareness across the organization for rapid resolution.

**Root-cause analysis:** In line with our commitment to service, a team is formed to investigate and address the root cause of the incident, with the goal of preventing further disruption or more efficiently restoring service.
Evolving roles: People supporting service.

Realigning our internal technology suite has given OIT cause to further reflect on our supporting structures. As such, the following organizational enhancements were made.

Service Management Office (SMO): Responsible for activating a culture of continual service improvement across OIT, the Service Management Office was involved in the Information Technology Service Management (ITSM) initiative from its earliest stages. Tasked with guiding business-relevant, cost-effective services aligned with the University’s strategic priorities, the SMO will also feature heavily in the evolution of our technology services. In part, this will include the provision of support for our new Service Offering Managers (SOMs) as they develop performance metrics for their offerings. Additionally, the SMO will provide ongoing training in ITIL-based processes to campus users and fulfillers.

Service Offering Managers (SOMs): Central to our service strategy is an evolution from technology to service delivery. In keeping with that aim, OIT has created a new Service Offering Manager (SOM) role. Working in close partnership with the SMO, these in-house service experts will guide service enhancements, identify emerging technology needs, and launch or evolve solutions across their lifecycle.

SOMs will serve as visionaries and educators in their respective areas. They will directly impact our customers, clearly defining available services and subservices so that individuals across campus can efficiently investigate and request what they need, while receiving enhanced support when issues arise. Moving into FY17, each SOM will be tasked with the development of key performance indicators (KPIs), working in close partnership with the SMO to systematically assess customer satisfaction and service quality. Additionally, they will assume responsibility for the ongoing maintenance of service content in the Knowledge Base.

ServiceNow System Administrator: Given the central role of ServiceNow in supporting our overall Service Management initiative, OIT has hired a dedicated ServiceNow System Administrator. Working as part of the Service Management Office, the administrator will be tasked with managing all aspects of our new service platform.

Support and Operations Center (SOC): The newly imagined Support and Operations Center will continue to serve as the front line for incidents, inquiries, and requests related to technology service. As the primary OIT users of SN@P, they will also play a central role in identifying emerging technology needs or issues. In addition, they will take on an enhanced communication role, reporting on outages via the OIT website, SN@P portal, and social channels, as well as supporting our reimagined Major Incident protocols.

Looking forward: Achieving service excellence.

Given the vast scope of the ServiceNow project and the number of people involved, many great suggestions for enhancements came in along the way. As FY17 begins, these potential upgrades and improvements are being catalogued and prioritized, as are a number of planned usability and accessibility enhancements. In addition, we are partnering with departments across the University that are interested in creating their own service catalogues and upgraded request and incident processes.

FY16 was a year of tremendous progress in changing how OIT delivers its services. In FY17, much time will be spent supporting the SCAD/DCS team as they bring this revitalized philosophy to the work they perform for their respective offices and departments. Of course, this is only the beginning of our transformation. Continuing into FY17, the University can expect more work across the ITIL framework, with projects related to managing problems, change, and events, and configuration management on the horizon.

A tribute to OPM

After years of dedicated service, the OPM ticketing system took its final OIT request in July of 2016. Tireless in its commitment to Princeton since the mid-1990s, OPM logged more than 3 million tickets during its long tenure at the University. It was even “multilingual,” rewritten in a number of new computer languages as technology standards changed over the years.

While several parties outside of OIT will continue using OPM for the time being, we offer this loyal system a very fond farewell. When OPM was retired from OIT work, it supported:

• 139 unique groups
• 995 unique queues
• 2067 user accounts, and
• received mail from 333 different incoming email accounts.

As a member of the Twitter social networking community, OPM also “tweeted” information about outages and alerts to the Princeton community. OPM was also home to the OIT KnowledgeBase and database of Princeton-specific answers to technology questions.

If you are wondering what OPM stands for, so are we. To this day, no one knows for sure.
Data, analytics and reporting: Insight in data.

CeDAR projects in FY16.

Continuing to grow the Information Warehouse: After building an enterprise-level “master” data repository, work in FY16 turned to its expansion. Newly created dimensional models add analytical capability from within the Information Warehouse. Work to integrate the various data marts into one truly integrated warehouse continues. Multi-source data sets were also integrated, with structures created to support inquiries from student outcomes to operational efficiency.

Looking ahead, CeDAR plans to bring information from Facilities systems about campus buildings into the master data repository. Integrating facility data with other campus data sources makes data-driven strategies and efficiencies in physical resource planning possible.

More computing power for our DataStage ETL engine: Princeton’s Extract, Transform, Load (ETL) tool extracts data from sources like PeopleSoft, loading it into the Information Warehouse for reporting, visualization, and other projects. To support an increased workload, the capacity of the ETL was increased by 50%.

The beginnings of a metadata repository: A metadata repository is like a guidebook for finding data. When users share a data-categorization language, connections surface. With a pilot launch of an Information Governance Catalog (IGC) this fall, CeDAR will take a major step forward in data usability. This advanced metadata tool creates data clarity via descriptions, sources, and usage, while providing insight into the robust offerings of the Information Warehouse. A complete rollout is planned for 2017.

Asking better questions.

As CeDAR deepens the University’s analytical capabilities around data, it is changing the nature and intensity of inquiry on campus. Business decisions find grounding in fact derived from data. Compelling academic projects emerge from new analytical possibilities. In FY16, CeDAR advanced this mission across multiple fronts.

Building relationships: From academic departments to administrative offices, CeDAR continues to promote data awareness, provide hands-on consulting, and further develop campus expertise in data, analytics, and reporting. With an eye on extending outreach, new partnerships were established with several departments, including Career Services and University Services.

Deepening expertise: Reflecting broad interest in data services, a Business Analyst and Data Modeler were added to the team. Through these combined areas of expertise, we will improve our understanding of where data insight is needed, while accelerating its use across campus.

Protecting data: With representation in the Data Management Advisory Group, CeDAR continues to work to ensure compliance with IT governance and information security policies and guidelines.

Building a program of outreach and learning.

To further develop campus expertise, CeDAR now offers a curriculum of small-group training programs by both inside staff and outside subject experts. In-demand topics, such as “Measuring Intangibles” and “Telling a Better Story with Your Data,” move beyond data as reporting, inspiring participants to seek the bigger picture.

FY16 outreach also included a presentation to the Academic Managers Group (AMG), and one-on-one consultation for data-analytic projects.

Learn more about the Center for Data, Analytics, and Reporting (CeDAR) at cedar.princeton.edu.

New curriculum for learning data visualization

In FY16, CeDAR enhanced its training and outreach program with new learning opportunities that focus on using the data visualization tool, Tableau®. A Tableau training curriculum was developed and will be continually expanded to highlight new tool features and respond to users’ feedback. Independent Tableau subject matter experts were also invited to campus to educate Princeton’s Tableau community on useful design strategies and current best practices.

More than 60 participants attended these sessions on data visualization:

- Tableau Training - 3-day session
- Tableau Intro - four 2-day sessions
- Tableau Workshop - 2-day sessions
Bringing data visualization to the back office.

While reports have the power to inform, visual data can inspire new thinking. With the launch of the centrally managed Tableau® service offering in FY16, administrators and researchers alike now have access to an advanced analysis and discovery tool.Bringing reports to life across multiple dimensions, it forms a perfect pairing with our Cognos Business Intelligence system.

“Tableau allows the campus community to visually analyze and portray their data, instead of just reporting on it,” explains CeDAR Senior Director Ted Bross.

Tableau-related initiatives took center stage in FY16, from installing a dedicated server to acquiring and consolidating desktop licenses campus-wide. CeDAR now manages nearly 100 licenses, creating an efficiency that should appeal to anyone who has struggled with system updates. Version control and upgrades are also centralized.

