This paper is the seventh and final installment in a series on *Preparing the IT Organization for the Cloud* from the ECAR Cloud Working Group. For institutions that have decided to adopt cloud services, transitioning to the cloud presents both opportunities and challenges. This series provides guidance to help institutions effectively prepare to address these challenges. More information can be found on the ECAR working groups [website](https://www.educause.edu/).

**Introduction**

The ECAR series *Preparing the IT Organization for the Cloud* was developed as a field guide for higher education institutions interested in implementing cloud strategies. The first paper in the series was published in May 2015, and since then the ECAR Cloud Working Group has published—including this one—six additional papers to help higher education address the many challenges of cloud adoption and take advantage of the opportunities the cloud provides. The ECAR Cloud Working Group’s goal was to provide insight and perspective that would help readers navigate complex decisions regarding the evaluation, adoption, and support of cloud services. We chose to publish this material as a series so we could provide deep dives into the selected topics, as well as adapt the materials to the changing environment and issues to provide timely and useful information.

Over the 18 months since the first paper was published, the higher education cloud computing landscape has continued to evolve. Higher education institutions have increasingly implemented cloud services, and it has become much more common for institutions to adopt cloud-first strategies to accelerate their move to the cloud. There has been a massive increase in the number of vendors that either provide cloud solutions or are building new platforms to migrate their solutions to the cloud. In addition, cloud vendors are evolving to meet regulatory and compliance requirements, resulting in more mature, robust, resilient, and secure solutions. Today, SaaS solutions are commonplace in higher education. Many institutions started by moving to SaaS-based e-mail and collaboration services, and now they are increasingly moving to SaaS-based enterprise applications and learning management systems. On the other hand, institutions have leveraged PaaS/IaaS in a more limited fashion, for purposes such as research, content management, or small applications, although some have started to move their ERP applications to IaaS cloud platforms, something that was nearly unheard of just 18 months ago.
Given the changes since this series began, we have chosen to use this final paper to summarize key findings and share specifics on how cloud computing has changed at our own institutions. These practical examples serve to help readers further apply this series to their own work.

We hope that you find this series useful and that this paper, rather than an ending, is a beginning to an ongoing cloud computing dialogue in the EDUCAUSE community.

Recap of the Series

From governance, migration, and operations to changes in the IT organization and user support, this series addresses how the cloud has influenced higher education IT, and it provides guidance on how IT organizations can prepare for and implement cloud services. The following section provides a recap of the series (not including the introductory paper), highlights each paper’s major points, and addresses new trends and opportunities that have emerged since its publication.

Developing Cloud-Aware Governance

The second paper of the series, Developing Cloud-Aware IT Governance, shows how a cloud-aware IT governance strategy helps increase awareness of cloud computing throughout the organization; highlights the considerations that come with adopting cloud solutions; and gives recommendations for developing effective, cloud-aware IT governance.

Cloud-aware IT governance helps align IT with institutional strategies and objectives. Key functions of cloud-aware IT governance include:

- Providing an agile, responsive, and easy-to-use decision-making process that encourages stakeholders to follow IT governance procedures
- Ensuring top-down and bottom-up needs are included so that the goals of both executive leadership and end users are met
- Identifying and managing risks to protect the institution and its interests
- Addressing security, privacy, and compliance issues
- Including the perspectives of a broad set of stakeholders across the institution
- Facilitating coordination between central and decentralized IT units

Moving to the cloud requires agility from IT governance. If governance processes introduce significant delays, end users will look for ways to circumvent it. Instead, it is important that cloud-aware IT governance comprise processes that add value and encourage users to use it.

Keys to incorporating cloud into IT governance are:

- Engaging stakeholders: Key stakeholders include many units outside IT, such as business process owners; administrative units including procurement, legal, security, and risk management; academic units; and faculty and students. The perspectives of these stakeholders will inform the institution’s cloud strategy.
- Rightsizing your governance: Establish the core goals of cloud-aware IT governance and define the nature of shared decision making. Cloud computing can shift decision-making responsibilities
from central IT to a more diverse set of stakeholders. Decision-making processes must be clear and well understood. IT governance should help prioritize the cloud services portfolio and facilitate communication. It must be able to respond rapidly when individuals and business/academic units explore solutions to emerging needs.

