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The Role of Cloud Computing in Modern Libraries

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Abstract

With cloud computing because increasingly popular, libraries are finding many ways that it can meet their technology needs better than traditional technology infrastructure. Some of the benefits libraries can get from cloud computing include less need for libraries to provide their own full technology infrastructure, as well as less need for skilled IT workers to install and administer this technology. However, libraries opting to use cloud computing solutions also need to consider potential drawbacks such as the loss of control, a lack of customization options, and privacy and security concerns. Companies offering cloud computing services may offer several different options to contend with these concerns, including public cloud, private cloud, and hybrid cloud solutions. Additional considerations that libraries must take into account when moving to cloud infrastructure are outlined, along with multiple examples of how cloud computing is being used in libraries today.

Keywords: cloud computing in libraries, library technology infrastructure, hosting, software as a service (SaaS)

Introduction

Cloud computing has been around for several decades now and has been growing in prominence and use since the turn of the twenty-first century. More and more companies, such as Amazon and Google, are now offering cloud hosting services and more organizations are turning to cloud solutions for their infrastructure needs. Libraries have been reliant on new innovations in technology since automation trends began in the mid-nineteenth century, and as more and more library services and resources are offered using technology, more libraries are beginning to embrace cloud computing to replace the traditional server architecture that has been in use for decades. "Libraries have been adopting cloud-based solutions for different services including electronic journal access management, statistics tracking, digital library hosting, and even integrated library system (ILS) hosting" (Mitchell, 2010b, Introduction). As libraries move more toward cloud services to meet their computing needs, many libraries now also expect new library technology offerings to be "deployed through these cloud-native multitenant platforms" (Breeding, 2018b, p. 10). Vendors in turn have started putting the majority of their development efforts into these cloud-based platforms.

Cloud Computing Models

There are various types of cloud computing deployment that can be taken advantage of including public cloud, private cloud, and hybrid cloud solutions. Public clouds are the most common type of cloud deployment and involve server, storage, and networking devices that are hosted and managed by a third-party provider and shared by multiple "tenants" who access these resources online. Public clouds have lower costs since the resources are shared and are very scalable, since organizations can pay for increased computing power and storage space as it is

needed. Private clouds have many similarities to public clouds but in a private cloud the resources are only used by a single organization. Private clouds are still flexible and scalable but can give organizations greater control over their resources and provide a higher level of security since those resources aren't being shared with other organizations (Han, 2011; Singh & Veralakshmi, 2012). A hybrid cloud environment can offer the benefits of both the public and private cloud options, where "critical services with stringent security requirements may be hosted on private clouds while less critical services can be hosted on the public clouds" (Shaw & de Sarkar, 2019, p. 20).

There are also a variety of models of cloud services that are offered today, with the three most common being Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). All three models have applications for libraries looking to take advantage of cloud computing options. Software-as-a-Service is a model where a particular software application is hosted by the service provider and the software is made available to the customer online through a browser. An example of the SaaS model used in libraries is Springshare, which offers the library-specific software LibGuides, that the company hosts online.

In the Platform-as-a-Service model, the provider offers a platform for organizations to host their own software applications, with the hosting environment, often including the web server and database, provided by the company. Some examples of PaaS that are used by many organizations, including libraries, are Google App Engine and Heroku. Infrastructure-as-a-Service is a model that allows an organization to replace their need for various computing infrastructure such as servers, networking, and storage space on-site with resources offered by a cloud provider through an online dashboard. Some examples of IaaS include Rackspace, Linode,

and Amazon Web Services. IaaS has many applications for libraries including hosting

institutional repositories or an integrated library system (Singh & Veralakshmi, 2012).

Examples of Cloud Computing in Libraries

While cloud computing has become more popular in general, libraries have also started to

find ways to take advantage of the benefits of cloud computing for their specific needs. One of

the most popular uses of cloud computing in libraries has been for the hosting of the integrated

library system (ILS) by cloud providers. Previously, vendors of integrated library systems would

provide the software to libraries and the libraries had to provision a server and host the

application on-site, including providing the maintenance, back-ups, and upgrades for the

software. However, in recent years, companies such as OCLC and Ex Libris have moved to offer

their software applications as a hosted solution, essentially becoming cloud service providers for

the libraries using their products. OCLC's Worldshare Management Services and Ex Libris'

Alma products are examples of the ILS offered through cloud computing (Bansode & Pujar,

2012; Breeding, 2018b; Singh & Veralakshmi, 2012).

