



**NORTHWESTERN
UNIVERSITY**

FY15 Information Technology Discussion Document

for the Information Technology Community at Northwestern University (IT@NU)

Prepared by

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Table of Contents

- FY15 IT DISCUSSION DOCUMENT 1**
- EXECUTIVE SUMMARY 1
- THE OVERARCHING CONTEXT 4
 - Introduction and Purpose*..... 4
 - Structure of the Document*..... 4
- THE DRIVERS OF CHANGE 4
 - External IT Drivers*..... 4
 - The World of Higher Education* 7
 - The Management of Information as a Key Topic* 8
- RESPONDING TO THE CHANGE AROUND US 9
 - A New Model for IT@NU*..... 9
 - Building Blocks of Transformation: Engagement and Aggregation*..... 10
 - Engagement 11
 - Aggregation 12
- INFRASTRUCTURE 15**
- EXECUTIVE SUMMARY 15
- INTRODUCTION 16
- KEY DRIVERS FOR IT INFRASTRUCTURE 16
 - Global Drivers*..... 16
 - Higher Education Drivers* 17
- RESPONDING TO THE CHANGE AROUND US 17
- CURRENT STATE 18
 - Building Blocks* 18
 - Areas for Attention* 19
- WHAT DO WE DO NEXT? 19
 - Mobility* 19
 - Information Management* 20
 - Cloud-Based Services*..... 20
 - Research Computing* 21
 - Collaboration* 21
 - Aggregating Shared Services at the Center*..... 22
 - Address Disaster Response and Business Continuity Issues* 22
- EDUCATIONAL TECHNOLOGY 24**
- EXECUTIVE SUMMARY 24
- INTRODUCTION 25
- KEY DRIVERS FOR EDUCATIONAL TECHNOLOGY 25
- RESPONDING TO THE CHANGE AROUND US 26
 - Current State*..... 26
 - Building Blocks 26
 - Areas that Require Attention 28
- WHAT DO WE DO NEXT? 29
 - Blended Learning* 29

<i>Learning Management System</i>	29
<i>LMS/Distance Learning</i>	30
<i>MOOCs</i>	30
<i>Rich Media</i>	30
<i>Classrooms</i>	30
<i>Learning Analytics</i>	30
RESEARCH TECHNOLOGY	31
EXECUTIVE SUMMARY	31
INTRODUCTION	32
KEY DRIVERS FOR RESEARCH TECHNOLOGY.....	32
RESPONDING TO THE CHANGE AROUND US	33
CURRENT STATE	34
<i>Building Blocks</i>	34
<i>Areas for Attention</i>	35
WHAT DO WE DO NEXT?	37
ADMINISTRATIVE SYSTEMS	40
EXECUTIVE SUMMARY	40
INTRODUCTION	41
KEY DRIVERS FOR ADMINISTRATIVE SYSTEMS.....	41
RESPONDING TO THE CHANGE AROUND US	42
CURRENT STATE	42
<i>Building Blocks</i>	42
<i>Areas for Attention</i>	43
WHAT DO WE DO NEXT?	45
<i>Services Infrastructure</i>	45
<i>Identity & Access Management</i>	46
<i>Reporting, Data & Analytics</i>	46
<i>Workflow</i>	48
<i>User Experience</i>	49
<i>Governance, Engagement, and Aggregation</i>	49
THE LARGER CONTEXT: OTHER PROJECT NEEDS	51
INFORMATION SECURITY	54
EXECUTIVE SUMMARY	54
INTRODUCTION	55
KEY DRIVERS FOR SECURITY	55
<i>Global IT Drivers</i>	55
<i>Higher Education Drivers</i>	56
RESPONDING TO THE CHANGE AROUND US	56
CURRENT STATE	57
<i>Building Blocks</i>	57
<i>Areas for Attention</i>	58
WHAT DO WE DO NEXT?	59
<i>Activities for FY14:</i>	59
<i>Activities for FY15:</i>	60

APPENDIX: IT GOVERNANCE FY13 IN REVIEW	62
EDUCATIONAL TECHNOLOGY ADVISORY COMMITTEE.....	62
<i>Executive Summary</i>	63
<i>2012-2013 ETAC Meeting Summaries</i>	63
<i>2013 Activity Summary of the Learning Management System Review Group</i>	65
ADMINISTRATIVE SYSTEMS ADVISORY COMMITTEE	67
<i>Administrative Systems Advisory Committee Meeting Review</i>	67
INFRASTRUCTURE ADVISORY COMMITTEE	69
<i>Executive Summary</i>	70
<i>Administrative Systems Advisory Committee Meeting Review</i>	70

FY15 IT Discussion Document

Executive Summary

This document is written by NUIT to share our perspectives on the IT environment that influences us, what we've heard through our partnerships within the community, and the directions we're pursuing as a result. It is intended for the IT@NU community, including our partners in schools and divisions, plus our governance and advisory groups. It is organized around the IT governance structure, and some familiarity with the material is assumed.

The paper is structured with an overarching introduction and then sections that correspond to the areas in the IT governance framework, with an additional section on Information Security, and an Appendix with annual reviews of the three active IT Governance Advisory committees. Reading this introductory section and any one of the four main sections will give a complete view of that area, and each functional area section has a one-page Executive Summary that summarizes the key points for that area.

The historic campus IT environment of the university owning all has passed. Today, the drivers behind the portfolio of IT services for the campus are often triggered by external transformations. The net effect of these transformations is that every IT organization is under incredible pressure to simultaneously change and produce at a much higher level, and every business unit needs to rethink how they manage their content, relate to their audiences, and provide their services.

The core missions of the University are undergoing qualitative changes. Online learning has exploded into being a central topic of impact to the higher-education field. While the impact of this on higher education in general is not clearly understood, the attention and new tools are reinforcing the move to a more blended learning approach as augmentation to the traditional classroom teaching methods. In the area of research, we are seeing continued effects of changes in how it is conducted (e.g., more collaboration, more modeling, larger data sets) and by external economic and security constraints. Research universities are responding to these shifts by consolidating data center facilities, aggregating computational resources, and increasing storage services – whether centrally on campus or leveraging services in the cloud.

These changes create many issues around the management of information that will require new approaches to IT solutions and information management. Our ability to respond to the changing world will be enabled by our ability to accept those changes and respond to them as a coordinated whole. The less flexible the IT organization is able to be and the less coordinated the business served by the IT organization is, the more pressure the IT organization will feel as it seeks to adapt to challenges and opportunities of the new IT environment.

The role of information technology is to provide business value to the University. The provisioning of IT services to provide that value is a shared responsibility between NUIT and the schools and departments that participate in the delivery of services. The current vision for IT delivery at Northwestern is as an overarching whole, based on close and evolving partnerships. Each organization – the central IT organization, and the distributed IT organizations – needs to play a different but complimentary role in the alignment and delivery of services.

In the past year, a new extension of the split of services has been emerging on campus to create an environment of more dynamic provision and delivery of services. The portfolio of shared services in the

new model includes those that are introduced and supported centrally, as well as a coordinated set of federated services that may be introduced or supported locally, but also includes central participation from the beginning at least in the planning and communications about the service.

The net effects of these information technology and higher education trends place every IT organization under incredible pressure to not only produce at a much higher level but to also simultaneously change how it does its work. Consistent with most universities, a more integrated approach to infrastructure, business system development, and IT services is a necessary change to more effectively and flexibly respond to the evolving IT needs. These are significant tasks of institutional change, but there is generally a shared understanding that fragmented service delivery is ineffective and inefficient. We are developing a collective vision for moving forward, and we have many examples of people starting to do things in a more collective and coordinated fashion.

Two key building blocks for this transformation are engagement and aggregation: engagement to move forward together, and aggregation to overcome our fragmentation. IT Governance, working groups, and Communities of Interest are all vehicles for developing a collective vision and a more coordinated approach to the planning and delivery of systems and services, increasing trust, and being more flexible with people, process, and technology. Although difficult and time consuming to reinvent, this engagement has to continue to be a significant initiative to move our IT environment forward effectively and efficiently. With aggregation, and thinking holistically rather than in isolated slices, we will address gaps in our service delivery, reduce duplication and scale resources where possible, thereby freeing resources that will be needed for all schools to support the emerging shifts in higher education (e.g., increased support for online learning, research, analytics, local enhancements to business process improvements, etc.).

IT Infrastructure: The external IT drivers have a great impact on infrastructure. They bring the information management opportunities and challenges of new cloud solutions into play; make normal maintenance windows more difficult to schedule; incent the trend seen broadly in universities of the move towards shared services deployed from the University data centers; and make supporting our community's increasingly wide range of personal devices more difficult. We have key building blocks in place (e.g., the Evanston Data Center is HIPAA-HITECH ready, the University network infrastructure is flexible and reliable, there is a growing interest in process improvement, and shared services are already present), but there will always be much more to do. For example, the current voice solution is approaching end-of-life; the Chicago and Evanston data centers require investment; complex requirements and future growth keep storage an area in need of ongoing attention; our strategy and process for vetting and enabling cloud solutions needs improving; enabling secure and auditable collaboration solutions that include the ability to easily share content with people beyond the traditional bounds of the University community needs improvement; process management experience across IT@NU is uneven; and we need to continue to prioritize improving interaction between our IT support structures and scaling our support services at the frontlines of user support.

Educational Technology - Teaching and learning technology has been a hot topic at higher education institutions over the past few years. Developments in online education technologies have resulted in new opportunities for distance learning and for augmenting the classroom experience, both with new tools and with new pedagogical approaches. In order to support the new pedagogical approaches, advances will have to be made in many areas: our core underlying Learning Management System; our tools and support for rich media (e.g. "course nuggets", e Textbooks, student video projects); digital repositories (to store content and make it accessible); classroom technology; video conferencing; and analytics. To be successful in these endeavors, and to provide the support for a transformation built on them, even deeper and broader partnerships will need to be built across the entire IT@NU community.

Research Technology - Changes in how research is conducted (increased collaboration across disciplines and institutions; increased modeling and simulation; creation and use of very large data sets; and increased use of shared central and national resources) in combination with increased regulations and the need for security, the need to conserve funding, and, more recently, the shrinkage of funding, has created many IT challenges. For example, like most research universities, research servers – shared and hosted – are being consolidated in central data centers here, but effective funding models are still not established; despite continued investment, complex storage requirements need more attention; ever larger data sets require continued funding for research-only networks; and the range of research that can use assistance with technology is broad (e.g., Digital Humanities, statistical computing, survey tools). Engagement with researchers at Northwestern will be critical in creating awareness of services and promoting their use, and in building communities of interest to expand knowledge and support.

Administrative Systems – This section focuses on common needs for our portfolio of administrative systems – which are broad, powerful, and a real asset, but fail to address pressing business needs (e.g., increasing efficiency in the administration of research, improving auditability in key processes, facilitating the desire for institutional analytics, reducing the workloads of enterprise system development teams, or integrating administrative solutions developed by distributed IT teams). There is much work to be done that will require rethinking our priorities and approaches to work. Enabling technologies (most importantly, a services architecture, but also identity and access management, portals) need to be emphasized; data needs to be integrated and managed more effectively; silo'ed systems need to be less customized and designed to be more aware of the University architecture; and increased engagement and federation with IT@NU is a necessary operating model.

Information Security - Information security is becoming a more critical issue to higher education with the increase in attacks and the increased sophistication of these attacks. These efforts have moved beyond the historic quest for hosts to commandeer for remote hacks, or for access to financial information, to now include attacks to gain personal information and intellectual property. These trends, along with the increased risk associated with the IT drivers listed in the introduction, and higher education's environment of openness and collaboration, means that we have to be far more diligent in our response to these threats. Our traditional lines of defense have been recently supplemented by the adoption of a structured standards-based Information Security Management System (ISMS), initiated by a recent risk analysis process, and the creation of the Security Advisory Committee under the Infrastructure Advisory Committee's overview. These new additions will supplement and give structure to a long list of building blocks and risk-mitigation tactics that are already in process.

The Overarching Context

Introduction and Purpose

This is the second yearly Information Technology (IT) discussion document prepared by NUIT to share our perspectives on the IT environment that influences us, what we've heard through our partnerships within the community, and the directions we're pursuing as a result.

This discussion paper is intended for the IT@NU community, including our partners in schools and divisions, plus our governance and advisory groups. It is organized around the IT governance structure, and some familiarity with the material is assumed.

We are not anticipating written responses on these points or on the overall compilation. Rather, we assume these discussions will take place as needed in the governance forums already established. However, if there is something you read that you feel is particularly off target, or leaves a gap that is important to fill, we welcome any and all input.

Structure of the Document

The paper is structured with an overarching introduction and then sections that correspond to the areas in the IT governance framework - IT Infrastructure, Educational Technology, Research Technology, and Administrative Systems – with an additional section on Information Security, and one Appendix that includes annual reviews from the three active IT Governance Advisory committees.

We hope that many will read the entire document, but we realize that time and relevance might preclude that, so the document is structured with that in mind. Each section in this paper is about 10 pages, and reading this introductory section and any one of the four main sections will give a complete view of that area. Also, the document has an Executive Summary, and every functional area section has a one-page Executive Summary that summarizes the key points for that section.

The Drivers of Change

The historic campus IT environment of the university owning all the resources, controlling access to them, and pushing them out to local members of the community has passed. Today, the drivers behind the portfolio of IT services for the campus are often triggered by external transformations, which result in our need for new approaches to delivering the IT services that enable and enhance how we do research, educate and learn, and perform administrative functions.

To understand how and why we must change, it's important to understand the broader worldwide IT environment that affects IT delivery on campus. The following synopsis captures some of the most impactful developments, highlighting the new opportunities and challenges they create in provisioning for Northwestern University's IT needs.

External IT Drivers

An Increasing Pace of Change – The world of information technology continues to be in a time of broad and rapid change, in which new possibilities created by technology are emerging in ever-shortening periods of time. As examples:

- A few short years ago there was relatively little discussion related to Online Education in elite research universities. Over the past few years, developments in this area have been prominent in mainstream national media as well as in discussions at all levels in universities around the world.

- Forrester Research predicts that the global market for cloud computing will expand from \$41 billion in 2011 to \$241 billion in 2020, and Gartner Inc. says that North America will account for 59% of all new global spending on cloud services between 2013 and 2016.
- The first iPad was released a little over three years ago, and now tablet sales are expected to exceed laptop sales this year.
- Blackberry's dominance was replaced by iPhone dominance, which has now been overtaken by Android sales.
- Google's Chrome internet browser was a distant third place in browser market share in 2011 but is now the market leader in desktop browsers, ahead of both Firefox and Internet Explorer.
- Dropbox, launched in 2008, had 50 million registered users by 2011, and now has 200 million, in a market crowded with competitors.

These changes illustrate the pace of change in the broader information technology world, which resonates within all IT vendors and IT service organizations. We used to think of 3 to 5 year planning cycles, and provisioning was done after very careful requirements analysis, long programming or deployment cycles, and heavy usability testing. This is now contrary to practices beyond our organization, and therefore contrary to the expectations of our users. More and more software vendors are opting for continual innovation instead of 100% stability at release, preferring to release new features quicker and address problems afterwards. These changes result in shortened internal development timelines, and shorter and less certain planning cycles.

Cloud Computing – The rapid development of cloud-based consumer-friendly, highly functioning, and price-effective applications and infrastructure continues to explode. It is safe to say that much of the functionality of our campus solutions – from email, to advanced research computing cycles, to storage, to many administrative applications – is available from external providers. Many in our community are savvy about the availability of these applications and readily adopt them when their functionality and/or ease of access exceed that of the campus equivalents.

Units all across the University, from central providers, to schools and business units, are taking advantage of this technology. The best guess today is that more than 100 applications across the campus are “cloud” applications. Examples include: Google mail for students, third-party admissions systems such as Slate, career management systems such as Simplicity and MBAfocus, online community systems such as “Our Northwestern” and the CampusGroups software used by Kellogg, online learning environments such as Coursera and 2U, cloud-based software development environments, file-sharing solutions like Box and DropBox, online survey tools, and the forthcoming new core administrative system for the Library.

Cloud adoption is expected to continue to grow on campus. From an IT delivery perspective, compelling reasons for adoption include increased options, the potential for expanding services without the traditional corresponding rates of expansion of IT or personnel for infrastructure support, and the speed of scaling or consuming only what is required. From the consumer side, the same attraction of a broad set of options, ease of use, and of rapidly developing functionality all work in cloud solutions' favor.

However, in order to effectively take advantage of these opportunities, we need to develop infrastructure and skills in new areas. We need to improve our enabling architecture and administrative processes to be able to integrate these services as easily and seamlessly as possible. This includes the skills, methods, and processes to appropriately support the cloud solution through the adoption of lifecycle planning. We need to assess the business case of each solution, making

sure that we not only understand the attractions of cloud solutions, but also the issues around information control, information security, reliability, business continuity, funding models, integration with the campus infrastructure, and activities related to withdrawing from cloud solutions.

Consumerization of IT – Many of today’s technology innovations are occurring in the consumer market, being adopted by the members of our community, and then being quickly demanded in the University’s business environment. Gmail, Skype, Google Docs, iPhones and iPads, GoToMeeting, Box and DropBox are all examples. Technology has been commoditized to the extent that these consumer-oriented products are incredibly sophisticated, accessible, and easy to use, and the market is driving innovation at a very rapid rate.

The community expects to “bring their own device,” or use their own app, and expects the University environment to either adapt to their preferences or, at the least, provide a solution that is equally easy to use. If the institution is not able to do this, individuals and units within the University community often choose personal productivity over the mitigation of institutional risk or participation within University enterprise tools. This presents issues in the areas of: IT help services and support for integration with application systems; information management, security, and risk mitigation; and system agility.

Mobility/“Always-On” – The explosion in use of mobile devices, combined with the growth of higher-speed data and cellular networks, has fueled the ability of people to do work and to access services, independent of time and place. Since the expectation is that any application must work well on the vast array of current (and yet-to-be-developed) devices and browsers, application development and data access philosophies need to embed mobility from the outset.

This creates challenges due to the increased complexity of developing applications that work well across the diversity of devices, and the need to have an increasingly sophisticated infrastructure (e.g., wireless, a services architecture) to maintain services consistent with the expectations that systems will be “always on” and available from all these devices.

Globalization – The University has spread beyond Evanston/Chicago to other cities within the U.S., to Qatar, and to locations around the globe via partnerships with international professional schools and the global spread of research engagements and student learning experiences. Now, with the University’s involvement in offering online distance courses (e.g., 2U, SCS, Massive Open Online Courses (MOOCs)), yet another aspect of our global reach will be realized.

As people have less and less physical proximity to the University’s services, the need and expectations that most services will be offered online and be accessible from anywhere are increasing. Ultimately, the growth of our IT infrastructure, and our ability to support it, will also become less dependent on geography and time zones, and the location of our infrastructure, our developers and our support teams, will become much less important.

More immediately, however, it means the introduction of issues related to expanded business complexity, language and cultural sensitivity, and the need for “always on” availability of systems across calendars and time zones. The latter compounds the difficulty of providing traditionally normal operational and maintenance tasks because opportunities for maintenance windows disappear.

Big Data/Analytics – One of the biggest changes in information technology is the growth of electronic information. IDC estimates that there is over one zettabyte (1 trillion gigabytes) of digital data in the world today, and many analysts see the digital universe doubling every year.

As the desire to gather and analyze larger sets of data makes its way into universities, the implications are profound: from the basic demands on the infrastructure (gathering, storing, analyzing, moving, and archiving), to the level and flexibility of data access (controls, indexing, and searching), to the quality and integration of this data.

Along with the growth of data goes the desire to use that data: analytics. Whether it is the desire to do data-driven decision making for administrative questions, or to look at data to understand the success of different teaching and learning approaches, or the growth of modeling within the sphere of academic research, analytics is becoming a commonly expressed need within higher education as well as in society.

Community/Social Media – “Social media” allow users to create and share their own content and directly engage one another in a community environment. This functionality is being deployed in many ways including: as a foundational tool for community interaction using the full range of social media elements; as part of general content sharing (Facebook, LinkedIn, Google+, Twitter, Tumblr, Instagram, Vine); as standalone blogs, wikis, or crowd-sourced rating sites; or as social media elements that are incorporated into more traditional web sites.

Collaboration is being redefined and social media constructs are becoming the basis for many of the activities that we are engaged in, including research collaboration, learning management software, alumni and admissions community engagement, and interacting around the content in e Textbooks. To provide social media within the enterprise, institutions have to find ways to influence and participate in these environments and to bring this functionality into their organizations. The use of Facebook and LinkedIn is becoming more commonplace within Northwestern, and the use of social software (Jive) by “Our Northwestern” and SESP (to extend interaction and learning above and beyond the classroom) represents an important, new innovation in campus use of social media.