- **Asking the right questions:** Proactively creating a list of common questions that individuals, departments, and units should answer in advance will help IT governance quickly evaluate requests. A similar approach can be applied to cloud vendors. Questions should not be encyclopedic or burdensome, asking only for the information needed to assess the risks and benefits of cloud service adoption.

- **Establishing a cloud review process:** To build consistency and speed, not only does the institution need to ask the right questions, but it also needs to develop the criteria upon which the answers will be evaluated. It may be beneficial to exempt certain types of decisions from review or to preapprove a set of cloud tools.

Successful, cloud-aware IT governance helps create a culture that supports the best interests of the institution and its communities. Implementing a strong IT governance process that is prepared for the changes in decision-making models that the cloud brings about will ensure that the institution can meet the needs of its stakeholders and align cloud services usage with its strategies and goals.

**Transforming the IT Organization**

The third paper in the series, *Transforming the IT Organization*, addresses the impact that cloud computing has had on the evolution of IT staff roles in higher education. The paper highlights organizational changes by identifying the following:

- Strategies needed to evolve the IT organizational structure
- How to prepare the IT workforce for the culture change of working with the cloud
- How to develop a culture of partnership with other institutional stakeholders
- The new roles and skills required on campus (outside the IT department)

In place of end-to-end control of solutions, IT organizations need to become agile at managing partnerships, whether with campus units, legal advisors, or vendors. Building and maintaining these partnerships calls for new IT skills, and the paper describes 12 roles in 4 areas: business, vendor management, technical, and data.

**Business Roles**

- **Business analyst:** Emphasizes user requirements and understanding of how cloud applications can be integrated into institutional business processes.

- **IT liaison:** Ensures that IT units stay informed and serve as strategic partners when cloud-based services are being considered; coordinates activities of units from around campus.

- **Product manager:** Serves as liaison between users, technical staff, and vendor partners to ensure that customer needs are met; serves as the customer advocate.
- **Project manager**: Ensures that the systems being adopted have been thoroughly vetted and implemented to meet the needs of the institution.

**Vendor-Management Roles**

- **IT strategic sourcing manager**: Acquires cloud computing services; this role should be filled by dedicated IT strategic sourcing staff who are qualified and experienced in the unique nature of cloud computing contracts and risk mitigation.

- **Vendor manager**: Owns and coordinates the ongoing relationship between the cloud consumer, cloud provider, and campus constituents. Remains part of the process from initial investigation through contract negotiation, ongoing use of the service, and end-of-life/transition to a replacement solution.

**Technical Roles**

- **Application administrator**: Handles the configuration, management, and access control for IT services.

- **Cloud architect**: Designs solutions that integrate multiple cloud (IaaS, PaaS, SaaS) and virtualization platforms, including on-premises services and solutions and data sources.

- **Emerging technologies analyst**: Provides research insights into future academic and administrative technology trends; is empowered to push the institution into experimenting with various emerging technologies.

- **Integration specialist**: Understands business structures and needs and develops integration requirements and processes to integrate cloud services with on-premises solutions and/or other cloud services.

**Data Roles**

- **Data custodian**: Focuses primarily on the security and management around where institutional data reside and are used in the cloud.

- **Information security analyst**: Serves as subject-matter expert for information security standards and requirements, third-party risk assessments, and mitigation plans.

Every IT organization will need to assess its need for these roles and outline a path for developing them.

