The Cloud: Why Post-Secondary Education will Never be the Same

What is the Cloud and Why Should we Care?

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Executive Summary

The maturation of the cloud signals a revolution in consumer and institutional technology choice. It will be easier than ever before to access the services we need directly, without having to configure our own PCs or call on IT staff. Instructors unhappy with the collaboration tools in the institutional learning management system (LMS), for example, might simply opt for cloud-based collaboration services.

Institutions themselves will also enjoy expanded choice. Colleges and universities will have the flexibility to move some of their technology needs to cloud resources while discontinuing other services that consumer resources can provide. This will allow institutions to decide which operations really need to be managed on-campus, which should be supported via campus agreements for cloud services, and which can simply be showcased for campus colleagues to choose from in the consumer marketplace. The cloud will also make it possible to transform a lot of IT capacity from a capital good to a just-in-time services expenditure.

Key benefits of the cloud include:

- Delivery of technology capabilities as services that can be accessed anytime, anywhere, much the way we access utilities like electricity or telephone connections;

- Elasticity, the ability to draw on as much or as little computing power as we need without having to reconfigure machines or networks;

- Virtualization, the ability to make use of computing services without regard to what operating system or hardware they run on; and

- High-speed network connectivity that makes it seem like work being done by a distant server is taking place on the device in your hand.

Exploiting the cloud's power, however, demands caution and calls for some fundamental changes in the way institutions behave. Key concerns institutions need to manage are:

- Security: how exactly are institutional data to be stored and protected by others?

- Cost: how much do cloud services really cost, especially when integration issues are considered?

- Lock-in: what is the exit strategy if cloud services fail or aren't cost-effective?

- Compliance: does the cloud vendor understand the post-secondary education's particular regulatory concerns?

Above all, the cloud calls upon post-secondary institutions to overcome the habit of doing everything internally, and to get better at integrating, brokering, and collaborating. Instead of building policy right into infrastructure and boxing constituents in with enterprise systems, we will have to educate users to become good choosers, certify rather than deploy information resources, and make IT governance more inclusive. Unless we develop the new management structures, incentives, monitoring, and controls to guide a "community" IT architecture that takes cloud computing into account, we may see the emergence of costly duplication, or worse, capabilities that operate outside the reach of our institutional policy structures, academic norms, or business controls.

Introduction

What, until recently was only a technology insider's buzzword, the "cloud" is now a pop cultural phenomenon and the subject of breathless consumer marketing. When Apple and Amazon, both famous for selling category-busting products to the masses, introduce consumer services with names like iCloud and Amazon Cloud Drive, you know something big is happening. Farther up the technology food chain, corporate heavyweights like IBM, Oracle, SAP, and Microsoft have made big bets on the cloud. CIOs who once talked about it mainly with each other, increasingly feel it's time to start talking about it with their executive peers.

But what is the cloud, and why should the post-secondary sector care? If you have an email account with a web-based email service such as Hotmail or Gmail, or if you've used YouTube or Twitter, then you've already had some experience with the cloud. The emails, videos and "tweets" that you read, watched or "tweeted" aren't housed on the computer or mobile device that you accessed them on. They sit on the cloud. And, in the same way that we access and share email, video and social media through the cloud, we can also access and share software, research, spreadsheets and student information.

This paper makes the case that, as the most important change in computing since the introduction of the World Wide Web, the cloud is of concern not just to post-secondary education's technology administrators, but to its students, faculty members, and leaders.

Information On-Demand

For years, the best way to bring the power of computing to a mass audience was to personalize the machine. Bill Gates famously set out to make the PC small and affordable enough to, "put a computer on every desk and in every home." Eventually, the personal computer became the gateway to the Internet, and PCs and broadband connections became indispensable essentials of modern life. But computers and network connections weren't purchased for their own sake. People bought them because they wanted the capabilities those things made possible. They wanted to edit and print documents, calculate business balances, and look up and communicate information. In most cases, buying a computer and loading it with software was the best way to do that.

The critical idea of the cloud revolution is to render technology capabilities into services that you can call up wherever and whenever you want, independent of any particular machine and its configuration. When you use such services, much of the work that might formerly have been done on your, or your organization's computer is assumed by heavy-duty infrastructure at the other end of a network connection. This allows a user, for example, to edit a document on the Google Docs cloud service without having any word-processing software on her own computer.

Reaching out to the cloud this way reduces the technological overhead that consumers and organizations must manage in order to get something done. It turns computing into an on-demand utility that is consumed in as great or small a quantity as needed. This utility, like water treatment or electrical transmission, is kept up-to-date and secure with little or no intervention on the user's part. So long as services are dependable, users needn't concern themselves with the details of how the utility works, any more than they need to know when their local water district is replacing one pump with another.