The net effect of all of these trends – increased expectations about usability, availability, and interconnected systems; faster change cycles; end users driving the portfolio of services due to the availability of consumer-oriented solutions; more organization needs being addressed via online services; the shift from developing and maintaining applications onsite to purchasing them and having them run by others offsite – is that every IT organization is under incredible pressure to simultaneously change and produce at a much higher level, and every business unit needs to rethink how they manage their content, relate to their audiences, and provide their services.

The World of Higher Education

There are additional trends and drivers specific to higher education that are also important to note, with the core missions of our University – teaching and learning, and research – undergoing qualitative shifts that amplify the transformations happening in the world of IT:

Online Learning – Online learning has exploded into being a central topic of potential disruption to the higher-education field. Heightened campus and societal interest has emerged in topics such as enhanced blended learning, active learning, Massive Open Online Courses (MOOCs), partnerships in delivery of enhanced courses beyond a single university, and enhanced learning analytics. The implications of these changes ripple across not only the teaching and learning side of IT services, but also into administrative systems’ abilities to handle these new mechanisms for offering course credits, and into the IT organizations, which will be stretched to provide support to faculty to adopt

these new approaches. While the impact of these forces has already been experienced, the ultimate impact of these forces is still to be determined.

Research – Research is also undergoing a qualitative shift in how it is being performed. Higher education IT is under increasing pressure to effectively support increased collaboration across disciplines and institutions, bigger datasets with complexities in moving and storage, and more simulations and modeling requiring increased computation. Added to this are uncertainties and cuts in government funding, growing government regulation (e.g., new regulations about protecting certain data and making other data more accessible), and increased requirements for the protection of personally identifiable information and intellectual property. Research universities are responding to these shifts by consolidating data center facilities, aggregating computational resources, and increasing storage services – whether centrally on campus or leveraging services in the cloud.

Security / Regulation – Information security continues to take on higher importance within higher-education environments. The University’s already high level of accountability for protecting the data we produce and store is being driven up by increased concerns about the security of economic and national security interests, increased regulations for plans and actions protecting human subject information, and increased expectations by funders of research. The importance of this increased level of accountability is compounded by the knowledge that cyber-attacks on research institutions have grown, with an increased focus on gaining access to intellectual property connected to research. The front page article in the July 16, 2013 NY Times entitled “Universities Face a Rising Barrage of Cyber Attacks” emphasized that campuses are facing millions of hacking attempts weekly, and these attacks are growing in number and becoming increasingly sophisticated. The target of these attacks is no longer just personal information, but also intellectual property. This is driving educational institutions to rethink their IT environments including technology, policy, and expectations about the degree of openness.

Cross-institution Collaboration – Whether it is based on developing better results or more efficiently producing those outcomes, we are seeing increased efforts in collaboration across higher-education institutions. Examples include the growing collaborative nature of research, the collaboration of universities in providing online learning offerings, the shared efforts in providing a shared/integrated infrastructure (e.g., all of the Internet2 service offerings for higher education), and increased efforts of joint negotiations and purchases through Net+ services. At the same time that many of these collaborations have the advantages of enhancing services or reducing cost and efforts, they can also lead to increases in costs in different areas such as common application development, integration of systems, the development of integrating infrastructure, or the resolving of issues related to the resulting more complex business processes.

Electrical Power and Cooling – The growth in demand for computing cycles and storage and related applications leads to an increased need for concentrated power and cooling. This is a significant issue for large consumers of local-based computing, but it is magnified on university campuses because of the impacts of the load of heavy research computing.

The Management of Information as a Key Topic

The core mission of higher education institutions is producing and disseminating information. The range of challenges associated with how universities fulfill their core mission have also accelerated and expanded with the impact of evolving technology and the related expansion of digital content and interest in analytics/big data, collaboration, and social media. As a result, it is logical that the management of information is at the base of many topics discussed in this paper.

In an age of massive content creation and collaboration, increasing regulation and security concerns, and ever-increasing consumer-oriented options, how do we meet the information sharing and communication needs of a community that expects the same functions and ease-of-use that are now deployed across the internet for personal services?

As we try to answer this question, the challenges, questions, and opportunities facing us take many forms:

- How do we make it easy for researchers to collaborate with people at other institutions while still keeping their sensitive data secure and private?
- How do we balance the attractiveness of cloud-based services with the concern about controlling access to our data?
- How do we balance the desire to do enterprise-based analytics with the desire to retain limited and business-line controls on data access?
- How do we ensure necessary common infrastructure needs are balanced with line of business needs?
- How do we effectively and efficiently retain and make digital content available for review and collaboration as it continues to grow in size, variety, and complexity?
- How do we provide institutional content when the devices on which it is consumed continue to diversify, and the audiences continue to fragment?
- How do we continue to reduce our institutional risk when many of the solutions required for secure information storage and sharing are less attractive than the highly available consumer products?

We expect that the answers to these and the other topics included in the following sections will require different approaches to information management, much like we are evolving our approach to providing our services away from prior assumptions (e.g., the necessity to provide all of our IT solutions, or directly manage all of our content). Ultimately, in our attempt to keep pace with the world around us, we will make changes in each of the key areas of service development and delivery: people, process, and technology.

Our ability to respond to the changing world in which we live will be premised on our ability to accept those changes and respond to them as a coordinated whole. The less flexible the IT organization is able to be – whether it is regarding people, process, technology, or funding – and the less coordinated the business served by the IT organization is, the more pressure the IT organization will feel as it seeks to adapt to challenges and opportunities of the new IT environment.

Responding to the Change around Us

A New Model for IT@NU

The role of information technology is to provide business value to the University in teaching and learning, research, administration, or other related activities. The provisioning of IT services to provide that value is a shared responsibility between NUIT and the schools and departments that participate in the delivery of services.

As has generally occurred over the years in higher education, the balance between the central providers and the distributed IT units has shifted at Northwestern, and the level of trust and cooperation between the parts of the IT community has varied. The current vision for IT delivery at Northwestern is as an

overarching whole, based on close and evolving partnerships within and among the central providers of IT and the distributed IT units in the schools and business units.

Each organization – the central IT organization, and the distributed IT organizations – needs to play a different but complimentary role in the alignment and delivery of services. When the combination of services provided by the central and distributed units is done well, the result is increased interoperability, more broadly leveraged functionality, improved information security and IT controls, reduced risks, and more responsiveness to unique unit requirements.

The core component of the central IT unit's role is to provide a set of base services: the commonly used, pervasive infrastructure and widely used applications such as the network, central servers, central administrative systems, collaboration services, and related support. These components require longer-term vision, sustained and uniform investment, interoperability, and common management in order to ensure an efficient and reliable base level of service for the whole community. Conversely, the role of the IT support units outside of the central organization is generally understood to be the provision of special needs beyond this base, both in terms of functionality as well as in increased levels of service.

In the past year, a new extension of the split of services has been emerging on campus to create an environment of more dynamic provision and delivery of services. The portfolio of shared services in the new model includes not only those that are introduced and supported centrally, but also a coordinated set of services that may be introduced or supported locally. This federated approach has arisen out of the understanding that the IT providers closest to the end users of the technology have an earlier and better understanding of their needs, and that developments to meet local needs can happen with more agility and without having to wait until similar needs aggregate enough to bring them to the top of the institution's overall priority list.

One thing that is different in a federated approach than in a strictly decentralized approach is that local units are encouraged to consider units beyond themselves, to look for other units who may benefit from the same or a similar service, and to alter their development process to include those other units. By adopting a federated approach where local innovation is encouraged but development occurs in a more collaborative way, the result is more agile and sustainable solutions than either a fundamentally centralized or decentralized model can produce. What this does not mean, however, is that a federated service is done strictly within the horizons of the distributed units with no role in the development of these services for the central IT organization. Even if the central IT unit is not providing any of the service, it is important to include them from the beginning in the planning and communications about the service due to their wide-ranging institutional knowledge and relationships.

This move to a federated approach to provisioning introduces challenges that need to be addressed, including, integrated planning, improved communications, new IT and business skills, improved service and project management practices, and new financial models (to appropriately handle consolidation resulting in central expenditures and distributed savings).

Building Blocks of Transformation: Engagement and Aggregation

The net effects of the trends mentioned in the preceding sections place every IT organization under incredible pressure to not only produce at a much higher level but to also simultaneously change how it does its work.

Consistent with most universities, a more integrated approach to infrastructure, business system development, and IT services is a necessary change to more effectively and flexibly respond to the evolving IT needs.

This requires adapting all aspects of delivery, including our people, process, and technology.

These are significant tasks of institutional change. The good news is there is generally a shared understanding that fragmented service delivery is ineffective and inefficient in the delivery of systems and services for the broader University community, the levels of trust are improving, we are developing a collective vision for moving forward, and we have many examples of people starting to do things differently.

Engagement

Having a collective vision, developing a more coordinated approach to the planning and delivery of systems and services, increasing trust, and being more flexible with people, process, and technology are all aspects of increased community engagement in IT delivery. Although difficult and time consuming to reinvent, this engagement has to continue to be a significant initiative to move our IT environment forward effectively and efficiently.

One of the biggest vehicles for engagement within the IT@NU community is the existence of the IT Governance structure. Ultimately, these forums will provide a vehicle to help the University make choices between competing and compelling projects. As we develop the framework and skills to be effective in governance, these forums – business-led and enterprise-focused – fulfill a critical engagement function. They provide opportunities to surface work and conversations that used to be isolated in pockets across the University but are now brought to enterprise-oriented forums, and they provide a mechanism to articulate visions and get feedback that gets carried over as “new options” to be considered in the practical discussions about business needs and opportunities that happen in everyday settings outside the governance meetings.

Under the IT Executive committee (Level 1), the three current Level 2 advisory committees (Educational Technology, Administrative Systems, and Infrastructure) were all very active this year in establishing a base of knowledge of what is happening in each area, identifying what many of the needs are and what a vision might be for satisfying those needs. (See Appendix A for summaries of the activities of these three committees. The Research Technology Advisory Committee has not been convened yet, and in the interim, the area of facilities for research computing is still being covered by the Execution Committee.) More recently, the committees have been working on a level of governance (Level 3) that is more specific to a given functional area and closer to the actual work being done in that area. Examples of these Level 3 committees are: Student Administration and Human Resources Administration Committees under the Administrative Systems Advisory Committee; Service Platforms Group and Security Advisory Committees under the Infrastructure Advisory Committee.

Another type of forum for engagement is rooted in a shared interest in a problem or an area of responsibility: workgroups and Communities of Interest. Workgroups are shorter lived and more focused on solving a particular problem, whereas Communities of Interest are longer lasting and are mobilized to share knowledge and make personal connections among those who are doing the same type of work. An example of a Community of Interest might be the Mobile MeetUps that are happening around the topic of mobility. Recent conversations about possible areas where this approach could be beneficial include bringing people together who are:

- using, or have an interest in using, the agile methodology to do projects;
- evaluating alternatives for online webcasts and/or video conferencing;
- software programmers talking about how we can develop a standard framework that people can use to increase the ability of programs to move across organizations more easily;
- doing institutional research in their unit;

- designing classrooms in their school to accommodate the new interest in flipped classrooms or active learning settings.

Aggregation

Our objective is to configure the delivery of services at Northwestern to maximize, from a campus-wide perspective, the capabilities and investment in IT services. Fragmented and duplicated services do not lead to maximizing capabilities or investment, and there are many examples of this, including:

- Multiple Active Directory forests, email systems, and COI processes.
- Lack of structure or resources to introduce and manage projects that require effort and commitment from multiple enterprise systems or don't align specifically to any established development group.
- Underdeveloped enterprise enabling technologies (services architecture, and the identity management ecosystem), and many administrative systems that have limited interaction with each other.
- Multiple portals, and limited buy-in on the University portal.

Opportunities for optimization include the following:

- Base line services need to be offered efficiently at the center, or made available to others in a sustainable and coordinated fashion (federated) when offered by a distributed unit, and not duplicated all over campus.
- The common infrastructure needs to be more hospitable and supportive of new and distributed systems so they can be integrated more easily. Supporting systems need to be less "stand alone" systems, and they need to become more aware of, and engaged with, each other via the common infrastructure.
- As services are developed by distributed units, we need to encourage the approach that as they're conceived and delivered, there is opportunity to develop them in a way that enhances not only their ability to address more than a narrowly defined set of local needs should those needs be there, but also their ability to migrate to the center should that be desirable.
- Support needs to be understood holistically, rather than through the lens of existing organizations, so improved cross-unit cooperation, or a shared provisioning of services, can provide opportunities for re-allocation of effort to new emerging areas of need.
- An integrated approach to project management and business analytics would better enable development of common resources for use across many administrative and support systems.

In order to accomplish this, all of IT@NU needs to:

- Collaborate effectively across the broader IT community, being more inclusive in decision making and ensuring clarity on requirements, priorities, directions, and deliverables.
- Be inclusive of the business units in IT planning and development; go into planning sessions with proposed solutions to business problems, but expect them to change due to added input.
- Deploy scalable solutions that are less stand-alone and can easily integrate with other in-house systems or cloud-based services.
- Look for new ways to approach problems that are not bounded by long-standing organizational boundaries or technological approaches.
- Increase flexibility and agility – adapt to opportunities and new use cases, adjusting plans midstream if needed.

In contrast to IT Governance (where the objective is to push work down in the organization in order to broaden involvement as a solution to the concentration of committee membership in a relatively small number of senior administrators), much of the effort over the past two years in other parts of the IT@NU world has been to foster an approach of *aggregation of infrastructure and services* approach in order to address the fragmentation that grew out of a less coordinated approach to service delivery. The idea here is not to mandate a sweeping realignment in an area, but to constantly look for opportunities to address our fragmentation via incremental aggregation, and to not shy away from doing it where there is an opportunity that makes sense.

There are many examples of where this approach is already in evidence:

- People:
 - Support for online learning at Northwestern is now being provided by a “virtual organization,” made up of people from NUIT’s Academic and Research Technologies group, the School of Continuing Studies, and the Searle Center for Advanced Teaching and Learning, rather than by three separate organizations.
 - The Graduate Student Admissions System and the Graduate Student Tracking System both have a development process that is premised on people from different organizations (McCormick, TGS, NUIT, SES) working closely together, including embedding a person from NUIT in McCormick’s team.
 - The Enterprise System Directors now have a dotted-line reporting relationship to the VPIT/CIO, and the Enterprise System Directors who have NUIT programmers specifically assigned to their functional area – i.e., FASIS, SES, ARD – now have direct operational control over them.
- Process:
 - Level 3 Governance: In the Administrative Systems Advisory Committee, the level of governance that is closest to the delivery of services (Level 3) is no longer organized by system, but is organized around functional areas that usually contain multiple systems.
 - Following on the common help desk approach that has been successful with Project Café support being handled by the University’s central help desk, shared help desk services via the University’s central help desk are being piloted at the Feinberg School of Medicine to provide a more integrated IT support management infrastructure and free up resources within Feinberg, rather than having separate instances for the University and Feinberg.
 - There is growing use among schools and business units of Footprints (the IT Service Management tool that NUIT uses to track support requests and their resolution).
- Technology:
 - NUCloud: management of servers, traditionally done in distributed units, has begun to move to a shared infrastructure provided at the center but administered locally.
 - Kellogg’s Exchange service is migrating to the University’s Collaboration Services environment.
 - Several units’ Active Directory forests are migrating into the University’s ADS Active Directory forest.

In many of these examples, baseline services that can benefit from scale (e.g., much of the infrastructure work and some of the support tasks) are being shifted to the center to free up resources that can be applied to other needs in the schools. In fact, this is the stated strategy for WCAS and The Graduate School. Other schools are also doing it to varying degrees. Continuing this transformation will free up resources that will be needed for all schools to support the shifts that are emerging in higher

education (e.g., increased support for online learning, research, analytics, local enhancements to business process improvements, etc.)

Many more suggestions for both engagement and aggregation are identified throughout the functional area sections that follow.

Infrastructure

Executive Summary

In addition to the “classic” IT Infrastructure services such as facilities, networking, and service platforms (servers and storage), this section includes software functions such as communication and collaboration services, and process areas such as the management of personal devices (i.e., end point management), and IT service management.

Many of the drivers outlined in the introductory section impact the IT infrastructure discussion: mobility, information management, cloud-based services, globalization, security/compliance, consumerization of IT, and ongoing changes in research computing. These drivers bring the information management opportunities and challenges of new cloud solutions into play; make normal maintenance windows more difficult to schedule; incite the tendency seen in a broad spectrum of universities towards shared services deployed from University data centers; and make supporting our community’s increasingly wide range of personal devices more difficult.

As in other universities, we are looking for ways to improve our support by looking for opportunities to decrease our fragmentation and duplication in our IT infrastructure and services. With the success of NUCloud and the introduction of level 3 governance committees, there is an increasing desire to collaborate, procure, and deploy solutions of common interest collectively. While the shared services that emerge from this engagement may exist either on site or in the cloud, either at the center or in a federated solution within the distributed units, a collective approach will provide opportunities via engagement to develop institutional priorities, leverage collective bargaining, procure enhanced services, reduce duplication of efforts, and decrease risk.

We also want to look for ways to succeed in using the new technologies that are driving the change and offering opportunities within them (e.g., cloud infrastructure options or collaboration tools). If we are to do this, we need to get better at assessing the risks and opportunities of these options, integrating them when they are appropriate solutions, and managing them through the lifecycle of the solution.

We have multiple key building blocks to help address the change around us. For example, the Evanston Data Center is HIPAA-HITECH ready; the University network infrastructure is flexible and reliable; there is a growing interest in process improvement; and shared services are already present (NUCloud, CrashPlan, KACE, FootPrints).

We also have made progress in many of our areas for attention, but there will always be much more to do: the current voice solution is approaching end-of-life; the Chicago and Evanston data centers require investment; complex requirements and future growth keep storage an area in need of ongoing attention; our strategy and process for vetting and enabling cloud solutions needs improving; enabling secure and auditable collaboration solutions that include the ability to easily share content with people beyond the traditional bounds of the University community needs improvement; and process management experience across IT@NU is uneven.

Finally, in order to maintain high levels of security, maximize our human resource investments, and maintain a quality user experience, we need to continue to find ways to improve interactions between our IT support structures, and we need to continue to prioritize the search for ways to scale the services we deliver (e.g., via self-service, automation, and remote support) at the front line levels of support (i.e., Tier I and II).

Introduction

In addition to the “classic” IT Infrastructure services such as facilities, networking, and service platforms (servers and storage), this section includes software functions such as communication and collaboration services, and process areas such as the management of personal devices (i.e., end point management), and IT service management. This is intended to mirror the responsibilities of the Infrastructure Advisory Committee. One way of thinking about this is that the facilities, service platforms, and communications services are the bricks and mortar of the IT infrastructure, while the support processes included here are the day-to-day infrastructure that is required to assist members of the Northwestern community when they need help in any of the subject-matter areas covered in the other sections of this document.

As the drivers surrounding the IT@NU community change, the IT services we offer, the way we offer them, and how we offer them will – and need to – change. We therefore start this section with a brief overview of the drivers most relevant to the IT Infrastructure area.

Key Drivers for IT Infrastructure

Global Drivers

Mobility – The IT infrastructure issue most directly related to this area is the ability of mobile devices to successfully communicate with applications over the network – Wi-Fi or cellular – within the University or in public networks. This is an issue of coverage and available bandwidth to meet demand density. Additionally, in an age of Bring Your Own Device (BYOD), our support teams need to be able to support these devices, and we need to mitigate the risks associated with so many different devices connecting to our network and applications.

Information Management – A conscious strategy is needed for managing information and making it an important resource. IT infrastructure concerns in this area are adequate capacity, appropriate protection, and policy-based retention and preservation.

Cloud-Based Services – When people talk about “cloud services,” there are a range of services they could be referring to: from Software-as-a-Service (“SaaS”: using an application provided remotely by someone else); to Infrastructure-as-a-Service (“IaaS”: using infrastructure such as servers and storage provided outside the organization or complete data center provisioning). The IT infrastructure opportunities and challenges will focus on IaaS, and over time, we expect to depend more on external services in the provisioning of the University infrastructure.