Since *Transforming the IT Organization* was published in August 2015, signs of new cloud teams and specific cloud roles are now emerging. For example, Indiana University created a position called Manager of Cloud Technology Support in order to begin the formal examination of how the institution could bring IaaS and PaaS technologies into the IT portfolio. Cornell University is in the process of moving much of its on-premises computing to off-premises cloud providers in an IaaS model. Its central IT organization is delivering a service—called cloudification\(^1\)—to help the campus move to this IaaS model. The new Cloudification team will provide consultation and best practices for moving services to the cloud. In addition to providing consultation to those moving to the cloud, the team will also deliver a Cloud DevOps support services environment, after services have been migrated to the cloud. This emerging team currently consists of a cloud architect, a cloud DevOps engineer, a cloudification engineer, and a cloud...
engagement manager. Where the Transforming the IT Organization paper had defined generic cloud roles and teams, we see these having evolved into real-world roles in the Cornell Cloudification service.

Building a Migration Plan

The fourth paper, Building a Migration Plan, helps readers develop a cloud migration plan to guide future efforts. A migration plan allows you to better manage organizational change, mitigate risk, and maximize the financial and service benefits of moving to the cloud. This paper outlines an approach designed to help higher education institutions migrate their administrative, academic, and research computing activities to cloud providers. Many of the common challenges facing institutions as they make these plans are discussed, including:

- The need for appropriate administrative processes (budget, purchasing, accounts payable, etc.) to support the purchase and use of cloud services
- The difficulty of migrating applications out of an institutional data center and into the cloud
- Vendor-selection processes that will last beyond initial pilots
- Lack of industry-provided migration paths
- Differing architectures, which require different staff skill sets regarding design, implementation, and operations
- Managing user expectations

For the most part, these concerns remain today, almost a year after the publication of the fourth paper in January 2016. One exception is that cloud vendors are now providing guidance to help organizations build their own migration plans. For example, Amazon now provides a Cloud Adoption Framework that addresses many of the issues that organizations must consider when adopting cloud computing strategies. Institutions may also take advantage of opportunities to learn from each other, such as during the Moving to the Cloud preconference seminar—facilitated by IT leaders from Cornell, Harvard University, and the University of Notre Dame—at the 2016 EDUCAUSE Annual Conference.

We continue to believe that institutions migrating to the cloud typically fall into three different usage patterns:

- **Experimental cloud**: The IT organization begins to learn about the various cloud services available to them in the forms of SaaS, PaaS, and IaaS. The organization may begin deploying some common SaaS solutions (such as e-mail and collaboration tools), which sometimes grows into testing IaaS deployments (e.g., building experimental servers for learning purposes).

- **Opportunistic cloud**: The IT organization begins to actively seek cloud solutions that meet new business requirements. New services may remain as traditional on-premises deployments, but cloud solutions are considered and deployed when benefits in reliability, scalability, or other areas are perceived.

- **Cloud first**: This strategy places cloud computing at the top of the decision-making chain. The default assumption within the institution is that cloud services will fulfill the majority of the institution’s computing needs. After institutions adopt a cloud-first strategy for existing services, they may implement a migration plan to move legacy services to the cloud.
Perhaps the biggest change since January 2016 is what we perceive—based on anecdotes—to be a significant increase in the number of institutions adopting these strategies across the board, as well as an increase in the number of institutions that are either already pursuing or plan to pursue a cloud-first strategy.

**Operationalizing the Cloud**

The fifth paper, *Operationalizing the Cloud*, addresses a wide range of operational issues associated with cloud computing. The effective adoption of cloud services requires changes to an organization’s existing operational practices and procedures, as well as an understanding of the risks of cloud computing. Highlights of the paper include:

- **Understanding risks**: Cloud computing introduces a new shared-risk model, which is different from how higher education institutions have traditionally managed risk. As a result, each institution will need to rethink its practices for assessing, mitigating, and accepting risk.

- **Procurement and vendor management**: The successful use of cloud computing requires IT professionals, business process owners, procurement officers, legal officers, and other stakeholders to be actively engaged in the development and ongoing management of cloud supplier contracts and relationships.

- **IT service management practices**: Institutions will need to adjust their service management practices to work smoothly with their cloud services. This includes a wide set of processes such as incident management, change management, and configuration management.

