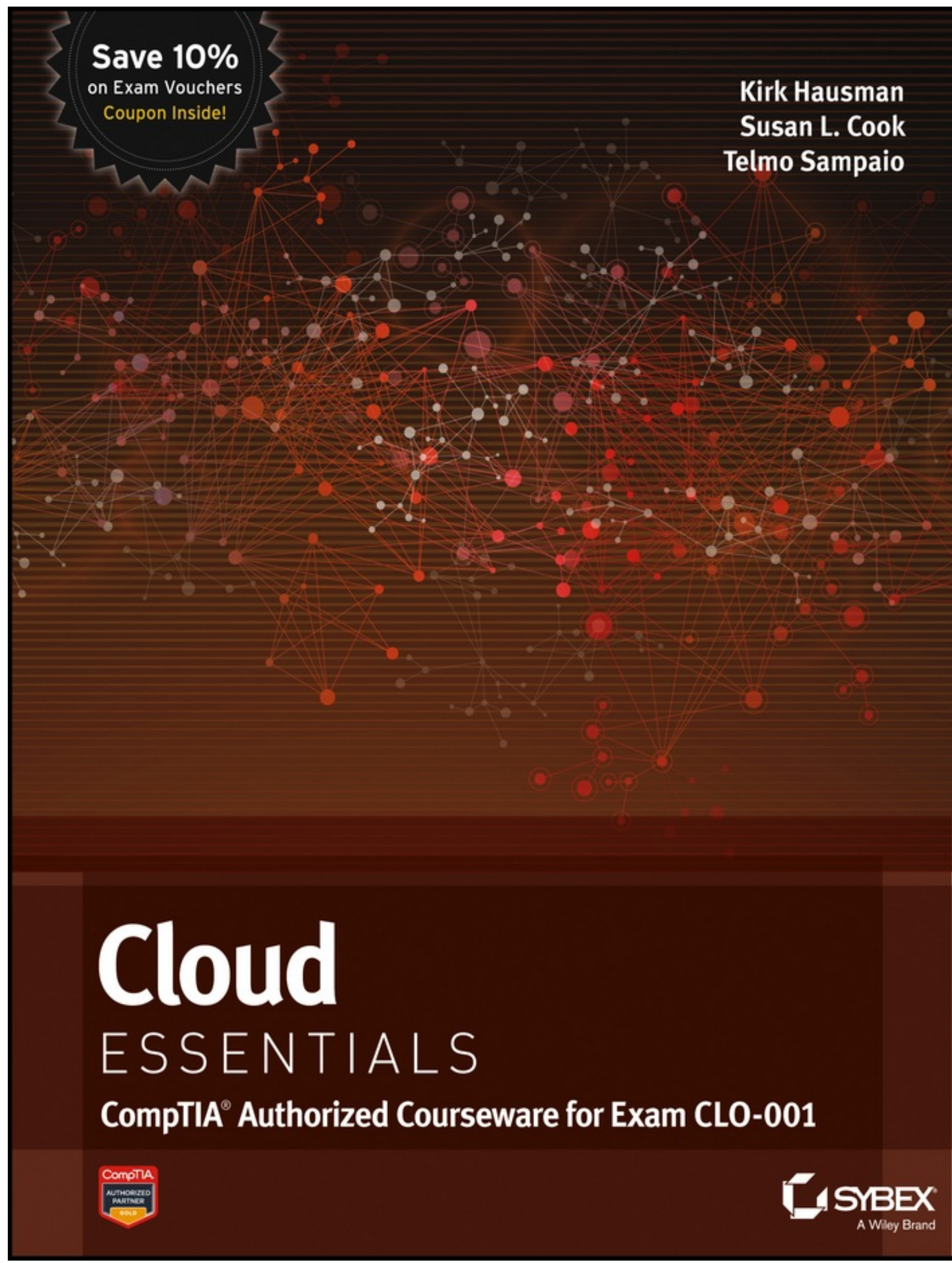

Kirk Hausman
Susan L. Cook
Telmo Sampaio

Cloud ESSENTIALS

CompTIA® Authorized Courseware for Exam CLO-001

SYBEX
A Wiley Brand

Contents

CLOUD

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Best regard

Neil Edd
Vice President and Publish
Sybex, an Imprint of Wile

To my two wonderful children and my bride (who married me even amidst this book's creation).

