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INTRODUCTION

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Technology can be complex, expensive, and difficult to manage. Many libraries find themselves severely constrained because they don't have adequate specialized personnel and sufficient funding to use technology to its full potential. Cloud computing can help turn the tables, lowering the thresholds of expense and expertise. While this model may not be a good fit for all libraries, or for all the different ways that libraries rely on technology, it's an option worth investigating and adopting when appropriate and beneficial. You can begin by experimenting with free or low-cost projects, moving along with more strategic components of technology infrastructure over time. This book aims to give you a clear understanding of this new approach to technology and how it can help a library by making technology more manageable and more cost-effective.

What Is Cloud Computing?

"Cloud computing" is not a precise term, with various definitions given; some examples:

According to *Wikipedia*: "Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid." (http://en.wikipedia.org/wiki/Cloud_computing)

VMware, a company involved in providing software and services, offers a more business-oriented definition: "Cloud computing is a new approach that reduces IT complexity by leveraging the efficient pooling of on-demand, self-managed virtual infrastructure, consumed as a service." (http://www.vmware.com/ap/cloud-computing.html)

Cloud computing takes its name from the way that it's fuzzy, distant, diffuse, and immense. This approach to technology relies on massive aggregations of hardware that form an amorphous mass that as a whole delivers some kind of computing activity. You can't see or touch the cloud—its actual pieces and parts are scattered in data centers, whose exact physical locations you may or may not know.

The term "cloud computing" is used quite freely, tagged to almost any type of virtualized computing environment or any arrangement where the library relies on a remote hosting environment for a major automation component. It's as much a marketing term as a technical one. Some of its characteristics include:

- An abstract technology platform that involves generalized access to remote computing resources rather than locally owned and managed discrete servers
- A utility model of computing involving fees charged for levels of use rather than capital investments in hardware or permanent software licenses
- Computing that's provisioned on demand, with resources allocated as needed
- Elastic quantity and power of the computing resources that increase at times of peak use and scale down when demand is lower
- Highly clustered and distributed computing infrastructure that spreads computing tasks across many devices to maximize performance with high fault tolerance for the failure of individual components

Cloud computing isn't an all-or-nothing proposition. A library can continue to manage some parts of its computing operation on locally managed servers as it makes selective use of cloud services. For those more open to experimentation, there are lots of opportunities to try out some cloud-based services or create prototypes to gain firsthand knowledge of its approach and how it might benefit the library. It's easy to start trying out services delivered in the cloud for one's personal computing needs. Introducing cloud computing into an organization such as a library requires a bit more thought and planning.

Today there's lots of hype surrounding cloud computing. Like any new technology, it has its enthusiasts and its detractors. There are lots of companies that offer their services through the cloud, and naturally they promote this approach and emphasize its benefits and downplay the risks and disadvantages. As libraries consider moving their essential services to the cloud, it's essential to separate hype from substance. This book will present both sides of the story, including the potential benefits and any caveats that might apply. Most of all, it will provide you with a clear understanding of the general concepts

and with enough details of the various approaches and service offerings that you will be able to make well-informed decisions.

Most cloud computing environments are built from thousands of generic computers clustered together. Through clustering and virtualization software, individual computer blades can be added to increase capacity. Clouds, because of the massive redundancy and clustering, are very fault tolerant. If any given component fails, the cluster just works around it. Cloud infrastructure is all about making many different discrete computers work together as an organic whole. Just as living organisms don't depend on any given cell, cloud-based computer infrastructure continues to function as individual components fail and are replaced; clouds grow in power as more components are added.

▶ A "CLOUDY" VIEW OF THE FUTURE

Let's paint a picture of cloud computing as it might be fully realized at some point in the not-too-distant future. You switch on your computer and it powers on instantly to a web browser. Computers of all sizes—notebooks, netbooks, tablets, and smartphones—are optimized for software delivered through the web. Personal computers have no need for local storage, because all data are stored up in the cloud. Gone are the days of installing software on your computer, managing new versions and updates. You do your work on applications accessed via the web.

Beyond a web browser, optimized for fast performance and loaded with plug-ins to handle all kinds of content, there's no need to have any software installed on most computers. By storing all content in the cloud and delivering all software as services, computing becomes more portable and flexible than the days when everything was tied to specific hardware devices. Computer crashes no longer mean a worrisome ordeal of restoring the operating system, reinstalling software, and hoping that your last backup is reasonably up-to-date.