Beyond providing operational support, CeDAR has become the center for Tableau learning on campus. A custom course was created, and the team offers hands-on consulting to help new users get up to speed, which has happened quickly. “Our campus users become the experts,” Bross says.

CeDAR has worked with many customers to create custom dashboards that accelerate the visualization process. “Our goal is to make sure people have the data and tools they need to inspire understanding and discovery,” Bross explains.

In part, the power of Tableau resides in its symbiotic relationship with Cognos. “Using the right tool with the data that CeDAR manages, people can integrate disparate sources of information more easily than ever before,” Bross says. Once that data becomes visual, the opportunities for discovery begin to grow.

Above: A sample dashboard created with Tableau that compares report usage and execution time, by data mart, and against two distinct time periods. The dashboard also shows hourly Cognos usage, by total report count.
When customer needs are at the foundation of everything that an organization does, projects are more likely to meet and exceed their success potential. Formally launched in January 2016, the OIT User Experience Office (UXO) delivers thought leadership, consulting expertise, and learning opportunities around all aspects of user experience (UX).

Much more than a set of methods, standards, and tools, UX is a mindset. When applied, it leads to highly usable, accessible, secure, and maintainable solutions that, above all, make sense to the people who use them. User-driven solutions also offer increased efficiencies, lower cost, and reduced information-exposure risk, while driving impact-oriented solutions that truly meet people’s needs.

Embracing user-centricity.

In FY16, the UXO became operational and has been working to build out its services, support new practices, and inspire a UX culture within OIT. The team also focused on supporting our campus partners, inspiring the use of design-thinking strategies to empower their projects and processes.

In part, UX is about creating interfaces that empower our users and build a trust that the solutions we offer work to their best interests. It is also about ensuring that technology solves the right problems, never losing sight of the people behind the systems. During FY16, strategic initiatives emphasized:

- **Building new levels of insight:** UXO brought on a senior user experience advisor with broad expertise and deep roots in the field of UX.

- **Establishing contemporary UX protocols:** Standards are being developed and rolled out to guide the routine application of standardized, research-based methods, practices, and tools. The goal of the project is to open up the world of UX and extend expertise to the broader campus community.

- **Making UX easy with a design toolkit for web applications:** Templates-in-progress emphasize a shared digital ecosystem, making easy work of incorporating UX requirements into the websites and applications we develop.

Bringing UX to campus and beyond.

Throughout FY16, the UXO spent time building connections both within and beyond campus. Meeting with groups from students to developers, the team opened up a dialogue about the power and potential of user-focus design.

A few highlights in the area of outreach include:

- **PADAWAN:** “A Conversation about User Experience,” with members of Princeton’s special interest group for programmers

- **Ivy Plus Web Roundtable:** “UX for University Websites,” conducted in partnership with OIT Web Development Services (WDS)

- **DrupalCon 2016:** “The Big Picture: How UX Affects Pretty Much Everything”

UXO projects in FY16.

Giving Timeline a UX-informed interface: The new Timeline application revolutionizes student planning, offering a new way for students to shape and manage their schedules. In concert with OIT staff, UXO helped design its user-centered interface to be launched in Fall 2016. Emphasis was placed on situating Timeline within a constellation of related projects. Learn more about Timeline on page 26.

Bringing UX into Services Now at Princeton (SN@P): Working with the OIT Service Management Office, UXO is helping shape the customer-facing aspects of the SN@P system, including service request forms, the services catalog, and the knowledge base of self-help solutions. See page 8 for more about the project.

Supporting campus inclusivity: As FY16 ended, UXO partnered with the Office of the Provost and OIT Web Development Services to recommend upgrades to the University’s inclusivity site, reflecting OIT’s commitment to supporting a campus experience accessible to all. The UXO will soon hire a senior web accessibility advisor to help campus partners make resources available to a range of audiences. Improvements to SN@P for hearing- and visually impaired users are also in progress.

Read more about the UXO at ux.princeton.edu.

“You can use an eraser on the drafting table or a sledge hammer on the construction site.”

--- Frank Lloyd Wright
Coming Soon:
The new Princeton website-in-the-making is UX-Informed

Perhaps more than any other asset, Princeton’s website is engaged by nearly everyone in the University community. As such, it serves diverse constituencies — from prospective students to faculty, staff, and alumni. As Princeton embarks on an ambitious website redesign, this raises a question: how can a reimagined site best reflect the needs of those audiences while serving as a vibrant, cohesive digital home?

In part, that answer is being uncovered through the discipline of User Experience (UX).

“When you plan a technology project, there are three aspects: customer, business, and technology concerns,” explains Mary Albert, UXO’s Associate Director. “UX prioritizes the customer in the context of the business and the technology.”

The UXO has been involved in the redesign from the earliest stages. Along the way, initiatives have included everything from the creation of a cohesive design document, in partnership with the Office of Communications, to formalized usability testing with students, staff, and visitors.

“It started with an audience analysis, which gave us the basis from which to begin,” Albert says. “Now we can map how we are meeting these audience needs. In the end, UX work helps to ensure the website meets the needs of real people.”

“Real people” is something you’ll hear a lot of from the UXO team, serving as a de facto mantra internally. Albert sees it as part of Princeton’s diversity commitment. “User experience is founded on principles of respect, inclusivity, and cognitive psychology. It also provides methods and tools that help us design solutions that to prioritize people’s time, attention, and need to complete their tasks,” she says.

As the project enters the design phase, the UXO will continue to work closely with partners to bring the project to a successful and highly usable conclusion.
**Project and Technology Consulting:**
Raising the bar for IT project management at Princeton.

When projects are aligned with the priorities of the University and the departments, they are best positioned to deliver high value and get results. The Project and Technology Consulting Office (PATCO) helps drive better outcomes for our customers through strategic portfolio planning, business analysis, and project management consultation. Starting with the annual IT project selection process, which identifies the collaborative work that OIT and departments will undertake in the coming year, the goal is to support technology investments that are aligned with campus needs.

PATCO’s mission is to assist departments in fostering innovation and driving bottom-line results by elevating their expertise in business analysis and project planning.

**Project management methodologies offer a framework for delivery success.**

A key to successful project management is having a common methodology that facilitates project collaboration across campus. PATCO has enhanced the Princeton Project Management Methodology (PPMM) to better integrate data and information security, user experience, and service management. The updated methodology reflects:

- **Greater security**: A broader set of potential security issues are identified early and remediated more rapidly.
- **UX-informed solution**: Best practices are incorporated from OIT’s new usability methodology, “Envision.”
- **Service Management links**: New services, as well as any changes or sunsets of existing services, are planned as part of the project.

New project management methodology templates reflect these enhancements, and are available for use by all members of the campus.

**PATCO assistance on projects in FY16.**

**Keeping alumni connected with TigerNet:** PATCO consultants advised on the successful replacement of Princeton’s TigerNet alumni platform. See page 24 for more on this project.

**Assisting with a major PeopleSoft upgrade:** The upgrade of the PeopleSoft HR module required a complete re-architecting of the environment and separation from the Student module. PATCO teamed closely with the project manager of this highly complex initiative to ensure its successful implementation.

**Building an IT-smart arts center:** In preparation for the major expansion of the Lewis Center for the Arts (LCA) set to open in 2017, the LCA asked PATCO to assist them in evaluating the impact of this new facility on the needs for IT support. The result of the IT support assessment was a concrete, data-driven business case for either adding an additional IT support resource or rebalancing its service levels/hours of operation.

