

Notre Dame's Cloud Computing Strategy

Executive Summary

Over the past five years, Notre Dame has gradually embraced cloud computing as a cost effective, flexible way to deliver increasing levels of computing functionality, performance and capacity to the campus community at reduced costs. We are now at a turning point where the costs of maintaining our existing infrastructure, combined with the increasing IT service demands from faculty, students and administrators, place us at a crossroads where we must transform our operations in order to meet University academic and operations requirements. In response, we are setting out a "Cloud First" strategy for computing at Notre Dame.

What is Cloud Computing?

Cloud computing involves the use of software and infrastructure provided through data centers operated by service providers. These offerings include Software-as-a-Service (SaaS) products that are managed end-to-end by a vendor. Notre Dame already uses a multitude of SaaS products, including Google Apps for Education, TravelND (Concur) and Sakai.

Lesser known, but equally important, are the Infrastructure-as-a-Service (IaaS) offerings that allow IT professionals to build customized technology environments within a data center operated by a service provider. Amazon Web Services (AWS) is the most significant vendor in this space, both by market share and functionality. Microsoft and Google have lesser offerings in this space but are expected to increase competition over the next few years.

What Advantages Does The Cloud Offer?

Embracing cloud computing offers Notre Dame an opportunity to achieve significant improvements in functionality at reduced costs, especially as related to future cost avoidance. We believe that the current environment presents an opportunity to transform our IT services and operations in a significant way. The major benefits offered by the cloud include:

- **Capacity.** Cloud vendors offer us virtually unlimited capacity. We have the ability to immediately provision resources, such as servers, in extremely large quantities, use those resources for as long as necessary and immediately de-provision them when they are no longer necessary. This model eliminates the need for over-provisioning resources to meet unknown future demands.

- **Resiliency.** The infrastructure that powers cloud services is highly durable and spread across multiple geographic locations. This alleviates concerns related to the availability and disaster recovery of on-campus data centers.
- **Agility.** Cloud computing facilitates the rapid deployment of IT resources, allowing us to create servers in minutes, rather than the weeks or months required to procure and configure on-campus equipment.
- **Cost.** The “pay as you go” model of cloud computing allows us to pay for only those services that we actually consume and purchase them on demand. By way of comparison, Notre Dame’s current virtual server infrastructure is only 50% utilized. We must maintain this slack capacity to respond to demands and be ready to address escalating needs. In a cloud model, we can achieve a 100% utilization rate.
- **Innovation.** By moving responsibility for maintaining hardware to cloud service vendors, OIT staff are able to focus on efforts that are central to advancing Notre Dame’s mission of **teaching**, research and service.

What Risks Are Associated With Cloud Computing?

The risks associated with cloud computing parallel those associated with running on-campus data centers. The primary difference is that, in a cloud model, we depend upon vendors for some risk mitigation activities. Two specific areas that require attention are information security and regulatory compliance.

From a security perspective, cloud computing customers must depend upon vendors as partners in a shared security model. In an IaaS approach, the University remains responsible for the secure configuration and maintenance of servers, just as we are on campus. The vendor, however, is responsible for physical security and the security of the underlying technical infrastructure. We have reviewed [AWS security practices](#) in detail and are confident that they meet or exceed the University’s existing security requirements. The AWS cloud stores extremely sensitive information on behalf of customers that include the Central Intelligence Agency, financial institutions and the private sector. The presence of this information demands that AWS maintain the highest level of security controls at all of their facilities.

The complex nature of cloud services, combined with the fact that data may be stored, processed and transmitted using resources that are geographically distant from campus, introduces regulatory compliance issues. We have reviewed the compliance practices of AWS and have already certified it for use with University data classified at the Sensitive level. Our current AWS contract provides the necessary protections for handling FERPA records. If use cases arise where we wish to use AWS for Highly Sensitive data, we will work through those specific compliance processes.

While there are risks involved with cloud computing, we believe that the controls we have in place adequately mitigate those risks and that the use of cloud computing does not increase the University's risk profile. A more detailed risk assessment is available as a component of the [cloud strategy document](#) that Notre Dame jointly developed with our peer institutions.

What Is Notre Dame's Current Cloud Presence?