- **Integration with current infrastructure**: Cloud implementations require IT professionals at an institution to address application integration, network design, security, and compliance.

- **Disaster recovery/business continuity**: Cloud services offer the promise of excellent disaster recovery capabilities to higher education, but they also introduce challenges such as the inability to fully test providers’ disaster procedures.

- **Exit strategies**: Developing an effective exit strategy is difficult and will vary depending on the type of cloud service (SaaS, PaaS, or IaaS) that is being leveraged.

Most institutions that adopt cloud services will find themselves spending a considerable amount of effort addressing the topics listed above and covered in the fifth paper. While the paper does not provide “one size fits all” answers to all of these challenges, it does articulate the factors to consider and can serve as a checklist of issues to consider as an institution begins to engage with cloud services.

**Cloud Awareness and User Support**

The sixth paper in the cloud series, *Cloud Awareness and User Support*, outlines how institutions can address end-user support, end-user documentation, user training, and community outreach in the cloud. Many of the advantages cloud computing offers come with new challenges when considering support for cloud-based products. The product designers are no longer just down the hall, and updates can be released at a rapid pace with little to no warning. This paper examines four areas of importance when introducing a community to cloud-based products:
End-user support: Supporting users directly is the starting point for most organizations. If nothing else, providing solid support for products that you have little to no control over is paramount to the success of any product rollout.

Documentation: Every product needs instructions, and the good news is that many cloud providers can provide partial or even complete documentation aimed at end users.

Training: For larger rollouts, organized training is often necessary. Cloud computing opens new avenues for training such as vendor-provided online training or train-the-trainer classes for IT staff.

Campus outreach: Tech fairs and communities of practice are fantastic ways to reach out to users and help them understand new products. Many cloud-based vendors will provide staff and other resources for these events.

Each of these areas of focus requires new strategies for cloud computing. The paper explores the following strategies and examines how each can help:

Form partnerships with your cloud provider. Often cloud providers can provide help with every aspect of the user experience. Look for vendors that provide at least high-level support to supplement your own IT staff. Vendors can also be fantastic sources of documentation and can often assist with outreach.

Focus on agility. Documentation from your cloud provider is great, but how often does it change? Are the links always the same? How often does the product change? Do you have any control? Often, supporting cloud products means adapting to frequent updates and becoming a guide rather than a guru.

Look for new methods of engagement. New products often require new strategies. Introducing strategies that may not have been used in the past may assist with the new challenges coming with cloud-based products.

The paper dives into these topics in much greater detail, with perspectives and solutions offered for institutions of any size.

ECAR Working Group Cloud Computing Perspectives

As we wrap up this series, the ECAR Cloud Working Group wanted to share some of our personal journeys and how cloud computing has transformed our roles and organizations. As you’ll see, we come from a diverse group of institutions, and cloud computing has touched us all, affecting our IT organizations in similar ways but also in ways that have caused us to make unique changes to better serve our institutions in this quickly changing environment. Our collaboration, research, and dialogue on cloud computing were driven by the needs we felt at our own institutions, and we were driven to produce this series in the hope that it might benefit our local organizations in their cloud adoption as well as serve as a useful guide for all of higher education IT. We hope that the following perspectives provide you with additional insight into how individual institutions engage with cloud services.
Mike Chapple  
Senior Director for IT Service Delivery  
University of Notre Dame  
ECAR Cloud Working Group Co-Chair

At Notre Dame, we’re working our way through a fairly aggressive cloud-first implementation plan in an effort to improve the quality of service that we provide to our campus community. Our effort is driven by a desire to find ways to meet increasing demand for IT services while avoiding a substantial capital investment in new data center resources. We began our cloud journey with a simple website migration project in 2012, followed by a series of pilot projects designed to help us explore various cloud technologies and find an appropriate fit for our campus environment. In 2014, we set the ambitious goal of moving 80% of our IT services to the cloud over a three-year period. Today, we’ve made substantial progress toward that goal and currently operate 58% of our services in the cloud.