**Teaming with colleagues to launch ServiceNow:** All OIT hands were on deck to support the July 2016 launch of ServiceNow at Princeton (SN@P). From project management support, to business analysis, to helping transition OIT from its antiquated help desk system to SN@P, PATCO worked alongside a broad team of OIT colleagues on this critical initiative that is transforming OIT. See the ServiceNow highlight on page 8.

**Fostering new vision:**
Creating a departmental technology roadmap.

From the sciences to the humanities, IT-driven research and learning tools are integral to academic innovation. As such, departments are beginning to seek a clearer picture of their technology needs. In FY16, PATCO embarked on a unique consulting partnership with the Department of Molecular Biology, designed to help them create a forward-looking technology roadmap.

“The department wanted to be able to look out three years to understand their technology needs as they related to teaching and research. And they wanted to determine where to invest to best support the needs of their faculty,” explains Janet Pumo, Associate CIO.

The PATCO team, in partnership with Princeton’s Research Computing group, developed and deployed a new assessment methodology, encompassing a broad range of considerations. A clear set of IT investment priorities were established by engaging faculty to discuss and prioritize their needs directly; interviewing the NIH to understand technology trends related to sponsored research; collaborating with Princeton’s McGraw Center for Teaching and Learning to include the latest pedagogical expertise; and analyzing the results with faculty and senior leadership from the Molecular Biology department.

“This was a very open process that involved the faculty at each major step,” said Sal Rosario, Sr. IT Project Consultant, who jointly led the effort, “and this was critical to its overall success.”

As a result, the department now has a pragmatic roadmap with a set of initiatives to implement over the next few years.
Research Computing: Powering insight

The need for advanced research computing support is ever growing. Each year, Princeton researchers are redefining their disciplines through boundary-breaking, computationally intensive research projects. Given that exciting reality, OIT continues to partner with the Princeton Institute for Computational Science and Engineering (PICSciE) to enhance Princeton’s cyberinfrastructure, our high-performance computational hardware and software, and our expert computational support resources. In a year defined by significant technology projects, our vision remains clear: to bolster the University’s 238 research groups across 24 departments with powerful resources that enable field-defining discoveries.

Advancing research through support: Investing in expertise.

In every hire, OIT aims to help faculty maximize the value of Princeton’s computational infrastructure. FY16 saw a number of strategic additions to the Research Computing roster.

Funding a team of research application analysts.

First announced in FY15, the addition of research application analysts to the group reflects Princeton’s commitment to supporting advanced computational research. Brought onboard through a combination of central and departmental funding, these experts specialize in both high-performance computing and a given science domain. They are thus uniquely positioned to provide relevant computational programming support, while helping faculty to best leverage their available funding to get access to dedicated programming resources with domain expertise. After a successful first hire, with a focus on Geosciences and Physics, funding was secured in FY16 for two additional positions of an anticipated five. These cross-disciplinary experts will support computational projects at the Princeton Neuroscience Institute and the Center for Statistics and Machine Learning.

Performance tuning analyst brings coding expertise.

Better code drives better performance. As such, it is critical that faculty are fully supported in making full use of the new computer architectures available in the latest generation of high-performance processors. In FY16, Research Computing completed the search for a performance tuning analyst, funded by the Provost’s Priorities Committee (PriCom). Working closely with OIT and across academic departments, the performance-tuning analyst supports the use and development of software on Princeton’s high-performance computing (HPC) and visualization systems.

Software and programming analyst extends research to the humanities.

Computer-intensive research has expanded well beyond the sciences. In FY16, the Center for Digital Humanities and OIT together hired a research software and programming analyst to join the OIT Software and Programming group. Forming a bridge between disciplines, the analyst works with faculty, graduate students, and postdoctoral fellows to build innovative, data-driven research tools and project plans. Given unprecedented demand for computational education, they also lead campus-programming workshops.

Powering research through cyberinfrastructure enhancements.

Princeton’s cyberinfrastructure is a critical component of the University’s globally recognized research prowess, and researchers campus wide rely on superior performance. Central to the OIT Research Computing team’s mission is to continually support the Princeton Institute for Computer Science and Engineering (PICSciE), which is one of the finest high performance computing centers in the world. In FY16, we significantly expanded the computing and networking power of Princeton’s cyberinfrastructure, while laying the groundwork for exciting changes to come.

Perseus debut boasts newest processors and greater capacity.

Cutting-edge research in subjects like astrophysics, general relativity, and chemical engineering requires highly parallel computing power, in which many calculations and processes occur simultaneously. In FY16, PICSciE and OIT introduced Perseus, Princeton’s newest high-performance computing cluster. A 320-node Dell Beowulf cluster, Perseus offers 340 teraflops of performance (10*12 calculations per second) and includes the newest Intel Broadwell processors.

Designed with the input of Anatoly Spitovsky and Matthew Kunz, Professor and Assistant Professor in the Department of Astrophysical Sciences; as well as Frans Pretorius, Professor in the Department of Physics; the system expands on and replaces Orbital, offering roughly seven times the performance capacity. Officially Princeton’s second most powerful HPC system, Perseus is a reflection of things to come as the University invests in its gateway systems that provide our researchers the path to the national supercomputing centers. Of note: plans to upgrade the Tiger cluster are currently being developed for FY17. The new system will have more than 13,000 CPUs and 60 trillion bytes of memory, again realizing Princeton’s commitment to keep high-performance computing capacity at roughly 10% of what is available at the national computing centers.
Network investment.

Heeding the need for a faster, more streamlined structure, the Research Computing team made significant progress in redesigning the campus network. Throughout the fiscal year, OIT’s senior architect, cyberinfrastructure engineer, and Networking and Monitoring group worked hand-in-hand with faculty researchers, finalizing plans for a secure, connective network that supports the movement of increasingly large data sets within and outside of campus. The design phase will continue into FY17.

While developing master architectural plans for the network, important improvements were made to produce 10-fold speed improvement in several critical areas.

ESnet upgrade: Shorthand for the Energy Sciences Network, ESnet is a restricted network that supports research into some of the world’s most important scientific challenges. The network connects faculty researchers working on Department of Energy (DOE) projects, such as the Compact Muon Solenoid (CMS) particle-physics experiment at the Large Hadron Collider (LHC) at the European Organization for Nuclear Research, or CERN. Given that scope and profile, both high bandwidth and optimal connectivity are crucial. In FY16, the Research Computing team upgraded the system to boost connectivity from 1Gb/s to 10 Gb/s. This enables large amounts of data to efficiently enter and exit the University in a secure manner. In aggregate, ESnet is expected to carry more than 100 petabytes of data per month globally by the end of 2016.

MAGPI connectivity gain: The Mid-Atlantic GigaPOP in Philadelphia for Internet2 (MAGPI) provides Princeton’s Internet2 service, which is a faster, research-centric alternative to the commercial internet. Used by government, research, and education organizations, it facilities data-intensive research not assigned to ESnet. In keeping with growing demand, OIT secured connectivity gains that were implemented as we entered FY17. By increasing the connection by an order of magnitude to 10 Gb/s, we continue to support traffic from backup services, while dramatically improving overall bandwidth.

Security-minded enhancements.

As with all of OIT’s projects, security is a top consideration for the network. The following projects-in-progress reflect innovation in supporting research while mitigating security risk.

Tools to support projects with restricted data: Academic research is inherently collaborative, often involving parties around the world. In cases where projects involve data classified as “restricted,” however, that introduces a special challenge. While solutions exist to allow authorized outside researchers into Princeton’s network on an as-needed basis, protected data cannot be moved out. To address these complexities, a collaborative project involving Research Computing and OIT’s Enterprise Infrastructure Services commenced in FY16. Tapping into Princeton’s enterprise security infrastructure, the team is developing a suite of tools to manage these complex projects with restricted use data.

