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HP Special Edition

Cloud Computing

FOR DUMMIES®

Learn:

- Why cloud computing will revolutionize the way we think about computing
- How the cloud will provide the means for everything to be delivered to you as a service
- How the cloud will help companies to improve business agility and reduce capital expenditures

Judith Hurwitz
Robin Bloor
Marcia Kaufman

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Cloud Computing FOR DUMMIES®

HP SPECIAL EDITION

by Judith Hurwitz, Robin Bloor, and Marcia Kaufman

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About the Authors

Judith Hurwitz is a technology strategist and thought leader. She is the president of Hurwitz & Associates, a business technology strategy firm that helps companies gain business benefits from their technology investments. In 1992 she founded the Hurwitz Group, a technology research group. She has worked in various corporations such as John Hancock, Apollo Computer, and Patricia Seybold's Group. She has written numerous white papers and publishes a regular blog. Judith holds a BS and MS degrees from Boston University. She is a co-author of *Service Oriented Architecture For Dummies,* 2nd Edition, Wiley, 2009, *Information on Demand For Dummies,* Wiley, 2008, and *Service Management For Dummies,* Wiley, 2009.

Robin Bloor, a partner with Hurwitz & Associates, has been an IT consultant and technology analyst for almost 20 years. He lived and worked in the UK until 2002, founding the IT analysis company, Bloor Research, which published comparative technology reports that covered everything from computer hardware architectures to ecommerce. Robin is the author of the UK business best seller, *The Electronic B@zaar: From the Silk Road to the E-Road* (published by Nicholas Brealey Publishing), which analyzed and explained the field of ecommerce. He is a co-author of *Service Oriented Architectures For Dummies,* 2nd Edition, Wiley, 2009, and *Service Management For Dummies,* Wiley, 2009.

Marcia Kaufman, a founding partner of Hurwitz & Associates, has 20 years of experience in business strategy, industry research, SOA, and information management. In addition to publishing a regular technology blog, Marcia has written extensively on SOA and the business value of information technology. Marcia has worked on financial services industry modeling and forecasting in various research environments including Data Resources Inc. (DRI). She holds an AB from Connecticut College in mathematics and economics and an MBA from Boston University. Marcia is a co-author of *Service Oriented Architecture For Dummies,* 2nd Edition, Wiley, 2009, *Information on Demand For Dummies,* Wiley, 2008, and *Service Management For Dummies,* Wiley, 2009.

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Dedication

The authors, on a whole, dedicate this book to Carol Caliendo, our colleague who made this happen.

Judith dedicates this book to her family: Warren, Sara, David, and Elaine.

Marcia dedicates this book to her family: Matt, Sara, and Emily.

Robin dedicates this book to Judy, for her encouragement, support, and advice, and to his children Maya, Jude, Hannah, Jacob, and Seth.

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Introduction

Welcome to *Cloud Computing For Dummies,* HP Special Edition. We authors are very excited by the topic and hope our enthusiasm is contagious. Cloud computing is one of the most important technology initiatives in business computing today. It's changing the way businesses gain access to sophisticated services over the Internet and changing the speed and agility of business without increasing capital expenditures. We hope this book is enough to ground you in cloud basics and to whet your appetite for this innovation platform.

Cloud computing and cloud services bring new ways of thinking about computing architecture and delivery models. With cloud, everything becomes a service so that companies can create new initiatives without a massive upfront investment. Cloud computing offers new and unique business benefits and will help change the way businesses collaborate, operate, and compete.

Foolish Assumptions

Try as we might to be all things to all people, when it came to writing this book, we had to pick who we thought would be most interested in *Cloud Computing For Dummies,* HP Special Edition. Here's who we think you are:

- **You're smart,** yet the topic of cloud computing gives you an uneasy feeling; you can't quite get your head around it, and if pressed for a definition, you might try to change the subject.
- **You're a businessperson who wants little or nothing to do with technology,** but you live in the 21st century and find that you can't actually escape it. Everybody around is saying "Cloud this" and "Cloud that," so you think you better find out what they're talking about.

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- **Alternatively, you're an IT person who knows a heck of a lot about technology,** but this cloud computing stuff is new, and everybody says it's something different. Once and for all, you want a clear definition.

Whoever you are, welcome.

How This Book Is Organized

This book isn't intended to be an exhaustive technical manual on implementing a cloud strategy. Rather, we give you a taste of the concepts and approaches that you need to consider when embarking on your journey toward using, and maybe even providing, cloud services.

This book is organized into five chapters. Chapter 1 is an introduction and overview to what we mean by the cloud. Chapter 2 provides an overview of the model of the cloud and the forms it is taking. Chapter 3 explores the issues of managing the cloud including organizational, management, and technical interfaces. Chapter 4 is focused on how organizations can incorporate cloud-enabling technologies in their own in-house business technology infrastructure. Chapter 5 is a list of the most important questions to ask when thinking about getting started with the cloud.

Icons Used in This Book

You may notice some icons in the margins of this book that point to certain types of information:

This is a particularly useful point to pay attention to.

Pay attention. This will save you time and trouble later.

You may be sorry if this little tidbit slips your mind.

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Chapter 1

Cloud Basics

In This Chapter

- Defining the cloud
- Looking at everything as a service
- Examining business drivers for consuming cloud services

The cloud is the next stage in the evolution of the Internet. It provides the means through which everything — from computing power to business processes to personal collaboration — is delivered to you as a service wherever and whenever you need it.

You can think of cloud as a way to access new kinds of technology-enabled services. Organizations today have choices in how they source and implement business services. They can access them in-house, have them hosted, outsource them entirely, or acquire them through the cloud. At the end of the day, most organizations will have a hybrid environment comprising services from multiple sources.

This means that not all technology-enabled business processes will be moved to the cloud — far from it. Companies will want to take a hard look at their most strategic business processes, intellectual property, and business information, and determine which computing assets should continue to be delivered through traditional technology delivery models and which ones are ripe to take advantage of the capabilities offered by the cloud.

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Important cloud definitions

There are number of terms and ideas you'll appreciate knowing as you read this book. They are as follows:

- **Cloud services:** Services that a user actually consumes. For example, a home consumer can use Snapfish for online photo sharing, a business person can use NetSuite for ERP services, a software developer can use Force.com to create niche marketing services, an application manager can use Amazon's EC2 for compute.
- **Cloud computing:** Refers to the underlying infrastructure that makes it possible to scale services exponentially and flex resources rapidly in response to variable supply and demand.
- **Multi-tenancy:** Most cloud services are multi-tenant, either at the software layer, the infrastructure layer, or both. This means that a single instance of software, and the compute platform it runs on, serves multiple clients from different companies. Although the resources in the cloud are shared, cloud providers are expected to have access controls and other security in place to provide a protected environment for each user.
- **Enterprise-class services (both software and infrastructure):** Designed to serve the specific internal enterprise requirements, including data security, integration, access, configurability, reliability, and availability.
- **Global class services (both software and infrastructure):** Designed for an external, arbitrary, and non-secured user. Global class software is natively multi-tenant, designed with Web 2.0 principles, massively scalable, and relies on software-based resiliency.
- **Private cloud:** The terms "internal cloud" or "private cloud" are sometimes used to express the notion of an enterprise-class virtualized and automated infrastructure. While this is quite different than cloud-based infrastructures, they share some similar attributes, and can benefit from some of the same technologies that help cloud services providers rapidly scale.
- **Elasticity:** Elasticity refers to the ability to flex to meet the needs and preferences of users on a near real-time basis, in response to supply and demand triggers. In the cloud context, elasticity refers to the ability of a service or an infrastructure to adjust to meet fluctuating service demands by automatically provisioning or de-provisioning resources or by moving the service to be executed on another part of the system.