Our cloud strategy embraces all forms of service delivery and is designed to find the most effective way to meet the technology requirements of our campus partners while effectively stewarding our limited human and financial resources. When we encounter a new requirement, we first seek to find a SaaS solution that meets the business needs and is both technically and financially viable. Our preference for SaaS is driven by a desire to obtain technology services that operate as high in the stack as possible, shifting the burden of operating technology infrastructure to our vendor partners. If we aren’t able to identify an appropriate SaaS solution, we then turn to PaaS and IaaS alternatives.

We’ve also found unanticipated side benefits of our cloud journey. As we take this opportunity to examine all of the IT services we provide to campus, we’ve found many places where we can improve the quality of those services or retire services that are no longer needed. We’ve also tried to build in as much automation as possible to reduce our technical debt and improve our future ability to rebuild the environment should it become necessary. Our cloud journey has been an exciting opportunity to explore new ways to deliver technology that helps our campus partners achieve their academic and business goals.

Thomas Dugas  
Director Information Security/Special Initiatives  
Duquesne University  
ECAR Cloud Working Group Co-Chair

Over the course of this series, I have been pleasantly surprised by the success of the papers and the increased discussion and collaboration on cloud computing. Five years ago, Sal Rosario from Princeton and I started the Cloud Computing Constituent Group at EDUCAUSE. We weren’t sure what to expect or whether the industry would even be successful. What I had the chance to be a part of was a major industry change that brought together new collaborations between EDUCAUSE and Internet2 to educate, inform, and partner to bring cloud computing to the masses. As I reflect on how much has changed, I am fortunate to have been able to meet so many individuals who were eager to take on a momentous topic and to break it down into smaller meaningful parts that could benefit others like us who were likely to be following our path.
Over the past few years, North Carolina State University has moved from an experimental to an opportunistic approach to the cloud, in which we evaluate options on a case-by-case basis and select the best, most cost-effective fit. Like many, we began with SaaS applications and have subsequently explored and adopted PaaS and now IaaS solutions in the public cloud. A substantial amount of exploration and adoption came from groups outside central IT, and we have seen increased collaboration among units that has been facilitated by our IT governance process.

As we look to the future, we expect that hybrid cloud solutions will play a role in conjunction with public cloud offerings. Throughout the campus, our IT staff, researchers, and educators are seeking to develop cloud-related skills and a deeper understanding of our options, from high-performance computing and rapid application development to commodity services such as storage and virtual servers. The considerations that we have addressed in this series of papers inform the development of our cloud strategies going forward.

Indiana University continues to employ an opportunistic cloud strategy with a clear shift to using cloud-based software solutions. The trend to cloud software has accelerated during the course of this series of papers. However, IU is taking a conservative and deliberate approach to platform and infrastructure. With two modern and geographically redundant data centers, IU has no pressing motivation to move enterprise systems to the public cloud. Nevertheless, the innovations in application development technology and systems architecture being made in the cloud technology space cannot be ignored. Researchers across the institution as well as developers in central and distributed IT units are eager to begin working with the cloud tool set.

Since signing the Internet2 NET+ agreements for Amazon Web Services and Microsoft Azure, IU has focused on structuring their deployment to align with the technical, support, and administrative needs of the enterprise. There is concern about making accounts available without the normal scaffolding of identity, networking, security, and even billing that users expect and administrators demand.

In keeping with the desire to leverage existing infrastructure, technologies that enable some aspects of the cloud stack are being built out in the data centers. IU is standing up Docker Datacenter in its on-premises VMware environment, and other innovations born in the cloud are sure to follow.

The hard work of building a broad base of hands-on experience among developers, network engineers, systems administrators, and systems architects has just begun. Going forward, it will take the support of management to identify opportunities for meaningful exploration of cloud techniques and tools without considering it a threat to current investments.
At the University of Washington, we’ve gone from building everything from the ground up—including e-mail, payroll, and financial systems—to adopting cloud-based services in virtually every IT tool we offer. We started this transition several years ago with our e-mail system. We introduced both Google Apps and Microsoft’s Live @ EDU (eventually becoming Office 365) to replace an aging system we built ourselves.