Generally speaking, there are three broad categories emerging for IaaS: Public Clouds, Private Clouds and, more recently, Hybrid Clouds. A public cloud is defined as an infrastructure service on the internet (e.g., Amazon web services) where anyone can buy services either as a dedicated instance/size or on a “pay-as-you-go” model. Private clouds are similar in concept, but the IaaS platform resides in house, on premise. Hybrid clouds are a combination of public and private clouds, with some data/applications residing on each. Agility, speed of deployment, and in some cases financial savings may lead some to use the public cloud; sensitivity of data content or other considerations may require a private cloud option. Potential use cases for hybrid cloud services include separation of development and test environments from production, additional burst capacity from the private to the public cloud during peak times, disaster recovery / business continuity capabilities, etc.

It is early in industry development of hybrid clouds, thus there are still key challenges such as multiple technical standards leading to integration and interoperability issues, managing multiple providers, varying levels of capabilities, software licensing, etc.

Globalization – The University’s IT infrastructure must support the academic, research, and administrative missions of any remote office or campus location, and system access from anywhere our users are. This will require reliable connectivity to extend the reach of central applications to any site for normal day-to-day use. Additionally, the replication and protection of data housed at the remote location back to the University’s central services are often necessary. Both of these needs must be recognized early when planning any new University outreach efforts.

Security and Compliance – BYOD (Bring Your Own Device), cloud adoption, and social networks have increased the degree of complexity in managing security threats within most organizations, especially higher education with its predilection to openness. Coming at a time of increasing regulations about sensitive data, these new fronts challenge traditional access controls and security practices, increase privacy and compliance concerns, and introduce the need for new policies and procedures that must be adhered to. No longer can the University simply attempt to prohibit use of these services. Instead, the trend is to mitigate these risks by consolidating facilities, educating the community, providing access to key data via virtual software that puts a barrier between the end user’s device and the application being used, investigating use of multi-factor authentication, and moving away from a reliance on physical location for authentication assurance (e.g., connected directly via a Northwestern network or requiring VPN connectivity) to a personal-based authentication that is location independent.

Consumerization of IT – One of the biggest areas of consumer-oriented alternatives to campus-based solutions is collaboration. Email and calendaring solutions, online communications (e.g., video conferencing, instant messaging, chat, online meetings) and file sharing have compelling solutions that are already familiar to our users. We need to offer solutions that are comparable to the functionality of these tools, while also providing enhanced campus services (e.g. easily knowable directories and email addresses) if we want to mitigate institutional risk associated with the spread of sensitive University content. IT consumerization also creates challenges in basic connectivity support simply due to the proliferation of devices and operating systems, each with their own quirks and software interfaces to be understood and traversed.

Higher Education Drivers

Ongoing Changes in Research Computing – Drivers for research computing will be addressed more fully within the “Research Technology” section of this document. However, the growth in research, and the sensitivity and size of the data being analyzed, pose considerable IT infrastructure challenges. These factors combine to produce a trend towards consolidation of research computing resources, including computation and storage, and a drive to offer advanced networking capabilities dedicated to research needs. The National Science Foundation (NSF) has acknowledged this need by funding research networks that enable higher speed and dynamic configurations including a recent grant for Northwestern research networking needs.

Responding to the Change around Us

As are other universities, we are looking for opportunities to decrease our fragmentation and duplication by aggregating our IT infrastructure and services. With the success of NUCloud and the introduction of level 3 governance committees, there is an increasing desire to collaborate, procure, and deploy solutions of common interest collectively rather than in isolation.

While the shared services that emerge from this engagement may exist either on-site or in the cloud, either at the center or in a federated solution within the distributed units, a collective approach will provide opportunities via engagement to develop institutional priorities, leverage collective bargaining, procure enhanced services, reduce duplication of efforts, and decrease risk.

To achieve this vision, and facilitate those movements to the center that would be beneficial, NUIT will need to embrace the following guidelines:

- Remove process hurdles and satisfy service requests quickly
- Avoid downtime whenever possible – work to eliminate single points of failure, and wherever possible, avoid downtime associated with maintenance
- Plan for and absorb spikes in demand
- Support BYOD trends by striving to provide full support for consumer devices
- Comply with security regulations and manage risk appropriately.

As we look for opportunities to decrease our fragmentation, we also want to look for ways to succeed in using the new technologies that are driving the change and offering opportunities within them. If we are to do this, we need to get better at assessing those opportunities and integrating them when they offer appropriate solutions. Similarly, when we assess the services we offer, we need to realistically consider the likelihood of their adoption when there are already highly available, compelling options for the Northwestern community. If there are real barriers to adoption, we need to re-examine our assumptions about our services.

Another focus of change needs to be endpoint management and the support of our community in the course of their daily working lives. In order to maintain high levels of security, conserve our resources, and maintain a quality user experience, we need to continue to lower the barriers between our IT support structures and scale the services we deliver at the basic level of support (i.e., Tier I and II).

Finally, if the transformation of services into shared services is to be sustainable, whether it is to the center or to a distributed unit, we need to be aware that the changes in service delivery will need to be accompanied by new funding models that take into account both the added burdens on the providing unit and the savings provided to the participating units.

Current State

Building Blocks

- The University's Evanston data center has been refurbished, is HIPAA-HITECH ready, and can be expanded to nearly triple its current size.
- Northwestern's intercampus network is both flexible and highly reliable, with diverse routes between campuses and to the Internet.
- The network within the main data center is 10Gbps, and the network has been upgraded to these speeds in selected spots on campus.
- Wi-Fi coverage on campus is increasing year-over-year – from 55% indoor coverage in FY12 to 70% in FY13, anticipated to be 85% by end of FY14.
- The University collaboration services are implemented on a highly available, two-campus platform.
- There is organizational understanding of service management concepts and process adoption across NUIT, and a growing interest in process standardization frameworks around campus.
- NUIT has had success partnering with the community on shared services under new financial models (e.g., NUCloud, CrashPlan, Kace, Social Science Computing Cluster).
- We have skilled staff with experience in virtualization, cloud-based applications, HPC systems, and advanced networks.

- Funding has been provided for hundreds of terabytes of administrative and research storage and planning for this is occurring now.

Areas for Attention

- The Chicago data center has reached capacity bounds that will require significant investment to overcome, and while NUIT has added additional rack space capacity to the Evanston data center, the available rack space is expected to be exhausted during FY14.
- As more business processes move online, business continuity capabilities need to be continually reviewed to ensure that the potentially expanding set of core services are included in the continuity plans with an agreed upon restoration time and manner. Provisioning of new central systems has been done with some level of failover capabilities to the Chicago computer room in the event of a disaster in Evanston. The capacity of the Chicago data center equipment, and changes in underlying technologies in our systems, make it possible to envision a disaster response that includes restoring most core systems, but the ever expanding definition of what is essential from a campus wide perspective needs to be continually evaluated and planned for. Many years have passed since our last formal evaluation and conducting a process to have business and school unit articulation of requirements and plans mapped to capabilities is an initiative that needs to be revisited. Additionally, extending this discussion to consideration of a backup site located away from Chicago could be part of the exercise.
- There are still gaps of Wi-Fi coverage in usable spaces indoors, and cell phone reception is spotty across campus.
- The end-of-life voice platform must be replaced.
- Even with significant investment in storage, complex requirements and future growth continue to make this a required area of attention.
- Process management practices are still new within NUIT, the initial base for interaction between NUIT and the distributed units is even less mature, and there is virtually no base of experience in the distributed units for how to offer federated services. A move to shared services will require investigating funding models for those services.

What Do We Do Next?

Mobility

Over the past few years, NUIT has invested considerably in expanding the Wi-Fi coverage within buildings on the Evanston and Chicago campuses. However, BYOD (Bring Your Own Device) and network-intensive applications are pushing the current Wi-Fi network to its limits. To serve the likely future expectations of the Northwestern community, capacity and capabilities must be further enhanced.

Responses

- Expand Wi-Fi coverage to 85% (FY14) and 100% of indoor usable areas. (FY15)
- Upgrade current Wi-Fi services to the next-generation Wi-Fi technology. (FY16+)
- Further improve cellular services across both campuses, both in coverage and effective data rate (4G and beyond); explore funding models in partnership with carriers and integrators. (FY15+)
- Investigate virtualization of desktops or applications to achieve compatibility and improve security between BYOD devices and applications. (FY15)

Information Management

Over the past three fiscal years, NUIT has invested in data storage for administrative, infrastructure, and enterprise application needs. We expect past central data storage growth trends to accelerate as aggregation to shared services takes hold. Future growth projections become especially difficult when research storage and library repository storage are included.

The storage, security, protection, archiving, and mandated access to research data is a significant future issue for Northwestern. This will be described in the Research Technology section of this document; however, the infrastructure implications in space, power, equipment, and network capacity are considerable. A crucial aspect will be the software services to make the research data accessible from processing platforms (e.g., Quest, national labs, private clusters) as well as researcher workstations. Underneath the software, the service will be built upon a combination of technologies, including on-site disk and tape storage, plus cloud storage. True advancement in these areas cannot be made until the requirements are better understood and the systems that will interface to the users are selected and implemented – a process that has not yet begun. The University needs to understand and define the requirements for retention and appropriate protection and preservation for information to understand the technical infrastructure to deliver it.

Responses

- In partnership with the Library and the Office for Research, and in consultation with the community, define a research data shared service and corresponding funding model to sustain it.
- Through existing governance groups, define a general storage shared service and corresponding funding model to sustain it.
- Review the multiple expressed needs, and alternatives being proposed, for digital repositories and recommend an institutional path forward. (FY14-15)
- Rationalize use of SharePoint versus cloud-based file services such as Box.net – define policies to help individual University faculty and staff make the right choice on where to place data for convenient collaboration and data safety. (FY14)
- Establish HIPAA-compliant processing capabilities within the Collaboration Services infrastructure. (FY14+)
- Support the Library and other partners to define and deploy a long-term preservation service for information of all types. (FY15+)

Cloud-Based Services

We estimate that there are over 100 university applications in the “cloud,” but only a handful of these applications involve some form of support from central IT. We need to collectively develop: a common understanding of what is acceptable to be in the cloud; a better understanding of available options and associated risks; an aggregation of interest from multiple schools and departments; and agreement on what is the role of the relevant IT unit (NUIT, or a school IT unit for applications deployed by school-based business units) in those transactions and their ongoing support.

Responses

- Engage with the governance committees to draft and publish guidelines for the use of cloud-based services. These guidelines should answer questions for units considering these services, including:
 - What are appropriate applications for cloud-based information processing?
 - What are the differences between vendors of Software-as-a-Service, Platform-as-a-Service, and Infrastructure-as-a-Service, and how do those differences affect any possible contractual relationship with the University?

- What types of information can be placed safely into cloud storage services?
- What management framework should be placed around cloud services? For example:
 - What steps are recommended – or required – when investigating a vendor and negotiating a service agreement?
 - What steps are required on an ongoing basis once a service has been deployed in the cloud?
 - What duties / responsibilities are assumed to reside with the most relevant IT organization (NUIT or a local IT organization) when a cloud vendor is being / has been selected?
 - What assistance is available from offices across the University?
 - What technical language should be included in a contract to ensure that the vendor will work with the University to allow secure and transparent use of Northwestern’s enabling architecture including our authentication system?
- Investigate the hybrid cloud model as an extension of our private NUCloud. (FY15)
- Explore the advisability of moving the Collaboration Services applications to the cloud (e.g., Office365) to reduce costs for hardware, power, space, and data center staff managing the hardware. (FY15+)
- Investigate options for extending storage into the cloud, or storage that could be tiered or moved into the cloud for long-term preservation (e.g., Box.net). (FY15+)

Research Computing

NUIT recently received grant funding for the beginnings of a separate research network between campuses and to select buildings. This follows deployment of 10Gbps services to Silverman Hall in 2012. We need to continue to look for opportunities to improve networking for researchers at Northwestern. We also need to continue to expand capacity in our larger data centers as research servers continue to migrate there from individual research centers and faculty offices. (See also the major section on Research Technology and the Information Management section above.)

Responses

- Deploy a separate research network to enable high-speed data transport needs and add software-defined flexibility. (FY14+)
- Based on bandwidth demands, upgrade intercampus links for general connectivity to 100Gbps and upgrade connectivity with external research networks to 100Gbps. (FY15-16)
- Continue expansion of research hosting space in the Evanston data center. (FY15+)

Collaboration

Northwestern has multiple building blocks in this area, and there are opportunities to reduce some of the fragmentation within the institution. However, it is also one of the most challenging areas to offer compelling solutions that compete with highly available consumer-oriented tools. Another significant challenge in this area is that the boundaries of the Northwestern community are continually expanding – in research, teaching and learning, and administration – and yet not all of our file-sharing solutions can appropriately accommodate this trend.

Responses

- Bring Kellogg email services into the central Exchange service. (FY14)
- Encourage movement of existing distributed SharePoint instances and Depot sites into the newly launched NUIT Share instance of SharePoint.
- Upgrade Exchange to version 2013 to reduce differences between the experiences of Windows and Mac users. (FY14)

- Investigate the feasibility of deploying MySites within SharePoint to reduce the differences between the SharePoint file sharing solution and DropBox or Box. (FY14)
- Deploy Box as a solution for non-sensitive University content. (FY14)
- Continue to explore ways to improve the ability of the core members of our community to share their files easily and appropriately with their colleagues and peers outside of the University.
- Issue an RFP to replace the current telephony system, which is approaching end-of-life. Deploy a new voice solution by FY16 that has better integration with the collaboration system, video conferencing technologies, and smartphones. (FY14-16)
- Investigate new approaches to working directly with telephone carriers to improve the cellphone reception on campus. (FY14-16)
- Encourage the creation of an IT Governance working group to examine the portfolio of online communications tools available to the University community. (FY14)
- Continue to evaluate external mail solutions to ensure students are being served well by our choice of external providers. (FY16)

Aggregating Shared Services at the Center

In addition to the projects listed above, NUIT is interested in exploring any opportunities that may present themselves to establish shared services in order to achieve efficiencies and free up resources in the distributed units.

Changes that directly affect user support have additional sensitivity. However, as more services become shared, as more user support tools become commonly shared and configured to scale basic management tasks for end user devices, and as central IT demonstrates its willingness and ability to be responsive, it is expected that these areas will become topics for discussion.

Responses

- Create a complete cost model of central data center services to help in the development of funding models and to compare against cloud-based and remote data center costs. (FY14)
- Begin to establish Service Level Agreements (SLAs) and Operational Level Agreements (OLAs) for central IT services to raise confidence in using central services. (FY14+)
- Encourage the creation of an Infrastructure Advisory Committee Level 3 committee on End User Support and an active community of interest to help promote the development and use of common end user management tools that facilitate the scaling of the basic level of support (FY14+). For example, the continued expansion of:
 - units using FootPrints to log tickets and track responses
 - creation and use of self-service and automated processes within Dell KACE
 - adoption of Bomgar for remote support.
- Engage the IT@NU community in discussions about consolidating the many Active Directory forests into the central forest in order to free up resources in the Identity Management team and to make shared services deployments easier and their user experiences better. (FY14)

Address Disaster Response and Business Continuity Issues

Business continuity requirements are driven by the business units providing services to the community. NUIT can provide leadership in the ongoing support of units with their planning, especially as it relates to IT infrastructure components of the planning process.

- Continue the definition and deployment of appropriate disaster response and business continuity methods and capacity. All enterprise applications utilize shared services within the data centers.

- Collect current business applications' technical Disaster Recovery standing and capabilities to improve recovery (FY15). Enumerate applications that:
 - can approach “fault tolerance” standing
 - can adopt a more rapid recovery posture
 - cannot leverage our infrastructure to improve recovery.
- Reinforce current backup site capacity to operate increasingly greater portions of the University’s business in an emergency. (FY14+)
- Investigate options for locating a backup site remote from the Chicago area. (FY15)
- Convene a working group to assist in the definition of appropriate levels of response to serious IT disruptions for: (FY15-16)
 - enterprise business applications, including prioritizing restoration
 - enterprise instructional applications, including prioritizing restoration
 - school/divisional applications outside of enterprise categories.

Educational Technology

Executive Summary

Teaching and learning technology has been a hot topic at higher education institutions over the past few years. Developments in online education technologies have resulted in new opportunities for distance learning and for augmenting the classroom experience, both with new tools and with new pedagogical approaches. SCS continues to produce successful online courses and degrees. Other forays into online learning – Coursera and 2U – are in the early stages, and current interest is high. Interest in blended learning is gaining, and experimentation with the technology that surrounds these approaches drives the priorities in this area:

Learning Management System (LMS): The current Blackboard (Bb) system is widely deployed but is considered to offer weak support for the evolving needs of blended learning. A pilot is underway to review alternatives to our current environment, and a recommendation is expected in Spring 2014.

Rich Media: New technologies enable new pedagogical options. Video “course nuggets,” student projects (e.g., those done in WCAS Language courses), and e Textbooks are all examples. Enabling the video production and consumption will have increasing importance, and being able to provide multiple levels of production quality and ease will be important to meet demand. NUIT and other units will be able to provide higher quality production levels, but other more self-service tools need to be developed and implemented in order to meet anticipated demand.

Digital Repositories: As the production of video and other forms of digital assets grows, the need to store, share, and make them accessible will grow. Multiple schools and units on campus have expressed interest in solutions in this general field, but they have also expressed differing functional needs and solutions. The growing adoption of Mediasite addresses some of these needs, but this is an area requiring review and recommendations for further advances in the next year.

Classrooms: The new pedagogies work best in physical spaces designed for group interaction, often with technology designed to facilitate this interaction. Lecture classrooms are designed for one-to-many interaction. As these new pedagogies grow, the University will need to transition its classrooms.

Video Conferencing: Video conferencing (and web broadcasting) is of growing importance, not only as a teaching and learning tool but as it aligns with the other technology in this section. Expanding its presence in classrooms, meeting rooms, auditoria, and for mobile users is very important, as is simplifying the experience when possible by using the desktop collaboration tools familiar to our users, or ones similar to them.

Analytics: The growth of interest in analytics has been fueled by the rise of online learning, and more tools are being created to capture and analyze this data. Interest in this area will grow over time.

Support: These pedagogical shifts, and the use of these new tools, will require growing levels of support. Schools that have had faculty participating in the early forays into these new pedagogies flag the need for increased, and different types of, support. Addressing these needs will require, at the least, increased optimization of resources across the IT@NU community. The combination of SCS, the Searle Center, and NUIT into a “virtual organization” to meet online learning needs is one instance of how this might take place.

Introduction

Teaching and learning technology has been a very hot topic at higher education institutions over the past few years. Developments in online education technologies have resulted in new opportunities for distance learning and in augmenting the classroom experience. In distance learning, advances in technology have fueled the explosion in Massive Open Online Courses (MOOCs) and expanded options for credit-based programs and courses. As augmentation to the classroom experience, online learning enhancements have led to blended learning enhancements, “flipping the classroom,” and an expanded learning environment “above the classroom” with social software. Within the classroom, enhancements such as use of personal response devices, use of Twitter feeds for real-time discussion of presentation materials, and tablet-enabled learning have continued to expand. Finally, with developments in learning management systems, new capabilities such as learning analytics are becoming more relevant to the learning environment in higher education institutions.

Northwestern, like many of its peers, has taken the first steps down this transformative path. The road forward will be one of accelerating evolution and experimentation as educators employ technology to enhance their teaching and learning experiences.

Key Drivers for Educational Technology

As described in the introduction of this document, the pace of change in IT is continually accelerating. This acceleration is felt acutely in teaching and learning, where many developments can be tied to the global news media generated by the developments in online learning. One of the byproducts of this exposure is heightened dialogue on campus about the transformation in higher education and how this might affect or enhance what is done at Northwestern. New pedagogical approaches are being explored at an unprecedented rate. New technologies and methods are being developed and applied to the spectrum of teaching modalities at an increasing rate. It is an exciting, volatile time for the practice of higher education, in which several key drivers beyond these online learning developments are leading to increased participation and experimentation at Northwestern.

Cloud Computing – The momentum that cloud services have gained during the past few years in the redevelopment of many of our most valuable consumer services is now at play in almost every dimension of educational technology. It’s no accident that the learning management systems that have increased in market share during the last two years in North America are cloud-based. “Legacy” learning management systems that were designed principally for university IT department operation are waning in market share and also in their pace of new feature development. The rise of well-designed, cloud-based learning management systems, social media systems, media delivery services, and learning analytics engines make a compelling argument that many of Northwestern’s current operating practices and system commitments for teaching and learning should be reviewed.