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However, companies are already beginning to find some important new sources of value in cloud services. The cloud can eliminate many of the complex constraints inherent in traditional architectures and service delivery models, and can lead to cost and efficiency savings. But perhaps the most interesting dynamic is how cloud services like social networks and collaboration tools are changing the way people in businesses access and share information.

Understanding the Cloud

Today, we already see the cloud as enabling a self-service-based allocation of technology resources or technology-enabled services. One of the key indicators of a cloud service is that the technology is abstracted away from the user. For example, the responsibility for IT assets and the maintenance of those assets is shifted to the cloud service provider. Users of cloud services are able to focus on value received from the cloud rather than how it works.

The architecture of cloud services is based on a dynamic approach that is scalable, request-driven, and in the case of infrastructure, can support a lot of different types of workloads at the same time. Service management, therefore, is at the forefront of how cloud computing becomes a reality. Cloud services must be architected or engineered to enable *multi-tenancy* — different companies sharing the same underlying resources. It must be able to manage data in a way that keeps it both accurate and secure. It must be able to adapt when a situation happens such as a power outage, and therefore it has to be resilient. Cloud services have to provide some measure of reliability, security, and manageability in a highly changeable world. Most importantly, they have to be able to scale massively so as not to constrain growth.

Scale and elasticity

From a service provider's perspective, one thing is universal: They can't anticipate the usage volumes or demands for services or how the services will be used by customers. One customer might use the service three times a year during peak selling seasons while another customer might use the cloud service as a primary development platform for all of its appli-

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cations. Therefore, the service needs to be available all the time (24x7) and it has to be designed to scale and flex. This ability is called *elasticity.* Think about the rubber band and its properties. If you're trying to keep 100 pens together, that rubber band needs to stretch. However, when you remove those pens, the rubber band resumes its original size and can now be used to hold together a dozen pens. How can a single rubber band accomplish both tasks? Simply put, it is elastic and so is the cloud.

Self-service provisioning

One of the benefits of cloud services is that customers can procure them without going through a lengthy process. This happens in an automated fashion as needed by the customer. The customer simply requests access to a service or to an amount of compute, storage, software, or other resources from the service provider and it is automatically provisioned. Contrast this on-demand response with the process at a typical data center. When a department is about to implement a new application, it has to submit a request to the data center for additional computing hardware, software, services, or process resources. The data center receives similar requests from departments across the company and it must assess the relevant merit of all requests and evaluate the availability of existing resources versus the need to purchase new hardware. After new hardware is purchased, data center staff must configure the equipment for the new application. These internal procurement and configuration processes traditionally take a lot of time.

Of course, nothing is as simple as it may appear. Although the on-demand provisioning capabilities of cloud services eliminate many of the time delays inherent in the typical data center provisioning process, an organization still needs to do its homework. Organizations need to consider elements of risk and exposure and ensure they don't outweigh the benefits of rapid provisioning.

Using Web services interfaces

Cloud services have standardized Web services interfaces that enable the customer to more easily link cloud-based capabilities to internal applications. Without standardized interfaces, each cloud provider has to invent interfaces,

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which only adds to the complexity. A good analogy is to think about a railroad network. What would rail transportation be like if each rail provider had designed a different type of rail infrastructure with different size tracks? It might have worked when each railroad company thought of itself as fighting for control. However, over time this approach would have added to the cost and complexity of the transportation network.

Billing and metering services

Yes, there is no free lunch. A cloud environment has to have a built-in service that sends a bill to the customer. And, to send that bill, usage has to be metered to measure usage. Even free cloud services (such as Google's Gmail or Zoho Internet-based office) are metered.

Monitoring and measuring performance

A cloud service provider must have a full management environment. This is necessary because the provider has to be able to manage its services consistently. It also needs to be able to monitor and measure the availability of the services it provides to customers in order to be competitive. Many cloud services providers will provide customers with a dashboard so that they can monitor the level of service they're getting from their provider. Many customers will leverage their own monitoring tools to measure the effectiveness of the service/offering to be able to meet its service level requirements.

Providing security to customers

For many customers, it takes a leap of faith to trust that the cloud service is safe. If you're going to turn critical data or application infrastructure over to a cloud-based service provider, you need to make sure that the information can't be accidently accessed by another company. Many companies have compliance requirements, set by their own organization or by an industry or government body, for securing both internal and external information. You will need to gauge the security risks and requirements and these may vary by ser-

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How are cloud providers different from traditional IT service providers?

Traditional IT service providers come in many flavors: hosting companies, co-location companies, outsourcers, and managed service providers. What these companies have in common is that they offer contract-based services, technology, or facilities to the customer. The contract is typically long term (a year or more), and it has relatively static properties. And, these traditional service providers are usually happy to customize an environment specifically to meet the needs of one customer.

In contrast, cloud service providers are geared toward on-demand services, with variable payment schedules, low commitment levels, and typically with little to no customization. It's like your home utility provider — you can have gas or electric services delivered to your home, but you can't really customize them. You can, however, use less energy one day, and therefore incur a reduced fee for that day.

vice. Without the right level of security, you probably will not be able to use a provider's offerings.

Everything as a Service

Organizations have tended to look at IT as a necessary means of helping the organization meet the needs of its customers or to help meet business goals. Traditionally, a company would establish a data center to provide the organization with computing capabilities. Although IT managed the data center to serve the needs of the business, sometimes IT had to help the business become more realistic in its expectations. Everyone in the business wanted 100 percent uptime for all applications, more frequent changes to applications, and more accessibility to data without spending a lot more money for IT staff and technology. IT management was able to help the business understand when additional IT spending would be the most worthwhile.

The relationship between business and IT, however, wasn't always smooth. Business management often didn't want to

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accept the compromises they were asked to make. Clearly, there are compromises based on balancing real or perceived need with available money. In fact, to ensure that the business was happy, the IT organization often bought a lot more hardware than they really needed just to make sure that a critical application would not run out of resources. Software was often designed as large, complex, interdependent applications that couldn't be changed without significant effort. Often hardware was hardwired to support a single application and provisioned to meet peak demands, which meant it was underutilized much of the time.