Creating a Science DMZ: Large-scale data sets cause congestion when they hit departmental firewalls, resulting in lag time for project stakeholders and others on the network. Yet in many cases, said data is traveling between known and approved sources. To support data-intensive projects in Genomics, Astrophysics, and other areas, Research Computing has embarked on an ambitious project to architect a Science DMZ that coordinates data transfers among researchers, reduces “pinch points,” and keeps research data traffic moving.

Based on a network design model that ESnet crafted for the DOE, the solution maintains the security provided by the main campus network, while preventing traffic jams and data-set rejections. Designed specifically for high-performance applications, it separates the traffic stream pushing computationally intensive research data from the general network, optimizing performance on both sides. Only users with Princeton credentials may access the system.

In part, the ESnet and MAGPI connectivity gains noted above will facilitate the success of the DMZ. By scheduling large transfers through three Globus Data Transfer nodes deployed on campus, including a dedicated system in Genomics, data transfer into and out of high-performance computing systems, such as TIGRESS is greatly accelerated. The support hours associated with monitoring are also reduced. Initial tests of the Science DMZ network concept conducted in FY16 showed a tenfold improvement in data-transfer speed.
With increased frequency, faculty research needs drive Princeton's network-performance requirements. In fact, it was the combined work of researchers in three departments — in partnership with Research Computing — that secured National Science Foundation (NSF) grant funding for the University’s Cyberinfrastructure Engineer, who came on board to support our Senior Architect of Advanced Networking in FY15. PIs included Jennifer Rexford, Professor of Engineering in the Department of Computer Science; Chris Tulley, Professor of Physics; Nick Turk-Brown, Professor of Psychology, with joint appointments in the Princeton Neuroscience Institute and PIScEi; and Curt Hillegas, Associate CIO, Research Computing.

Their initial charge was ambitious, yet critical: to design and build the network of the future.

In a field defined by rapid evolution, however, the network will never reach a point of stasis. From real-time brain imaging to remote visualization, high-throughput, low-latency connectivity remains mission critical. Piggybacking on the (net)work in progress, a grant proposal submitted in FY16 outlines plans to harness the combined power of network monitoring and big-data aggregation. If approved, it will change the nature of network-performance monitoring at Princeton.

The goal is to drive a superior Quality of Experience (QoE) for the University’s researchers by creating a big-picture view of science application performance on the network from one moment to the next. By continuously gathering performance data from multiple campus vantage points and then aggregating it into a streaming platform, it is hoped that new analytic methods will map performance to the ultimate QoE — something that is not currently well understood. The expectation is that new methodologies will emerge at the intersection of network measurement, software-defined networking, and large-scale data streaming, with machine-learning assistance.

The PI list on the grant proposal emphasizes the cross-disciplinarity of high-performing science applications. The PIs are Nick Feamster, Professor of Computer Science and Acting Director of the Center for Information Technology Policy; plus Kosuke Imai, Professor with joint appointments in the Department of Politics and the Center for Statistics and Machine Learning. They are supported by Annabella Selloni, Professor of Chemistry; Jonathan Cohen, Professor of Psychology and Co-Director of the Princeton Neuroscience Institute; and Jen Rexford, Gordon Y.S. Wu Professor of Engineering, and Chair of the Computer Science Department.

Together, they bring broad experience building large-scale network measurement, monitoring, and analysis systems. Ultimately, the team aspires to craft a holistic, scalable, and easy-to-deploy measurement / software solution that will be released into the public domain.

“It used to be that the performance requirements of the network were driven by the enterprise side,” explains Hillegas. “Now, so many researchers are dealing with much larger data sets that it’s driven by research.”

If approved, systems can be put in place to capture real-time metrics regarding network usage. In turn, performance can be more efficiently tuned. Given that data-intensive research and off-campus collaboration will only grow, this amplification in insight and responsiveness are considered to be essential.

“The need for this kind of investment will only grow,” Hillegas predicts.
IT Security: Proactively protecting the University.

In an era that requires constant digital vigilance, OIT plays a leadership role in safeguarding Princeton’s information and infrastructure. Each day, technology and data insight are both strategically employed to enable access to information and systems, while guarding against threats. Taking a comprehensive, risk-based approach, OIT places best practices in IT and information security at the center of everything we do.

For the whole of FY16, IT risk management was an area of concerted focus, encompassing a range of initiatives from the addition of new security roles to projects that take a layered approach to keeping the University’s assets from harm. In laying the groundwork to maintain a secure, IT-powered campus, our mission is clear: to protect the information, people, and resources of Princeton.

A holistic approach.

The Open Systems Interconnection (OSI) 7-layer model provides a holistic view of the IT and data ecosystem, from networks and cables to application data. A conceptual model that reflects all aspects of the network, it provides a broad-based structure by which to think of security in a context where information is no longer centralized. As we fortify our strategy, we are working across layers, focusing not just on bits and bytes, but also on trends and patterns.

IT Risk Assessment: Investing in security insight.

As a higher-education institution, Princeton requires 24/7 technology access and information sharing. Given that reality, a constellation of rapidly evolving systems, applications, devices, and IT services forms the foundation of the University’s work. As these resources grow in scope and scale, they become ever more robust, interconnected, and complex — as do the associated security risks, which must be managed with diligent care.

In that spirit, OIT embarked on an independent IT Risk Assessment in FY16. Initiated through the collaboration of OIT leadership and the Chief Audit and Compliance Officer, the extensive process was guided by a specially assembled working group, advisory group, and steering committee. Charged with building upon our already successful Enterprise Risk Management (ERM) process, a nationally renowned auditing firm was retained to conduct a comprehensive risk assessment over the course of a year, with a focus on information security.

Throughout, 29 University departments and nearly 100 individuals participated in surveys, intensive interviews, and analysis. Not only did this facilitate broad and invaluable insight into the key assets most in need of protection; it generated important dialogue about the role everyone plays in campus information security, which is by itself a security win.

The assessment has already motivated several projects that will kick off in FY17. It also culminated in the creation of a sustainable, repeatable methodology developed specifically to assess IT risk at Princeton. Based on the National Institute of Standards and Technology (NIST) Cybersecurity Framework, which was collaboratively developed with the input of more than 3,000 security professionals, it accounts for a wide breadth of risks. Modern and qualitative, the framework will enable us to strategically prioritize risk management on an annualized basis, upgrading controls to provide the highest level of vigilance for our maturing technology landscape.
The results of the assessment were presented to the Board of Trustees. From there, a roadmap and resource plan will be developed to support OIT’s ongoing risk-mitigation strategy.

Additional security wins:

**BitSite implementation:** Much like a credit rating, this tool offers an external rating of Princeton’s risk vis-a-vis our higher-education peers, updated daily. Among the benefits are fast alerts regarding potential configuration problems, infected machines, and other elements that threaten security.

**Secure Send launch:** Available to anyone with a Princeton email address, Secure Send includes built-in protection for on- and off-campus email attachment delivery.

**Red team engagement:** During this real-time test, an outside firm staged a simulated attack to gauge the University’s reaction and protocols. OIT was pleased with the resulting response times.

What is IT risk?
IT risk is comprised of threats and vulnerabilities that may impact the confidentiality, integrity, and availability of Princeton’s information and underlying systems.
Information Security: Enabling access for those who need it.

Across the campus network, a countless number of devices can serve as access points for bad actors, from mobile phones and laptops to wireless printers. As the “Internet of Things” continues to expand, it becomes clear that a sound network perimeter — though vital — can no longer protect and secure alone. Today, everyone must take responsibility for information security.

