
In effect, Diigo enables you to create a mobile research station, allowing students and other users to have all their notes and pertinent information at their fingertips. This is a completely unique concept and set of tools, one which adds tremendous value to the social information network phenomenon. As a website it is destined to hang around for a very long time, unless and until it is surpassed by another website using the same core concept. (Is that Google lurking in the wings?)

This concludes a run-down of three of the more useful social information sharing sites I've found, and I believe law schools and libraries will benefit greatly from promoting these sites and making them a part of their social media offerings.

In the second installment of this topic, I will highlight a few of the lesser-known open source sites which perform some completely unique tasks, and go well beyond the research function into visual appearance, presentation, and even the world of print. Happy hunting!

Will Future Library Services be in the Cloud?

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What Cloud Computing Is

These days we often hear about services related to cloud computing. The cloud computing paradigm would lead to novel solutions for storing and processing data in the cloud. It is said that cloud computing has become an increasingly important technology trend and will change all levels of the computational ecosystem to reshape the way information is processed, stored, and accessed. Microsoft released its Office 2010 worldwide, which includes a cloud computing component, in May 2010. More to the point, cloud computing is not just the future. Without realizing it, we are already using cloud services such as Flickr, Google, YouTube, LibGuides (<http://www.libguides.com>), and Serials Solutions, (<http://serialsolutions.com>). Cloud computing is Internet-based computing, and "cloud" is a metaphor for the Internet. The cloud implies networked computers that distribute processing power, applications, and large systems. The cloud consists of specialized data centers that host thousands of servers. Software and personal data are stored at the remote site "provider's servers," rather than on a personal computer. Cloud-based applications are not running on a single computer, but are spread over a distributed cluster, using storage space and computing resources from many available machines as needed.

Because cloud services are also provided on demand, cloud computing is also termed "on-demand computing. The common element [in cloud computing] is a shift in the geography of computation."¹ Arguably, the main advantage of cloud computing is its scalability and virtualization. Clouds offer the automatic resizing of virtualized hardware resources, so the cloud is easy to grow and shrink in its size. Scalability requires dynamic reconfiguration; as the system scales, it needs to be reconfigured in an automated manner. Scalability also allows a program to continue running smoothly even as the number of users grows. It is not just that servers must respond to hundreds or thousands of requests per second. The system must also coordinate information, coming from multiple sources, not all of which are under the control of the same organization. The pattern of communication is many-to-many, with each server talking to multiple clients and each client invoking programs on multiple servers. This optimized computation functionality inside a web browser is a considerable feat in the cloud. Virtualization is the key enabling cloud technology, as it is the basis for features such as on-demand sharing of resources and enhanced scalability.

To my surprise, according to Wikipedia, the underlying concept of cloud computing dates back to the 1960s, when John McCarthy opined that "computation may someday be organized as a public utility." (See http://en.wikipedia.org/wiki/Cloud_computing.)

More recently, Amazon ventured into cloud computing with its AWS (Amazon Web Services). Offered through Amazon.com, AWS is a collection of remote computing services, and provides online services for other websites or client-side applications. The Amazon Elastic Compute Cloud (EC2) for computational transactions and Simple Storage Service (S3) for cloud-based data storage are a central part of AWS. Amazon EC2 allows users to configure core server components such as operating system, web server, and firewall, and to deploy applications. S3 provides an online storage web service over the Internet. Users are charged by Amazon for the storage space.

Another well-known provider for cloud computing, Google launched its Google Apps and App Engine. Google Apps provides web-based office tools to streamline setup and minimize maintenance. Data is simultaneously preserved in multiple secure centers to reduce total information technology (IT) costs. Google App Engine supplies a hosted service for applications within the Google server and massive storage system. Google's App Engine "hosts python programs in a highly scalable

manner.”²² Google provides a data store API (application programming interface) which allows you to collaborate with Google Apps using your existing infrastructure and aids in the setup and deployment of *Google Apps*, such as Google Secure Data Connector. Cloud services are charged on a pay-per-use basis. A useful analogy is the power grid for electrical distribution to individuals, which uses consumption-based pricing for commodity services. You basically pay for what you actually use.

Cloud Service Continuum

There are three types of cloud computing services: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). In a SaaS environment, although users have access to the provider’s applications running on a cloud infrastructure, there is no access to the underlying infrastructure such as network or server. The applications are accessible from various client devices through a web browser. The pricing model with SaaS involves a startup fee and standard monthly or annual subscription fees. For library services, SaaS can be used for electronic journal access and management systems, open URLs, instructional guides, and statistics tracking. PaaS solutions focus on the delivery of a computing platform on which a locally developed or managed application can be deployed. In the PaaS solution, organizations don’t have to own and manage the underlying hardware and software. Also, PaaS may include facilities for application design, application development, and even testing. The PaaS model can be applied to Integrated Library Systems (ILSs), initial website applications, and archives management software in library operations. IaaS solutions allow end-users to provision networking components such as servers and storage space. The end-users are responsible for configuring network access and managing core server components, including operating system, web server, and firewall. An institutional repository discovery layer or ILS discovery layer are library functional examples. Each type of service requires a different level of commitment from the service provider, and different levels of cost incur based on the service level agreement (SLA) with the provider.