Then something interesting happened. Companies like Amazon.com and Google started offering their excess computing capacity and storage to businesses. They also began to offer software services that could be used to link internal application services to external capabilities in their environments. So, if an organization wanted to try out a new application without having to build out additional compute and storage capacity, they could rent capacity, do the test, and go back to business as usual. They could use a business service rather than program from scratch.

As we expand beyond traditional computing techniques we are entering an era where everything becomes a service. This philosophy will revolutionize not only the way we think about computing but also how we think of running our businesses.

Business Drivers for Cloud

In this section we talk about the drivers and benefits of cloud services.

Supporting business agility

One of the most immediate benefits of using cloud-based services is the ability to add new capabilities or capacity quickly. This important characteristic can enable the business to respond more quickly and efficiently to market and competitive changes.

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A typical cloud service provider has economies of scale that an individual organization lacks. The self-service capability of the cloud means that it will be easier for the IT organization to add more compute cycles or storage to meet an immediate or intermittent business need.

With the advent of the cloud, an organization can try out a new application or even develop a new application without first investing in hardware, software, and networking. This can have a positive impact on companies that want to innovate and experiment without risk.

Reducing capital expenditures

In tight economic times companies are challenged to increase functionality of IT while minimizing capital expenditures. For example, your company may want to add a new business application but it doesn't have the budget for additional hardware or software and management of that application. You might need to increase the amount of storage available to various departments. Cloud service providers offer this type of capability on a prorated basis.

A cloud service vendor might rent out storage on a per-petabyte or gigabyte basis. Other vendors that offer Applications as a Service will charge a per-user price for an application. Some cloud vendors provide business services that can be combined with both internal services and systems and Software as a Service-based applications. The company can therefore pay only the cost for the users who need the application without investing in physical infrastructure. However, as with anything else, there are checks and balances that need to be understood. An application that is being used by many thousands of internal users may be more cost effective with an in-house implementation. A vendor might offer a specialized service that is of interest to a small number of customers. In this case, it may not be worthwhile to rent this capability because per-customer costs are high. However, in other situations, the internal costs might be higher than what it would cost to access that service via the cloud.

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Chapter 2

Getting Inside the Cloud

In This Chapter

- Introducing a simple model of the cloud
- Looking at Infrastructure as a Service
- Examining Platform as a Service
- Getting to know Software as a Service
- Understanding Business Process as a Service

In this chapter, we introduce a simple view of the cloud as it appears from the perspective of a cloud services customer. Then we describe the different services that may be available to these customers from cloud providers. We spend the rest of the chapter providing and describing a list of issues that the cloud service customers need to consider if they are going to manage and administer a cloud service in a sensible way.

A Simple Model of the Cloud

As soon as you start to read about cloud computing you run into the repetitive use of the adjective clause *as a service.* For example, Infrastructure as a Service, Hardware as a Service, Applications as a Service, Software as a Service, and so on. You have probably noticed that there are a multitude of companies providing all kinds of cloud services. Services you purchase from these cloud service providers will be offered to you in a way that is similar to your television cable provider. Your cable contract provides you with access to watch a specific set of television channels. In addition to receiving your standard channels, you may have a self-service option where you can purchase a movie to watch on demand.

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The customer of the service accesses those services via defined interfaces. These interfaces are, in fact, all that the user ever comes in contact with. To continue our cable television analogy, the customer never sees the infrastructure that provides a movie on demand — they only see the screen that enables the user to select and purchase the movie. By contrast, cloud computing refers to the underlying infrastructure that provides the service and which may be very sophisticated indeed.

In Figure 2-1, we illustrate the different types of cloud services as being one of four layers, plus an overarching management and administration level. The reality is that any IT vendor that provides some kind of service from the cloud may include elements from several layers. The purpose of this model is more as an aid to understanding what lies beneath a cloud service, because these four layers refer to different types of discrete capabilities.

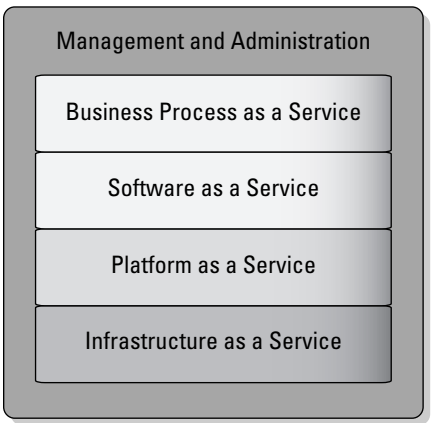

Figure 2-1: A simple model of cloud computing.

Infrastructure as a Service

Infrastructure as a Service (IaaS) is the delivery of a compute foundation (servers, networking technology, storage, and data center space) as a service. It also includes the delivery of operating systems and virtualization technology to manage the resources.

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The Infrastructure as a Service customer is renting computing resources rather than buying and installing them in its data center. The service is typically paid for on a usage basis that reflects the amount of resources used over time. The service may include *dynamic scaling* so that if more resources are required than expected, they will be provided immediately (probably up to a given limit.)

Additionally, the arrangement will involve an agreed *service level.* The service level states what the provider has agreed to deliver in terms of availability and response to demand. It might, for example, specify that the resources will be available 99.999 percent of the time and that more resources will be provided dynamically if greater than, say, 80 percent of any given resource (CPUs, memory, disk space, or network bandwidth) is being used.

Currently the most high-profile Infrastructure as a Service operation is Amazon's Elastic Compute Cloud, which is generally known as Amazon EC2. It provides virtual machine resources that are scalable through a Web services interface. EC2 offers scalability under the user's control with the user paying for resources by the hour. Despite its claim to "elasticity" EC2 is currently not dynamically scalable. EC2 offers three operating systems: Linux, Solaris, and Windows.

Platform as a Service

With Platform as a Service (PaaS) the provider delivers more than infrastructure. It delivers what you can think of as a solution stack for both a software development and runtime environment. A good example of this is Bungee Connect, a fairly recent cloud-based venture that provides a full set of development and life cycle management software. All the software development takes place in the cloud, as does the software testing. Bungee only starts to charge fees when applications are deployed and used. Platform as a Service can be viewed as an evolution of Web hosting. In recent years Web hosting companies have provided fairly complete software stacks for developing Web sites. Platform as a Service takes this idea a step further by providing life cycle management.

Platform as a Service is inherently multi-tenant and naturally supports the whole set of Web services standards and is

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usually delivered with dynamic scaling. Platform as a Service typically addresses the need to scale as well as the need to separate concerns of access and data security for its customers.

Although this approach has many benefits for customers, disadvantages also exist. If a customer uses proprietary languages or tools provided by a single vendor it may be locked in. Usually in Platform as a Service offerings there are elements of the platform — perhaps the development tools or even component libraries — that are proprietary. Consequently, the customer is wedded to the vendor's platform and can't move its applications elsewhere without rewriting them to some degree. If that customer suddenly becomes dissatisfied with the provider, the IT organization will have to rewrite the application at great cost.