Big Data/Analytics – The increasing sophistication of big data/analytics tools and the emerging development of learning analytics interoperability standards are attracting the attention of educators, students, and teaching centers. Although the field of learning analytics is young, the emerging capabilities that are being incorporated into the most recent offerings of the more advanced learning management systems, e Text collections, and social media platforms need to be incorporated into IT@NU’s planning.

Mobility – Another challenge being felt in higher education from the technology sphere is the growing use of mobile devices. Higher education has not yet understood or fully embraced opportunities to exploit the benefits of mobility for teaching and learning. The 2013 Educause ECAR study of students and technology shows that smartphone and tablet ownership (and use) by higher education students is

the fastest growing device ownership segment; the same study shows that most students assign lower and lower values to the quality of university-provided mobile services. We need to pay attention to improvements in mobile infrastructure and services, including those in the classroom and in the online systems used by our students.

Consumerization of IT – As in other aspects of IT, the tools available to users beyond the campus are shaping the expectations and requirements at the University. Examples such as the use of Skype are driving expectations of equivalent functionality and ease of use with video conferencing. Similarly, interactions made possible through social media platforms are expected to be possible in our teaching and learning environment. A final example is that incorporation of media in the teaching and learning needs to be as available and easy as YouTube.

Increasing Pace of Change – Today the biggest challenge for IT education technology efforts at Northwestern is to move more quickly in supporting faculty innovation in blended learning and online education. Equally important, we need to do this at a scale of adoption that dwarfs previous efforts, which historically have involved relatively smaller groups of faculty “pioneers.”

Responding to the Change around Us

To support the transformation in Northwestern’s educational practices, we need to foster an environment for experimentation into new methods of teaching and learning. The major components of that environment are:

- Strategic infrastructure investment
- Centrally supported software offerings
- Integration of locally provided solutions
- Support for selecting and integrating externally hosted services
- Faculty and student support services

The challenges of creating such an environment can’t be faced alone by NUIT. As Northwestern strives to improve innovation and outreach in its educational offerings, partnerships between central providers and the schools are critical to sustain continued growth and experimentation.

Current State

The sections below briefly describe where progress has been made already, and what remains to be done in the near term.

Building Blocks

Innovation in teaching and learning is occurring today on many fronts at the University, and these efforts point to new opportunities for strategic Northwestern educational experiences. An increasing number of Northwestern faculty are making commitments to emergent teaching models and online education practices, and many elements of the desired future-state environment are in place. The list below highlights some of the significant strengths of the institution and steps we have taken.

- The University’s efforts in online education and blended learning during the past year are generating energetic and thoughtful dialog on campus. New institution-wide committees have been established to set policies and explore avenues in these new educational areas.
- In 2012, the Educational Technology Advisory Committee (ETAC) began studying the educational technology landscape at Northwestern. The members of ETAC have uniformly expressed the need for substantial improvements in the University’s electronic teaching environment during the coming

year. These improvements are critical to the transformation to a “new normal” of blended learning at Northwestern.

- Under the leadership of ETAC, a campus-wide evaluation of our learning management environment is being conducted with extensive faculty participation, including piloting an alternative learning management system (LMS) in University courses. The objective is to make specific recommendations for improvements to the course management system. By spring 2014, over 100 pilot courses will have been conducted with an alternative LMS, supporting almost 4,000 students.
- The adoption rate of Blackboard Learn by Northwestern faculty has been high. Though dating back to 1999, this course management system remains the primary electronic teaching environment for the majority of our faculty and students. Wide use of this environment will make migration to an improved environment more manageable than it otherwise would be if the digital teaching environment at Northwestern were more fragmented.
- The base level of physical classroom conditions at Northwestern is now very good, and a standard set of classroom technologies is in place for all classrooms. Last year, Wi-Fi coverage was extended to 80% of the Registrar-controlled classrooms. With the completion of renovations to Kresge Hall, Wi-Fi coverage in classrooms should reach 100%. In anticipation of the closing of Kresge Hall next summer for two years of renovations, eleven classrooms in the University Library are being upgraded this year for seminar-style collaboration activities. In Annenberg Hall, a major upgrade was made to a large classroom space this year for student group-based, active learning practices.
- Increased partnership is happening between teams at the Searle Center for Advancing Learning and Teaching, the School for Continuing Studies, and NUIT, resulting in stronger support services for online and blended learning efforts.
- The University’s efforts in online education and blended learning during the past year are generating energetic and thoughtful dialog on campus. New institution-wide committees have been established for setting policies and exploring avenues in these new educational areas.
- First generation efforts are now underway at Northwestern with Coursera MOOCs. MOOC efforts are helping us learn to teach “at scale,” take first steps with learning analytics, and extend Northwestern education offerings well beyond traditional campus boundaries. The experience gained by our faculty pioneers in these first Coursera MOOC efforts is already invigorating reflection and leading to new intentions for improvements to the education environment on campus.
- Most of Northwestern’s schools and units have been eager to experiment with new learning technologies. This includes producing MOOCs, exploring a social media platform as a base for teaching and learning, conducting pilots of new LMS’s, using MOOC platforms for on-campus courses, experimenting with language instruction activities in new LMS’s, developing new devices for classroom technology – the list could go on. These are all positive signs of an engaged community helping to drive experimentation in this area.
- Startup efforts with a consortium of universities that have joined with the 2U commercial venture are allowing Northwestern to investigate the role of synchronous, virtual courses for small groups of undergraduate students. Populated with enrolled students from both Northwestern and from other universities, 2U classes offer credit-bearing outcomes and the opportunity to fit required courses into students’ demanding course fulfillment schedules.
- Distance learning courses offered by the School of Continuing Studies are growing in number and global reach as quickly as the University can expand them, assuring the highest quality-control over the offerings.
- Faculty at Northwestern who have pioneered our first Coursera MOOCs have recently been able to sample learning analytics services applied to the “at-scale” student communities of their MOOCs. These very early experiments have allowed faculty to explore interesting questions about patterns

of study, engagement, and progress in learning communities. These analytic practices, particularly when deployed within systems powerful enough to enable “real-time” or “recent-time” queries, provide great opportunities for empirical investigations of learning theories and teaching practices.

- Mediasite has been expanded to several additional Northwestern schools during the past two years. This commercial video capture and management system provides advanced classroom video capture services, integrates with teaching and learning platforms, and also can play a critical role at the University in providing faculty with web-based services for creating course-cast content.
- Northwestern videographers have demonstrated success in helping Northwestern faculty produce quality video-based “course nuggets” for use in blended learning transformations of traditional courses, as well as in developing quality video content for Northwestern’s first generation of Coursera MOOCs.

Areas that Require Attention

Northwestern faces challenges in achieving its ambitions for teaching and learning in today’s environment of transformation. Attention and a series of upgrades to our current teaching and learning infrastructure are required to address these challenges.

- Blended learning and online education: A more effective suite of support, consulting services, and tools for making the transition to blended learning and online education will be required. This will require moving forward in unison across schools and units to enable more engagement and a deeper embracing of new pedagogical models. Practically every faculty member at Northwestern who has experimented with blended learning has decided to continue to use techniques employed in these experiments due to improved test results and higher quality of student discussion in the flipped version of the course. To support this increased demand, a campus service point is needed that will be easy for faculty and TA’s to access, where they can get expert consulting help and can use easy-to-master tools that help in the transformation of their courses from lecture-centric experiences to blended learning.
- Course management system: Blackboard Learn, the course management system used by Northwestern for 14 years, offers weak support for the transformation to blended learning. Alternative learning management solutions are now available that offer superior educational technology tools, more scalable and efficient operations, a much more contemporary and friendly user experience for blended learning, improvements in mobile device support, and features that support meaningful collaboration among student learning communities.
- Media production and editing: To fully implement blended course design, faculty and staff need widespread and accessible rich media production and editing capabilities. The current landscape is very uneven, with some units having fully up-to-date facilities and software tools; others have access to only a few tools and no facilities. In addition, the University provides a patchwork of services for the management and distribution of rich media (including video, audio, and images) that is hard to navigate and less than complete.
- Learning analytics: As more of Northwestern’s teaching and learning is moderated by technology, the development of learning analytics to serve teaching interests cannot be ignored. Although this is a field of expertise that is comparatively new, the opportunity for Northwestern faculty members to develop new insights into teaching methods and our learning communities is too great an opportunity to miss.
- Classrooms: Many of our classrooms have been designed solely for lecture modes of teaching. Most of those classrooms will require modification to support blended teaching and learning. Included in this category are advances in video conferencing capabilities and ease of use for group work.
- Cloud offerings: In some cases, there are immediate gains to be achieved for Northwestern faculty and students from cloud offerings in educational technologies. These benefits include improved

system reliability; rapid scaling of system capacity to support periods of high demand (such as during mid-terms and finals week); a reduction in overall system costs for the University; provision of 24/7 availability of the teaching and learning systems (and help) across all time zones of the world; and delivery of better overall performance and user experience within our applications. All of these benefits of a successful, secure cloud offering will better support our educational goals. More exploration is needed to determine the right mix of on-campus and cloud services.

What Do We Do Next?

Blended Learning

Expand faculty support for blended learning and online education. This will require us to:

- Expand NUIT's support and service for rich media production – NUIT's service capabilities should be expanded for development of "course nuggets," course-casting, and video capture. Develop a tiered set of video services and course-cast capabilities, in partnership with school IT units. The goal is to establish desktop, distributed drop-in self-service, and specialized high-production "course nugget" pedagogical production models for implementation at scale in the following years. (FY15)
- Help faculty explore new pedagogical techniques – NUIT and partners across the university will focus on blended learning techniques and organize outreach to faculty and staff to help familiarize them with concepts and tools. (FY15)
- Provide more dedicated support for blended learning – In recognition of the need for support in this area, two existing A&RT staff positions are being dedicated to supporting blended learning. (FY14)
- Expand NUAMPS – Additional staff positions will be created in NUAMPS (Northwestern University Advanced Media Production Studio) to support the growing need for media content production associated with blended learning. (FY14)

Learning Management System

For FY15, begin the campus-wide transition from the old Blackboard Learn course management system to the new, recommended Learning Management System (LMS) identified in spring 2014 by ETAC. The transition will start in summer 2014, and the old Blackboard Learn course management system will be retired from production use by August 2015. This will require us to:

- Move or enable users to move selected learning content from Blackboard into the new LMS.
- Work in partnerships across NUIT, ETAC and the schools and units of the University to support a transformation of Northwestern's electronic teaching environment by transitioning to a multi-media friendly, app-oriented, and interactive learning management system.
- Build a network of affiliated support staff in schools and units across the University to help support the transition to the new LMS. Also, NUIT, The Searle Center and other campus partners will bring blended learning techniques and information to the training sessions for the new LMS.
- Train faculty on the new system with NUIT and school support units working together.
- Rebuild the data connector service between the Student Enterprise System and the new LMS. New standards have come into play since the data connector service was first built for Blackboard, and adoption of these standards will allow for easier management of student data with Northwestern's electronic learning environment.

LMS/Distance Learning

Expand NUIT's operational support for the new Learning Management System (LMS) to accommodate a larger number of distance learning courses offered around the globe by NU schools. (FY16+)

MOOCs

Support a second round of Coursera MOOC offerings that distinguishes Northwestern's teaching to a worldwide audience. Continue to innovate within the Coursera platform and work closely with their developers to guide and enhance the faculty and student experience. Support faculty who have taught Coursera MOOCs to repurpose their MOOC learning content into on-ground courses. (FY15)

Rich Media

For FY15, centrally provide comprehensive support for faculty in all NU schools for Mediasite services. This will allow on-demand recording of lectures or class meetings, secure storage of media, and authenticated distribution. For 16+, extend the rich media toolset, including:

- *Digital Access Management* – A solution for digital repositories and related management systems may be required to supplement the services of an improved learning management system to provide a complete set of services for advanced and shared project work by our students. The ETAC governance committee will support this investigation. (For FY16+)
- *E Texts* - Expand the University's efforts with eText collections licensing and with dynamic report services from eText platforms that provide analytics feedback for students and instructors, hosted within the new Learning Management System. This work will take place in partnership with the University Library. (For FY16+)

Classrooms

During FY14, the University Classroom Committee is improving eleven classrooms in the University Library to better support blended learning and seminar-style classroom meetings. In addition, video conferencing services are being added to a classroom in Searle. Meanwhile, joint meetings of the chairs of ETAC and the University Classroom Committee are now taking place on a regular basis in order to steer classroom design efforts at the University to classroom models that will support the new normal of blended learning. For FY15, work with the University Classroom Committee on the design of teaching spaces in new buildings, as well as the development of new classrooms in the Kresge Hall renovation effort. A video conferencing and webcasting review will be part of this activity.

Learning Analytics

For FY15, and under the direction of the Coordinated Service Center for Distance and Online Learning (CSC/DOBL), establish a startup workgroup for Learning Analytics to serve both online education and blended learning courses at Northwestern. The development of learning analytics services that are easily accessible within the University's LMS should enable students to optimize their study activities, for instructors to reflect upon and investigate the most effective learning strategies for courses, and for administrators to provide better evidence of Northwestern's education quality to credentialing agencies.

Research Technology

Executive Summary

Over the past decade, several macro-level changes have begun to transform the way in which research has been conducted: increased collaboration across disciplines and across institutions; increased modeling and simulation; creation and use of very large data sets; and increased use of shared central and national resources.

These trends create challenges for how the University delivers infrastructure and services to support research in order to attract the best faculty and students, increase grant funding, enhance research instruction, and form communities of researchers and practitioners. A spectrum of different needs exists across the community, which demands the careful exploration of a spectrum of solutions. Centralized campus offerings, cloud-based solutions, federal, state, and consortium facilities should all be considered as potential parts of the enterprise solution.

The role of the research technology support staff is to partner with the community to grow campus expertise across IT@NU to broker and support targeted solutions. The following points highlight the areas in which we must grow our services in order to support the evolving demands of research computing.

Develop a shared vision for delivery and support of research cyberinfrastructure – Understanding infrastructure and services for research technology support requires more formal and informal participation of researchers from across campus. Establishing governance to determine needs, set priorities and develop plans is a priority for this year. Increased grass-root interaction with researchers by campus support teams is another priority to be planned this year.

Continue to build out and refresh the core research computing services – Data center facilities for hosting, high performance computing, research storage, advanced research networking, and visualization services have all received attention over the past four years providing a solid base for research needs. However, with the increased collaboration, higher computational requirements, big data pressures and economic drivers leading to centralized services, there are ongoing requirements to not only maintain, but to expand these services to meet the needs of our researchers.

Develop new Research Data Management Services – New data management opportunities and requirements are facing our researchers. Solutions and services need to be extended to researchers to ensure effective use of data with information security and compliance with granting agencies requirements.

Enhance Training and Support – Research Technology has struggled to push training to the widely distributed staff who need it. MOOCs may provide part of the answer, making the information available on demand. But vital to this effort will be the development of deeper, more consistent relationships with the individuals and units that support researchers.

General Research Support – In addition to the areas above, there is a need to support across-the-board research activity such as statistical computing, survey tools, and the digital humanities. Each may not be a case for central support, but we need to aggregate pockets where needs do exist.

Introduction

Over the past decade, several macro-level changes have begun to transform the way in which research has traditionally been conducted:

Traditional	Emerging
Methods of theory supported by experiments	Methods that integrate theory and experiments with modeling and simulation
Discipline centric	Interdisciplinary
Small, local investigative groups	Very large collaborations, including large scale multi-institutional, international projects
Dependence on local facilities	Use of highly distributed resources
Modest-sized data sets	Extremely large data sets
Separate and often local resources	Shared central and national resources

In response to the above trends, we have witnessed steady growth in the development and provisioning of shared research cyberinfrastructure in universities worldwide to meet the need for scalable, affordable, secure, and robust centralized research computing services.

Key Drivers for Research Technology

Increasingly researcher requirements for IT infrastructure services and support are extending beyond the capabilities of individual facilities. Whether due to economic drivers, higher computational requirements, larger storage requirements, increased collaboration, or to meet increased regulations, there is a growing need for consolidated, centralized IT infrastructure required to perform complex research. Advanced research infrastructure services are increasingly necessary to attract top-notch students, researchers, and grant dollars. These facilities are not just demanded by high-end science users; high performance computing, data-intensive research, and visualization have permeated a broad range of disciplines encompassing not just traditional computational domains, such as the physical sciences and engineering, but also medical research, the social sciences, performing arts, life sciences, and the humanities.

While funding agencies such as the National Science Foundation (NSF), Department of Energy (DoE), and the National Institutes of Health (NIH) provide access to a tremendous set of national resources, there is still a great demand by researchers for access to infrastructure resources at their home institutions. Below are a few of the more significant external drivers impacting IT provisioning for Northwestern researchers.

Sequestration – Business models for sustainable research cyberinfrastructure are sensitive to significant contributions by researchers that depend on federal funding. Government sequestration is reducing research funds awarded by the federal government. For example, NSF has begun to restrict the funding of larger multi-year center grants in favor of one-to-two year exploratory projects. NIH and other agencies are outright cutting the number of funded research projects. This puts research universities in a challenging position – robust computing facilities are required to remain competitive, while the funding for these facilities is shrinking.

Security and Regulation – Compliance and regulatory stipulations abound, requiring privacy, security, and access controls, and introducing challenges to existing business operations and processes. These result in enhanced due diligence activities and require the development and implementation of new

policies, standards, and procedures. For example, there is an ongoing demand on academic computing centers to manage HIPAA/HITECH information such as electronic Protected Health Information (ePHI) for medical research. These regulatory requirements call for institution-wide policies and infrastructure (information storage, transmission, and access) that ensure the security of regulated data while supporting the need for collaboration.

Big Data / Analytics – Researchers across the world are collecting data from an array of increasingly diverse sources and instruments, including sequencers, sensors, social media, video, images, blogs, and many large-scale specialized research instruments that are capable of generating several terabytes of data with each acquisition. The rate of instrument implementation and data acquisition is increasing, introducing new challenges in the storage, computing, and movement of these data, as well as in the development of technical skills necessary to find insight within the growing volume of accessible information.

Open Access – New mandates by the White House Office of Science and Technology Policy require that research data and publications arising from federally funded research must be made available to the public (where legally allowable) in ways that make this information easy to find, accessible, retainable, preserved, and usable.

Cloud Computing – Improvements in cloud tools and solutions for research may soon begin to mitigate the need for some on-premise solutions for computing and analysis for some research workflows. For example, we are beginning to witness an increasing amount of genome analysis being conducted cost-effectively on cloud platforms. However, research tools for cloud solutions continue to lag significantly behind traditional high performance computing platforms. As a result, researchers must evaluate if the benefits of the cloud solutions overcome the costs in more limited tools and the human resource costs of using these cloud services. (i.e., effort and skills development needed to port applications to new platforms.

Responding to the Change around Us

It is important to note that while the demand for research computing services is accelerating, a spectrum of different needs exists across the community, which demands the careful exploration of a spectrum of solutions. Centralized campus offerings, cloud-based solutions, federal, state and consortium facilities should all be considered as potential parts of the enterprise solution.

From a Northwestern perspective, the response to campus and funding agency drivers, is increased interest in developing and leveraging a common research infrastructure. Contributing to this move to a more consolidated research infrastructure are: efficiencies related to capital infrastructure costs (facilities, computing, networking, and storage) and ongoing operating costs (such as energy), opportunities to more broadly leverage specialized and expensive facilities (such as clustered and grid computing), and requirements to more securely store, preserve, and share information.

Delivering these future common infrastructure services requires increased partnerships with schools, departments, and faculty to prioritize, provision, and support critical research services. The growing diversity of research needs for hosting, computing, data storage, visualization, Big Data, and networking makes rationalization of service options much more difficult than even a few years ago. It is vital that NUIT engage a broader community of knowledgeable practitioners to explore and evolve the available services, and to help educate the research community about their use.

Current State

This section presents expanded details on the building blocks we have in place and the areas that need more immediate attention.

Building Blocks

The adoption of advanced computing and analysis infrastructure as indispensable tools in virtually every discipline fundamentally changes the way research problems are being approached. Rapid increases in raw computing power and storage capabilities enable new research inquiries, even in disciplines where computation played essentially no role a decade ago. In science and engineering, computer simulations are now the third pillar of research, next to theory and experiment. Use of new types of multi-core processors and systems, data intensive computing, and Big Data science will enable studies of problems in their full complexity and realism.

Over the past 5 years, Northwestern has made consistent investments in the provisioning of research infrastructure and support capabilities.