Ubiquitous Internet connectivity means uninterrupted access to all your data and applications. Your collection of music, movies, and video streams in your personal storage space in the cloud is easily accessed from any of your many devices. Likewise, the library's media collection, including thousands of digitized images, documents, videos, and the like reside in high-capacity storage, replicated in multiple ways to protect these irreplaceable objects even if one of your providers suffers some kind of catastrophic technical or business failure.

Cloud computing also reshapes the way that organizations handle their computing needs. Technology infrastructure will become highly specialized to support connectivity and less for storage and computation. There's no need for servers in the library's computer room, for example, because all of its software and systems are accessed via remote services. The integrated library

system and other specialized applications are accessed through software-as-a-service arrangements. The library's website and other administrative software are supplied from different service providers. Cloud computing can potentially enable a reality where libraries spend more of their resources creating innovative services without having to worry about the logistics and management of technical infrastructure.

▶ EVOLVING TOWARD CLOUD COMPUTING TODAY

More realistically, the age of cloud computing hasn't quite arrived in full. Obstacles remain. Internet connectivity, for example, isn't yet sufficiently pervasive or cheap enough for many of us to untether ourselves from local data and software. There are still too many areas without wireless or even cellular data access. Even in well-connected areas, there will always be outages or circumstances where Internet access is problematic. When completely reliant on cloud-based services, interruptions in connectivity mean lost productivity.

Today, cloud computing usually supplements rather than replaces locally installed software. Only a small proportion of organizations have fully implemented cloud-based computing. Yet many organizations have shifted selected aspects of their operations away from locally supported computing, with many planning increased adoption.

Though the trend toward cloud computing is heading upward, traditional local computing still dominates in most libraries. While it's not a given that all computing will shift to the cloud, there are many cloud and cloud-like services already available, with more individuals and organizations adopting this approach. It's fairly easy to take advantage of products and services offered through the cloud for personal use, but moving larger-scale applications from locally supported arrangements to cloud services will take a great deal of planning and maneuvering. We will cover the planning issues more extensively in Chapter 3.

▶ THE MANY FORMS OF CLOUD COMPUTING

Some cloud-based services come fully formed. Applications such as word processors, spreadsheets, and calendars are often available for little or no cost by simply signing up for an account. You can also use cloud services to create your own customized applications. It's possible to run web servers, databases, and other applications out on a cloud without ever having to purchase your own hardware. Core automation systems such as the integrated library system can be implemented through server arrangements where the vendor hosts and maintains the software.

Cloud computing has become so pervasive that people use it all the time without necessarily realizing it. The popular applications provided by Google for e-mail, word processing, and calendar embody many of the characteristics of cloud computing. See Chapter 7 for practical examples of cloud computing in action.

Although cloud computing has been around a while, we can anticipate ever wider adoption, and it may grow at some point in the near future to be the dominant model for computing. According to Forrester Research, the cloud computing industry will grow from its current size of $41 billion in revenue seen in 2010 to $241 billion in 2020 (see Stefan Ried's April 21, 2011, blog post "Sizing the Cloud" at http://blogs.forrester.com/stefan_ried/11-04-21-sizing_the_cloud).

▶ CONTRASTING EXAMPLE: LOCAL COMPUTING

To understand cloud computing, let's first review the traditional approach, as might apply to your library's web server. It runs on a server that the library owns and maintains, mounted in a rack in a computer center or computer room. You can see it and touch it. Someone's responsible for keeping the operating system up-to-date, configuring the software, and performing other technical and administrative chores. Your library paid the cost of the server hardware and pays for the electricity that powers and cools it.

By contrast cloud computing takes a much more abstract form. It's a service that appears as needed. The hardware on which it resides isn't of direct concern to those who use the service. You're aware it exists somewhere out in the cloud, but where it's located isn't a concern.

Cloud computing is elastic. It isn't of fixed size. Rather, it expands and contracts according to demand. With conventional local computing, if the usage of the computer exceeds the capacity of a server, you have to buy more memory, disk drives, or even more servers. Cloud computing, by contrast, offers the ability to scale computing resources according to variable levels of demand. Capacity fluctuates according to demand, with more computing power available during peaks of high use and scaling down during periods of lower activity. You budget for the computing cycles and storage actually used rather than having to pay for capacity to handle highest use all the time.