Examples of Platform as a Service include the Google App Engine, AppJet, Etelos, Qrimp, and Force.com, which is the official development environment for Salesforce.com

Software as a Service

The next layer in the stack is Software as a Service (SaaS). When discussing this layer we refer to the situation where the service provider offers the customer the ability to run business applications that are hosted by the provider. The Software as a Service business has its roots in an early kind of hosting operation carried out by Application Service Providers (ASPs.) The ASP business grew up soon after the Internet began to mushroom, with some companies offering to host applications securely and privately. Hosting of supply chain applications and Customer Relationship Management (CRM) applications was particularly prominent — although some ASPs simply specialized in running e-mail. We actually prefer the term Application as a Service as a more accurate description of this layer. The phrase Software as a Service can be misleading because all of the services in the cloud (except for Infrastructure as a Service) include software that is delivered to customers as a service. However, Software as a Service is the common term.

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There are a number of obvious advantages in buying Software as a Service including:

- There is no necessity to purchase any hardware or change anything in your in-house data center.
- The Software as a Service vendor does all the heavy lifting: operating, maintaining, and supporting all the software, hardware, and communications technology.
- The price is likely to be lower than the cost of running the same software in-house because the provider can establish economies of scale in its operation that the customer couldn't hope to achieve.
- The price is on a *per-use* basis and involves no upfront capital costs. This makes Software as a Service very attractive to any company that doesn't have any capital budget that isn't spoken for. The company can still adopt new software, first testing it on a rental basis and then continuing to use it, if it proves suitable.

As a hangover from the traditional ASP model there are two distinct modes of Software as a Service:

- **Simple multi-tenancy:** This is where each customer has its own resources that are segregated from those of other customers. It amounts to a relatively inefficient form of multi-tenancy.
- **Fine grain multi-tenancy:** This offers the same level of segregation but from a software engineering perspective it is far more efficient. All resources are shared, except that customer data and access capabilities are segregated within the application. This offers much superior economies of scale.

Massively Scaled Software as a Service

All "as a Service" businesses are based firmly on the reality that the service provider can offer the service at a much lower cost than if you provided it for yourself. If the price difference is large enough then, assuming there are no other complica-

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HP's SaaS offering: IT management and application quality

HP is well known in the traditional IT management software arena. But they also offer a SaaS portfolio to help customers better manage their IT projects and services, ensure the quality and performance of their IT applications, and monitor their online businesses. In fact, HP is one of the largest SaaS providers today.

HP's SaaS offerings allow customers to leverage HP's Business Technology Optimization solutions without the need to purchase and maintain the software or to build out the infrastructure to run it. HP SaaS is a managed service delivered through the Internet that accelerates usage and adoption of HP software products through best practices and ongoing mentoring. With these types of SaaS solutions, you can reduce IT complexity, refocus your IT organization on business initiatives, and shift capital expenditures to investments in innovation.

HP SaaS offerings include software based on its popular licensed products: Service Manager, Business Availability Center, Quality Center, Performance Center, and Project and Portfolio Management Center.

HP Software as a Service (SaaS) is appropriate for customers who have:

- A need to reduce IT complexity and focus on business initiatives
- Aggressive timelines for usage and adoption
- Strategic initiatives to shift from capital expenditures to operational expenditures
- Teams that require 24/7 availability and support (for example, distributed teams)

For more information on HP's Software as a Service offerings, go to `www.hp.com/go/saas`.

tions, it's a win-win — the provider grows a thriving business and the customers pay less to run their applications.

But some applications can be run *really* inexpensively if they're run in the cloud. When you have millions of users doing exactly the same thing, and we mean *exactly the same thing* (not similar things), it is possible to keep the cost per user to a very, very low rate.

This is possible because the provider of the application can optimize all data center components including the hardware,

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communications, and software to support just one or two types of workloads. Internet e-mail systems are like that (for instance, Yahoo Mail). They can be built for massive scalability. There are, in fact, many services on the Internet that are built that way, although you probably don't think of them as applications in the normal sense. Environments such as Facebook, eBay, Skype, Google Apps, and others are all designed for massive scaling. The data centers for these applications have been engineered precisely to handle the workloads they run and thus the cost per user can be a fraction of what the cost would be in a normal data center.

You may not think of many of these Web sites as being software applications at all. Nevertheless, they are software and all of them are used directly by businesses for business purposes. Facebook is used by some companies as a free intranet for its employees, eBay is the basis of over 500,000 small businesses, Skype is used by small businesses the world over, and Google Apps has over a million different businesses enrolled. HP's Snapfish is also an example of a massively scaled Software as a Service offering for photo sharing and printing.

Economies of scale

The companies that provide Massively Scaled Software as a Service achieve dramatic economies of scale in their data centers — much more so than companies offering Infrastructure as a Service, Platform as a Service, or Software as a Service. It's worth listing all the reasons why:

- The standardized workloads can be executed on a highly integrated, massively replicable infrastructure stack. Unlike a traditional enterprise, they don't have to support a wide array of workloads and a heterogeneous stack of hardware, middleware, OS, and so on.
- The computer hardware and network is highly streamlined and can be bought in bulk and configured to allow expansion. Often these companies require that hardware be engineered for their unique scaling requirements.
- All software can be stripped down so that only what is necessary is loaded.

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- The service/software itself is written from scratch in a cloud-optimized way, tailored for efficiency at an instruction level.
- The provider may not offer or guarantee a specific service level.
- There is no need for virtualization technology to build virtual machines. The software can be engineered to the bare metal.

Business Process as a Service

A Business Process as a Service is a series of actions taken in steps to complete a business task that is delivered on a cloud platform. An example of a Business Process as a Service is an "order-to-cash" process designed for use by manufacturing companies. The process would accommodate the specific needs of manufacturing companies without necessarily creating a perfect match with the unique processes at any one organization. The goal is to design the business service according to industry best practices so that many companies would find it helpful. This service could be provided via an Internet interface and combined with either software as a service offerings or even in-house applications. Business Process as a Service has its origin in the traditional outsourcing business, where a company outsources its entire IT department in order to reduce costs by turning business processes over to an expert.

For example, HP's Enterprise Services business unit (formerly known as EDS) provides Business Process as a Service for several industries. Its AirSOA offering is a transportation system that provides SOA-based services for common functions across a swath of transportation industries. In addition to business critical functionality, it provides "connecting fabric" for the development and integration of services to enable new business models and opportunities.

Recently, we have witnessed more and more outsourced business services involving the combination of skilled professionals with software. The huge amount of software development work that is outsourced, for example, depends on software development and project management tools that enable the

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coordination of remote teams. Some firms outsource HR activities, including recruiting, training, and benefit administration.

As cloud computing develops, this trend will naturally continue with professional services becoming increasingly involved in creating technology-enabled services.

Managing the Cloud

If you refer back to Figure 2-1, you will notice that the four layers are surrounded with an area called "Management and Administration." This is the place where life in the cloud can get very complicated. It's simple enough to describe and envisage using some kind of cloud computing service, but you also have to integrate it into the IT operations of the organization and that isn't necessarily a simple thing to do. For example, because a cloud requires a self-service capability, it must be designed to manage not just provisioning of requests from the customer but also issues such as workload management, security, metering, monitoring, and billing services. For more on this topic, see the next chapter.