- Quest – Since 2009, the University’s commodity-use, high performance computing cluster has grown to support about 1,000 users running more than 300 research projects. Resource utilization remains at 85%, which is exceptionally high for a commodity-use cluster supporting a vast array of domain applications. The resource set has continued to grow, providing new commodity-computing capabilities, GPGPU functionality, and pilots of new file transfer services (Globus Online) for movement of large data over commodity and research networks.
- Social Science Computing Cluster – Under a long-standing partnership between Weinberg, Kellogg, and NUIT, the Social Science Computing Cluster supports the research and teaching activities of social science faculty and their graduate students through advanced computational capabilities and targeted analytical software applications.
- Vault – Vault collaborative research storage is used by about 1,000 faculty members, research staff, and graduate students to share and store moderately sized data sets.
- Data Storage – Supplemental storage provides users of Quest with cost-effective storage space to facilitate data analysis pipelines and workflows, and to meet the need for persistent storage of large-scale results from Quest computations.
- Advanced Research Network – Early deployment of an advanced research network connected the Center for Advanced Molecular Imaging (Chemistry of Life Process institute) at 10Gbit speeds. External funding obtained late in 2013 from NSF will be leveraged to extend this higher capacity research network to additional labs, increase the aggregate network performance between Evanston and Chicago to 100Gbit, and increase the network capacities to 10Gbit for both Quest and Vault.
- Visualization Services – The Visualization Services group was expanded in 2012, bringing new support for animation, dynamic interaction, and digital illustration. Through this group, faculty members across all disciplines can now produce highly informative visual representations of their real, simulated, or conceptual research data. The visualization services offered by the University provide researchers with the opportunity to visually analyze complex data, communicate their science to broader public and peer communities, and develop outreach media for promoting their research.
- Security – To satisfy HIPAA/HITECH compliance requirements for hosting and processing regulated information, we adopted several security policy and procedure improvements at the data center. Additional practices and protocols are being adopted to further prepare the University to respond to formal HIPAA/HITECH compliance audits, should they occur.

- Community Support and Engagement – The growing complexity of research is producing equally more complex tools, technologies, and data options. Training, outreach, and consultation in the design and use of research computing resources and services have become core functions. These people-oriented services look to extend research and grant opportunities via deep partnerships, increase the competitive nature of Northwestern proposals, and support research inquiry of our faculty and students.
- Research Infrastructure Facilities – Ten years ago, research activity in the central data centers occupied less than 5% of the available floor space. Today, research server hosting accounts for over half of the floor space in three facilities. At the main data center in Evanston, the University has invested over \$7 million in power and cooling improvements. Plans are to expand future capacity by over 45 equipment racks, with the majority dedicated to research. Operated by NUIT, the LG87 research facility was upgraded in 2010 and has been in continuous operation for over two years. There are no plans to enlarge this facility. Due to constraints in available power, cooling, and floor loading, hosting of research equipment in the Chicago data center is being phased out in favor of Evanston.

Areas for Attention

Northwestern has invested significant resources in centralized research computing functions. However, there is much to be done to meet future demand and ensure sustainable growth in support of researchers. Listed below are a few key areas requiring attention.

Continued consolidation of research computing in central facilities - Central computing facilities provide numerous benefits over locally hosted workstations and servers in terms of performance, backup, security, etc. In some instances, however, there are benefits to local solutions that complicate that transition. Some researcher-owned equipment requires high-touch maintenance. For example, prototyping practices may require quick turnaround (on the order of minutes to a few hours) to determine if the simulated model is producing a desired result. Even when local benefits are not so tangible, there may be obstacles to consolidation – moving or porting applications between infrastructures requires support to address technical challenges. NUIT will need to continue finding ways to address these needs from the central facilities, and the community needs to continue evaluating and challenging the assumption of local hosting requirements to optimize ongoing facility investments.

Exploration of cloud computing – A few years ago, cloud computing saw minimal use in scientific research, but the past few years have seen some growth. Genome analysis has found its way onto cloud-based platforms, and the results are increasingly positive. While not yet deemed a core source for performing computational research, cloud options must be part of the conversation with faculty in the same way that migration onto federated resources becomes necessary when needs exceed the capacity of our HPC environment. Continued exploration of cloud-based systems is necessary.

Research Hosting – Research computing applications present significant demands for space, power, and cooling in the data center. With technology advances continuing to provide more and more computing for less power in less space, effective stewardship of these resources strongly signals the need to retire aged computational equipment (e.g., that is four or more years old). Many in our community also struggle to provide adequate administrative and management support for these services and this equipment.

- The research co-location facility is expanding by approximately 8 racks per year. An equipment retirement model needs to be developed that cycles out old equipment for modern compute infrastructure to make the best use of the University's investment in data center capacity.

- NUCloud has provided a mechanism that reduces some of the administrative burden on partnering schools, while increasing the flexibility for provisioning new services. Is a similar model viable for research activity?

Computation and Analytical Services – New analytical tools are needed to support Big Data inquiries. Today Northwestern operates a computing facility that is analyzing datasets that are in excess of 200TB's each – but not without challenges. Given its immense size, not all data can be kept, and moving data in and out of the facility is hampered by the limitations of commodity network bandwidth and competing traffic. The need for large-volume, high velocity, and multiple varieties of data analysis will only continue to increase as our researchers explore new ways of developing insight. Future requirements in this area include:

- Capabilities for multi-terabyte data workflows and large volumes of unstructured data required by emerging scientific inquiry.
- Support for researchers needing to scale beyond University resources. Transitioning users onto larger national infrastructures, such as XSEDE or BlueWaters, can require significant technical staffing resources, but it has the potential to result in significant scientific impact. Identifying areas of research and applications that can most benefit from these larger environments is necessary in building improved training and awareness of these facilities.
- Continued evaluation and strategy for new computing and alternative computing technologies. Technologies such as GPGPU, Hadoop, and Intel PHI offer the potential to positively impact research application areas by introducing new efficiencies that reduce the mean-time-to-result, and they may enable more complex research inquiries to occur.
- Development of a cloud services strategy. Cloud computing provides opportunities for scientists to leverage off-site computing capability, but it is not the best match for all projects.
- Review of the financial model for sustaining investment in Quest.

Data Storage and Management Services – The extent of improvements made in life-cycle management of research data will directly impact the competitiveness of research proposals submitted for funding. Researchers are routinely acquiring multiple-terabyte data sets from a diverse array of sources and instruments. The scale alone presents challenges. It is compounded by increased regulations for data access, preservation, security, and appropriate distribution. Vault, a University system for sharing research data, is designed to support some specific tasks and workflows, but it is not a complete solution.

- Off-site services – Cloud storage services, such as Box.net, provide ease of use and scalability for limited types of data sharing not easily replicated with localized solutions. Newer variable-cost cloud data archiving options (e.g., Glacier) provide exceptionally low cost services for storing archived data, but charge for access and transfer. Ongoing evaluations and strategies must be developed to set appropriate expectations for cloud-based data sharing and storage.
- Support for regulated and proprietary data - We estimate that Northwestern may have over 1 petabyte of regulated data residing on researcher desktops, laptops, mobile devices, USB drives, and servers. Neither Vault nor Quest was originally intended for use with regulated data. However, there are increasing expectations by regulators and funding agencies for institutional-wide implementation of policies and infrastructure that ensure the security of regulated data. Plans for ensuring the security of research data will require the development of governance, organization, policy, workflow, and technology solutions.
- Protection and archiving strategy – Research data storage, its protection, and its accessibility are coming under increased scrutiny by federal funding organizations. The community needs to develop a policy-based strategy that will meet federal, state and University requirements.

- Research Data Management Planning Services - Government funding agencies like the NSF and NIH are requiring researchers to follow agency guidelines when planning data management. However, data management needs vary based on the research project and the types of data being handled. Researchers must be engaged to determine the support they need in navigating the creation and execution of these plans.

Research Networking – Traditional methods for shipping data on hard drives are quickly losing viability as the datasets being produced on instruments and supercomputers, or gathered from sensors, are increasing in size and fidelity. Data is not necessarily located at its collection point. Simulation, modeling, and analysis of data are being accomplished everywhere, from local facilities, to national computing centers, to cloud services such as Amazon EC2. Specialized network services, which support collaborative science research teams worldwide, are increasing in use. These networks can create and control special integrated environments comprised of multiple resources at geographically separate locations (e.g., instruments, analytic appliances, compute clusters, storage, visualization displays, and others). There is now widespread recognition – including by the funding agencies – that supporting research data requires networking services that are fundamentally different than those that support general types of traffic. Northwestern needs to continue to develop specialized research networks separate from its commodity network, including customizable network services that can optimize performance.

Security & Regulation Requirements – Increasing requirements by regulators and funding agencies call for institution-wide policies and infrastructure that ensure the security of regulated data. To this end, there is pressure placed upon research organizations to assume responsibility for regulatory compliance and acquire the resources necessary for the development, implementation, assessment, authorization, and monitoring of common controls. Clarity around auditing and policy enforcement – who is responsible for compliance, how do we ensure compliance – is becoming increasingly important but must be balanced with the driving needs of the organization.

Visualization – Exploring and presenting subject data in advanced ways is an area that holds great promise for research, outreach, and educational efforts. We have the opportunity and need to expand efforts beyond the communities currently exploiting these opportunities.

General Research Support – In addition to the areas above, there is a need to support across-the-board research activity such as statistical computing, survey tools, and the digital humanities. Each may not be a case for central support, but we need to aggregate pockets where needs do exist.

Service Support, Training, and Delivery – The growing complexity of research, along with the bevy of technology options and compliance requirements, is producing equally more complex tools, technologies, and data options. At times, central support for research applications, environments, and training can result in less-than-ideal solutions, given limits of domain knowledge and central staff resources. At the same time, high turnover in graduate students and post-docs makes identifying individuals in the community more difficult, and not all research groups have dedicated research support staff. To more fully understand where points of leverage can be found to better meet the needs of the research community, collectively we need a comprehensive understanding of applications and services in use by researchers, and the knowledge of who currently provides support/assistance.

What Do We Do Next?

NUIT is jointly establishing governance with the Office for Research to ensure community-lead direction in the development and sustainability of future IT infrastructure and services supporting research. Additionally, opportunities for increased interaction with researchers across campus will be explored to disseminate information on available services, and uncover new needs and services as they arise. Below are a few concrete steps that need to be undertaken in the next two years to advance this model.

- *Develop a shared vision for delivery and support of research cyberinfrastructure* – The model for delivery of research computing services is five years old. As described at the outset of this section, since their development research requirements have continued to evolve, and facilities provided on campus need to evolve with it. Some specific next steps are:
 - Charter a formal governance committee in the ITGOV structure. (FY14)
 - Revisit the mid-term research infrastructure plan. (FY14 – FY15)
 - Gather requirements for facilities, computing cycles, and research networking.
 - Gather requirements for research data (storage, protection, access, archive).

Quest and Vault, two robust central services offered today, have suffered from slow, incremental faculty investment. It is necessary to revisit the funding models for these services, and re-evaluate how to promote these services for greater adoption and investment. In conjunction with the governance committee:

- Clarify and promote the value proposition of these services. (FY14 – FY15)
- Develop a funding model for these services that better supports refresh and expansion. (FY14 – FY15)

- *Continue to build out and refresh the core research computing services* – Even with the understanding that a shared vision is necessary to adequately address the diverse needs of the Northwestern community, we must continue to maintain and expand existing services to meet the needs of our faculty and students:

Computational Services:

- The original Quest phase 1 purchase in 2009 has come off warranty (FY14). A refreshment of a portion of this capacity is necessary to complete the final year of guaranteed purchased allocations by University faculty. This will also introduce more modern computing equipment as a means of continuing to attract faculty investments.
- Quest Phase 2 (purchased in 2010) will be off warranty and due for replacement in FY15.
- Evaluate Quest for support in analyzing regulated data. (FY15 – FY16)
- Continued faculty interest and investment will require expansion of Quest. (FY16)

Data Storage Services:

- Provide new, initial services (yet to be identified) capable of storing up to 0.5 petabytes of research data. (FY14)
- Evaluate the ongoing fit of Vault collaborative storage alongside cloud services such as Box. (FY15)
- In concert with the Library, Office for Research and other University partners, identify and develop a model for preservation, archiving, and curation services. (FY15+)

Research Networking Services:

- Leverage NSF CC-NIE funding to expand Northwestern’s research network (FY14):
 - Increase the intercampus backbone to 100Gbps
 - Provision 10Gbps capabilities to Quest and Vault
 - Enable 11 new research labs with 10Gbps networking capabilities.
- Evaluate if the emerging ScienceDMZ research networking model is appropriate for Northwestern research activities. (FY14-FY15)
- Transition GlobusOnline from a pilot to production service. (FY15)

Visualization Services:

- Expand visualization services to cover a broader range of interactive and illustration needs. (FY14+)
 - Raise awareness of emerging visualization services and domain-specific solutions. (FY14)
 - Continue to involve students in the development of highly informative visual material through internships and other work-study opportunities. (FY14+)
 - As demands on visualization services continue to grow, plan for necessary supporting infrastructure (FY15 – FY16) and staff. (FY16 – FY17)
- Develop new Research Data Management Consulting Services – New technologies are emerging to address challenges caused by larger, geographically disparate datasets, open access, and security mandates. It's a volatile market, and faculty members have little systematic guidance on how to proceed productively and compliantly with their data management. It's vital that Research Technology engage the community to develop a culture and practice of federated research support and consulting.
 - Initiate and continue conversations with partner institutions (e.g., CIC, AAU) on developing consortium-based data repository services or entering into shared contracts with external providers. (FY14+)
 - Identify and distribute best practices for data management across NU. (FY14 – FY15)
 - Prepare for new training and outreach efforts on the NSF, NIH, and DOE responses to open data requirements. (FY14 – FY15)
 - Explore and identify internal/external services that would aid in compliance of NU researchers. (FY15+)
 - Enhance Training and Support – There is solid expertise in Research Technology to support researchers in technology selection and process execution. However, the group has struggled to push training to the widely distributed staff who need it. Traditional classroom training has proven unsuccessful. MOOCs may provide part of the answer, making the information available on demand, but vital to this effort will be the development of deeper, more consistent relationships with the staff (and graduate students, post-docs, etc.) that support faculty researchers. Specific next steps include:
 - Explore opportunities to further involve staff from departments and research groups in joint support of software and application environments. (FY14 – FY15)
 - Develop a vision and strategy to build a sustainable learning model for research computing. (FY14 – FY15)
 - Cultivate a new peer-to-peer network of research consultants to improve support, training, and time-to-resolution (FY15)
 - Improve central research computing services to enable federated support and administration. (FY15+)
 - General Research Support – Evaluate needs related to increased support and services for across-the-board research activity such as statistical computing, survey tools, and the digital humanities. (FY14)

Administrative Systems

Executive Summary

Northwestern has a wide range of administrative systems with extensive functionality, including:

- The commonly understood “enterprise systems” (alumni/development, business intelligence, human resources, facilities, finance, research, student) that are supported from central units.
- Systems that serve the broader University but are supported in business units (library, space management, research compliance, etc.)
- Systems that have emerged through a decentralized fashion but have grown or are growing beyond the originating unit (OnBase, ImageNow, GATS/GSTS, etc.)

The focus of this section is on common needs and priorities across systems. As a frame of reference, a sampling of the upcoming needs/priorities for specific systems is included at the end of this section.

Addressing common needs effectively requires us to view the administrative systems landscape holistically. This holistic vision applies to the integrated operations of the systems and to the organizations that support them. As IT@NU, we must align our energies towards the following overarching objectives: integrate systems and their data; answer key business questions; enable requirements beyond the major business units more easily; enable more efficient work; decrease time-to-service delivery; include external participants; and limit costs.

The following points briefly describe the areas in which we must progress over the next few years to move toward this vision:

- Services Infrastructure: The principal enabling technology to support this vision is a service-based architecture, which will provide the foundation for many of our top priorities: integrating systems in real-time; deploying cross-system workflows; helping integrate data; reducing duplication of data entry.
- Identity & Access Management: Improving our IAM system will facilitate service provisioning across our systems and services (local and cloud based) and enable easier access to services for our faculty, staff, students, alumni and other partners across their full lifecycle of different relationships with the University.
- Reporting, Data & Analytics: There is unmet demand for more data access and reporting from our major enterprise systems. This demand is shifting towards wanting a more holistic (i.e. cross-system, cross-functional area) view of data.
- Workflow: Electronic workflows add value by standardizing and streamlining equivalent paper processes, guiding users through business processes, automating behind-the-scenes event-driven transactions between systems, and facilitating analytics on business processes. Very few electronic workflows exist today outside of those native to existing transactional systems. We need to build workflows between and around these systems.
- User Experience: Our users want our applications to be easy to find, gain access to, and navigate. Deploying each of the aforementioned enabling technologies will help as will developing plans and activities related to a unifying strategy and approach to system access.
- Governance, Engagement, and Aggregation: Balancing line-of-business needs against the work needed to deploy these enabling technologies will require concerted engagement at all levels of

IT@NU, as will improving the integration between development efforts in distributed units and in the enterprise systems that help fill gaps in services.

Introduction

Northwestern has a very wide range of administrative systems with extensive functionality, which are critical in supporting the mission of the University and the day-to-day functioning of the institution. These systems include:

- The commonly understood “enterprise systems” (alumni/development, business intelligence, human resources, facilities, finance, research, student) that are supported from central units.
- Systems that serve the broader University but are supported in business units (library, space management, research compliance, etc.)
- Systems that have emerged through a decentralized fashion but have grown or are growing beyond the originating unit (OnBase, ImageNow, GATS/GSTS, etc.)

Of critical importance to our administrative systems are a set of enabling technologies and techniques. Identity and access management (IAM), integration tools (including the emergence of a services-based architecture), portals, and security and information management practices are essential components of our administrative systems portfolio.

The focus of this section of the discussion paper is on common needs and priorities across systems. As a frame of reference, a sampling of the upcoming needs/priorities for specific systems is included at the end of this section.

Key Drivers for Administrative Systems

As described in the introduction to this document, the IT landscape has changed both rapidly and dramatically. This change affects technology to differing degrees on a global scale, within the higher education industry, and within our institution. The macro-level drivers most relevant to the administrative systems agenda at NU are identified below.

Redistribution of IT Provisioning – The wide availability of software offerings and relatively low cost of acquisition and local development enable units to deploy specialized local systems providing services that are enhanced and aligned to the unique needs of the schools and departments. This creates pressure on the central administrative systems teams to update skill sets and preserve staff time to partner with IT@NU implementers. This also heightens the priority on building the enterprise integration architecture to make our ever-more-diverse portfolio of applications an asset rather than a hindrance.

Big Data/Analytics—We already know there is great demand that is unmet as it relates to accessing the data of our major enterprise systems, both in each subject area and in integrated applications. Emerging needs include empowering higher-level analyses such as research, teaching and learning outcomes, and business decision making. Some of this data will be unstructured and require different tools, hardware, and skills than we currently possess.

Cloud Computing—Many new administrative applications that we acquire are cloud-based; many more of our existing vendor solutions have roadmaps that offer or mandate the migration away from on-premise solutions to cloud-based versions. We need to transform our architecture and administrative processes to be able to integrate these services as easily as possible.

Security/Regulations – Our operating environment is subject to an ever-increasing set of regulations, and compliance with these rules often creates “must do” projects that were not anticipated in our planning processes. We must also evaluate the security of data in our applications in an ongoing way, particularly as we aspire to move more functions online and use single sign-on across the enterprise.

Consumerization of IT – Our administrative systems are increasingly compared to consumer offerings that our users frequent for both business and personal tasks. User experience must now be a consideration in applications that support even the most complex business functions.

Mobility/“Always On” – The expectation is that any application must work well on the vast array of current (and yet to be developed) devices and browsers at any time and from any place. Our diverse ecosystem of administrative systems varies widely in their ability to support such expectations.

Community/Social Media—The “campus experience” is no longer confined by physical presence. Our stakeholders, particularly alumni and students, expect a vibrant online presence within which they can connect and engage one another and Northwestern resources.

Responding to the Change around Us

Addressing common needs in an effective fashion requires us to view the administrative systems landscape holistically. That holistic vision applies to the integrated operations of the systems and to the organizations that support them. As IT@NU, we must align our energies towards the following overarching objectives:

- Integrate systems and their data
- Answer key business questions
- Enable more efficient work
- Decrease time to service delivery
- Include external participants
- Limit resources required to delivery necessary administrative systems

To make this vision a reality, we must view our administrative systems as an ecosystem, rather than individual applications. In this model, the ability to deliver integration, both inside Northwestern and to other systems in the cloud or at partnering organizations, must be of paramount importance.