Securing information is about safekeeping, but it is also about access. Each day, individuals across the world require reliable access to Princeton’s information. To keep data from falling into the wrong hands, the Information Security Office (ISO) maintains a strong security posture. This includes a governance structure and policies that facilitate the University’s work, while maintaining robust, scalable security and architecture systems.

Information Security Policy update

Princeton's Information Security Policy was extensively revised in FY16. Approved by the Data Governance Steering Committee, the updated policy was achieved through the work of a University-wide, cross-departmental team. Clear and purposeful, the policy lays out exactly how information is to be handled at each classification level, from restricted information such as credit-card numbers to public information like press releases.

A corresponding website, protectourinfo.princeton.edu, was developed as an action-oriented companion. Designed to make it easy for users to understand their responsibilities, it offers rich guidance, including:

- The complete policy
- Data-classification guidelines
- Encryption recommendations
- Data-handling practices
- Approved storage and sharing tools
- Network-connection options
- Easy access to assistance

Chief Information Security Officer (CISO): Shaping Princeton’s vision.

OIT took a major step toward its goal to foster a true culture of information security: a new Chief Information Security Officer (CISO) was added to the team in February 2016 to lead the Information Security Office. Reporting to the Vice President for Information Technology and Chief Information Officer, and bringing deep leadership experience to the organization, the CISO will guide the development of a University-wide information security policy and strategy.

The CISO will also lead an expanded Information Security Office (ISO). Recognizing the need for specialized expertise and campus-wide support the CISO identified new roles that the office will seek to create and fill by early fall.

- **Information Security Architect:** Sets the direction for the protection of the campus-wide network architecture and security solutions.
- **Information Security Engineer:** Provides expertise regarding compliance, threat management, incident response, and forensics.
- **Information Security Analyst:** Supports the IT Risk Assessment and continuity of operations strategy, while managing the ISO project portfolio.
- **Information Security Training and Awareness Specialist:** Manages outreach and education initiatives, as well as security messaging and the comprehensive ISO website.

As FY16 came to a close, a new ISO mission statement was in development, along with a strategic plan to outline activities for the next 18 months. Addressing the programmatic and cultural aspects of risk prevention, areas of emphasis include data governance, risk assessment, business continuity, and compliance.

Network focus at the SOC

In FY16, the role of the OIT support arm also expanded. The revamped Support and Operations Center (SOC) continues to play a help-desk function, providing 24/7 assistance with campus technology issues as part of our Service Management initiative. With a security-focused reorganization, the SOC has been positioned to more efficiently guide responses across these areas:

- **Business application support:** Dedicated administrative-system specialists power faster issue routing and resolution.
- **System monitoring:** A team of staff actively monitors network security throughout the day, allowing OIT to quickly identify and resolve disruptions.
- **Major incident:** A new protocol with IT service management origins, the SOC identifies and escalates major issues that require OIT’s full and immediate attention.
Cyberinfrastructure Safety: Focus on fortification.

Much like with the IT Risk Assessment, OIT’s FY16 investment in cyberinfrastructure security exemplifies a forward-looking network-protection philosophy. In the past, information was more centralized. Now, Princeton’s network includes users and devices all over the world that require safe, continual connectivity. As that network expands, OIT is leveraging data insight and smart infrastructure to ward off unauthorized intrusions.

Software: Upgrades across systems.

As FY16 came to a close, Princeton saw security gains in a number of areas:

Two-factor authentication rollout: It used to be that a strong password was sufficient to block hackers. Princeton’s complexity requirements result in more than 60 quintillion combinations. Yet as intrusion techniques advance, complexity isn’t enough. In the face of high computing power and increasingly sophisticated phishing techniques, even the strongest passwords can be cracked. Given that risk, OIT introduced two-factor authentication in early 2016.

Two-factor authentication beats would-be intruders at their own game, requiring a second factor of verification for access to select Princeton resources. By investing a few moments confirming an access request on a second device, system users become an important part of our IT security force, while keeping personal information like paychecks guarded. Even if an outside party obtains a password, they won’t have that second device, resulting in a denied request.

The initial rollout of two-factor authentication provides protection to more than 12,000 accounts. In FY17, OIT will complete the final phase of deployment across all University accounts.

Princeton printer protection: Even as the world grows more digitally oriented, academia requires reliable printer access. In the past, however, printing was open to virtually anyone. In FY15, OIT first introduced PulpNet, a printer and copier network that shields devices from unauthorized, non-Princeton traffic. With the completion of the project in FY16, the entire University printer network is now restricted for use by those on the campus network or VPN.

Regular maintenance windows for network care: Part of OIT’s charge is to continually align toward information technology best practices. This includes regular application of security patches and software enhancements. Given the scale of the University’s work, network uptime is also paramount. As OIT works to create system redundancies that will advance that aim, we reorganized our upgrade approach, designating specific maintenance windows. Achieved with the buy-in of numerous campus stakeholders, this will minimize the impact of planned downtime while promoting fully supported systems.

Protecting the border: Shoring up Princeton’s network requires a high-performing border system by which packets of traffic are allowed in or rejected according to the threat they pose to campus. Yet, as the volume of traffic increases in an IT-powered landscape, our systems must have sufficient capacity to keep authorized traffic flowing. An upgraded Intrusion Prevention System (IPS), installed in FY16, improves the ability to block bad agents from the network. At the outer border, they are auto-rejected based on a continually updated library that “fingerprints” malicious packets and rejects them. Legitimate traffic can then more efficiently pass in and out of a smart second layer. Like virus protection for the network, the IPS focuses not on content, but on hackers and spambots, rejecting them at the network’s front door.

Security Information and Event Management (SIEM): Princeton’s network is vast and complex, encompassing everything from our aforementioned network boxes to our computers, routers, switches, and data centers. With a new SIEM system, OIT can now monitor logs throughout the day, creating a baseline for “normal” activity across the system. With this data in hand, it becomes easier to identify and address aberrations as they arise. Additionally, data can be used in a forensic capacity to help analyze incidents when they do happen and to help us prevent repeat incidents.

Hardware: PCI-DSS Certification for 3.1

Designed to guard against fraud and reduce exposure risk, the Payment Card Industry Data Security Standards (PCI-DSS) guide the storage, processing, and transmission of cardholder data. In March of 2016, OIT and the Office of Finance & Treasury completed a multi-year initiative to achieve compliance with PCI-DSS version 3.1. Alignment with these evolving vulnerability controls ensures that Princeton takes a strong protective stance, both for our own community and for those with whom we do business.

Critical Infrastructure: Partnering for campus protection.

Princeton’s Critical Infrastructure (CI) team is charged with ensuring the high availability of systems and services that support Princeton’s information and operational technologies for life safety, critical communications, and data center facilities. These assets are so vital that their incapacitation or destruction would have a debilitating effect on education and/or research services. While many of these systems are managed outside of OIT, we stand by as a responsive partner, providing ongoing network and communication system support. With this charge, OIT expanded its critical infrastructure capabilities in FY16.

Associate director joins OIT to partner with campus and oversee Princeton’s critical infrastructure.

In December 2015, an associate director of Critical Infrastructure joined the OIT Enterprise Infrastructure Systems (EIS) team. Co-funded by Facilities and OIT and serving as a bridge between OIT and Campus Safety, the Associate Director will help define and manage IT projects related to power, building management, communications, and critical services. With an understanding of both customer needs and IT specifications, the aim is to eliminate silos and create a well-informed conduit to IT services.
Putting the pieces in place.

During an FY16 discovery phase, relationship-building and input generation were top priorities. Going forward, a combination of security measures, standards clarity, automation, and smartly architected solutions will guide a purposeful approach to Princeton’s critical infrastructure. The following efforts are priorities for the CI team.