As a support specialist, I’m in nearly constant contact with the faculty, staff, students, and alumni using the many different IT services we’ve provided over the years. So even though I saw the friction of giving up control and the difficulty involved with depending on outside vendors for critical services, I also got to see our users appreciate and embrace these new, more modern e-mail systems. Our jobs have changed completely. Our engineers have become customizers, and our support specialists are now guides rather than experts. These aren’t easy transitions, but the increased value we’re delivering is astounding. The features and benefits of cloud-based services go far beyond anything we’ve built ourselves.

When this series began, I was at George Mason University, where we used private and public clouds to provision institutional services and were starting to develop a defined strategy for the provision of cloud services. Now I’m at Binghamton University, where we have invested, like many institutions, in what are now considered traditional cloud services, such as hosted e-mail, hosted learning management systems, and SaaS. While a few institutions are removing data centers completely, our upcoming data center renovation will create a smaller and more efficient footprint that will allow us to leverage cloud services in more strategic ways.

At Binghamton, we are embracing more and more cloud opportunities—not just in IT groups but also across the institution—including our institutional website, portal, scholarship management, admissions, and storage services. The impact on the IT organization and its staff is palpable—we are learning new skills, from managing risk and/or vendors to being a cloud “guide on the side” for our campus partners.

What just a few years ago seemed like the cutting edge is now a path that many institutions walk, whether that institution is on the beginning of the cloud path or cutting in new roads. For my part, I am pleased that the cloud is fulfilling its promise of saying “Yes, you can do that!” to departments across our institutions, allowing all of us to be more agile and responsive to our community’s needs.
The cloud continues to help Denison University meet our operational goal of “keeping the college healthy” by leveraging both hybrid and off-premises tools and services to meet the rapidly changing needs of the college, with a small IT staff. Once the service offerings became widely available for the higher education community, liberal arts colleges like Denison quickly adopted cloud services to augment their traditional, on-premises services to reduce the overall costs associated with providing IT services to our collective campuses.

At Denison, we have adopted a “cloud-first” approach in exclusively evaluating SaaS tools before even considering building a local, on-premises solution. When custom solutions are developed internally, the infrastructure or platforms for those solutions almost exclusively reside in the cloud. Over the past four years, Denison has seen a major shift toward cloud-based solutions as major legacy IT services have reached end of life: e-mail and file-sharing services, telephony and unified communications, recruitment and admissions solutions, and a replacement for our learning management system with a social learning platform.

In June 2010, EDUCAUSE published my article “If It’s in the Cloud, Get It on Paper: Cloud Computing Contract Issues” based on my experiences at UCLA in negotiating my first cloud computing contract for a web-conferencing service. At that time, this was somewhat novel. In June 2016, I was invited to speak at the EDUCAUSE/NACUBO Enterprise IT Summit on significant changes that had occurred with cloud computing in the intervening six years as cloud computing became more the norm.

During those six years, overall spend on cloud computing services increased by over 165%. Specific cloud computing services saw substantial growth as well. During the intervening time, the U.S. government increasingly embraced cloud computing by:

1. Establishing a cloud-first policy requiring government agencies to evaluate cloud computing options before noncloud investments;
2. Issuing the NIST Definition of Cloud Computing; and
3. Launching the Federal Risk and Authorization Management Program (FedRAMP), which has now authorized over 60 compliant services.

In recognition of the impending prevalence of cloud computing, on June 15, 2011, the American Institute of Certified Public Accountants (AICPA) issued its Service Organization Controls (SOC) 2, “Report on Controls at a Service Organization Relevant to Security, Availability, Processing Integrity, Confidentiality or Privacy.” SOC2 has become one of the most common standards by which the security of cloud computing services is evaluated.

In further recognition of the growing use of cloud computing, on February 5, 2013, the Payment Card Industry (PCI) issued its Data Security Standard (DSS) Cloud Computing Guidelines to clarify the
shared responsibility for cardholder data processed in a cloud environment and how specific roles may vary depending on the cloud service and deployment model.