—Kirk Hausman

To Jonathan and Cassandra.

—Susan Cook

To my half brother Fernando Barros. For being there for me during my teenage years. For listening to me and my problems even when he had his own to take care of. You were an uncle, a friend, and a brother. I love you and will always carry you in my heart. I know you are up there in a cloud somewhere looking down at us. Rest in peace.

—Telmo Sampaio

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Kirk Hausman has been an IT professional for more than 20 years, working in state governmer health care, and higher education and as an enterprise architect and security consultant. He is the c author of *IT Architecture for Dummies* (Wiley, 2010) and the upcoming *3D Printing for Dummi* (Wiley, 2013). Kirk teaches information security, digital forensics, and networking, and his researc includes social media management, cyberterrorism, additive manufacturing (3D printing), ar strategies for developing interest in young learners toward STEM subjects. He has facilitated clou initiatives using Amazon EC2, Azure, and high-performance computing technologies. Kirk holds master's degree in information technology and a range of professional certifications, including PM CGEIT, CISSP, CISA, CISM, and CRISC. Kirk can be reached via kkhausman@hotmail.com.

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Telmo Sampaio is the chief geek for MCTrainer.NET and TechKnowLogical, specializing in Syster Center, SharePoint, SQL, and .NET. Telmo wrote his first application in 1984, with the intent o demonstrating physics concepts to his fellow classmates. His passion for technology and teachin made him a self-taught developer from an early age. In 1989 he moved to Wellesley, Massachusett when his father was transferred to work in Boston for a year. He kept developing applications demonstrate science and math concepts and decided to remain in the United States after his fami left. In 1990, while still in high school, he was hired by IBM to demonstrate its most powerful CA application, CATIA, to corporate customers like Boeing. In 1991 he moved back to Brazil and studie systems analysis at PUC/RJ. When Microsoft extended its Microsoft Certification program to Braz Telmo was one of the first in the country to become certified. In 1994 he started teaching Microso classes. Soon he was managing the largest training center in Latin America, after having worked fo Microsoft in Brazil as a technical account manager. To date he has been certified in over 20 differe Microsoft products, passing over 80 exams. After moving back to the United States in 2003, Telm became a contributor to several Microsoft certification exams, an author for official courseware, and speaker at events such as TechEd, PASS, and MMS.

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—Susan Coo

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to understand what I write about.

—Telmo Sampa

CompTIA Certification

Qualify for Jobs, Promotions and Increased Compensatio

CompTIA The CompTIA Cloud Essentials specialty certification demonstrates that an individu knows what cloud computing means from a business and technical perspective, as well as, at a hig level, what is involved in moving to and governing the cloud.

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- **The cloud is a new frontier** that requires astute personnel who understand the strategic impact c cloud computing on an organization.
- Research has shown that **certified IT professionals score better** when tested for their knowledg of foundational principles and skills, and from the employer's perspective, certification provides solid evidence of successful training.
- **Cloud technologies and business needs are moving faster than organizations can adapt.** Therefore staff understanding of cloud computing is key for the initial project planning for cloud solutions, and a safe and well-managed implementation of any cloud project.
- Getting your people up to speed with a fundamental understanding of cloud computing enables the whole organization to speak the same language.

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Introduction

IT is moving out of the local data center into the cloud, where data and services become easi available via cell phones, tablets, and other mobile devices around the world.

In this book, you will learn the basic concepts of cloud computing as it exists in an internation setting, using the criteria specified by professional cloud computing foundation certifications us throughout the United States and worldwide. With the information provided in this book, you will b able to understand the specific terminology and its application in the continued shift into the clou where costs are billed like electricity and reflect monthly usage levels rather than the traditional u front major cost of new servers and storage for a data center rack. Migration into the cloud allov rapid deployment of test applications and then rapid scale-up to meet growing demands witho worrying about whether the current network or hardware can keep up.

Who Should Read This Book

Cloud Essentials is for anyone who is interested in understanding the fundamentals of clou computing from both a technical and a business perspective. This book is suitable whether you are student using it in an IT class, an entry-level IT professional who needs a better understanding cloud computing, an IT manager in an organization considering adopting cloud services, or nontechnical manager or executive curious about what cloud services can do for your business.