A University-wide Critical Infrastructure List (CIL): CI-essential assets, systems, and networks are being documented in a format primed for continual updates. These include life-safety systems, building management control systems, and others critical to campus operations.

CI documentation update: As part of the SN@P launch described on page 8, documentation related to data center operations and CI services was crafted.

Building-level IT infrastructure review: A two-year, proactive audit of our campus-wide security, environmental, and IT closet cabling operations is now in progress.

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<th>Critical infrastructure threats concern:</th>
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<tr>
<td>• Physical or cybersecurity</td>
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<tr>
<td>• Public health or safety</td>
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<td>• Economic health</td>
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Working toward a CI governance model.

To effectively govern CI, broad insight from multiple campus stakeholders is required. Given the proliferation of the Internet of Things, everything from door locks to emergency blue light phones must be accounted for. In FY16, a cross-office Critical Infrastructure Governance Committee was convened, including key members of OIT, Facilities, and Public Safety. Their work will continue into FY17.

Major critical infrastructure initiatives in FY16.

Energy plant communications upgrade: As part of an ongoing project, CI served as a liaison between Princeton’s energy plant, its vendors, and OIT in the design of their new Supervisory Control and Data Acquisition (SCADA) communications system. Shaped with CI input, the new architecture and design is highly available and secure.

Lab research support: In keeping with its overarching safety charge, CI worked with individual laboratory research areas to improve communications and security protocols for management and monitoring of various critical systems in those labs.

Onboarding Perseus: In the spring of 2016, Princeton debuted its newest high-performance computing system (HPC), as described on page 16. CI directly supported the Research Computing and PICSciE teams, defining the environmental requirements for optimal performance, from placement and cooling systems to power systems and cabling. Taking into account the needs of the complete HPC ecosystem, the resulting implementation maintains system redundancy while optimizing performance.

Supporting teaching and research.

Network re-architecture: Network uptime and critical communications availability go hand-in-hand. As such, the CI team has been heavily involved in framing the strategy for Princeton’s revamped network, with work continuing into FY17. For more on this project, see page 17.

Site protection projects.

Video surveillance: Through collaborative analysis, the performance of Princeton’s video-surveillance systems was evaluated and enhanced with an eye on maintaining reliable, up-to-date systems with minimal interruption.

Phone system project: As Princeton modernizes its phone and voice communications platform, moving towards a completely IP-based system, CI was a partner in designing solutions for critical voice services such as E-911 and blue-light emergency phones across campus.

Call dispatch upgrade plan: The Public Safety team encompasses more than 100 individuals who rely on technology to protect the campus community. With a planned upgrade of their Call Dispatch System (CDS), CI consulted on the project proposal, which led to the decision to move the CDS system into a university data center to benefit from significant environmental and security gains. With SAGIT support, the implementation will occur in FY17.

Fire alarms: Optimizing a critical campus service.

In partnership with the Fire Marshall, Facilities manages a vast network of alarms that cover the entire campus. To ensure the highest level of safety, it is essential that our alarms continually communicate with the Department of Public Safety and other parties responsible for monitoring the University for emergency situations.

Over the course of six months, beginning in January 2016, the CI team worked closely with Facilities and the University’s principal fire alarm vendor to evaluate and troubleshoot certain issues related to the dedicated network on which these systems rely. With work completed in August of 2016, the system command center is now even more highly available, ensuring optimal safety for the Princeton community.
OIT continues to invest in powering strong, technology-enabled administrative systems for the University. This commitment carries into FY17, with significant enhancements to PeopleSoft Campus Solutions on the way. When complete, OIT will have accomplished major upgrades to all of Princeton’s core administrative systems — Finance, Human Capital Management (HCM), and Campus Solutions — within a space of just four short years.

In FY16, OIT focused efforts on two systems that serve a broad swath of the University community, from applicants and newly admitted students to administrators and alumni.

Modernizing undergraduate admissions technology.

Princeton receives more than 27,000 undergraduate applications annually, each of which must be handled with great care and precision. From registering with the University and submitting the application to completing financial-aid forms and alumni interviews, each step is critical — and until now, each was managed by separate, custom-built solutions supported by OIT. Applications were read on OnBase. Data was housed in PeopleSoft. Separate interfaces connected everything from financial aid to bridge-year applications.

While that system served the University well for many years, the Undergraduate Admissions Office was ready for an upgrade. With that charge, OIT brought together a cross-functional technology team in FY16 to support the office in its transition of the admissions process to a powerful, cloud-based platform offering “one-stop shopping” for all things admissions, from the student application to decision day.

Major benefits across the application lifecycle.

The new admissions system will represent a great leap forward for Princeton in terms of convenience, student communication, and data handling. Most importantly, the system greatly enhances the application experience for everyone involved. Tech-savvy applicants enjoy a mobile-friendly platform throughout the admissions experience, where they have quick access to the information they need. Materials ranging from financial aid and bridge-year applications to official test scores are tracked through a customized dashboard and checklist, making easier work of staying on top of and completing the application process.

On the administrative side, the Undergraduate Admissions Office, readers, and alumni interviewers can now review complete applicant data from a single location, saving time and reducing the need to work across systems. Admission materials are easier to read, and supported by fast workflows as they move from one point person to the next. Upon student admittance, coordination with other campus systems is seamless. Moreover, the software supports improved applicant communications, with fast-access email and social communication tools fully integrated into the platform.

Flexible and highly redundant to ensure maximum uptime, the new system improves accessibility, accelerates workflows, and reduces the need for continuous OIT support of custom systems.

Planning the strategy for a smooth transition.

A top project priority was to ensure a seamless 2016-2017 application season. This made it critical to get things right the first time. With that aim, the decision was made to plan for the new technology to be enabled for the admissions season from day one, eliminating the need for continued OnBase and PeopleSoft support. To ensure clean communication throughout the transition, OIT provided a single point of contact between the software vendor, the Undergraduate Admissions Office, and various OIT technical teams, including support from ERP Campus Solutions.

Having built and managed the original OnBase solution, OIT dedicated a significant effort to data integration and testing, ensuring that the vendor solution was primed to capture information correctly while interfacing cleanly with campus systems, including Financial Aid. Entering the fall of 2016, students were registering, support for the Common and Universal College Application was up and running, and applications were coming in. OIT will continue to monitor the system throughout its inaugural season, and is working on automated monitoring solutions.

Looking ahead at work to implement the second phase of this project, the Arts Supplement and Alumni Interview site will continue to be managed internally during this admissions season, and then rolled into the new technology solution for fall 2017. By the time decisions are made for the fall 2017 incoming class, integration with the Financial Aid system will be complete, allowing for the delivery of award letters with admissions decisions. Communication with satellite systems that service admitted students will also be finalized, including OnBase, PeopleSoft, and the Information Warehouse. OIT will continue to support the University’s integrated financial aid and bridge-year application systems going forward.

TigerNet gets a reboot.

The TigerNet Online Community brings together Princeton alumni, linking them with one another and the University through a common medium. Secure and password-protected, the platform keeps Princetonians engaged well past their years on campus. In FY16, OIT supported the Office of Alumni Affairs in a platform upgrade to new service providers. The project was supported by FY15 SAGIT funding, and launched in February 2016.

On a tight timeline, OIT played an active role in the vendor-selection process, consulting on functional, technical, security, and contract reviews. From there, attention turned to the smooth transition of the data interface, including user profile and privacy settings, along with discussion-group subscriptions. To minimize downtime at go-live, a strategic
database-conversion model that mirrored live data feeds to both the development and existing platforms was created, keeping the replacement database fully populated and up-to-date in advance of launch.