The Edward Snowden revelations of June 2013 that the NSA was collecting information “directly from the servers” of a multitude of cloud service providers has had a significant impact on cloud computing service providers and their clients’ perception of them as trusted partners. To protect their image and client base, many cloud service providers subsequently began issuing transparency reports regarding government requests for access to client data, as well as contesting such government actions. The Snowden revelations have had international implications as well, including the February 2, 2016, replacement of the U.S./EU “Safe Harbor” construct for personal data sharing outside the EU with “Privacy Shield,” intended to provide stronger protections on the handling of EU citizens’ personal information.

The ever-increasing number of data breaches (781 in 2015 alone) comes with a high price tag, estimated at $217 per compromised record. This has led to a commensurate increase in the purchase of cyber-risk insurance (CRI) to help transfer that risk. From 2013 to 2014, the number of organizations purchasing CRI increased by 32%, and the average amount of coverage purchased increased by nearly 22%.

Finally, in December 2013, the U.S. government issued a warrant to access a Microsoft client’s personal information that resided in a Microsoft data center in Ireland. Microsoft appealed arguing that a U.S. judge has no authority in Ireland. This still-contested case exemplifies the challenges associated with the rapid development of cloud technology and the inability of laws to keep pace with its implications. This case and the issues highlighted above serve as reminders that institutions’ ability to maximize the many benefits associated with the use of cloud computing services entails dedicating resources to monitor, manage, and maintain the institution’s relationship and contract with its cloud suppliers.

Joseph Vaughan
Chief Information Officer
Harvey Mudd College

Tiny Harvey Mudd College has about 6,500 alumni, but among them we count the creators of the MIME standard, SQL, and Remote Procedure Calls, all technologies that have played a critical role in the rise of cloud computing. It is fascinating, as the CIO of this little college, to try to stay on the surfboard as we ride this new wave.

During the period that this cloud computing series was written, the treasurers of the seven Claremont Colleges got together and agreed to migrate from multiple financial management systems to one (Workday) and at the same time adopt the same business practices across the colleges. They achieved this goal, with minimal demand on the local IT units, in about 21 months. This is an almost incredible pace for a consortium of seven separately incorporated institutions. They are now embarking on a similar initiative to adopt Workday HCM, with a go-live date of January 1, 2018.

Harvey Mudd doesn’t really have a compute cluster for high-performance computing (HPC), but we do have an XSEDE Campus Champion, which gives us access to the best supercomputing resources in the country. When the college is recruiting new faculty, the topic of HPC has come up frequently in recent years. The dean of the college tells me that conversations vital to recruitment have taken place between the XSEDE Campus Champion and the new recruits.

For me, these examples indicate the kind of agility, speed, and power that cloud computing affords institutions like ours. They also hint at some of the changes that have to be embodied at the institution: flexibility, agility, and change hardiness are needed throughout the organization.
Bill Wrobleski  
Director, Technology Infrastructure  
University of Hawai‘i System

The University of Hawai‘i is in the unique position of having a new state-of-the-art data center with a significant amount of available power and space. As a result, we do not have the same urgency to move to the cloud as other, more resource-constrained institutions. That said, we recognize that cloud computing is an important part of our future. To move toward that future, we’ve adopted an opportunistic cloud strategy summarized in this sentence: “UH will adopt cloud computing services on a case-by-case basis, taking into account functional, financial, and logistical factors.” This strategy has led us to focus on projects where we see the most short-term value, such as best-of-breed SaaS solutions and a cloud-based disaster recovery solution. We’re now moving toward projects to help deepen our technical expertise, including using cloud services to provide redundancy to our authentication and identity management infrastructure. We hope our gradual, step-by-step approach will provide the optimal value for UH and make our transition to cloud services as smooth as possible.

Conclusion

The Preparing the IT Organization for the Cloud series has provided a timely and comprehensive look at the impact of cloud computing in higher education. While this series has come to an end, the ongoing dialogue about cloud computing in higher education will need to continue as technologies, services, and our institutions evolve.