Although deep technical knowledge and work experience in the IT field are not necessary, it will b helpful if you have a basic understanding of enterprise technologies such as networking ar client/server architecture, and those who have worked in and around an IT environment are likely gain a better understanding of some of the topics being covered.

If you are preparing to take the CompTIA Cloud Essentials certification exam (CLO-001), this boo is ideal for you. It will also help those preparing to take the EXIN Cloud Computing Foundatio certification exam (EX0-116). You can find more information about the CompTIA Cloud Essential certification at http://certification.comptia.org/getCertified/certifications/cloud.aspx and about th EXIN Cloud Computing Foundation certification exam at www.exin.com/US/en/exams/&exam=exi cloud-computing-foundation.

What Is Covered in This Book

Cloud Essentials is organized to provide you with the knowledge needed to understand the basics cloud computing and how it may be implemented in a business environment. Each chapter begins wi an introduction and a list of topics that correspond to chapter headings. Illustrations, diagrams, ar screen captures are included, where appropriate, to enhance your understanding of the topic. At th end of each chapter, in "The Essentials and Beyond," you will find additional exercises that you ca work on independently and 10 review questions that will help you prepare for the CompTIA and EXI exams.

Chapter 1, "What Is Cloud Computing?" Starts by defining cloud computing and identifying the

attributes that differentiate cloud services from hosted services. Covers virtualized computing environments and high-performance computing as they relate to cloud services and discusses the client/server relationship in the cloud.

Chapter 2, "Cloud Models" Discusses the four types of cloud deployment models and hosting options. Also identifies the IT-based organizational roles helpful both with transitioning and managing IT operations to the cloud.

Chapter 3, "Service Models" Identifies the various types of cloud service models using the industry standard syntax of *as a Service* and explains how they relate to each other. Examines Software, Platform, and Infrastructure as a Service models in detail and explains their use in a business computing environment.

Chapter 4, "Current Cloud Technologies" Compares traditional computing solutions to cloud services, using currently available cloud offerings as examples. Examines accessing cloud services across networks, relating cloud functions to the OSI model. Discusses how cloud services can empower mobile computing.

Chapter 5, "Cloud Business Value" Starts by identifying the business drivers for cloud computing such as reduced costs and increased efficiency. Covers both direct and indirect costs of cloud computing and what types of organizations are likely to benefit from cloud computing.

Chapter 6, "Cloud Infrastructure Planning" Covers networking requirements and goes into more depth on the OSI model. Identifies several network challenges associated with cloud computing as well as changes to the network infrastructure. Discusses how to leverage automation for resource provisioning, achieving interoperability between services, and introduces cloud computing standards.

Chapter 7, "Strategies for Cloud Adoption" Explores aligning cloud deployment with organizational goals and provides guidance on selecting cloud service vendors. Identifies the impact to business processes and discusses the importance of service-level agreements (SLAs).

Chapter 8, "Applications in the Cloud" Explains the role of standard applications in a business environment and the difference between desktop, distributed, web-based, and cloud applications. Discusses important considerations to developing cloud-ready applications and migrating applications to the cloud.

Chapter 9, "Cloud Service Rollout" Identifies topics of consideration for inclusion into a cloud service rollout plan. Includes the importance of identifying vendor roles and responsibilities and organizational skill requirements, both technical and business related. Follows with a discussion o the transition from a test to a production environment and ends with incident management planning.

Chapter 10, "Cloud Service-Level Management" Provides an overview of the Information Technology Infrastructure Library (ITIL) and discusses how its service management practices apply to cloud computing, particularly service desk operation. Discusses developing and utilizing performance metrics to monitor and improve service.

Chapter 11, "Security in the Cloud" Provides foundational material covering information security and risk management in preparation for identifying cloud-specific security risks and mitigations. Introduces some of the more well-known information security standards appropriate to a business environment.

Chapter 12, "Privacy and Compliance" Discusses legal and privacy risks involved in adopting cloud computing services and provides examples of applicable laws in various jurisdictions. Examines strategies for identity management in the cloud.

Appendix A, "Future of the Cloud" Explores the future of cloud computing through an examination of advanced cloud-specific hardware, ongoing development of smart cities, and increasing automation of traditional data center operations.