Throughout the project, OIT partnered with the Office of Alumni Affairs to advocate for product that met project goals while best serving the University’s needs. From vetting vendor solutions against Princeton’s high data-integrity and user-experience standards to serving as a technical advisor and sounding board, this joint approach drove the project through to a successful completion.

For the Office of Alumni Affairs, the modernized platform delivers an enhanced mechanism by which to steward alumni engagement. Significantly, it improves the ability to support alumni volunteers, building a consistent experience across organizations at the class, regional, and affiliated group level, and ensuring PCI compliance for e-commerce transactions pertaining to event registrations and associated services. The platform also maintains the essential connection between the platform and Stripes, the University alumni database of record.

For alumni, the new TigerNet experience offers new reasons to stay connected:

• **A modern way to network:** Users find an upgraded, mobile-friendly platform.
• **Richer profiles:** Alumni can now add social media links and more extensive information about their personal, professional, and service-related interests and affiliations.
• **Faster contacts:** Expanded search options make it easier to find fellow Princetonians.
• **Support for volunteer groups:** Hosted subcommunity sites for classes, regional associations, and affiliated groups will provide a consistent set of tools and services to support our wide volunteer base.
• **Princeton-affiliated Gmail accounts:** Easier for the University to manage, Gmail accounts have proven enormously popular. The Google platform offers a cost-effective way to support the @alumni.princeton.edu email domain, in addition to giving alumni full email accounts and autonomous control over email forwarding options.

Upon the deployment of the new platform, OIT’s Support and Operations Center (SOC) played a crucial role in efficiently managing thousands of new email requests. Moving forward, SOC’s 24/7 team will also ensure that alumni are fully supported in their use of the platform, accepting and routing TigerNet-related inquires to ensure the best experience for our alums.

Leading up to launch, a strong communication campaign from the Office of Alumni Affairs provided a timely opportunity to engage with this highly valued University community. As we enter FY17, plans for new features are in progress.

### Raising the value of IT investments: Funding large, strategic technology projects

The Strategic Advisory Group on IT (SAGIT) is chaired by the Provost and includes the Executive Vice President, Dean of the Faculty, Vice President of Finance and Treasury, and Vice President of Information Technology. This group determines which large, innovative and/or compliance-based IT initiatives will be funded. SAGIT-approved projects typically comprise 10 percent of the entire OIT project slate; however, they are typically the most expensive and complex, and could not be implemented without special funding.

### Choosing the right projects

The SAGIT selection process has two phases. At the beginning of each year, departments identify projects that they anticipate will need SAGIT funding. (For FY16, SAGIT specifically encouraged proposals that emphasized data-centric decision-making, fostered cross-departmental synergies, and improved security.)

SAGIT then prioritizes those project proposals and approves those which are most promising to move forward with the presentation of a full business case. To assist in its development, each proposal is assigned a Project and Technology Consulting Office (PATCO) resource. These business cases articulate the business impacts, costs, benefits, peer-school solutions, and metrics for gauging success. Throughout the year, as these business cases become fully developed, SAGIT reviews them and approves or declines them for funding.

Those approved for SAGIT investment receive support that covers one-time costs related to hardware, software, and labor expenses. Roughly 10-15 projects qualify annually. They also receive a PATCO staff resource to provide project oversight and ensure success. (See page 15 for more information about these specialty PATCO resources.)

### SAGIT-funded projects completed in FY16

- **Faculty/assistantship pay-cycle modifications:** Assessed feasibility to extend pay for 9-month appointments over a 12-month period so faculty receive consistent monthly pay throughout the year.
- **Replacement of TigerNet alumni online community:** Migrated the alumni network to a new system upon the vendor’s discontinuation of our existing system. Elements included the alumni interface and staff/volunteer tools.
- **University Health Services electronic student health record encryption:** Encrypted student electronic health-record data to provide a more secure environment and to proactively prepare for when encryption of medical records soon becomes a federal requirement.
- **Legal spend and matter management:** Implemented a tracking tool for outside-counsel invoices in the Office of the General Counsel (OGC), Facilities, and the Office of Technology Licensing (OTL). These provide increased cost control, spend, budgeting, and analytics.
- **Secure remote access replacement:** Replaced the legacy secure remote access system, VPN, with one that increases capacity, provides greater stability, is easier to use, and can be deployed as needed to targeted constituencies.
A core objective in planning technology solutions is to identify efficiencies that create a synergistic ecosystem. Not only does this expand the reach of the University’s IT budget, it helps us deliver better solutions. This year, three projects in particular demonstrate this ethos. Reflecting a consultative approach and broad vision, they showcase the power of building shared data and functionality into the business.

New Princeton website: Change is on the horizon.

In FY16, the University’s Office of Communications led the charge in planning for a complete redesign of the main University website. Reflecting a new vision for Princeton’s digital home, the goals of the project are ambitious and fully invest in developing an accessible, UX-informed, media-rich digital experience.

OIT supports the process.

In support of this high-profile project, OIT provided consulting and insight related to:

- **Design partner selection**: OIT assisted in the selection of a design partner with broad experience in the education space.
- **Usability**: Wireframes that show the new website structure and functionality were enhanced by the OIT User Experience Office, with special attention paid to student needs and ease of use.
- **Information architecture validation**: OIT assisted in conducting tests to ensure the proposed architecture and navigation are intuitive and resonate with our website visitors.

In FY17, the OIT Web Development Services (WDS) team will continue on as the website build and consulting partner.

Accelerating in-house Drupal 8 expertise.

A major win of the University website redesign project is the decision to adopt the Drupal 8 content management system. While earlier versions of Drupal will continue to be supported for years to come, this redesign work provides a timely opportunity for OIT to build in-house expertise in the product’s newest iteration. With its commitment to evolve in tandem with the Internet, Drupal 8 promises a powerful, enterprise-level digital experience. The “Lightning Distribution” system, offered by our Drupal hosting service, brings together key Drupal 8 modules for rapid development of rich content experiences across devices. As we re-envision our site, we look forward to leveraging its advanced media management capabilities, drag-and-drop layouts, intuitive workflows, and greater preview capability.

Timeline: Calendar management gets a boost.

Several years ago, a dialogue was initiated to explore how administrators could better promote campus events. Feedback from students indicated that they were overwhelmed by the sheer volume of opportunities in their email inbox. Hearing that need, OIT partnered with the Undergraduate Student Government (USG) to envision and develop a calendar-management solution, called Timeline, which better connects with and places students in the driver’s seat when it comes to planning their schedules.

Academic and personal event planning unite.

Timeline evolved with broad-based input. Three years in the making, it consolidates everything related to a student’s academic experience into a single application. It also provides students with an easily viewable digest of events aligned to their interests, eliminating the need to scroll through endless lists. Among the student benefits are:

- **A personalized calendar**: Course-related dates, assignments, housing deadlines, and more will automatically populate the Timeline view.
- **Targeted posts**: Group affiliation triggers inclusion of additional information.
- **Tagged posts**: Self-selected tags will enable feeds of relevant events.
- **Personal entries**: Students can add their own content and reminders.
- **Custom alerts**: Individuals can choose when and how to receive event alerts.

High on the priority list for Timeline is governance, especially for the purpose of managing the overall information load and establishing who can initiate communications with whom. A Timeline Infrastructure Committee has been established to develop protocols that ensure the effective distribution of appropriate and coordinated event communications.

Designed for compatibility.

Recognizing the near-universal need for better event promotion, Timeline feeds directly into the main website. It was also crafted so that Drupal template-site users can present entries from both Timeline and the native event module. The tool is compatible with Office Hours, BlackBoard, and course / registrar data from PeopleSoft, with housing and library integration in progress.