We suggest interested parties participate in this dialogue by joining the EDUCAUSE Cloud Constituent Working Group, which will be the home of many important discussions over the course of the next few years. Interested parties should also plan on attending cloud discussions and presentations at the EDUCAUSE Annual Conference or EDUCAUSE Connect Conferences. Finally, we expect that new working groups focusing on continuing areas of concern related to cloud computing will be launched. We welcome suggestions for new project topics and encourage people interested in joining in such a group to reach out to us via the working groups website. The combined knowledge and experience shared in these settings should help technology leaders guide their institutions through this significant time of change.
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We would like to additionally thank Sarah Christen, Assistant Director of Community Platforms and Cloudification Services, Cornell University, for her contributions to this report.

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Notes
1. For more information, see the Cornell blog Cloudification.
2. These roles are defined at Cornell as follows:

   Cloud architect: Possessing a very broad range of technology skills, this position assumes the traditional roles of a network architect, system administrator, and application developer. As Cornell moves toward infrastructure as code, the lines between these three traditional roles begin to fade and the positions start to overlap. Additionally, having someone in this role who can oversee and consult on future directions, with an eye toward ephemeral servers and complex new networking challenges, becomes critical.

   Cloud DevOps engineer: This position consists of individuals who can create reusable automation. The position understands the concepts of managing ephemeral servers and containers rather than the individual management of many unique server configurations. This position is focused on being able to manage many services in the cloud by automating and simplifying. Unlike application stack support for legacy applications, where each application was unique, this role helps orchestrate simultaneous automation across many applications.

   Cloudification engineer: The primary function of this position is to help the campus make the transition from on-premises servers to cloud platforms. The position not only helps manage the implementation of new delivered services but also serves as the resident cloud delivery expert, with a focus on helping campus customers use modern technologies and DevOps practices. This position is primarily focused on the implementation and transition from on-premises computing to new cloud services and not on daily DevOps support.
Cloud engagement manager: This new role supervises the onboarding of all new accounts and manages the associated billing processes. In addition to serving as the campus liaison with all of the cloud service providers, this position also organizes all on-campus cloud services training and local hack-a-thon programing collaboratives and serves as the communication/event coordinator between the Cloudification team and the on-campus technical community.

3. See the Cloud Services Working Group for more information about Internet2 cloud community conversations.


5. Instagram was launched on October 6, 2010, and as of June 2016 had over 500 million active monthly users. Twitter usage grew by over 916%. Uber went from its first paid ride on March 27, 2010, to nearly $11B in revenue by 2016. Amazon Web Services revenue grew by 800%. To provide some perspective, during this time the population of the world only grew by 7.07%.


8. See FedRAMP.

9. It remains pertinent to remember the following regarding SOC2: (1) The cloud service provider determines which portion of its infrastructure to include in a SOC2 audit, so be sure it’s the portion germane to your use; (2) the cloud service provider determines which of the five principles (security, availability, processing integrity, confidentiality, privacy) to include in the audit; and (3) for the most sensitive cloud workloads, ensure that it’s a SOC2 Type 2 audit, which includes an opinion on whether the controls were operating effectively and is applicable to a specified time period, not a specified date.

10. Providers included Microsoft, Google, Yahoo, Facebook, and Apple. On April 14, 2016, the ripple effect of the Snowden revelations ultimately led Microsoft to sue the U.S. Justice Department, challenging the government’s authority to secretly access information. The Snowden revelations also played a strong role in the EU’s April 14, 2016, decision to replace its Data Protection Directive with the stronger Data Protection Regulation, with which Privacy Shield will ultimately need to align. Given that the nature of cloud computing services includes the provision of a standardized service, cloud service providers could elect to adopt the EU standard so as to not exclude the large EU client base, potentially resulting in non-EU nations receiving the same level of protection.


12. See “Ponemon Study Shows the Cost of a Data Breach Continues to Increase.”