The following sub-areas describe the areas in which we must progress over the next few years. This section of the discussion document details current state, areas for attention, and next steps in each of these domains.

- Services Infrastructure: creating the foundation to integrate data and systems in real-time and to build and maintain the overarching administrative environment;
- Identity & Access Management: enabling access to our diverse systems to authorized users;
- Reporting, Data & Analytics: leveraging data for operational and strategic benefit;
- Workflow: enabling, performing and documenting automated business processes;
- User Experience: presenting a cohesive and intuitive portfolio to our users; and
- Governance, Engagement, and Aggregation: working as partners to identify enterprise priorities and work together as a community.

Current State

The sections below briefly describe our current administrative systems landscape.

Building Blocks

Our first building block has to be the fact that we have implemented market-leading software applications in the enterprise system areas known as the main “pillars” within our industry – human resources, student administration, finance, research administration, and alumni/development. We

continue to enhance and extend our administrative systems portfolio. Across our teams, there are plans to move numerous new functions online. The hard work and strong expertise of the IT@NU staff who have worked on these implementations and subsequent initiatives are highly valuable assets to our University.

- Services Infrastructure:
 - We are currently working on a proof-of-concept for a services architecture.
 - PeopleSoft systems have services built into them that can be exposed as services.
 - We are beginning to leverage services for real-time data integration on select projects.
- Identity & Access Management:
 - NetID has been instituted as the enterprise identifier.
 - We will soon publish a roadmap for our IAM platforms.
- Reporting, Data & Analytics:
 - The core data from many of our major administrative systems has been warehoused allowing us to increase the capability of our systems to produce line-of-business reporting.
 - Expertise in Cognos report and query development is well-established in some units, with training of more staff ongoing.
- Workflow:
 - We have built local workflows in enterprise systems to control routing and approval for a variety of discreet business processes.
 - A forms and workflow engine for internal student applications is being built for deployment later this year.
 - Workflows are being built in OnBase for several key sets of internal processes.
- User Experience:
 - Experience is growing on campus with “electronic forms with workflow” solutions.
 - Our vendor products are also continuing to mature, embracing standards such as responsive design or complementary mobile applications.
 - The new online alumni community embraces social media, user-generated content, UX design.
 - New research collaboration tools promote collaboration (internal and external to NU) and embed innovative content aggregation, network mapping, and search features.
- Governance, Engagement, and Aggregation:
 - There are an increasing number of partnerships between central and unit-based IT@NU resources.
 - From a planning and engagement standpoint, the new IT governance structures are taking root at level “two” – in this case, the Administrative Systems Advisory Committee (ASAC).
 - We are in the process of launching the planned governance committees at levels “three and four.”

Areas for Attention

Whether it is making systems easier to use, data easier to access, or processes more efficient, there is much left to be done. While we are reaping benefits of our current systems, significant levels of inefficiency and lack of capability persist. The increased demand for integrated solutions challenges our teams to deploy secure, scalable solutions to meet the needs of our business.

- Services Infrastructure:
 - There is no enterprise services infrastructure in place, thus we cannot enable integration of applications easily, and we cannot do it in real-time in a scalable manner.
 - We have minimal experience with designing/building reusable services.
 - We need to have resources with the knowledge on both sides of the service (provider and consumer) within the IT@NU community to leverage these tools.
 - We need the support of governance to develop the policies that enable these services to be consumed and reused by a diverse audience.
- Identity & Access Management:
 - Many sets of system-specific access rules are enmeshed in the central Identity Management System.
 - Insufficient standards-based Identity Services are in place, complicating connections to external systems.
 - No single Identity Repository, with room for history and multiple concurrent roles, is in place.
 - We are not able to provide platforms for secure login to simplify access granting and revoking, and to enable partnerships.
 - We have manually asserted NetIDs without sufficient management controls.
 - Single-factor authentication may not be sufficient for highly sensitive information in the future.
- Reporting, Data & Analytics:
 - Very little integrated reporting and analytics have been developed to date.
 - The data in our repositories are silo'ed and are best suited to meet the operational needs of the areas from which the data are sourced. Significant work remains to integrate our data across systems and functional areas.
 - Existing data access permissions are premised on who has the ability to input, delete, or change transactional data. These permissions do not translate to reporting permissions, thereby requiring the construction and maintenance of a second set of security rules for data viewing access.
 - Development of skills within the community to access data and build self-service analyses has been slow to materialize.
 - Data access policies need to reflect the increasing demands of more complex requirements.
- Workflow:
 - Little work has been done across business units to formally define and document end-to-end business processes for domains.
 - In many areas, paper workflows or hybrid electronic/paper workflows hamper efficiency.
 - No overriding workflow engine is implemented on campus to control and guide business processes that cross systems.
- User Experience:
 - Limited adoption of the NUPortal diminishes its effectiveness.
 - As deployed, many administrative applications have relatively cumbersome user interfaces, requiring significant user training and support.
 - There is very limited deployment of mobile capabilities, whether via native applications or responsive web design.
 - The growth of device types and browsers puts pressure on improving the user experience.

- As more services move online, the need to keep them accessible becomes more important.
- There is large interest in having electronic forms-with-workflow solutions, but solutions built inside enterprise systems with their native tools are difficult to deliver and maintain, and the existing one-off custom applications do not scale.
- Governance, Engagement, and Aggregation:
 - Our administrative systems teams are busy with significant backlogs of project and enhancement requests; many projects are “required” for regulatory or contractual reasons.
 - Increasingly, requested improvements are of a cross-system nature or relate to enabling infrastructure elements of some sort – technical or procedural – and, as such, are in competition with initiatives more fully confined to a single system’s purview.
 - We cannot do everything centrally nor can we isolate ourselves to application- or organization-based silos. The community of providers spans IT@NU, and we must work together in close partnerships.
 - Coordination of priorities across our administrative system areas remains silo’ed; we must embrace greater aggregation in our approaches.

What Do We Do Next?

In this future model, users will gain access to composite applications that are easy to use, accessed via a common interface or approach, and employ workflow and real-time integration via a services architecture. These composite applications are likely to employ both cloud-based and on-premise components during the lifecycle of a business process. They are also likely to be comprised of a hybrid of traditional enterprise vendor products, forms/workflow tools, and custom-developed applications. The following sub-areas describe the necessary steps we need to take in the next few years to make this vision a reality.

Services Infrastructure

Our belief, buttressed by the requests we’ve received, is that our first priority needs to be embracing a services architecture for our administrative systems. This component of the enabling architecture will be a transformative catalyst in the way we deploy our systems and how our users interact with those offerings. Making this paradigm shift is essential to many of our top priorities, including:

- Real-time integration capabilities based on standards among on-premise systems and databases, and with applications in the cloud from external organizations, etc.
- Building enterprise workflow capabilities, deploying solutions to the portal, creating mobile apps
- Federated development efforts among IT@NU entities
- Making data “integrate-able”, enabling the reduction of duplicate data and duplicate data entry, and making data more easily accessible to those with business reasons to use it

This infrastructure also presents an opportunity for major effort-saving within enterprise system development teams by using a services infrastructure to aggregate interfaces to/from enterprise systems, and to provide access to frequently requested data sets. To realize these benefits, we must commit our enterprise systems to supporting and working within a services architecture (FY15+).

The deployment of enabling architecture will require us to be opportunistic in our selection and timing of projects. The intention is not to simply halt line-of-business development, but to invest in the development of enabling technology skill sets within line-of-business operations as improvement opportunities are identified.

Our key next steps in this sub-area include:

- Build technical expertise within NUIT and the IT@NU community as it relates to building, publishing, and consuming web services, using the standard protocols of both SOAP and REST. (FY14+)
- Build functional expertise in designing real-time web services that are strong candidates for use by multiple consumers; this will require a transformation in our interface design practices. (FY14+)
- Establish governance procedures for publishing and accessing the to-be-built services in our registry. (FY14-FY15)
- Engage our partners in the IT@NU community of application providers to identify high value-add opportunities towards which to deploy these solutions. (FY14-FY16+)
- Engage our governance committees and the IT@NU community to build an understanding of the value and necessity of enabling technologies priorities. (FY14+)
- Implement a highly available production infrastructure, including a services registry and messaging brokers to perform the integration. (FY14)

Identity & Access Management

Powering nimble integration and streamlined identity authentication continue to drive the transformation of the Identity & Access Management (IAM) systems at Northwestern University. The diverse needs of the University systems drive the requirements for this offering. These requirements include:

- Using a single electronic identity to access online systems and services at Northwestern University
- Streamlined integration to on-campus and cloud-based systems
- Simplifying provisioning/deprovisioning of access
- Ease of integration with collaborating institutions and partners
- Secure and uncluttered processes for management of the identity life cycle

Creation of a robust and flexible IAM system is essential to supporting the continued expansion of initiatives in the IT@NU community. As more federated development occurs across the University and seamless collaboration (both internal to Northwestern and with our external partners) is the expectation, there is heightened awareness of the need to improve the IAM solution.

The key next steps for transformation in this sub-area are:

- Begin the IAM replacement project. (FY14-FY15). There is an opportunity to leverage IAM in provisioning and authorization rather than requiring that all access be administered in full granularity within each application.
- Define a strategy to begin reducing redundant services related to real-time authentication, specifically Active Directory. (FY15)
- Define an enterprise-wide strategy for using multi-factor authentication, and initiate deployment in areas of greatest need. (FY14-FY15)
- Promote greater adoption of SSO (single sign-on), as it greatly improves the user experience when used across all systems. (FY14-FY15)
- Evaluate demand to have a "light" IDP offering (e.g., a solution enabling integration between social identities and Northwestern id's). (FY15)

Reporting, Data & Analytics

The priority for the last few years at Northwestern has been in meeting the various line-of-business reporting needs in areas such as finance, human resources, student records or alumni and development. The demand for information continues to shift towards getting a more holistic and multi-disciplinary view of data in many areas of administrative importance such as research administration, student

lifecycle or faculty retention. These requests from our community highlight the need for more access to information and an integrated approach to information management.

The needs for aggregation and integration of information are also reflected in the ways schools and central areas are beginning to organize locally in response to the analytics needs. Several schools and central units are developing local “reporting and analytics” functions with the goal of transforming them into knowledge centers for data to meet the disparate and growing needs. Until we tackle these challenges, this asset will remain underused. A data warehouse discussion paper (scheduled for presentation to ASAC in winter, FY14) has been written on this topic, highlighting the challenges and opportunities, and suggesting next-step recommendations to maximize benefits from a data warehouse in the future.

In order to meet the growing demand for reporting and analytics, we need to:

- *Develop and support an analyst culture* – The shift towards knowledge centers for data and analytics provides opportunities for collaborative partnerships between IT and the business units in developing a community of business intelligence practitioners: core data warehousing and business intelligence skills in the center, surrounded by a community of power users, report developers, and data consumers that are focused on using business intelligence and analytics tools to support decision making. The center should build capabilities that encourage adoption of tools by local power users, provide forums for connection among distributed local experts along with more formal training offerings and train-the-trainer approaches to build awareness and expertise. (FY15+)
- *Establish information management through governance* – Administrative Systems Advisory Committee (ASAC) has recently approved a level 3 information management committee within the IT governance framework that will develop institution level data governance policies and practices for data sharing, data access, data definition, and data integration. The management committee will be chaired by the Director of Institutional Research in the Office of Administration and Planning with broad participation from many schools and central units. The goal is to staff and convene this committee in early 2014.
- *Merge data repositories and reallocate central resources* – As stated earlier, an integrated data warehouse is needed to meet many of our reporting needs so that users in business units do not have to manually “stitch” together information across the various systems. Integrating the disparate data warehouse repositories will require significant upfront and ongoing effort. Central resources need to be reallocated to focus on this effort so that we can accelerate building this critical infrastructure that is needed for reporting and analytics.

Key responses include:

- allocating resources for data warehouse integration efforts, including data definitions, data quality, and data lineage (FY15+)
 - building both integrated and line-of-business reporting capacities (FY14-FY16)
 - implementing a security architecture for access to both integrated and aggregated views of data from multiple systems (FY15-FY16)
 - provisioning integrated data through the data-as-a-service architecture and through business intelligence tools (FY15+)
- *Develop capabilities for advanced analytics* – Big data analytics and predictive analytics are driving transformation in higher education alongside many other industries. The traditional data warehouse is a robust platform to analyze structured data, but it is limited in its capability to allow analysis of large volumes of unstructured data (e.g., free form text such as user-generated comments) generated from various applications and devices.

At Northwestern, social media platforms such as “Our Northwestern,” learning management systems such as Canvas, and online learning systems such as Coursera are beginning to generate large volumes of unstructured data that can hold valuable insights for our administrators and faculty, and requests have surfaced to develop the data infrastructure and tools to mine unstructured data (e.g. Our Northwestern). In order to enable analysis on such data sets, our core data warehouse and business intelligence system needs to be augmented with big data capabilities and analytical tools that can mine unstructured data and perform predictive analysis.

We foresee this topic being explored much further at Northwestern in FY15 and we need to begin exploring the related information technologies.

By forging partnerships with business units where the needs for advanced analytics originate, IT@NU will be able to better develop the capabilities to offer scalable solutions in the emerging advanced analytics landscape. (FY15-FY16)

Workflow

Very few, if any, online workflows currently exist other than the workflows that are natively built into the transactional systems we have. These workflows are built into their internal code base, and to the extent those workflows are able to be “exposed” to external systems, they can be further leveraged outside of those systems. However, a real need is to build workflows beyond internal systems to include workflows between and around these transactional systems. The need for workflows comes in a variety of contexts:

- Workflows that guide people through processes. These range from relatively simple online completion, routing and approval of a form to complex, multi-step workflows that span multiple systems.
- Automated event-driven workflows. These workflows pass information between systems automatically based on logic built into the workflow.

Workflows not only add value by unifying applications via smooth real-time data flows, and by facilitating complex business processes, they also add value because information about the execution of the workflows can be captured via behind-the-scenes transaction logging, which can be analyzed subsequently to improve the business process.

The key next steps in this area are:

- Rationalize the future use and management of our forms and workflow tools – Increasingly, the community is using tools to build electronic forms and workflows within these tools. This development should be not only encouraged, as it can result in quick deployment of solutions to meet real business needs, it should be aggregated and leveraged using a service infrastructure to create cross-application capabilities to support business processes from start to finish (FY15+). We will gain the greatest effectiveness in this area if we can select toolsets around which to standardize and leverage IT@NU partnerships to create more cohesiveness by putting these tools in the hands of the distributed community (FY14+).
- Identify and document key business processes – The implementation of workflows need to be driven by business needs, not technology. Finding the right tools to build workflows should follow an identification of the types of workflows that we want to automate because different tools have different strengths and weaknesses.
- Explore workflow engines – To gain the most benefit from aggregated workflows, we should explore the market for workflow engines that are specifically designed to operate “on top of” transactional system workflows, and pass a user to transactional workflows as appropriate.

User Experience

Our full portfolio of administrative systems numbers in the dozens, if not in the hundreds. To say that these applications are diverse is an understatement. An ecosystem must be our assumption going forward, as the availability of reasonably-priced, niche solutions (many of which are offered as Software as a Service) will continue to result in the proliferation of our administrative systems. We should also be prepared that any component of this ecosystem can change, even the largest components, and be prepared to unplug one application and insert another with minimal disruption to the user experience.

Our users are clamoring for a better user experience. They want our applications to be easy to find, gain access to, and navigate. Users also expect them to work anytime, anywhere, from any device. In some areas, our lack of intuitive user interfaces is merely frustrating; in other key areas, the user experience needs to be transformed to meet core strategic objectives. Growing research and engaging our students and alumni are key components of the *NorthWestern Will* and are direct drivers of our need to improve in this area. So, too, are the overall trends of mobility and the consumerization of IT – users simply expect more, and they are not unreasonable in these expectations.

We must develop a shared vision of the user experience for administrative systems at NU – both those at the center and those developed by our IT@NU community (FY15). This should include the appropriate role of NUPortal vis-à-vis other unifying interfaces. (e.g., University site, school sites). We should then confirm that our vision is achievable within our current portal platform and tools.

- Key steps we need to take to accomplish these objectives include: *Enhance our unifying layer offerings such as portals and dashboards* – The NUPortal remains underused as a platform, with most of the content aimed at financial and research administration functions. This results from a more reactive approach to building content at this layer, rather than a proactive approach. While it may prove that we need to update our design or pursue alternate platforms, we should engage the user community to both identify and produce content for these unifying layers that resonates with prominent user roles or “personas” (FY15). Deploying a services architecture, providing integrated data solutions (e.g., as dashboards) and maximizing our use of forms and workflow solutions further add to the potential of building a compelling front door to our administrative systems landscape. We must also bring our systems (all of them, where possible) under a common single sign-on (SSO) umbrella to maximize the ability of users and processes to cross applications (FY15).
- *Develop skills to build mobile device-friendly solutions using responsive design and/or native apps* – Our diverse ecosystem of administrative systems is unlikely to result in a “one-size-fits-all” strategy to deploy a mobile device-friendly and browser-agnostic user experience. We are not forced, however, to do nothing, waiting for a singular solution to emerge. Where our vendors offer solutions – responsive design via HTML5 coding or native mobile apps are common examples – we should evaluate these capabilities and deploy them if they meet our business needs (FY15). As we develop applications locally, we should be embedding similar capabilities as a standard practice (FY15+). The need for aggregation of various mobile solutions created using different approaches will likely arise very soon, and we should be prepared to offer as cohesive of a user experience as possible. This should be coordinated with our teaching and learning systems effort and our portal offerings (FY16). In anticipation of these development efforts, we should be developing skills within the IT@NU provider community (FY15-16).

Governance, Engagement, and Aggregation

Throughout the presentation of the business system groups to ASAC, it is clear that all of our application system teams have significant backlogs of critical system maintenance and ongoing upgrades. These range from quarterly maintenance updates, to updates to underlying technical tools or databases, to full-blown major version upgrades. Combined with the ongoing workload of user support, security administration, and report/query development, a significant portion of available staff time is already

committed to these initiatives. These operational responsibilities are large and grow with the ongoing development of our systems across the University.

In addition to ongoing maintenance, each of our major systems has a list of functional improvements and enhancements to provide the user community with additional functionality. Some of these changes can be addressed easily within the native applications and others are more complex system developments that are performed within the business application, deferred due to their complexity, or managed by schools and units with local innovation or developments.

Deploying the enabling technologies described in this document is our top priority for enterprise systems. We acknowledge that balancing these activities with line-of-business demands will present challenges. However, we anticipate that the deployment of these technologies will create new capabilities and economies in the future, whether by reducing the complexity of the development environment, reducing customization of vendor-provided solutions, reducing continued development of one-off interfaces, reducing duplicative effort in multiple business systems, or enabling broader participation in the development of services.

With enabling technologies, our objective is to leverage delivered features of the functional systems and use enabling technologies to aggregate functions and simplify the user experience or, if necessary, extend our applications through development of associated services. Broader participation in development, through increased engagement and federation with IT@NU is a result of this model. In this manner, we can create a “community of interest” among the IT@NU providers and improve the efficiency and effectiveness of our efforts in future initiatives.

In order to progress toward a more holistic view of our systems, we need to create new ways for having overarching discussions about development. Just as new application deployments need to be conscious of the overall ecosystem of applications, so too do requests for new functionality within existing applications. To help facilitate this effort, we envision a centralized business management unit that spans the enterprise systems. This unit will be comprised of business analysts and project managers who can develop and execute projects using the entire landscape of available tools to achieve solutions integrated into the overall ecosystem.

We need to charter and convene level 3 governance committees to move governance closer to the functional areas (FY14). As with our initiation of level 2, we should expect that these groups will take time to become effective in surfacing and prioritizing goals and initiatives. The investment of time towards this goal is essential: using our key principles of business-driven prioritization, a balance of school and central unit participation, and IT@NU supporting the discussions of these groups as a partner and advisor can pave the way for us to adopt integration as our new convention in our administrative systems pursuits.

Increased engagement with the unit-based application providers in the IT@NU community is also important in this model. They have critical knowledge of business needs and can help central providers by articulating the vision via use case development, prioritizing work relevant to advancing the enabling architecture, and engaging their units. As the designers and implementers of many of the solutions in our administrative systems ecosystem, the IT@NU community will be particularly well suited to assist in the design of workflows for the enterprise that assemble business processes across functional system areas.