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Chapter 3

Managing Cloud Services

In This Chapter

- Looking at organizational issues
- Administering cloud services
- Examining the technical interface to the cloud
- Managing resources
- Maintaining connections

At first glance, the cloud may appear to be a totally self-service environment. However, you probably won't be surprised to find out that the reality is more complicated than that. Cloud services, like all other types of technology-enabled service, must be managed. And because most organizations will leverage a combination of services from multiple sources — in-house, hosted, managed services, or via the cloud, a company must be able to manage and maintain the health of these varied services in the same way. In this chapter, we discuss the dimensions of cloud management that you need to consider.

Examining Organizational Issues

Cloud services will have a major impact on your organization in ways that may not be obvious. The cloud impacts the whole company, not just the IT department. For example, do you know how cloud services fit into your overall corporate and IT strategy? Also, if you decide to utilize the cloud, you have to make sure that it supports your corporate and IT governance requirements. At a more detailed level, there are important issues of emerging standards, business process management, and the overall issues of managing costs.

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What's the strategy?

Like any other technology strategy, a cloud service strategy has to be considered in relationship to the overall strategy of the IT organization, as well as the overall company strategy. Many companies are planning to adopt cloud services in order to more rapidly gain access to new services or to reduce capital expenditures. There are many early examples of how companies have been able to reduce costs with various cloud service implementations. However, most of these cost-proven benefits have been based on small, well-defined projects. A complex evaluation of costs, benefits, risks, business cultural issues, and corporate and governmental standards must take place before developing a cloud strategy that will encompass a more comprehensive implementation.

Cloud services will help organizations enter the age of utility computing in an incremental manner. With *utility computing,* any customer can "plug in" because all the interfaces have been standardized between implementations. In order for companies to be successful in doing so, management needs to decide what types of services they will begin to deploy from the cloud. One organization may decide that a Software as a Service approach will be beneficial whereas another organization will begin by using incremental compute capacity on demand. It is thus a good idea for organizations to consider now what cloud services might be appropriate for them and where they might fit before planning a usage strategy. Most organizations will adopt a hybrid strategy combining internally delivered services with services accessed from traditional outsourced or hosted services providers or via the cloud.

Analyze your long-term services strategy in terms of your needs and risks. To help you do this, HP offers a Cloud Discovery Workshop designed to help companies create a cloud strategy that incorporates elements of technology, governance, and process automation.

Are we well governed?

Four distinct cloud categories exist: Infrastructure as a Service, Platform as a Service, Software as a Service, and

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Business Process as a Service (for more on these topics, see Chapter 2). Each one of these approaches provides a set of governance challenges. To make matters more complicated, there is no clean dividing line between these approaches to the cloud. Emerging vendors often combine multiple approaches into their offerings. In addition, the hybrid environment where on-premises applications will be used in collaboration with traditional hosted services and cloud services will be the norm.

This combination of governing internally-provided services and externally-provided services introduces new challenges. For example, how do you manage the overall life cycle of your IT resources including software licensing, cost allocation, and chargebacks? IT governance issues are complicated by the appearance of new suppliers and new capabilities. Ideally, service providers of all types will deliver the same levels of control that you would have with your own resources. However, when you don't control how that new supplier operates, it makes governance more complicated. It will require a higher level of oversight to ensure that service management and governance standards are met.

Business process monitoring

Most cloud services will impact the way business processes are implemented within an organization. So your business should plan to have a standardized way to monitor business processes that live entirely or partially in a cloud environment. An organization's important technology-enabled business processes need to be constantly monitored by software. Many organizations already use third-party business process providers for services such as credit checking and payment services. Usage of services from third-party providers will continue to expand as more and more services are made available in the cloud. And these services will be linked with other services from a variety of internal and external providers. Software components of such business processes may migrate into the cloud, as long as this migration doesn't impede the monitoring of such processes. For that reason, all cloud propositions need to be examined to see if they impact business process monitoring.

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IT costs need to be managed

All IT departments monitor costs, but few monitor them in terms of *asset performance* — the requirement to optimize the return on investments for both hardware and software. This is likely to change with the onset of cloud services. Unlike traditional licensing models, cloud propositions are going to be based on rental arrangements. This cost model will need to be compared to the capital investments models in the data center.

Evaluating the differences between the two cost models is going to be a complex procedure for many companies. In some situations the new cost models will shift some responsibility away from IT to the business unit. For example, if one of your company's business units hires 20 new employees and your e-mail is managed in the cloud, then the business unit will need to budget for 20 more users. So the responsibility of IT to ensure that server capacity and IT staff is sufficient to support the additional users has been transferred to the cloud services provider. However, IT departments will need to carefully monitor the effectiveness of the cloud environment in order to support the enterprise.

Administering Cloud Services

How do you know whether your cloud services are doing what you want them to do? How do you know if the performance is at the right level? How can you judge whether the data you deleted two weeks ago is really gone? Judging the problems that might be associated with a cloud service isn't easy. How does an organization carry out due diligence about a specific supplier?

Performing due diligence is going to be one of the most complex areas faced in managing the cloud. There will be disappointed customers, some as a consequence of unrealistic expectations and some as a consequence of poor service. It is going to be particularly important for the IT department to put an administration system in place that allows it to monitor every dimension of the service it is receiving.

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In theory, the cloud service provider can build and provide a very stable service that is less expensive than a customer can implement internally. However, there can also be a serious gap between the actual service and the promises made in the provider's sales literature.

Customers need to do their homework in evaluating the providers before adopting any service. Which vendors are available to solve your problem? How effective are the providers in managing their own environment? Do they provide repeatable services? How do these vendors handle an outage? What is their experience in dealing with customer issues? In addition to finding a good partner, it is always good to have more than one provider as an alternative.

Service Level Agreements and monitoring

Every company that buys any service of any kind from a cloud service provider will have to either accept a standard Service Level Agreement (SLA) from the provider or negotiate such an agreement. It is hard to imagine any organization committing mission-critical services to the cloud without negotiating an SLA that includes significant penalties if the promised service level isn't delivered. The organization needs to know what service level is appropriate under changing business conditions. Organizations can't simply assume that the service provider will provide all the monitoring. Rather, the organization must have its own ability to monitor service in order to satisfy the company's goals for performance.

HP and other vendors provide software to ensure that SLAs are created, monitored, and upheld across any or all services. SLA management software is often embedded in service management or business service management software applications.

Support

Support problems don't disappear when applications or infrastructures move to the cloud. You have to make sure that support targets are agreed on with a cloud services provider.

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Therefore, there needs to be alignment between the internal support team that has to deal with internal customers and the cloud provider. What processes are in place to resolve problems when they arise? Just consider the situation where some important application has a performance problem. Especially in a hybrid environment, it might be difficult to know whether the problem resides within the cloud or outside of it. Such situations need to be prevented or dealt with very smoothly.