▶ A UTILITY MODEL OF COMPUTING

Cloud computing can be characterized as a utility model. There may be some minimum base charge, but what you use is measured, there is a certain cost per unit, and you are billed for what you use. In the same way that the electric

company installs a meter that measures what you use and sends you a monthly bill, many forms of cloud computing measure what you use as the basis for what you pay. The more you (or your users) consume, the more you pay. In an infrastructure-as-a-service model, for example, the provider tracks the resources consumed, such as the quantity of virtual servers provisioned; the number of processor cycles, database transactions, bytes stored, and webpages requested; and the incoming or outgoing network activity. Different rates will apply depending on options selected, such as the number of processor cores associated with virtual servers, memory allocated, storage replications, and other factors. Subscription agreements to these services include tables that specify what rates apply to each category of use. The monthly bill will vary depending on usage patterns.

In general terms, cloud computing allows an individual or organization to pay for only the computing resources they use without having to make large up-front purchases for equipment. The fees will increase as any given application gains popularity and will decrease during periods of slack activity. This pay-as-you-go model differs significantly from the budget models that apply to applications implemented on purchased equipment.

Many cloud-based services offer free introductory packages. A variety of consumer-oriented cloud storage sites allow limited amounts of storage either through an advertising-supported business model or as a lead-in to premium paid services. Even higher-end cloud computing environments offer try-before-you-buy options that provide access to a limited amount of computing resources for an introductory period before monthly charges apply. These introductory offers allow an organization to evaluate competing services prior to making a financial commitment to any given offering.

The measured service model to cloud computing can support a low-cost software development environment. The level of computing resources needed and the consumption levels will be much lower during a software development process than they will be once the completed application is placed into production. The general character of cloud computing of paying only for the resources used should result in flexibility and savings compared to the alternative of purchasing equipment that may never be used to its complete potential.

▶ BENEFITS

A number of factors drive the movement toward cloud computing. This approach offers opportunities for organizations to lower their overall costs for technology, improve performance of highly used services, support widely distributed users, and increase reliability.

For many organizations, local computing involves high cost and low efficiency. Even though prices have declined over recent years, server hardware represents a major expense. The capacity of most servers greatly exceeds the current needs of the organization. Because this equipment must last for five or more years, organizations tend to purchase excess capacity beyond immediate needs to accommodate anticipated growth in use. With cloud computing you pay for what you use as you use it instead of paying for excess capacity never consumed.

Personnel costs related to technology can be greatly reduced through increased reliance on cloud computing. Local computing depends on technical personnel with specialized training in server administration, network security, and applications support. The maintenance of local servers involves constant diligence in keeping operating systems on the latest versions, applying security patches on a regular schedule, tuning servers for optimum performance, monitoring systems availability, as well as implementing customizations and configuration changes. Shifting to software delivered through a cloud model can drastically reduce technology-related personnel costs or at least allow an organization to target the talents of their staff members more selectively.

The cloud computing model eliminates the need to purchase and maintain local server hardware. Other than this direct cost component, it impacts indirect costs such as the energy required to power and cool this equipment, any occupancy costs associated with data centers, and administrative overhead.

The business models associated with cloud computing avoid the large up-front costs associated with software licenses. Rather than purchasing permanent licenses, many organizations can achieve substantial savings by shifting to software-as-a-service or other services. Software-as-a-service, for example, usually involves a set monthly or annual subscription fee rather than a large up-front investment for purchasing a license. Traditional software licenses will often require ongoing payments for service and support. The software component of cloud computing may or may not see substantial changes relative to traditional licensing but has the potential to substantially reduce costs related to personnel and hardware.

In Chapter 3, we'll take a closer look at all the cost issues involved, with comparisons between local computing and cloud-based alternatives. It's essential to perform an analysis of total cost of ownership over time in order to understand the budget impact of cloud computing as the basis of an organization's technology strategy.

As libraries more than ever face the need to fulfill their missions with ever few resources, cloud computing can contribute an important dimension to technology strategies. Libraries need to have every possible tool available to them. In the absence of diminishing technical personnel and smaller

budgets for computing equipment, it may be possible to gain access to equal or even superior automation products through cloud-based services. In broad terms, increased adoption of cloud services should allow a library to focus its technology budget and personnel less on activities that involve necessary, but routine support for library operations, allowing it to focus more on creating strategic or innovative services. Are there routine support services, such as e-mail, word processing, or financial systems, that the library currently spends excessive time and resources supporting that could be accessed with significantly less effort and expense through some cloud-based service? Does a library want its most technically proficient—and highest paid—personnel spending their time dealing with the upkeep of a room full of servers, or should this talent be focused on higher level activities that make a stronger impact on the library's mission? The subsequent chapters of this book should help clarify the realm of cloud computing from a vague marketing term into a menu of strategic tools for your library.