To increase engagement and integrate diverse offerings into a positive user experience, leverage the IT@NU community and involving central systems teams early in planning for programmatic changes or service offering changes is critical. When assessing any potential development or system acquisition,

the units can also benefit the future administrative systems landscape at NU by prioritizing the ability of the potential solution, irrespective of its programming techniques or platforms, to integrate:

- Within a robust services architecture, including workflow
- Within a standards-based IAM architecture
- With the enterprise information architecture

We can work in partnership with the IT@NU community to establish a common software selection approach and criteria for technical compatibility, usability, and services/support (FY14-15).

The Larger Context: Other Project Needs

In addition to forgoing common challenges, the following list gives a sampling of some of the larger administrative systems initiatives underway or planned for the near future:

Student Information Systems:

- Enhance the course and teacher evaluation process to include learning objectives, etc.
- Further optimize graduate student funding.
- Implement a method for collecting payments after a student has left the University.
- Implement a method for encumbering tuition.
- Implement a new academic advisement report, a new class planning and scheduling tool, and standardize various University Financial Aid applications.
- Implement automation to support rollout of Semester Online.
- Integrate with several new admissions local systems.

Human Resources:

- Streamline and enhance the recruiting process and access points for both faculty and staff to improve the overall experience for applicants, hiring managers, and others involved in the onboarding process.
- Implement automation to eliminate paper and manual processing associated with managing positions and requesting additional pay, reappointments, and terminations.
- Enhance the functionality for reporting conflict of interest for both faculty and staff, including improved reporting and integration with FSM.
- Implement federally mandated changes (e.g., taxation changes, DOMA, affordable Care Act, etc.)
- Implement online solutions in FASIS to improve business process efficiencies throughout the organization, including the online attestation for mandated reporters (DCFS), receipt of Staff Handbook acknowledgment, and management of tuition benefits in FASIS.
- Expand use of the BI Tool to include the payroll expense distribution report and activity reports, and provide additional analytics to the community.

Financial Systems:

- Deliver forecasting and additional financial planning capabilities.
- Create income statement-style management reporting for schools and major units.
- Improve workflow through feature enhancements, particularly in the Expenses module.
- Enhance vendor maintenance capabilities, including support of compliance requirements.
- Expand integrated reporting capabilities for payroll, student, recharge, other transactions.
- Perform a major upgrade to, or potential replacement of, the facilities management system.

- Provide secure access to financial and other/ integrated data sets, both online and via Web Services.
- Enhance integrated reporting capabilities for the research community.

Alumni/Development Systems:

- Increase integration with the alumni/development system of relevant data from student, HR, financials, athletics, ticketing/members, and other systems.
- Migrate online giving and volunteer fundraising functions to a new alumni community platform.
- Develop integrated stewardship reporting capabilities.
- Deploy a mobile platform to support select online alumni community and fundraising staff.
- Develop data warehouse/analytics that leverage incoming data from “Our Northwestern.”
- Increase revenue generated from matching gifts by purchasing and managing matching gift policy details and employment records in CATracks, and implement auto-generating matching gift claims.
- Simplify tracking and managing planned gift proposals and prospects in CATracks.
- Implement CATracks campaign management tools for storing and reporting on key information for planning and managing a capital campaign and specific campaign initiatives.
- Increase activation and adoption in “Our Northwestern” by leveraging game mechanics such as badging, challenges, etc.

Business Intelligence:

- Complete development and rollout of admissions data reporting solutions for Undergraduates and for the Kellogg School of Management; also integrate applicant data with student records.
- Streamline Alumni Relations and Development’s reporting process for endowment stewardship.
- Improve research administration reporting by integrating information (NUFinancials, InfoEd, FASIS, SES, eIRB, eACUC, etc.) and increasing ease of access and efficiency for administrators and Principal Investigators.
- Provide the Report on Faculty Activities across multiple systems – FASIS, SES, InfoEd, NUScholars (teaching, course loads, publications, citations, research).
- Mine data from “Our Northwestern.”
- Analyze and report on graduate students admissions data.
- Develop an institutional dashboard to easily share institutional- and school-level metrics.
- Improve analytics for Kellogg Admissions, Student, and Alumni Lifecycle by integrating data across multiple systems to get the complete lifecycle picture of students.
- Match and integrate the disparate security rules in different data marts.

Research Systems:

- Perform a major upgrade for human subject protocol management, along attendant business processes. Train the research community (faculty, staff, clinicians and students) in the use of this improved system.
- Implement a Training Management System to deliver and track compliance-related training.
- Continue implementation of animal subject protocol management system, with enhanced reporting and access to the “protocol library” for the researchers.
- Implement state-of-the-art census management system, utilizing RFID technology, leading to improved accuracy and information for researchers and administrators.

- Identify and implement a replacement system for the CCM operations and management of the facilities.
- Complete the in-house development of the laboratory information and safety system.
- Identify and implement a University-wide Conflict of Interest system for faculty to meet federal reporting requirements.

Other Priorities in Common:

- Adopt more agile practices in supporting systems and performing projects.
- Continue development of policies and procedures for engagement with local IT units.
- Upgrade vendor software (including patches and legislative and regulatory updates) and underlying toolsets.
- Implement Single Sign-On and multi-factor authentication (where appropriate).
- Improve the user experience via work centers, dashboards, chaining activities (business processes), the portal.
- Integrate enterprise content management (imaging, forms, workflow) capabilities with enterprise systems.
- Enhance provisioning/termination processes with SOA, triggers, roles, and automation.
- Continue deployment of necessary architecture to support business continuity / disaster recovery needs (i.e., active-active configuration across data centers).

Information Security

Executive Summary

Information security is becoming a more critical issue to higher education with the increase in attacks and the increased sophistication of these attacks. Recent press has highlighted the efforts of organizations and individuals to gain access to systems and information on university campuses. These efforts have moved beyond the historic quest for hosts to commandeer for remote hacks, or for access to financial information, to now include attacks to gain personal information and intellectual property.

The drivers of IT from a global perspective dramatically impact information security. Consumerization of IT and mobility mean that securing our systems is increasingly difficult given the expectation that any device should be able to connect to our services at any time and from any location in the world. The movement to using cloud computing and migrating our services and information to providers beyond the campus means that information is less under the control of the institution and we are less able to verify its control. Big Data, including the storing and aggregating of that data, means the probability and impact of exposure is greater. Finally, a trend that we have seen direct evidence of is the increased organization and sophistication of those trying to compromise our systems and data. All of this is amplified in higher education's environment of openness and collaboration.

All of these trends mean that we have to be far more diligent in our response to the threats to information security. Adoption of industry-accepted security standards and formal risk assessment processes increase the diligence of our response. Working effectively as IT@NU to identify and prioritize risk mitigation steps is a necessary component of this response.

Many positive steps have taken place to strengthen our information security position. Putting us in good stead are the adoption of a standards-based Information Security Management System (ISMS), the recent risk analysis process, the creation of the Information Systems Security Plan/Practices (ISSPP), our education and awareness program, the use of external security expertise, our technology solutions (including HIPAA/HITECH data center), our monitoring and auditing programs, and our collective community approach and commitment to information security.

With the increased sophistication of attacks, the University must build upon the solid work that has been done to date. Ongoing assessment of risk and development of policies and solutions to minimize identified risks need to continue. This will be done with the assistance of the newly created Security subcommittee of the Infrastructure Advisory Committee and direct partnerships with campus units. Expansion of services and process improvements are planned for the vulnerability assessment program and the service provider security assessments. Technology expansion and improvements are planned for intrusion prevention and detection, endpoint management, encryption, and multifactor authentication.

Introduction

As has been widely reported and generally understood, information security is becoming a more critical issue for all of us, including higher education. The front page article in the NY Times, July 16, 2013 entitled “Universities Face a Rising Barrage of Cyber Attacks”¹ emphasized that campuses are facing millions of hacking attempts weekly and increasing, and these attacks are becoming increasingly sophisticated. The target of these attacks is no longer just personal information, but also intellectual property. This increased attention is on top of the ongoing risks and effort that result from new technology changes, new business processes, and the ever-expanding regulations being introduced to ensure protection of information and systems, making information security an area for heightened attention.

Responding to these challenges requires vision, coordinated engagement across the institution, and the leveraging of opportunities to improve our defenses when they arise.

Key Drivers for Security

Beyond the increased attention for information security particular to universities, many of the challenges we face at Northwestern come as a result of the macro-level drivers described in the introduction to this document. The impacts of those most relevant to the world of security at Northwestern are briefly described below.

Global IT Drivers

Inevitability of Institutional Change – Changes in business practices, goals, and objectives are inevitable, as we try to respond and take advantage of technology change. These responsive changes inevitably will introduce exposure to compromise, unauthorized access, and non-compliance conditions, as operations are expanded and new systems, equipment, and applications are acquired and implemented.

Consumerization of IT/Mobility – “End point” devices, which are often the first and last lines of defense, are less under the control of the institution than they have ever been with the rise of smartphones, tablets, and personal computers at home. Making sure that these devices are secure, and are being used securely by all of their users, is increasingly difficult. Additionally, the expectation of access to anything, from anywhere and with any device means that implementation of security from an infrastructure and application perspective becomes increasingly difficult to manage through localization or other restrictions of access.

Cloud Computing – As more vendors move their applications to the cloud and stop offering on-premise delivery options, the challenges related to security become less under the control of the institution and less able to verify or control. This change requires new and different contractual arrangements, and introduces privacy, compliance, and liability concerns.

Big Data – The growth of Big Data situations presents new challenges on several fronts. When the data being collected is sensitive data (e.g., personally identifiable information, intellectual property, etc.), the impact of its exposure or compromise is qualitatively greater. Big Data trends towards greater access, aggregation, and manipulation of data compound the problem, increasing the probability of loss and resulting impact.

Increasingly Sophisticated Hacking – The execution of social engineering and other hacking techniques continues at a higher pace and an increased level of sophistication, placing personal and institutional information at increased risk. Nation-states are employing external cyber-warfare practices against

¹ http://www.nytimes.com/2013/07/17/education/barrage-of-cyberattacks-challenges-campus-culture.html?_r=0

national infrastructure to disrupt delivery of critical services, and they are conducting insider attacks against corporations and research institutions to steal intellectual property, patents, protocols, and state secrets.

Higher Education Drivers

Security/Regulations – Compliance and regulatory stipulations abound within higher education, requiring protection of student data, human subjects and medical information, proprietary business information in research data, credit card information, and information related to the national interest. All of these require privacy, security, and access controls, and they introduce challenges to existing business operations and processes in order to accommodate them. For example, new policies, standards, and procedures may need to be developed and implemented, and due diligence activities may need to be enhanced.

Cross-Institutional Collaboration and User Experience – An open but secure infrastructure presents unique challenges. However, as collaboration expands beyond the traditional borders of the University in all phases of University activities (teaching and learning, research, administration, co-curricular activities, and engagement with the surrounding community), and as consumer-oriented collaboration tools become readily available, the challenges increase due to the simple expansion of complexity and to the tendency for members of the community to choose ease of use and personal productivity over the mitigation of institutional risk.

Responding to the Change around Us

We need to be very programmatic, diligent, and coordinated in our information security activities. Because campus information security risks are directly related to the weakest line of defense from a University-wide perspective, information security requires significant IT@NU collaboration and more demonstrable accountability. Proactively, we need to be ensuring that we are adopting collective security plans and practices that are informed by recommended practices in the field. Critical elements in responding to ongoing threats include monitoring emerging and up-to-the-minute threats, having common awareness in order to prioritize effectively, having coordinated engagement across the institution in order to respond and execute, and leveraging opportunities to improve our defenses whenever they arise.

Adoption of the industry-accepted security standards enhances Northwestern's ability to proactively improve its information security practices, while maintaining a high degree of flexibility in responding to constantly changing condition and demands. This information security approach (<http://www.it.northwestern.edu/security/security-management.html>) is based on the International Standards Organization (ISO) standards of Security Management and Security Operations, and it brings structure to help us prioritize our efforts. Its iterative process provides a comprehensive framework for:

- Understanding an organization's information security requirements,
- Implementing operating controls to manage the risk,
- Monitoring and reviewing the performance and effectiveness of implementation,
- Improving continually based on objective measurements.

One objective of this system is to provide assurance that information assets are given a level of protection that reflects their value or the risk their compromise/loss poses to the University.

The requirement for coordinated engagement across the University is being met from partnerships, both long-standing and new:

- Collaborative efforts with the IT@NU community and Northwestern's business units (e.g., Office of General Counsel, Student Affairs, Government Relations, Human Resources, Office for Audit and Advisory Services, Office for Research, etc.)
- IT Governance Committees – Governance is more than the set of policies and internal controls used to direct and manage information security, reporting, and accountability. These committees provide forums to bring up and vet security topics with high-level business and IT leaders from around the campus, and they will help to enhance strategic alignment with business strategy, emphasize organizational objectives, and deliver valued services that optimize asset protection at the lowest possible cost. A key element of this process will be the recently established Security sub-committee of the Infrastructure Advisory Committee.

Finally, while we want to be structured in our approach to vetting risk and value, we also know that opportunities to reduce our risk sometimes arise in a business context that does not adhere to our structured assessment. We also want to be flexible so as to recognize and take advantage of these opportunities for process improvements or enhanced security practices when they arise.

Current State

Building Blocks

For many years we have been working to improve the Information Security environment at the University.

- By adopting the Information Security Management System (ISMS), we will follow a systematic and measurable approach to establishing information security practices, and its initial risk assessment will provide a great starting point for prioritizing efforts to mitigate information security risks.
- Using a combination of surveys and interviews, University business and technology leaders participated in a risk analysis and identification process in Sept. 2013.
- Many on-going partnerships with the IT@NU community and business units across Northwestern have been established.
- Information security is on the agenda of the Infrastructure Advisory Committee (IAC), and the recent creation of the Level 3 Security Committee underneath the IAC augments this.
- The recently created Information Systems Security Plan/Practices compiles the University's information security policies in one place. It summarizes the operational framework, provides direct access to policy statements, and helps identify and describe procedures for the appropriate use and protection of University data.
(See: <http://www.it.northwestern.edu/bin/docs/ISSPP.30Sep2013.pdf>)
- A well-developed education and awareness plan has been in place for many years and is renewed annually.
- A robust audit process exists through Audit and Advisory Services to look at information management risk issues both in central and distributed IT areas.
- Internal monitoring tools are in place and our next-generation firewall (Palo Alto) has proven invaluable in our ability to detect and prevent malicious traffic.
- NUIT's Information Security specialists participate in multiple external organizations, discussion forums, and industry forums (e.g., CIC, EDUCAUSE, REN-ISAC, FIRST, security discussion groups, vendors, media outlets, government agencies, etc.).
- There is ongoing engagement of external industry experts to provide advice and assistance on security practices and threats.
- The University Data Centers are HIPAA/HITECH compliant.

- Prior to contracting for information processing services with outside parties or service providers, we conduct security assessments of third-party providers of services to ensure controls are in place to minimize the risk of exposing University data to potential unauthorized access and loss. Developed by NUIT, this Service Provider Security Assessment Program uses a survey document and process to: establish communications and promote constructive dialogue between Northwestern and potential service providers; help identify business, technical, security, compliance, legal, and other control factors; and determine the level of risk inherent in the processing of data beyond the University's physical controls.
- NUIT's Vulnerability Assessment Program is a set of policies, procedures, tools, and services to assist schools and departments in the auditing, identification, and remediation of security vulnerabilities. Use of this program across the University continues to increase.
- The Feinberg School of Medicine has been the focal point of a variety of security initiatives that can be candidates for wider adoption around the University. This includes added security for email and networking (restrictions for computers containing PHI), and encryption of personal computers and laptops.
- Initial testing of a two-factor security solution has been completed, and discussions about appropriate application of the solution are in progress.
- Multiple schools and business units use a software solution to manage personal computers (e.g., Symantec's Altiris or Dell's Kace), and there is an opportunity to leverage these solutions to provide automatic software patching.
- A Network Access Control solution was put in place for student residential housing and the guest wireless network and is available for broader implementation within the University.

Areas for Attention

Initial implementation of the ISMS will require a high level of engagement to ensure that prioritized risk management projects are pursued and that policy development remains in step with risk management activities. Other areas needing attention are listed below:

- Compliance activities (i.e., policies, standards, and procedures) to meet regulatory and research program requirements present ongoing challenges because IT services remain distributed and are subject to locally governed processes, priorities, and infrastructure.
- Research's regulatory and program requirements require further understanding and action. The role of Security and Privacy Officers and the definitions of their risk management responsibilities require clarification.
- Storage use recommendations for local and cloud-based infrastructure need development to ensure adequate protection of sensitive data or to identify out-of-compliance conditions.
- The security assessment services (network and internet) need to be expanded to cover a higher percentage of campus devices and sites.
- Expansion of Endpoint Management Services would help to preserve a secure environment via better control over security settings and issues with personal computers, and they can provide automated patch management, application of anti-virus, backup, and other effective control and management measures. This could include requiring devices to comply with specific security criteria before being granted access to a University network.
- Cloud-computing assessments require additional attention. The cloud vendor assessment is a one-size-fits-all document that often is counter-productive with smaller vendors, and our process for vetting the sensitivity of information in cloud solutions is a point-in-time assessment that should also include a review over time.

- Multifactor authentication (MFA) is a security system in which more than one form of authentication is implemented to verify the legitimacy of a transaction. Using two or three independent credentials, the goal of MFA is to create a layered defense and make it more difficult for an unauthorized person to access a computer system or network. Multi-factor authentication significantly reduces the risk inherent in continued use of limited-strength passwords, and it avoids the “single point of failure” in instances where user credentials (ID and password) are compromised through hacking or user carelessness. Appropriate implementations of multi-factor authentication need to be identified and implemented.
- In a world of increasing security threats and complexity, people with security duties included in their job description are still under-identified across the institution.
- Encryption helps organizations achieve privacy and regulatory compliance by protecting and securing information. Wider deployment of encryption across applications and devices needs to be investigated, implemented, and promoted.
- Embedded security services would assist development teams in the delivery of secure and useable applications and systems through early identification and mitigation of security vulnerabilities. Ongoing assessment activities would assist developers in maintaining awareness of and exercising secure coding practices.

What Do We Do Next?

Activities for FY14:

Information Security Management

- Document the plan, including determining priority setting, for the schedule required for policy selection and implementation activities.
- Establish the IAC’s Security/Privacy Committee as the vetting body for information security policy and standards proposals.
- Establish the “Plan, Do, Check, Act” process to help ensure the policy development structure and process is properly executed.

Risk Management

- The recently conducted risk assessment will be released to the IT Governance and Risk Assessment communities in January 2014.
- Confirm the priorities, as described in the report, with members of the Infrastructure Advisory Committee.
- Identify and select the ISO standards that, where implemented, would offer the best opportunity for risk remediation.
- Recruit resources (e.g. the IAC’s Security Committee) to direct and exercise the Risk Mitigation efforts to address prioritized threats.
- Develop recommendations for policy statements to the committees for review and vetting.
- Work with Audit & Advisory Services to identify those risks addressable by the ISMS.

Vulnerability Assessments

- Increase the number of University sites that are assessed through greater promotion of these services to the user community.
- Embed the use of these services within the system and application development processes, starting with teams within NUIT’s Management Systems.

Service Provider Security Assessments

Deployed over 3 years ago, the survey document and process is in need of review and revision:

- Revise the queries contained within the survey to reflect current security controls and compliance requirements and adjust the weighting factors to individual queries to more accurately represent current risks.
- Improve existing processes (e.g., facilitate vendors' completion and return of survey documents, reduce overall time for processing, automate scoring activities, etc.).

Intrusion Detection/Prevention

- The next generation firewall (Palo Alto) has proven invaluable in our ability to detect and prevent malicious traffic. Review the service for additional capabilities that should be considered for implementation.

Business Continuity Planning

- Further document processes and procedures to ensure essential functions of the information security staff can continue during and after a disaster.

Compliance

- Introduce a recently acquired HIPAA Security and Privacy Training video. In compliance with HIPAA/HITECH, training is required of any individual having access to electronic Protected Health Information (ePHI).
- Publish a HIPAA/HITECH User's Guide to help business units establish security practices required for compliance and promote compliant end-to-end processing of regulated data (first quarter of 2014).

Endpoint Management

- Promote expanded adoption of the University's solutions for endpoint management (Dell KACE) to remediate risks identified in the recently completed risk analysis.
- Promote implementation of the Network Access Control (NAC) "quarantine" option on a grander scale to include wired and wireless networks. (Using quarantine can help avoid loss of all access privileges in instances where a NetID is disabled because it allows continued yet limited access to network resources, and it offers advice on remediation.)

Encryption

- Expand the use of encryption where sensitive data is present.
- Already an established University policy, explore encryption awareness and enforcement options (i.e., Active Directory policy, managed environments).