Billing and accounting

One of the benefits of the cloud is that customers can acquire just as much capability as they need. For this to work, the process of billing and account management must be automated. Customers, therefore, need to be able to monitor what they are using and how much it costs. Potential problems arise if service level penalties aren't clear and if the provider adds in too many "incidental charges." Customers can run up unexpected bills if they aren't able to track usage accurately.

Looking at the Technical Interface

Because the cloud service market is so new there are few applications that have been built from the ground up for this new environment. So far, no corporate applications were built with this model in mind. Traditional applications have been designed by either the IT organization or an application vendor to run in the data center.

Organizations that already have well-designed interfaces between application and infrastructure components may find it easier to transition to the cloud. Companies that have moved to a Service Oriented Architecture (SOA) are well positioned to make the move. With SOA, organizations build modular business services that include standardized interfaces. This modular approach is needed for the highly distributed environment of the cloud. SOA is a good start; however, there will need to be a lot of standardized interfaces developed for cloud service platforms in the coming years.

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APIs and data transformations

The cloud Application Programming Interface (API) is the software interface that allows a company's infrastructure or applications to "plug in" to the cloud. This is perhaps the most important place for standardization. Many vendors in the cloud space would like to claim overall leadership and control over the interfaces. Therefore, many different vendors are developing their own interfaces. This, in turn, means that customers are likely to be forced to support multiple APIs.

Even if vendors agreed to a set of API standards, there would still be data transformation issues to deal with as data moves from one physical machine to another. These data transformations are the same as those required in projects such as the building of a data warehouse, with just one minor difference. The Platform as a Service and Software as a Service environments must adhere to the data standards of the particular cloud service provider. In order for an organization to easily build connections between its internal data center and the cloud, it will need to utilize standardized APIs and data transformation capabilities.

Data and application architecture

As new services are created internally to support the changing demands of the business, these services need to interoperate with cloud ecosystems. These services may be expected to migrate to and from the cloud. For example, a company might initiate a partnership that requires the establishment of a neutral development and deployment environment executed in a cloud service environment. This means it will have to build an architecture that is modular enough to allow services to move between platforms.

The consistency and flexibility of a SOA approach makes it a good fit for the cloud. In a SOA environment, software components are put into services or containers. These containers are encapsulations of software that execute a specific task. Once software exists within a container it can be ported from one environment to another, making it easier to port into and out of the cloud. This is another area where standards will need to emerge.

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Security in the cloud

Companies planning to use cloud services must have the assurance that there are tight and well-defined security services. Many levels of security are required within a cloud environment. For example, it is important that identity management be in place so that any application service or even hardware component can be authorized on a personal or group role basis. HP provides software for this purpose, called Security Center. Like many HP software offerings, it's available both as a licensed, on-premises basis as well as through a SaaS model.

There also needs to be the right level of access control within the cloud environment to protect the security of resources. There needs to be a comprehensive security infrastructure provided at all levels and types of cloud services. Developers also need tools that allow them to secure the services they design to be delivered in the cloud. Organizations need consistent security across their own data center environments that intersect with a cloud service.

Managing Cloud Resources

In theory, cloud services-based resources should be no different from the resources in your own environment, except for the fact that they physically reside remotely. So, ideally the cloud service customer will have a complete view of the resources they use today or may want to use in the future. Although this sounds straightforward, achieving it isn't that easy. In most cloud environments, the customer only sees the services that they have procured. There may be entire applications that are used on a cloud services basis. There are development tools that will be cloud based. In fact, there can be testing and monitoring environments that can be based on the cloud. So, how does an organization approach managing cloud resources? There are three aspects of cloud resource management that apply: IT security, performance management, and provisioning.

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One way to make sure the performance, availability, and security related to cloud services is up to expectations is to look at HP's Cloud Assure offering. Cloud Assure combines management and automation to guard against malicious code and ineffectual performance and it gives IT a better view into the overall state of the cloud services being used by the organization.

IT security

Security is a major concern for new adopters of cloud computing. Ideally, an organization will want the IT security in the cloud to integrate seamlessly with the IT security in its own data center.

However, the cloud service provider will implement its own IT security procedures in order to protect customers from external threats and to ensure that individual customer environments are isolated from one another. For every type of cloud service, the provider will be delivering a good deal of the IT security. The customer may need to understand how the cloud provider handles issues such as patch management and configuration management as they upgrade to new tools and new operating systems. The customer should also be able to understand the IT security software and hardware (firewalls, intrusion detection systems, Virtual Private Networks, and secure connections) that the cloud provider has in place. Cloud customers will also want to know how the cloud providers are protecting the environment. In the case of Infrastructure as a Service and Platform as a Service, cloud providers need to clarify the kind of IT security it expects the customer to put in place on its own behalf.

With Software as a Service, the provider is responsible for all security except for access security — either an identity management system or at least a local access control application — through the customer's own systems.

Performance management

Performance management is all about how your software services run effectively inside your own environment and through the cloud. If you start to connect software that runs

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in your own data center directly to software that runs in the cloud, you create a potential performance bottleneck at the point of connection.

The reality is that when you move applications or services into the cloud, you change the basic topology of the data center network and you change the configuration of some applications and possibly some interfaces. This means that performance needs to be considered and designed in at the start for every type of cloud service.

Services that are connected between the cloud and your computing environment could impact performance if they aren't well planned. This is especially likely to be the case if there are data translations or specific protocols to adhere to at the gateway into the cloud. Because the customer's ability to control the resources directly will be much lower in the cloud, the connection points need to be monitored in real time. There will need to be expanded bandwidth at connection points.

From the performance perspective, the situation is likely to be much less fragile if systems don't straddle the data center and the cloud.

HP Business Availability Center software provides transparency into the availability, performance, and effectiveness of business services and applications, including cloud-based services. It also helps you to better predict and respond to service degradation.

Provisioning

With Software as a Service, a customer expects provisioning of extra resources to be immediate, automatic, and effortless. The cloud service provider is responsible for maintaining an agreed-on level of service and will provision resources accordingly. The situation is similar to Platform as a Service or Infrastructure as a Service, but the customer may need to directly request additional resources — because in both cases the customer is directly managing the cloud resources rather than having them managed on its behalf.

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The normal situation in a data center is that software workloads vary throughout the day, week, month, and year. So the data center is, of necessity, built for the maximum possible workload, with a little bit of extra capacity thrown in to cover unexpectedly high peaks.

One of the immediate attractions of Infrastructure as a Service is that a data center could move its volatile workloads into the cloud and pay for additional resources on an as-needed basis. In other words, hardware utilization in the data center will be much more efficient.

Service management

Service management in this context covers the management of services regardless of where they originate. It is a broad discipline that considers the necessary techniques and tools for managing services across physical and virtual environments. Service management encompasses many different disciplines including configuration management, asset management, network management, capacity planning, service desk, root cause analysis, workload management, patch, and update management.

The reality is that the cloud itself is a service management platform. Therefore, well-designed cloud service portfolios include a tight integration of the core service management capabilities and well-defined interfaces.