Moving one's work to the cloud means that user devices become simply an interface with cloud services. This allows devices to be simpler, cheaper, and more portable. You no longer need to have a particular computer or storage device at hand to access your software and files. The cloud also makes it much easier to share information and collaborate on group projects. It is the cloud that permits us today to buy and begin reading a novel on a smartphone, pick up where we left off on an e-reader, and finish on a personal computer—and then share our accumulated marginal notes with friends all over the world at the touch of a button.

Like many great simplifications, this one depends on sophisticated technologies, and cloud computing has benefits that go beyond simply storing and sharing content remotely. These include:

- Elasticity, the ability of a technical infrastructure to respond smoothly to wide swings in demand;

- Virtualization, the ability of one computing environment to simulate another one, so that a single machine can run multiple programs originally designed to work on different operating systems and even on different hardware; and

- Fast network response time (also known as low latency), that permits work done by a faraway server to feel like it is taking place on the device in your hand.

Taken together and combined with standardized ways of exchanging information, these technologies allow centralized data centers to operate at tremendous scale, while also permitting the distribution of that processing power to many distant end-user devices. Cloud technologies also permit great flexibility in shaping services. Cloud service offerings take many different forms, from raw computing cycles that customers purchase to run their own programs, to development platforms for writing software, to polished business applications that look and feel like the ones you formerly installed on your own computer by inserting a

CD-ROM, to full-fledged administrative systems for large institutions.

Cloud computing is the next logical step in the evolution that has seen computing move from the laboratory to the commercial mainframe, the minicomputer, the personal computer, and the network server, and from there to the web. Cloud computing is bringing more devices into our lives while shifting the energies we now put into hands-on system administration—thankless but necessary tasks like updating applications and antivirus software, and backing up data—into more useful work. As networks become increasingly fast and ubiquitous, we will create virtual personal and organizational information environments that live in the cloud, choosing devices to access them according to circumstances. In a step toward this scenario, for example, Apple is enabling its portable devices to sync with music and other content directly from Apple's iCloud service, rather than via a cord connected to a PC.

Cloud computing will not just change our computing paradigm; its particular conception of a "service"—something accessed on demand from anywhere, easily adapted to individual needs, and priced according to what is consumed—will increasingly flavor expectations about more traditional business, personal, and academic services. Professional services once thought safe from commoditization, such as legal counsel and medical advice, are now feeling the encroachments of cloud services that leverage the growing richness of online content and communications. Industries built around bundled offerings, from journalism to cable TV and telecommunications, are now finding it hard to hold their products—indeed, their industries—together. Online interlopers cherry-pick the best lines of business, and consumers empowered by a growing range of choices probe relentlessly for products that better fit their personal desires. Post-secondary education not only is not immune to this trend, it seems tailor-made to be disrupted by it.

From "Users" to "Choosers"

The fundamental force that the cloud and allied technologies are bringing to post-secondary education is consumer choice. The range of cloud-based services that replace (or displace) traditionally campus-based services is huge and growing, including not just instruction but digitized book collections, tutoring and counseling services, even course and faculty rating systems. To the rapidly growing population willing to learn online, cloud-based instructional opportunities range from accredited institutions around the world to targeted and consumer-friendly "edupreneurs" like the Khan Academy and 60secondRecap. Increasingly ubiquitous network access and the growing assortment of cloud-ready devices will increase the richness and interactivity of online learning experiences. For example, courses will make greater use of device cameras, sound, motion detection, and location services to immerse mobile learners in "augmented reality" experiences. Online learning will no longer bring to mind an isolated and immobile student staring at a screen and clicking on a mouse.

But cloud-driven choice will also affect on-campus students and other constituents. Where a given institutional service isn't meeting a student's or faculty member's needs, he or she can now often find ready alternatives in the cloud that were unrealizable even five years ago.

Faculty members and students alike routinely use commercial cloud tools to do things that might once have lived on the institutional learning management or e-mail system: Twitter for course announcements, YouTube for videos, Google Docs for group projects, Facebook

for study groups. Staffers and department managers too can bypass enterprise business systems and choose from a tempting selection of business-oriented cloud alternatives. Even infrastructure isn't immune; the researcher can buy virtual servers and storage from Amazon rather than resort to the local high performance computing centre, while the freshman unhappy with her institutional web drive allotment can move to a cloud tool like Dropbox.