Multifactor Authentication

- Complete the evaluation of a MFA solution and make recommendations in FY14.

Activities for FY15:

ISMS

- Continue to develop and implement policies to mitigate risks identified through ISMS risk management activities and those of Audit and Advisory Services.
- Refresh Information Systems Security Plan/Practices as policies are introduced, revised and removed.

- Exercise the “Plan, Do, Check, Act” process to help ensure policies are current and effective. This activity is to include review of existing policies.
- Schedule and execute the risk analysis process (survey and interview).
- Stay current with development of the ISO standards.
- Continue to expand services to meet the changing landscape, regulations, compliance requirements, and demands for services.

Compliance

New and expanding regulations and project requirements will continue to drive the policy development and revision processes.

- Update existing policies and guidance to ensure continued compliance with new/revised regulations.
- Continue to work with NU departments to keep abreast of pending and implemented regulations to ensure policies and processes remain compliant.

Collaboration

- Continue to establish and maintain partnerships within the University and with external entities, vendors, and authoritative sources relevant to our operations.

Security Information and Event Management (SIEM)

SIEM describes the software, products and services combining security information management and security event management. SIEM provides real-time analysis of security alerts generated by network hardware and applications. SIEM is sold as software, appliances, or managed services and is used to log security data and generate reports for compliance purposes.

- With NUIT departments, develop business requirements and conduct a feasibility study of SIEM.

Appendix: IT Governance FY13 in Review

Educational Technology Advisory Committee

2012-2013 Educational Technology Advisory Committee Members:

Gad Allon, Managerial Economics and Decision Sciences, Kellogg
Ron Braeutigam, Office of the Provost (co-chair)
Stephen Carr, Office of the Dean, McCormick School of Engineering
Tom Collinger, IMC, Medill School of Journalism, Media, and Integrated Marketing Communications
Tracy Davis, Office of the Dean, The Graduate School
Michael Hannen, School of Education and Social Policy
Jennifer Hobbs, Graduate Students representative
David Keown, IT Planning, Information Technology
Greg Light, Searle Center for Advancing Learning and Teaching
Franziska Lys, Department of German, Weinberg College of Arts and Sciences
Rene Machado, Office of the Dean, Bienen School of Music
Paul Riismandel, School of Communication
Sofia Sami, Associated Student Government
Geoff Swindells, University Library
Sean Reynolds, CIO, Information Technology
Joel Shapiro, Office of the Dean, School of Continuing Studies
Bob Taylor, Academic and Research Technologies, Information Technology (co-chair)
Emerson Tiller, Office of the Dean, School of Law
Jay Thomas, Office of the Dean, Feinberg School of Medicine

Executive Summary

- The Educational Technology Advisory Committee (ETAC) was launched in May 2012 as one of the governance committees in a newly-established, federated framework for Information Technology planning at the University.
- The Committee met fourteen times during 2012-2013. The early meetings were dedicated for report outs from each of the schools and from each central support unit (Library, NUIT, Searle Center) regarding their top priorities for support of educational initiatives at Northwestern. The report outs helped the Committee to gain a campus-wide perspective on pain points for each of the units, and the report outs also identified some immediate shared priorities for where help is most needed from the central units.
- The Committee determined that the most pressing need for action is a comprehensive review of the University's course management environment, currently anchored by the Blackboard Learn system. A work group of twenty-five faculty and staff was created in January 2013 to conduct this review and to make recommendations for improvement to Northwestern's electronic teaching and learning environment. Final recommendations will be made next spring in a report to ETAC that will also be shared with the Northwestern faculty community at large. A top priority of the Review is to identify a learning management system that will help our faculty to more easily adopt modern tools and capabilities for blended learning (in person and online).
- ETAC has begun quarterly, joint planning meetings with the leadership from the University Classroom Committee. These ongoing meetings will enable coordinated planning and prioritization of activities between these two committees, which are responsible for shaping many aspects of the educational environment on our campuses.

2012-2013 ETAC Meeting Summaries

May 11, 2012 ETAC Launch Meeting

Co-chairs Ron Braeutigam and Bob Taylor set the general agenda for the Educational Technology Advisory Committee's (ETAC) work. Sean Reynolds presented the vision for the IT Governance framework at strategic, advisory, and operational levels. Bob Taylor presented on potential topics for the Committee's study and investigations during the first year: including Learning Management Systems (LMS), E-textbooks, Smart Classrooms, Mobile, and Online Learning.

June 6, 2012 ETAC Meeting (Report Outs from SCS and NUIT)

Representing the School of Continuing Studies, Joel Shapiro reported on the scope, scale, and method of its online education programs. Bob Taylor discussed NUIT's strategic planning process and objectives around its educational technology services such as Blackboard, Lecture Capture, Smart Classrooms, and blended and online learning. Ron Braeutigam updated members on recent discussions between Northwestern and 2U around forming a consortium of universities to offer for-credit classes online.

July 18, 2012 ETAC Meeting (Report Outs from Communication and Medill)

Bob Taylor relayed information about forging a campus-wide agreement to use Mediasite for lecture capture and academic webcasting. Paul Riismandel presented on Viewcast Media Platform, a digital asset management system under investigation by the School of Communications and how it will be used to implement ePortfolios. Tom Collinger gave a report on the Medill School of Journalism's

educational technology strategic plan and recent projects including the Integrated Marketing Communications online graduate program.

July 23, 2012 ETAC Meeting (New Efforts Being Investigated at the University in Online Education)

Provost Dan Linzer provided details about in-progress discussions at the University regarding its potential engagement in two new online education opportunities. Northwestern has been invited by 2U to join a consortium of peer institutions that would allow students to earn credit for tuition-based undergraduate courses offered via the Semester Online program. Northwestern is also considering a partnership with Coursera to offer Massive Open Online Courses (MOOCs) from select Northwestern faculty.

September 17, 2012 ETAC Meeting (Report Outs from SESP and McCormick)

Mike Hannen and guest presenters Keely Sorokti and Jeff Merrell put forward a report on the School of Education and Social Policy's (SESP) educational technology strategic plan and recent projects including the SESP "Hive," a social media platform based upon Jive, used by the Masters in Learning & Organizational Change program. Steve Carr presented a report on the McCormick School of Engineering's experience with educational technology. Committee members discussed what educational technology topics might warrant deeper exploration by committee workgroups.

September 27, 2012 ETAC Meeting (Report Out from Feinberg; First LMS Market Survey)

Jay Thomas, assisted by Brian Agne, presented the Feinberg School of Medicine's educational technology strategic plan and the variety of home-grown systems currently used to support Feinberg's educational goals. Bob Taylor and guest presenters Bill Parod and Brian Nielsen presented information about Learning Management Systems and a survey of currently available options.

October 10, 2012 ETAC Meeting (Report Out from TGS; Committee Votes on Work Priorities)

ETAC committee members anonymously ranked the importance of several educational technology topics to determine schools' interest levels and discover what areas may rate further study. Based on survey results, committee members proposed taking steps towards developing what would eventually become the Learning Management Systems Review Group. Tracy Davis presented a report on online education efforts at The Graduate School.

October 31, 2012 ETAC Meeting (Report Outs from Law and WCAS)

Emerson Tiller presented a report about online education and blended learning efforts at the Law School and how several new degree programs are shaping its strategic plan for educational technology. Franziska Lys and guest speakers Adam Finlayson and Chris Comerford of the Weinberg College of Arts and Sciences presented a report on the evolution of educational technology activities and current projects such as the Student Dossier, which is on track for University-wide adoption.

November 19, 2012 ETAC Meeting (Report Outs from Library and Kellogg)

Geoff Swindells reported on the Northwestern University Library's educational technology strategic plan, advisory bodies, and core educational technologies and services including its digital collections and digitation projects. Gad Allon of the Kellogg School of Management presented a report on Kellogg's educational technology strategy and tools including an online simulation game developed in-house and now widely used in peer institutions. Also highlighted were Kellogg's online education efforts, including a MOOC on Udemy.

December 10, 2012 ETAC Meeting (Report Outs from Searle Center and from the LMS Study Group)

Greg Light and guest presenter Susie Calkins of the Searle Center for Teaching Excellence presented information about its workshops and seminars, individual consultation services, and group analysis and evaluation projects designed to help instructors develop their technology-enhanced learning. Tom Collinger updated the committee on LMS Review Group structure, membership, and goals. Ron Braeutigam and Sean Reynolds related the latest developments around online education initiatives with 2U and Coursera.

January 18, 2013 ETAC Meeting (Blended Learning and “Course Nuggets”; NUIT Planning Cycle)

Greg Light gave a presentation about educational and learning objectives that are associated with course nuggets. Guest presenter Harlan Wallach explored the production processes and techniques used to develop course nuggets and presented examples of course nuggets created and used at Northwestern. David Keown presented an overview of the FY14 NUIT discussion document, related activity within other committees, and a detailed view of the educational technology section.

March 12, 2013 ETAC Meeting (Classroom Design Activities at NU)

Sean Reynolds provided progress updates on how the University’s six Coursera MOOCs are developing. Mike Hannen, guest presenter Mike Curtis, and Bob Taylor reviewed classroom design and planning at Northwestern and how rooms of various sizes can be designed to support active learning, flipping-the-classroom, and blended learning pedagogies. University Classroom Committee co-chairs Jean Shedd and Ron Nayler discussed their committee’s priorities around classroom design and related challenges, the Kresge renovation, and how ETAC and the University Classroom Committee might collaborate on planning and projects.

May 14, 2013 ETAC Meeting (Online Education Activities at NU)

Guest speakers Jake Julia and Marianna Kepka talked about the 2U and Coursera initiatives in progress at Northwestern and the related governance and support structures. Guest speaker Candy Lee discussed her online teaching experiences, how those experiences varied between different platforms, and online tools she used to facilitate and enrich the teaching and learning experience. Bob Taylor provided a brief history of Coursera activities occurring on campus and apprised committee members of the status of the six MOOCs being developed at Northwestern.

July 25, 2013 ETAC Meeting (First Report back from the Learning Management System Review Group)

Bob Taylor and the Learning Management System Review work group chairs (Greg Light, Gad Allon, Franziska Lys, Emerson Tiller) reviewed the group’s framework for LMS evaluations and discussed timelines for final recommendation to the ETAC committee. Canvas by Instructure is currently judged the strongest of the candidate LMS for Northwestern’s interests. Desire2Learn and New Blackboard continue to be studied. Canvas will be piloted in sixteen NU courses (representing seven schools) during fall quarter 2013, and pilot course opportunities will be opened up to additional faculty for the winter and spring 2014 quarters. ETAC approved of the LMS Review Group’s progress and its plans to bring final recommendations to ETAC by June 2014. FY2014 Ron Braeutigam briefed committee members on the latest updates with the 2U and Coursera initiatives.

2013 Activity Summary of the Learning Management System Review Group

- In October 2012, ETAC identified a pressing need for action: a comprehensive review of the University’s course management environment, which has been anchored by the Blackboard Learn system for over twelve years.
- In January 2013, a work group of twenty-five faculty and staff was created to conduct this review and to make recommendations for improvement to Northwestern’s electronic teaching and learning

environment. The Review Group is chaired by Greg Light, Director of the Searle Center for Advancing Learning and Teaching.

The Review Group agreed upon a charge of determining the best educational technology options for supporting NU faculty's growing interest in blended learning, "flipping the classroom," and online education---in addition to providing continuing support for more traditional curriculum practices at Northwestern.

- In February 2013, the Review Group identified four sub-committees that will perform assessments in four major criteria.

The students and faculty in each pilot course will be surveyed by the LMS Review Group for faculty satisfaction with the LMS (led by Gad Allon, Kellogg); student satisfaction with the LMS (led by Emerson Tiller, Law); learning outcomes that can be attributed to the LMS (led by Franziska Lys, WCAS); and technology capabilities of the LMS (led by Bob Taylor, NUIT).

- During the winter and spring quarters 2013, the Review Group hosted on-campus demonstrations and briefings for four, top candidate LMS systems: LoudCloud, Instructure's Canvas, Desire2Learn and New Blackboard.
- In June 2013, the Review Group determined that Instructure's Canvas demonstrated the best initial fit for Northwestern's interests in a modern learning management system. The Review Group requested that NUIT prepare for fall quarter pilots of Canvas in a variety of NU courses. A contract was signed in July with Instructure for access to the cloud-based Canvas platform for pilot courses by Northwestern during the academic quarters of 2013-2014. Canvas is cloud-based (running on Amazon Web Services), so no infrastructure build out was needed at the University's data centers in order to make the LMS available to Northwestern faculty and students.
- Test accounts will be available to NU faculty during the 2013-2014 academic year in "sandbox" instances of Canvas, Desire2Learn and New Blackboard, for comparative review of the user interface and the functional feature set of these three top-rated LMS candidates.
- Briefings and workshops will be offered to faculty throughout the fall and winter quarters regarding the pilot and sandbox LMS efforts. An online survey of all faculty will be conducted in October 2013 regarding their experiences in Blackboard Learn and their teaching goals in an alternative LMS environment.
- At the end of the spring quarter 2014, the LMS Review Group will conduct a final assessment of the pilot courses experience. A recommendation for improvements to the Learning Management System environment at Northwestern will be shared with the campus community at large and will be presented in June 2014 to ETAC for further action.

Administrative Systems Advisory Committee

2012-2013 Administrative Systems Advisory Committee Members:

Pam Beemer, *Human Resources*
Simon Greenwold, *Weinberg College of Arts and Sciences*
Jim Hurley, *Office of Budget and Planning*
David Browdy, *Feinberg School of Medicine*
Alice Kelley, *McCormick School of Engineering*
David Keown, *Information Technology*
Meg McDonald, *Office for Research*
Sarah McGill, *the Graduate School*
Mike Mills, *Office of the Provost*
Ron Naylor, *Facilities Management*
Julie Payne-Kirchmeier, *Student Affairs*
Brian Peters, *University Services*
Karyn Reif, *Alumni Relations and Development*
Sean Reynolds, *Information Technology*
Jason Schober, *Project Café*
Roxanne Sellberg, *University Library*
Jean Shedd, *Office of the Provost (Chair)*
Ingrid Stafford, *Office of Financial Operations*

Administrative Systems Advisory Committee Meeting Review

May, 2012

- IT Governance Framework - Sean Reynolds

June, 2012

- Financial Systems Overview - Jason Schober
- CIO Assessment of Priorities - Sean Reynolds

July, 2012

- Student Enterprise System (SES) Overview - Ann Dronen
- Alumni Development Enterprise Application (ADEA) Overview - Regan Holt

August, 2012

- Business Intelligence Overview - Luna Rajbhandari
- Faculty and Staff Information System (FASIS) Overview - Kathy Tessendorf
- Emerging Themes - David Keown
- Letter from the Provost - Jean Shedd

September, 2012

- Research Information Systems - Dan Volocyk
- Project Café - Jason Schober
- NU Library - Stu Baker

October, 2012

- SIMS - Paul Weller
- FAMIS - Jason Schober, Liz Schaps
- Cyber Infrastructure - Tom Board
- Emerging themes - Sean Reynolds

January, 2013

- FSM Administrative Systems - David Browdy
- NUIT FY14 IT Discussion Document – Sean Reynolds

February, 2013

- TGS - Mike Satut, Sarah McGill
- WCAS - Simon Greenwold, Chris Comerford
- Model for Distributed IT Services - Sean Reynolds

March, 2013

- McCormick - Alan Wolff
- Services Architecture - Tom Board
- File Mgmt, Scanning, workflows - Sean Reynolds

April, 2013

- File Mgmt, Scanning, workflows (cont'd)- Sean Reynolds
- Service Architecture Initiative – Sean Reynolds
- CIO Update: IT Organizational Changes – Sean Reynolds
- Governance – A Proposed Framework for Student - David Keown

June, 2013

- Working Group Updates
 - o Scanning/Workflow/etc
 - o IAM Initiative
 - o SOA Initiative
 - o Research Administrative Systems
 - o Federated Services

July, 2013

- Student Affairs - Julie Payne-Kirchmeier, Jim Roberts
- Level 3 Governance Update - David Keown

Infrastructure Advisory Committee

2012-2013 Infrastructure Advisory Committee Members:

Shehzad Amin, *NUIT*
Stu Baker, *University Library*
Dan Blumenfeld, *Audit and Advisory Services*
Tom Board, *NUIT*
Christel Bridges, *School of Law*
Carl Christensen, *Feinberg School of Medicine*
Chris Comerford, *Weinberg College of Arts and Sciences (Chair)*
Michael Hannen, *School of Education and Social Policy*
Raghu Katakam, *Kellogg School of Management*
David Keown, *NUIT*
Julian Koh, *NUIT*
David Kovarik, *NUIT*
Ray Mathew, *School of Music*
Rick Morris, *School of Communication*
Sean Reynolds, *NUIT*
Jim Roberts, *Student Affairs*
Harry Samuels, *NUIT*
Michael Satut, *The Graduate School*
Douglas Troutman, *Medill School of Journalism*
Bob Vance, *NUIT*
Dan Volocyk, *Office for Research*
Alan Wolff, *McCormick School of Engineering*
Ken Woo, *School of Continuing Studies*
Wendy Woodward, *NUIT*

Executive Summary

- In FY13, the Infrastructure Advisory Committee (IAC) focused on developing as a governing body through knowledge sharing and conversation. Through this, we intended to **surface conversations, familiarize ourselves with the institutional landscape, identify priorities, and coordinate efforts** across IT organizations. (A summary of the IAC meetings is included below.)

Key activities have included unit presentations from committee members, periodic roundtable updates, completion of two basic information lists, regular CIO Updates, and targeted discussions on infrastructure priorities. In the discussion following each break out session, the benefit of these conversations was cited as one of the most positive aspects of the committee's experience. In fact, there were also multiple instances when, despite this progress, people still said they felt they did not know enough about what is happening across the University.

- At the same time, one of the most explicitly expressed needs was to more directly turn these discussions into meaningful and realizable actions. This desire was expressed despite a rather active agenda of activities spawned from the committee in its first year, and despite the concern that finding room for committee activities is challenging given the responsibilities everyone already has.

The most notable success during the committee's first year was the launch of the pilot NUCloud infrastructure service, the further refinement of its functionality, the crafting of an application process and sustainable funding model, and the oversubscription of a Phase II.

Other areas in which the committee has spawned, or participated via the sponsorship of, working groups include:

- Wireless Network Expansion
- Category-3 Network replacement
- Windows 8 Supportability Review
- Identity and Access Management Review
- Virtual Software Desktop and Application Delivery
- Network Access Control
- Voice Solution RFP

Administrative Systems Advisory Committee Meeting Review

May 2012

- IT Governance Overview – Sean Reynolds
- FY13 NUIT Planning and Budget Process – Sean Reynolds
- Next Steps – Chris Comerford

June 2012

- Priority Brainstorming
- Future Role of School Technology Leaders as a group

July 2012

- Committee Purpose/Overview – Chris Comerford
- NUIT Projects in Flight – David Keown

- Next steps on Prioritization – Chris Comerford
- Committee Processes – Chris Comerford
- Formation of Windows 8 working group

September 2012

- Status update on Prioritization Process – Mike Hannen
- Mobility Discussion Paper – Bob Taylor
- NUIT Planning and Budget Update – David Keown
- Project Working Group (WG) formation
 - o IAM
 - o NUCloud
 - o Cat3 network wiring replacement
 - o SharePoint Lists – demographics, data centers

October 2012

- Roundtable
- Application Virtualization WG formation

November 2012

- SharePoint/Box Discussion
- Project Updates
 - o NUCloud, IAM
 - o Wireless Expansion
 - o NAC
 - o Unit Presentation – WCAS

December 2012

- Committee Discussion of Prioritization Working Group Report
- Unit Presentation – NUIT Planning

January 2013

- FY2014 Discussion Paper
- NUCloud Working Group Report

February 2013

- Discussion of IT FY2014 Discussion Paper
- NUCloud Working Group Report
- Unit report - SoC

March 2013

- Roundtable

April 2013

- Unit Presentations – TGS, SCS, McCormick
- Services Architecture presentation – Tom Board

May 2013

- Unit Presentations - Medill, NUL
- NUCloud Financial Model
- CIO Report

June 2013

- Level 3 Governance
- Unit Presentations - NUIT CyberInfrastructure, Bienen School of Music

July 2013

- Unit Presentations – Kellogg, NUIT TSS
- Voice Solution RFP WG formation
- Level 3 Governance
- Updates

August 2013

- Roundtable

September 2013

- IAC Retreat