HP has a long lasting and very well regarded service management practice, with both software and service offerings that reflect the best practices for service management. In fact, HP is one of the authors of ITIL v3, a framework of global IT management best practices intended to help facilitate the delivery of high-quality technology-enabled services.

Maintaining Connections

Perhaps the biggest problem that organizations face when they consider shifting to applications in the cloud is the issue of software dependencies. How does the organization deal with

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the dependencies between services? In theory, all the applications that are running in an organization's data center share infrastructure and data. However, as companies begin migrating applications or capabilities such as data or storage into the cloud, they need to move toward technical independence.

Therefore, before any part of the data center is moved to the cloud it needs to be separated from dependencies that already exist. For a gradual move into the cloud, the full inventory of applications and systems needs to be considered in terms of which ones must — or at least should — move together. It is interdependencies that will determine this, no matter whether they're from a hardware perspective (a specific clustering of processors is required), from a platform perspective (they must use a given OS and a given middleware product), from a software perspective (they need to be closely coupled with other related applications), or from any mixture of these.

Removing the dependencies among various applications and systems will help the organization to evolve the data center into a more flexible and modular environment. Establishing this architectural approach will, in effect, create containers of functionality within the data center that will ease the adoption of cloud services.

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Chapter 4

Harnessing Cloud-Enabling Technologies

In This Chapter

- Looking at virtualization
- Examining scale-out infrastructure
- Understanding business service automation
- Explaining business service management
- Implementing IT service management

If there is one message that rings true for businesses of different sizes and across many industries, it is "Be prepared for change." In a dynamic economic environment, the survival of your business may depend on your ability to remain focused on your core business and adapt quickly to a changing world. Whether you've been in business for 2 years or 200 years, yesterday's profitable business model can't be counted on to translate into future growth and profits. As your business adapts to changing government and industry regulations, evaluates new business partnerships, and anticipates competitive threats, IT needs to help the business find new ways to respond. At the same time, these plans for change must often be made within the context of limited resources for finances, people, technology, and power.

In this chapter, we consider how companies are utilizing cloud-related technologies to enhance the performance, flexibility, and scalability of their own in-house data centers.

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Although comparing cloud services to internal data center services is like comparing apples and broccoli, IT managers can certainly harvest certain technologies and look toward some of the benefits that are typically associated with cloud computing.

As you evaluate whether cloud services are right for your company, you can leverage technologies used by cloud services providers, such as virtualization, automation, massive scale-out storage and compute, and business and IT service management to enhance the performance, flexibility, and continuity of your in-house data center.

Examining Virtualization

The allure of virtualization is clear. For IT organizations, virtualized solutions are faster to deploy and lead to increased hardware utilization and lower power and cooling costs. For the business, this can mean faster time to market for new services, greater service resiliency, and lower IT operational costs. Virtualization is a key ingredient for many cloud service providers; it gives them greater flexibility for moving workloads around vast pools of resources.

In today's data centers, virtualization is an important element of IT strategy. Virtualization enables the pooling and sharing of IT resources — including servers, storage, and networking — which can then be allocated dynamically across applications and processes. In a virtualized world, people, processes and technology work together more efficiently to increase service levels and meet other business needs. Since capacity can be allocated dynamically, chronic over-provisioning becomes a thing of the past, and you free up existing resources to be more efficiently utilized.

HP offers a portfolio of virtualization solutions. These offerings include products for virtualization of servers, storage, and network connections; software for consolidated management of virtual and physical resources; and services to deploy virtualization strategies across your environment. HP's solutions are designed to help customers:

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- Move virtual resources around the data center quickly and inexpensively
- Provision new capacity in minutes
- Improve the performance of business services
- Put unused capacity to work for the business

Massive Scale-out Servers and Storage

Provisioning a hardware infrastructure for massive scale-out and a cloud-enabling data center requires servers and storage designed for *scale,* which means they deliver maximum performance combined with extreme density and power efficiency. This approach increases affordability, reliability, and manageability when deployed in large numbers.

HP has designed solutions for scale-out customers and offers a portfolio intended to help customers with massive scale-out in enterprise, high performance computing, and cloud computing environments. For example:

- HP BladeSystem c-Class is designed for performance density, power and cooling efficiency, and manageability, making it an appropriate platform for scale-out. An HP BladeSystem solution can be tailored to meet a broad range of customer workloads.
- HP's recently announced ProLiant BL2x220c, which includes two independent servers in one blade enclosure, essentially doubles compute performance without increasing the size of the data center.
- HP StorageWorks 9100 Extreme Data Storage System is a scale-out storage infrastructure. It is designed to scale in both capacity and performance enabling data and content rich applications to expand rapidly when required.

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Business Service Automation

IT was never simple, but today's IT environments are rapidly growing in complexity, resulting in increased management costs, downtime related to uncontrolled change, and risks of meeting compliance requirements.

Many IT organizations still use manual practices developed when servers were dedicated to single applications that seldom changed. Today, manual techniques are obsolete. IT needs to manage complex multi-vendor infrastructures cost-effectively while complying with corporate policies. And there's only one way to meet the challenge: automate.

HP Business Service Automation is designed to help organizations confront these challenges by providing a service-centric, integrated solution suite that enables businesses to:

- Create a common view of both physical and virtual resources
- Automate change across all the devices making up the business service
- Connect IT processes and coordinate siloed teams through a common workflow
- Integrate with monitoring and ticketing tools for a holistic service management solution

HP Business Automation Center can help to deliver cost efficiency, quality, and compliance in complex environments.

Business Service Management

Today's economic reality demands that IT improve operational efficiency while at the same time delivering high-quality services. To achieve operational efficiency, IT organizations are turning to business service management to help isolate problems, understand business impacts, and lower costs.

HP Business Service Management (BSM) is an end-to-end management solution portfolio that integrates network, server, application, and business transaction monitoring. It can help

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customers improve IT operations efficiency while delivering high-quality services. Some of the benefits of this portfolio include:

- Monitoring and managing the end-user experience in order to address events before they have a negative impact.
- Detecting and resolving problems at the business transaction level (online purchases, stock trades, and travel reservations) before customers are impacted.
- Improving efficiency with consolidated event and performance management that includes management of virtualized environments and the automation of server administration.
- Reducing costs and increasing agility through end-to-end automated network management.

IT Service Management

Effective, reliable, and flexible technology infrastructure services are critical to the success of business initiatives today. That's why many enterprises are transforming IT organizations by moving away from being traditional technology providers to become providers of reliable, low-cost technology services.