What Cloud-Based Solutions Can Do

Organizations utilize cloud computing to use external expertise and resources to deliver complex and better services. It shifts the bulk of the responsibility for infrastructure support out to a vendor, and basically outsources data files and software support to a provider that specializes in web-based computing. Also, a cloud-based solution doesn’t require the organization to invest in a server infrastructure, since there is no need to perform client-based software upgrades. Storage, network security, operating system upgrades, hardware costs and all of the various and miscellaneous activities associated with maintaining a local computing infrastructure are outsourced to service providers. Cloud fees are off-set by lower maintenance costs in both personnel and software licensing fees, since these applications are centrally installed and utilized. Therefore, organizations are freed from coping with license issues for locally-hosted software. Cloud computing lowers the expense for adaptable computing resources, since to initiate a cloud service there is no need for either a per-host license to run the software or an up-front commitment.

Challenges on the Horizon

While cloud services seem to promise great benefits, the cloud paradigm presents a number of challenges both functionally and legally. Since data is stored in a remote location, confidentiality and privacy risks are associated with this model. The absence of geographical boundaries in the cloud opens up new international legal and operational issues. Also, there can be liability issues to consider in terms of which resources or operations are outsourced, since there may be some functions that must be maintained and stored locally by the institution. A provider’s application may set hurdles to accommodate local needs, since users would not be able to tailor a customized application in a cloud computing environment. Individual needs from different constituencies, such as student bodies and faculty members, may not be met if limited solely to the applications the service provider offers. Once an institution and a provider sign off on a service level agreement (SLA), the SLA functions as a license that locks in the specific service with the specified price for the specific period. But at the time of the signing, it is almost impossible to fully anticipate future needs or requirements. When reviewing the benefits of the SLA consider the lack of a guarantee of provider perpetuity, including the possibilities a disaster may occur or the provider may someday declare bankruptcy. Other aspects to consider include: 1) How and where can data back-ups and archive information be located in the cloud? 2) How can unwanted data be expunged? 3) How can cloud-based applications be included in the organizational network? 4) How can services be managed in a decentralized environment? 5) How feasible is data migration from one provider’s server to another provider’s server? 6) How much preparation time would be needed to deploy cloud computing? 7) Is there any chance of losing access to your documents stored at the remote location?

Can Libraries in the Clouds have a Green Approach?

OCLC is at the leading edge of the cloud paradigm for library communities. The organization has distributed cataloging and other library services for a number of years. OCLC’s bibliographic utility is built by years of its members’ contributions. This centralized database is the infrastructure for sharing MARC (Machine Readable Cataloging) records among libraries

throughout the world. OCLC is uniquely positioned to provide cloud-based services with libraries globally. In this sense, OCLC can be called a library cloud computing provider because cataloging resources are distributed through OCLC's web services.

Now, OCLC has introduced its Web-scale Management Services (WMS) designed to integrate three aspects of service (management, user, and network), to create a more seamless discovery and delivery platform, and to result in a much less complicated library system. The innovations of the WMS may leverage the data contributed by thousands of libraries over many years for increased end-user satisfaction. OCLC's WorldCat Grid Services (http://www.oclc.org/us/en/services/brochures/213093usf_worldcat_grid_services.pdf) provides new ways to access data at the network level permitting implementation of more customized services and functions. Its aim is to support groups interested in overall library data management.

Since libraries are in the early stages of adopting cloud computing, potential projects with other vendors such as Amazon are possible in the near future. What IT issues should be considered when planning a cloud-based solution? The SLA should cover uptime (a measure of computer operating system reliability), legal protection, and security. Libraries need to ascertain who is responsible for what tasks and at what cost by assessing in-house personnel and technology resources. Current library operational expenses must be considered to ensure that migration will improve overall library services and cost effectiveness. It takes a lot of energy to run computer equipment, and almost as much to keep it cool. Cloud computing is gaining popularity among fiscally-constrained libraries, as it can efficiently manage computing resources while contributing to the goal of Green IT by saving energy. Cloud computing mitigates power costs and energy consumption for libraries, so it would make sense to move to the most efficient available technology model. As libraries make inroads into this next phase of their technology strategy, they find themselves at an important turning point, where they can augment overall operations beyond their locally maintained computer infrastructure. In this context, cloud-based solutions offer opportunities for libraries to expend fewer resources and to focus more on activities with direct benefit to library services.

Future and Evaluation of Cloud Computing

The underling concept of cloud computing has been around for a long time, but the future trend of cloud computing is difficult to predict, since the development and implementation of cloud computing involves many factors. What is the benchmark to evaluate a cloud solution? Although it is not easy to compare the total cost of ownership (TCO) of cloud and traditional solutions, "there seems to be more research which questions the validity of these measures."³ The traditional method of comparing systems is to evaluate average performance under a particular workload. However, this method is not sufficient for analyzing cloud computing due to its innovative technology. Clouds may help libraries reduce technology costs in order to expand and enhance other costly projects, as well as create new services that would not be possible without cloud computing. Efficiently utilized computation saves time that can be used to focus efforts on other areas. Therefore, evaluation of end-user satisfaction and the impact on library services will be critical. Finally, provider service quality should be assessed and compared to that of other providers on a regular basis.

¹ Brian Hayes, "Cloud Computing," *Communications of the ACM* 51, no. 7 (July 2008): 9.

² Binning Carsten, "How is the Weather Tomorrow? Towards a Benchmark for the Cloud," *ACM* 9 (2009): [3].

³ Erik Mitchell, "Using Cloud Services for Library IT Infrastructure," *Code 4lib Journal* 9 (2010): 6.

MANAGEMENT

Managing Change and Transition

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Since I have been managing major changes in my department due to library reorganization, I was hoping there might be some management training specifically geared to managing these changes. Currently, managing change has become one of the most important management skills that we can possess. Lo and behold I discovered that such a course was offered by the Learning & Organization Development department right on Duke's campus! Unfortunately, I was six months into the transition when I discovered the course. However, I did learn a great deal about leading change, especially the human side