Institutions, too, are consumers, and the cloud will likewise open up new opportunities for them. The cloud can help the IT organization evolve from the empire-building, "just in case" full-spectrum shop that does it all into a more flexible and agile "just in time" organization that looks at many ways to source IT capabilities. In many cases, the IT cost structure will be turned from that of a capital good, with heavy up-front expenditures on things like servers, storage clusters, and software licenses incurred before any institutional work gets done, into expenses only incurred when service is consumed. Institutions will also be able to move some IT activities externally to cloud providers and stop providing others because consumer cloud services are robust enough that users can provide for themselves.[1] In between, the IT organization can provide on-campus delivery of those resources that require a local presence or meet unique institutional needs. All of this will help reduce overall IT costs. Examples of these kinds of benefits already abound. Rather than build additional computing and storage capacity to meet the peak demands posed by holidays like Mother's Day, companies like 1-800 Flowers use cloud-based resources to augment their own resources. Such an approach might serve us well during periods of course registration. Similarly, a great many universities have stopped providing student email and now provide access to university-branded cloud-based mail services operated by Google, Microsoft, or others. Last, there is a wide variety of useful and often small cloud services like Evernote, Dropbox, and many others that are widely used by faculty members. While such consumer solutions present challenges to our institutions, they also reduce the need for us to invent, develop, and operate valuable services and often do so at no cost to the institution.

Adapting to a New World

Post-secondary institutions are famous for being full-service organizations. Besides teaching a hundred or more disciplines; a university may provide housing; food, and health services; maintain police forces; run large retail and other auxiliary enterprises; and offer athletics and cultural programs. The observation that colleges and universities are like municipalities falls short only because in many cases, we are expected to do more things than many city governments ever attempt. The habits of doing it all and doing it ourselves are deep and strong in post-secondary education.

And so it has been with technology, where for decades our institutions have tried hard to cover every technological base, undertaking administrative and academic computing, networking

and communications, web design and content management, user support for everyone from the nervous incoming undergraduate to the eminent research scientist, and much else besides. During the first decade of the Internet era, trends in technology fed a strong "enterprise" mentality favoring central IT influence and authority. When broadband networking was not available to consumers, the institution provided it; when web skills were rare and Internet

tools not very powerful, the institutional IT unit filled the vacuum; when learning management systems introduced an entire new realm of technology-enhanced instruction, IT units quickly assumed authority over them.

Today, however, the cloud and its allied technologies are undermining the foundations that created the modern institutional IT organization. "Big bang" projects have fallen into disfavor and modular cloud tools are making an end run around enterprise systems and "official" resources. Systems that were once expensive to buy and tricky to manage have been commoditized and "cloudified," like the email and calendaring tools that many institutions have moved to Google or Microsoft services. Devices have proliferated wildly in type and function and often come tied to external service contracts and infrastructures the institution can't touch. Even as the complexity of the technology environment explodes, the ability to control it declines. As one writer puts it, the "users" that institutional IT units once could treat as a captive audience and exercise some control over are becoming "choosers" with a great deal of technological independence.[2]

All this means that our post-secondary institutions and their IT organizations will have to overcome the habit of doing everything internally, and get better at integrating, brokering, and collaborating. Where in the past we have been able to instantiate policy in the very infrastructure and enterprise systems we deployed, we will now have to find ways to help newly-empowered "choosers" to choose wisely. This might include, for example, improved data management policies that spell out best practices in storing institutional data in third-party systems, and identifying appropriate data stewards. Institutions will have to decide how they will support staff or other constituents who need technical assistance in the use of cloud resources, perhaps offering support for particular "certified" services but refusing it for others. And institutions will have to rethink IT governance—currently used mainly to prioritize campus projects for funding, but likely to be equally valuable in the future as a forum in which to discover how constituents use above- and below-campus services, and to formulate guidelines for using them. Institutional IT is fast becoming one member of a larger and richer ecosystem.

We do not, however, have to take the cloud as it comes to us. Though "the cloud" is often referred to as a singular, there are many clouds, and post-secondary education has particular needs that may be addressed by some but not others. "Public" clouds like those offered by Amazon, IBM, and Google are highly standardized and operate at large scale, but may not be configurable either technically or contractually to an institution's needs. "Private" clouds can be shaped to a better fit, for example by having the characteristics needed to run certain software packages, or by meeting specific regulatory concerns. The many situations in which one institution hosts systems for another might be seen as examples of private higher

education cloud services. Such situations are growing in number and in scale and the creation of such shared resources remains a major opportunity for institutional collaboration in higher education and a major selling point for cloud computing.

Not Every Cloud has a Silver Lining

Cloud computing is here to stay. It is used daily by millions of people who may or may not know that their Google documents, their Amazon Kindle books, their Apple iTunes and App Store purchases, their email, their web photograph albums, and their Netflix streaming movies all represent a new model of computing. Just the same, it is fair to say that cloud computing is immature and that a great deal of hype and speculation surrounds it. It is unlikely that the model itself will fail fundamentally, but to what extent it will dominate our digital future, what it will cost, and exactly where it will succeed and fall short remain open questions.