Implementing best practices puts you on the road toward enhanced service management, lower operational costs, and higher customer satisfaction. To help customers move forward with greater ease and confidence, HP assembled a team of service experts to develop the HP Service Management Reference Model. This model is designed to be used as a tool to help transform corporate IT organizations, and provides the foundation for the HP Service Management Framework which has five components:

- **Strategy and governance:** Providing service strategies and defining service portfolios to increase the value technology brings to the business
- **Design and planning:** Providing appropriate service design to help ensure service quality through implementation and deployment

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- **Transition and control:** Providing management of service transition into production so that services meet business requirements
- **Operation and technology:** Providing services and managing enabling technology to meet agreed service levels and increase customer satisfaction
- **Continual service improvement:** Providing ongoing alignment of services to changing business needs while improving process efficiency and effectiveness

Working with HP

As you consider the opportunities provided by the cloud, you can look to HP for assistance. HP provides technologies that allow service providers to build and manage services that deliver great business outcomes. HP also provides technologies, services, and solutions that can help you create an agile, adaptive infrastructure to deliver the business outcomes your organization demands. HP has a wide range of capabilities to help you manage technology-related services from multiple sources: in-house, hosted, outsourced, and via the cloud.

HP can work with you to clarify your goals, determine the needs of the business, and identify ways to put different service delivery models into place. HP recognizes that managing your hybrid business technology ecosystem will present new challenges and can help your organization conquer those challenges and improve the performance of your business services.

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Chapter 5

Six Questions to Ask

In This Chapter

- Assessing the flexibility of your environment
- Looking at the security of your existing environment
- Getting to the next stage

How good is your overall computing environment? That is a big question and is not easily answered because there are so many business and technical factors to consider. So, where do you start? We think that there are six fundamental questions that you should start with.

In this chapter, we take a look at them. After you have an idea of where your organization stands in these six areas you will be in a good position to decide where to start with the cloud.

How Flexible Is Your Existing Computing Environment?

We know that this is not a small question to answer but it is important to start by taking stock of where you are today. What does your computing environment look like? In many large organizations there are hundreds of silos of applications with thousands of dependencies that are difficult to manage. The data center has evolved over time into a complex tangled web of applications, servers, networks, and the like. Many data centers have grown in an uncontrolled manner in order to simply keep pace with the business demands. If your

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computing environment isn't well architected it will be very difficult to move to a services-based environment. This type of analysis gives you clues to the degree of cost savings that may be possible if you can simplify your infrastructure by adding business services and replacing some existing capabilities with cloud services. By simplifying the structure of your computing infrastructure, your organization may be better positioned to deal with change.

What Is the Architectural Foundation of Your Computing Environment?

What is the structure of your data center? Are there hundreds of applications, each with its own supporting infrastructure? Are there common business services used by multiple applications? Are these services self-contained without dependencies to other applications and services within your environment? It will be much harder to move components into the cloud if you can't separate applications or business services from your data center services. Has your organization implemented workload management? The more service-enabled your computing environment becomes, the better prepared your organization will be to take advantage of various cloud services. Being able to implement cloud services on an incremental basis can help organizations react quickly to business needs.

What Are the Costs Associated with Your Existing Environment?

One of the most important tasks you need to do to prepare for the cloud is to assess your cost structure. How can you determine the cost savings if you don't know what you're spending today? The reality is that this is not a black-and-white issue. There are situations where you will want to use business services that are offered by cloud application vendors. You may want to build some internal Service Oriented Architecture (SOA) based services that can live inside a cloud environment to benefit customers and partners. There may be situations

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where it is much more cost effective to move a service such as e-mail, software testing, or storage to the cloud because the internal costs are so much higher. There may be other situations where the costs for implementing a key application in the cloud may be much more expensive than running it internally. You will not be able to make an informed decision without the right level of knowledge about your costs today and what they might be in the future.

How Will You Handle Security Requirements?

Many organizations that are considering placing some computing assets into the cloud are concerned about security and accountability. We recommend that you assess your current IT and business governance situation as you develop your cloud strategy. For example, you may want to leverage a third-party credit checking service that is available from a cloud vendor. How well constructed is that offering? Does it conform to your company's business rules? In some cases, there are rules that prohibit certain types of information from leaving the organization's internal environment. Do you conduct business in countries with strict governmental requirements for data protection? How good is your internal security today? If you're considering a cloud service provider, you need to be confident that the company can support your security and governance needs with oversight and accountability.

How Is Your Company's Business Strategy Changing?

Cloud computing is often viewed as a technique for supporting change. So you should start by getting a good handle on how and why the business is changing. For example, your company may be ready to acquire companies to gain access to new customers or new markets. Your company may need to change its business model because of dramatically changing business conditions. Understanding this will help you determine the best ways to leverage the cloud for future growth and competitiveness.

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How Do We Get to the Next Stage?

Although it might seem like a lot of work to go through the exercise of understanding your current environment, it will be instrumental in helping you to pick the right cloud strategy for your organization. You may determine that the best starting point is to implement Infrastructure as a Service so that you can add incremental storage capacity to support a new business initiative. Or, you might decide to use Platform as a Service so you can limit the capital expenses needed to develop a new application. Another starting point in some organizations might be to add Software as a Service such as a Customer Relationship Management (CRM) service to support critical sales efforts without having to expand internal resources. Some organizations might have the need for a Business Process as a Service such as a supply chain service on demand that could be used to support a pilot test of a new line of business.

There is no one right path to leveraging cloud services within your business. It will depend on the state of your data center, your applications, your service portfolio, and your changing business requirements. Whatever your starting point, cloud computing is an approach that can be pragmatically used to augment, modify, or radically transform your technology and business infrastructure.

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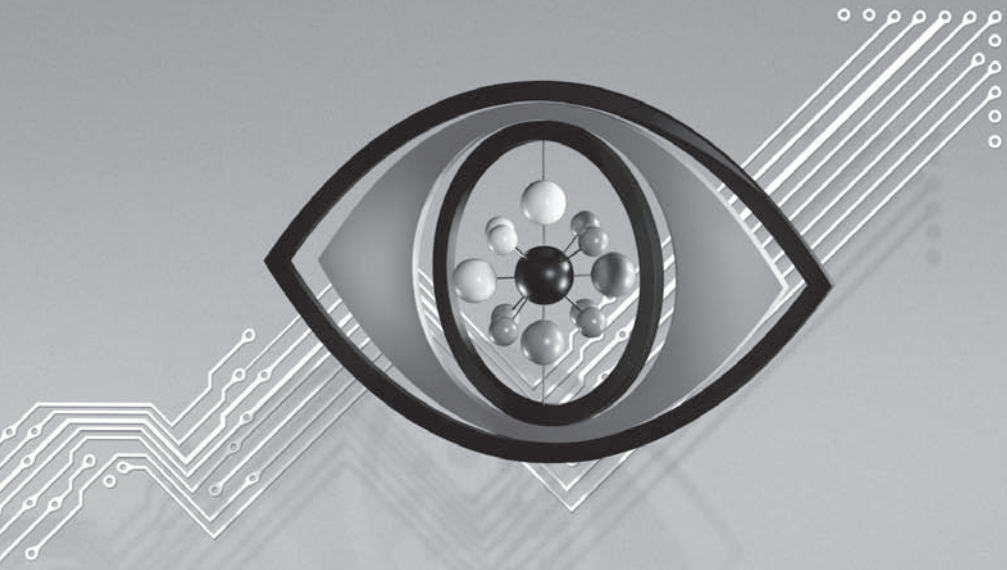

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