In addition to the ILS, libraries have also turned to cloud computing to provide hosting

for institutional repository software. Institutional repositories were also previously purchased as

software applications that libraries then had to provide server space for, but now open-source

repository applications such as DSpace and Fedora Commons are offered as hosted solutions for

libraries by companies such as ByWater Solutions. DuraCloud is another example of hosting for

institutional repository software that is now provided virtually (Bansode & Pujar, 2012;

Breeding, 2018b; Han, 2010).

There are also examples of library-specific software that was created as a cloud-delivered

resource, such as Springshare's LibGuides platform, which offers libraries a reference services

software that is hosted in the cloud. Springshare's software can also be used to host a library's

website, which is an option that more and more libraries are now using. Discovery platforms are

also a cloud-based product that has been created for libraries by companies such as Ebsco, which

offers Ebsco Discovery Service (EDS), and OCLC, which offers WorldCat Discovery. Other

cloud-based tools that are not specific to libraries are also often used to provide library services,

including Wikis, "tools for building websites without the need for a knowledge of HTML and

with the option of continuous collaboration" (Scale, 2009, p. 11), and Google Docs.

Benefits of Cloud Computing

Cloud computing offers many benefits that libraries can take advantage of, including a

generally lower cost for providing computing resources, as well as less need to provide

employees who are specifically skilled in server administration and the implementation and use

of other technology. Procuring and managing a full IT infrastructure on-site requires a great deal

of skill in specific technology, and "library professionals in most cases not being trained in

maintaining servers find it difficult to undertake some of these activities without the support of

IT staff from within or outside the organization" (Bansode & Pujar, 2012, p. 506). Cloud

computing providers allow libraries to take advantage of not only the technology resources

offered, but also the human resources. "Large data centers routinely employ engineers whose

skills span the full range of technical specialties. The depth of technical expertise available far

exceeds what would be possible in a smaller operation (such as a cluster of servers operated by a

library)" (Breeding, 2018a, p. 18).

In addition to the cost of human resources, the cost of owning and maintaining individual

servers can be very high, and libraries may find cost savings in leasing those resources from a

cloud provider instead (Bansode & Pujar, 2012; Han, 2011; Ning & Xing, 2013; Singh & Veralakshmi, 2012). Mitchell (2010b) found that using Amazon's EC2 had similar costs to providing one's own server infrastructure, "but provided operational benefits" (Cost Comparison), while Han (2011) found that the cloud computing model showed a 50 percent cost savings. Bansode and Pujar (2012) write that "initially the cost could be higher but may reduce depending on the usage of services" (p. 511).

In addition, some cloud services may be provided at no cost, where providing the resources to host those services on-site without cost would not be possible. For example, Google App Engine provides a free option for those applications under a certain quota and has indicated that as much as 90 percent of applications were hosted there for free, making it "a great PaaS resource for small web applications" (Han, 2011, p. 202). Han (2010) compared the cost of using the cloud services of Linode, which was chosen for its "full SSH and root access using virtualization, four data centers in geographically diverse areas, high availability and clustering support, and an option for month-to-month contracts" (p. 89), for two nodes ran $480 per year, compared to an estimated cost of at least $4,000 to run the same hardware within the library (p. 90).

Han (2011) suggested that previous analyses of total cost of ownership found in the literature did not present a complete picture because it missed staff retraining costs and system management. Han suggests that total cost of ownership must take the following areas into consideration: "hardware, software, recurring licensing and maintenance, bandwidth, staffing allocation, monitoring, backup, failover, security audit and compliance, integration, training, and speed to implementation" (p. 198-199).

While security can be a concern when relying on cloud providers for resources, including data storage, Breeding (2018a) writes that "cloud-based services can have the capacity to deliver strong security since they operate on a large scale and have strong business interests in avoiding any type of service interruptions, including those related to security failures" (p. 18). Breeding suggests that cloud providers most likely offer better security than that which "can be accomplished with in-house resources" (p. 17).