Notre Dame currently uses over 100 cloud services in our daily operations. Many end users are unaware that some of these services are cloud-based, and these services have high satisfaction rates. In fact, these services are among some of the most highly rated technology services on our campus. Current SaaS offerings at Notre Dame include:

- **Box.com** collaborative storage
- **Google Apps for Education** mail, calendaring and applications suite
- **Concur** travel and expense reporting
- **Sakai** learning management system
- **TouchNet** credit card processing
- **CrashPlan** computer backup service

OIT has also conducted a number of significant pilot projects using Amazon Web Services to provide infrastructure services. OIT services currently hosted in AWS, in partnership with University Communications, include:

- Notre Dame homepage (www.nd.edu)
- Over 400 departmental websites (including evp.nd.edu and oit.nd.edu)
- Notre Dame mobile app
- Backups of OIT servers

In each of these cases, OIT engineers leveraged cloud computing resources to achieve the advantages of cloud computing described above at a lower cost than an equivalent on-premises solution.

How Will Notre Dame Move Into The Cloud?

Our Cloud First strategy states that we will turn to cloud services as the preferred option to meet all new business requirements. This has been our *de facto* approach for several years. When facing a new requirement, we will first consider Software-as-a-Service solutions. If no SaaS solution meets our requirements, we will then turn to an Infrastructure-as-a-Service approach.

In addition, we will begin the process of migrating existing on-premises services to the cloud, reducing and eventually eliminating our reliance upon on-premises data centers. Following this approach, we expect that 80% of our services will move into the cloud over the next three years. At the end of that migration, we intend to use Data Realty as our only local data center and reclaim the space occupied by the data center on the first floor of the IT Center.

What Costs Will Be Associated With This Move?

The complexity of IT services currently offered on campus and the variable nature of the pricing models for IaaS solutions make it difficult to estimate the costs of implementing a solution in the cloud prior to actually building it. We are confident that our cloud migration will be cost-neutral, and likely cost-beneficial, when comparing our current computing costs to current demand.

As an illustrative example, the infrastructure that supported the Notre Dame homepage on our campus cost approximately \$26,000 annually. Our Amazon deployment of the same service costs approximately \$7,200 annually and provides far superior service. This 72% reduction in cost illustrates the potential for cost savings, but should not be considered typical, as the operation of a website is one of the computing models most suited to the economics of cloud computing.

In another example, Columbia University recently conducted a cost analysis for building a research datacenter either within their existing on-campus data center or in Amazon Web Services. Their estimate was that the services that would cost approximately \$2.0M on-campus over four years could be run in AWS for \$1.2M during that same period.

The institution will also achieve financial benefits from this move. According to the Utilities department, the power consumed by OIT data centers is responsible for approximately \$180,000 in annual costs. In cloud computing models, the costs of power are included in vendor price models, so the University will immediately realize these savings. Additionally, the space currently occupied by data centers will become available for other administrative or academic uses.

What Are Other Organizations Doing?

Many private sector organizations have already adopted similar Cloud First strategies. Large technology companies, such as Netflix, Adobe and SAP are making major moves in the cloud. Traditional companies, such as Pfizer, Dow Jones and Bristol Myers Squibb are AWS customers. Government agencies, including the Food & Drug Administration, NASA and the Central Intelligence Agency make use of AWS cloud services. The CIO of Dow Jones recently unveiled a plan to move 75% of their infrastructure to AWS over the next 3 years, with a projected \$100M savings.

General Electric, in particular, has set forth a cloud strategy more aggressive than Notre Dame's. They have set a goal of migrating 90% of their computing to the public cloud and have been moving in that direction. Over the past year, they deployed 90% of their new applications in the cloud. Chris Drumgoole, GE's COO of IT, [recently said](#) "We're big fans of the idea that everything ends up in the public cloud utility model eventually."

In higher education, many institutions are in the same position as Notre Dame. We have widely adopted SaaS approaches to cloud computing and are beginning to transition significant portions of our infrastructure to the cloud. Harvard has adopted a goal similar to Notre Dame's -- transitioning 75% of their workloads within the next three years. Notre Dame technologists worked with colleagues from peer institutions to develop a Cloud Strategy for Higher Education. Participants in that working group included Columbia, Cornell, Duke, Georgetown, Harvard, Stanford, the University of Chicago, the University of Iowa, the University of Minnesota, the University of Southern California, the University of Virginia and the University of Washington.