Policy and decision makers considering cloud computing's place in higher education should keep a few basic concerns in mind:

- Security. Counterintuitive though it may feel, there is a good case to be made that remote external storage of data may protect security better than local storage. This is because the large-scale operations of cloud providers permit professional data management and sophisticated protection mechanisms. Every post-secondary education CIO will tell you that the overworked assistant professor or graduate student who fails to keep his research server's security up to date is a far more terrifying security nightmare than the malevolent hacker chipping away at Google's firewalls. Nevertheless, there is the chance that if a cloud service does fail at security, it could fail dramatically. This is an area where exposed institutions really need to do their research.

- Cost. While many aspects of cloud computing suggest that cloud services could and should be cheaper to deliver than premises-based equivalents, the economics of the cloud are not yet established or fully understood. It will be necessary for institutions to do the detailed analysis necessary to determine whether the promise is really being met. A key cost issue, not necessarily evident to any given business unit, is the difficulty of integrating functions or information between cloud services and institutional systems, or between different cloud services.

- Lock-in. Even where a cost advantage is gained with cloud services, institutions must be wary of losing their ability to exploit alternatives, for example by allowing internal skills to atrophy or by becoming too dependent on unique service features. A common tactic of outsourcing providers is to make an attractively low initial bid, then raise prices dramatically once the customer's switching cost becomes prohibitive. Every venture into cloud services should include an exit strategy.

- Regulatory compliance. Cloud service providers may be unaware of special regulatory issues that affect post-secondary education, such as protections on student records or research subjects. Ensuring effective regulatory compliance is one of the best arguments in favor of certifying cloud services and/or developing a private post-secondary education cloud. Trans-border data management regulations will constrain and shape Canadian cloud computing alternatives and choices.

Conclusion: Realizing the Cloud's Potential

The very nature of the cloud makes it challenging to manage. It is a radically distributive technology which will prove both appealing and dangerous within institutions as distributed as colleges and universities. Recall the challenges posed when every campus department wanted to build and manage its own web site! With cloud computing, there will be a lot of opportunity for inappropriate uses, sloppy practices, conflicting approaches, and invisible dependencies—just as there will be great opportunities for liberating information, reducing bureaucracy, and empowering creativity. College and university leaders need to have a strategy for achieving the latter and minimizing the former before the accident happens.

Realizing the cloud's potential will mean allowing decision-making to continue to move down the technology hierarchy, while also ensuring that good advice, intelligent understanding of cloud service issues, and an appreciation of the good of the institution as a whole move along the same path. Even at the top of the hierarchy, new skills and practices emphasizing integration, services and data management, and governance will have to be fortified. Leaders will need to pursue an aligned institutional strategy, take a 360 degree look at institutional skills, needs, and capabilities, assess the evolving cloudscape, and provide resources of all kinds where reengineering is necessary.

Unless we develop the new management structures, incentives, monitoring, and controls to guide a "community" IT architecture that takes cloud computing into account, we may, without knowing, create costly duplication, or worse, capabilities that operate outside the reach of our institutional policy structures, academic norms, or business controls. That said, cloud computing also holds the promise of liberating post-secondary institutions from the perennial and seemingly perpetual cost-rise associated with IT. As well, we have the opportunity to make those who use technology and business services to pay for those services, or to make institutional subsidies transparent. Cloud computing shifts the economic makeup of IT from a fixed to a variable model, creating the potential for universities to "expose" which campus organizations consume the infrastructure and services and also reconsider policies about recovering the costs of such consumption. Today such costs are either centrally borne, or are shared proportionally among all users. When you pay by the sip, you can determine who might be hogging the straw! Cloud computing will be a new basis for institutional competition where institutions will be able to enlarge their "footprint" without confronting the wide moat of large capital investments. As with so many things, with cloud computing there is much at stake, but much to be gained.

(Endnotes)

1   See Karla Hignite, Richard N. Katz, and Ronald Yanosky, Shaping the Higher Education Cloud (EDUCAUSE and NACUBO, 2010), http://www.educause.edu/Resources/ShapingtheHigherEducationCloud/20542. See also Brad Wheeler and Shelton Waggener, "Above-Campus Services: Shaping the Promise of Cloud Computing for Higher Education," EDUCAUSE Review, vol. 44, no. 6 (November/December 2009), at http://tinyurl.com/ybxdmlg.

2   Ronald Yanosky, "From Users to Choosers: Central IT and the Challenge of Consumer Choice, EDUCAUSE Review (November/December 2010), in Richard N. Katz, ed., The Tower and the Cloud: Higher Education in the Age of Cloud Computing, at http://www.educause.edu/thetowerandthecloud