Another benefit of cloud computing compared to traditional computing infrastructure is the energy savings provided since organizations are only using, and paying for, the amount of resources they need. Breeding (2009) points out that a traditional server running a typical application may only use 10 percent or less of its processing capacity and memory (p. 23), which presents a waste of overall resources that the library is providing. With cloud computing providing computing resources, multiple virtualized machines may be set up to use more of a capacity-level amount of computing power, leading to reduced energy consumption and an increase in green IT initiatives (Breeding, 2009; Ning & Xing, 2013; Singh & Veralakshmi, 2012). "The impact can be more than shifting consumption from one organization to another. To the extent that it delivers computing services more efficiently, these models can reduce energy consumption overall" (Breeding, 2009, p. 24).

Challenges of Cloud Computing

In spite of the numerous benefits to using cloud computing, libraries also face several challenges in moving their resources to the cloud. One of these challenges is the overall lack of control that can come with moving hosting of services to a third-party. This is especially true for libraries using SaaS and PaaS service models, where they have no ability to control the server

configuration or other computing resources. This means that libraries must rely on the provider for things like connectivity, uptime, and security.

When using cloud-provided software especially, there is less flexibility in the customization of the product. "In a SaaS arrangement, the user can configure the software as needed but can not customize it at the level of changing functionality" (Breeding, 2009, p. 23). This is one of the trade-offs from building your own software, which can then be customized according to your specifications. This concern may have led to the delay in embracing SaaS and PaaS solutions because libraries' "core applications often require specialized software or configurations which are either localized or simply application specific" (Mitchell, 2010b, Impact on Library Services), making it difficult for libraries to relinquish control of the application to a third-party.

Libraries must also contend with privacy and security concerns when moving their services to the cloud. Privacy of patron data is one of the central tenets of libraries and entrusting this data to a third-party can be a cause for concern, especially when the library is using a public cloud, where other organizations are sharing the same server resources. "For some patrons and institutions, engaging in social activities in the cloud is rife with privacy concerns. Add to this the need for a new set of skills to implement and manage complex cloud services, and the whole thing may seem to be a bit too much" (Mitchell, 2010a, p. 85). However, in the case of privacy, the use of a private cloud may alleviate some of these concerns. Security may still be a concern, but as mentioned earlier, cloud computing companies housing large data centers are likely to employ a number of technical specialists to oversee these resources and are likely to have more technical expertise in this area than most individual libraries can provide (Breeding, 2018a).

Other issues that can be of concern for libraries include "availability of a service, data confidentiality, data transfer bottlenecks, legal jurisdiction" (Han, 2010, p. 90), "network connectivity and bandwidth, dependence on outside agencies, limited flexibility, cost, knowledge and integration" (Bansode & Pujar, 2012, p. 511).

Considerations to Implementing Cloud Computing

While some of the issues cloud computing can present for libraries may be somewhat limiting, the many advantages of cloud computing may make it worthwhile despite the challenges. Before making a decision to move some or all services to the cloud, libraries will need to take a number of factors into consideration. Most cloud service companies will provide customers with a service level agreement (SLA) outlining the guaranteed uptime, legal protections, and level of security that can be expected (Mitchell, 2010b). This should be considered first along with other things like the total cost of ownership of providing all of the servers, networking equipment, storage space, and bandwidth against the cost of the cloud provider services. This total cost of ownership must also factor in the cost of replacing servers and other resources at their end of life and technical staff to maintain and administer the equipment. In addition, when dealing with patron data, legal issues must be considered, including in what geographic region the data is being stored, and what security protections are in place.

Breeding (2018a) also recommends that before entering into any contractual agreements, libraries make sure that specific questions are answered to their satisfaction, including what security-related certifications the vendor has earned, whether the vendor has a chief security officer, the levels of redundancy in place for hardware and software components, rollback

options available in case of data corruption or ransomware encryption attacks, whether all network communications are encrypted, whether all patron data is encrypted, and what the specific responsibilities of the library are in regard to security (p. 18).

Conclusion

With all of the benefits that cloud computing has to offer libraries can take full advantage of this virtual infrastructure to save money and other resources while still providing a high level of service to patrons. Since the beginning of the twenty-first century libraries have been implementing more and more services through cloud computing resources and in recent years have fully embraced cloud computing options, as current library vendors have moved their research and development almost exclusively to cloud-based products. This switch toward cloud computing has allowed libraries to move away from relying on outside IT staff or attempting to hire library personnel with rare IT expertise, to offload that need to third-party vendors. The result has been applications and platforms that better serve libraries' already tight budgets and better serve patron needs by providing more stability, more flexibility, and the modern technology architecture that patrons are familiar with.

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