Set to launch in Spring 2017, Timeline will be available as a download for Android and iOS. Additional uses for faculty and other campus audiences are being explored.
Site migration to Drupal: In full swing.

The OIT Web Development Services (WDS) team is officially one year into the Roxen migration project. In the end, it will have supported the move of nearly 300 University websites to the Drupal environment. In this first year, 66 sites were moved into Drupal, representing slightly more than 20% of the overall effort. In addition to ramping up and assisting clients in custom and template-based environments, WDS continues to improve scripts that work to reduce manual intervention and accelerate the migration timeline by automating the move of certain types of content.

WDS has also reorganized to optimize, creating a support and operations division, along with two delivery teams, each consisting of a project manager, designer, developer, and content strategist. To further the migration effort, term-based content strategy and design roles are in the search phase as FY17 begins. SAGIT funding has been made available to offset expenses associated with migrating websites to the OIT-managed Drupal environment.

Drupal template enhancements made.

While helping customers plan and manage their migrations to Drupal, WDS has launched a number of upgrades to the template website environment, including:

- Better image handling: Image placement and captioning are now easier.
- News and event sharing: RSS feeds allow sharing of content between sites.
- Tableau integration: Data-visualization views can be integrated into Drupal.
- Course offerings: Course data is available from the Office of the Registrar.
- Timeline integration: Customers have new ways to add and promote events.
- Social sharing for news: Site visitors can share news of interest.

New Drupal migration cohorts created.

Group learning benefits everyone, especially when it comes to technology. For that reason, WDS has introduced new Drupal migration cohorts. In gathering four to six site owners together for weekly workshops, this bundled approach allows for shared learning, regular in-person time with the WDS team, and built-in peer support.

Monthly template training continues.

Interest in Drupal remains high on campus. As such, monthly training workshops continue to draw capacity crowds. Beginner-to-advanced topics span everything from video embeds and menu creation to formatting. Those interested can view and sign up for current offerings through the University’s Employee Learning Center at www.princeton.edu/training.

Realizing Drupal’s Benefits: The Undergraduate Announcement

For decades, the process of creating the annual Undergraduate Announcement involved heavy lifting across departments. In a single document, it presents the University’s academic regulations, programs of study, and course offerings, reflecting the full scope of Princeton’s academic units and the policies that guide the undergraduate experience. As such, its creation required the sourcing of data from multiple campus systems, from SharePoint to PeopleSoft — not to mention copious manual copying and pasting.

In FY16, the Office of Information Technology partnered with the Office of the Dean of the College to develop and deploy a solution that will greatly streamline the production process going forward: a Drupal-supported Undergraduate Announcement. Officially launched in August of 2016, this single site enables project stakeholders to work in a shared environment, while making it easier for students to find the information they need.

“The Drupal-supported Undergraduate Announcement site enables dozens of people to upload content in a single place,” explains Jill Moraca, Manager of OIT Web Development Services. “That saves time, and best of all, we will not need to reinvent the wheel next year.”

Given that many departments are migrating their sites to Drupal, content will increasingly be sourced in a more readily compatible format. Additionally, effort in subsequent years can focus on content edits and updates, rather than a complete rebuild from the ground up.

A simplification of both business and editing processes, this central environment provides a ready-to-go framework for partners throughout the campus community who provide critical guidance to our newest students.
### OIT by the numbers

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,606,589,386,358,780</td>
<td>bytes of storage offered by the high performance storage system</td>
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<td>3,093,504,460,849,150</td>
<td>bytes of data stored in the TIGRESS high performance computing facility</td>
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<td>135,205,570,478,080</td>
<td>bytes of RAM on the TIGRESS high performance computing systems</td>
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<td>37,991,624,000,000</td>
<td>bytes of undergraduate student email stored in Princeton Gmail</td>
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<td>21,880,281,392,742</td>
<td>bytes of faculty, staff and graduate student email stored in MS Exchange</td>
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<td>16,140,702,000,000</td>
<td>bytes of data in centrally-managed Oracle database environments</td>
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<td>7,758,411,000,000</td>
<td>bytes of data in centrally-managed Microsoft SQL Server database environments</td>
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<td>31,890,132,172</td>
<td>bytes of data in centrally-managed MySQL database environments</td>
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<td>92,158,283</td>
<td>email messages passed through spam/virus filtering systems</td>
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<td>13,960,305</td>
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<td>7,463,644</td>
<td>sheets of paper printed to cluster printers by students</td>
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<td>5,970,361</td>
<td>in funding awarded to undergraduate students through the Student Activities Funding Engine (SAFE)</td>
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<td>5,635,502</td>
<td>documents managed in the OnBase Document Management System</td>
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<td>5,360,137</td>
<td>jobs run on the high performance computing systems</td>
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<td>3,978,148</td>
<td>unique client IP addresses served through Princeton’s CAS authentication system</td>
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<td>3,384,117</td>
<td>unprinted pages saved by print release stations and technology</td>
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<td>2,988,377</td>
<td>Princeton Mobile site page views</td>
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<td>1,849,119</td>
<td>unprinted color pages saved by print release stations and technology</td>
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<tr>
<td>1,593,895</td>
<td>in funding awarded to graduate students through the Student Activities Funding Engine (SAFE)</td>
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<td>1,350,599</td>
<td>print jobs submitted to OIT cluster printers, by students</td>
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<td>1,183,926</td>
<td>calls handled by the Unified Messaging system</td>
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<td>896,659</td>
<td>reports generated from the Information Warehouse</td>
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<td>854,290</td>
<td>documents brought into the OnBase system in FY16, alone</td>
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<td>349,912</td>
<td>in funding awarded to undergraduate groups through the Student Activities Funding Engine (SAFE)</td>
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<td>281,812</td>
<td>page views in the Blackboard Learning Management System on the busiest day</td>
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<tr>
<td>127,341</td>
<td>sheets printed to the color OIT cluster printer</td>
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<td>77,663</td>
<td>donations processed by the Stripes system</td>
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<td>75,287</td>
<td>print jobs sent to printers at the OIT computer clusters using the new mobile printing service</td>
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<tr>
<td>74,264</td>
<td>average daily page views in the Blackboard Learning Management System</td>
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</table>
25,028 compute cores offered by the TIGRESS high performance computing systems
11,096 university machines protected by campus security management software
9,305 University computers centrally managed and kept up-to-date by OIT
9,086 user computers backed up to the new Crashplan backup system
7,309 students printed to OIT computer clusters printers
6,781 requests for support from the Learning Space Support group
2,907 check-ins for computer support at the OIT Solutions Center Tech Clinic
2,209 undergraduate students sought technical assistance from the OIT Solutions Center Tech Clinic
2,008 databases centrally managed by OIT
1,864 undergraduate students requested activities funding through SAFE
1,295 requests for support addressed by OIT Client Support Services staff
1,170 virtualized servers run on 31 centralized servers
1,068 event setups by the Learning Space Support group
717 clients actively use OnBase as their document management solution
691 graduate students requested activities funding through SAFE
495 purchase orders were created by the OIT finance group
469 course setups by the Learning Space Support group
371 Requests for new servers, of which 97% are requests for virtual servers
228 requests to borrow mobile technology from the Mobile Technology Loaner program
226 remote support sessions conducted by technical support staff from OIT and the SCAD/DCS community with the University community
164 undergraduate groups requested funding through the Student Activities Funding Engine (SAFE)
95 database servers centrally managed by OIT
87 Peoplesoft middleware servers centrally managed by OIT
75 percent of the total visits to the OIT Solutions Center Tech Clinic by undergraduate students
31 centralized servers run 1,170 virtualized servers
1 Services Now at Princeton (SN@P) system managing OIT services