Appendix B, "Answers to Review Questions" This appendix includes all of the answers to the review questions found in the section "The Essentials and Beyond" that appears at the end of every chapter.

Appendix C, "CompTIA's Certification Program" Describes CompTIA's certification program and the Cloud Essentials CLO-001 exam. Maps each exam objective to specific chapters and section in this book.

Appendix D, "EXIN's Certification Program" Describes EXIN's certification program and the EXIN Cloud Computing Foundation EX0-116 exam. Maps each exam objective to specific chapters and section in this book.

Glossary Lists the most commonly used words throughout the book.

In addition, we have provided suggested or recommended answers to the additional exercises at th end of each chapter. You can download these at www.sybex.com/go/cloudessentials. There you'll als find a bonus appendix, which includes a security case study.

Sybex strives to keep you supplied with the latest tools and information you need for your wor Please check its website at www.sybex.com/go/cloudessentials, where we'll post additional conte and updates that supplement this book if the need arises. Enter **cloud essentials** in the Search box (type the book's ISBN, **9781118408735**), and click Go to get to the book's update page.

Chapter 1

What Is Cloud Computing?

Cloud computing has become such a buzzword in the industry that it is being used to market mar different types of software and network services, not all of which really fit the proper, technic definition of the *cloud*. So, before we examine the use, impact, and security issues of working in th cloud, it is necessary to define what cloud computing really is.

This chapter defines cloud computing, covers the origins of cloud computing, and briefly examin the technologies used in cloud computing to help you understand the role the cloud can play organizational enterprise planning.

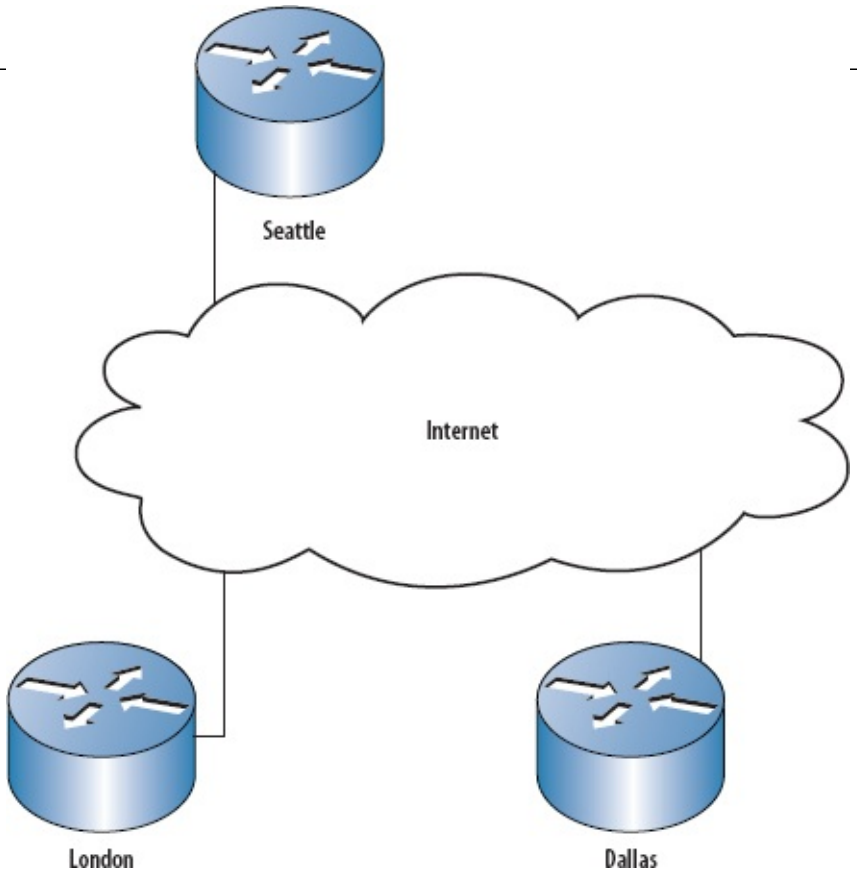
- **Defining cloud computing**
- **Understanding distributed application design**
- **Understanding resource management automation**
- **Understanding virtualized computing environments**
- **Understanding high-performance computing models**
- **Understanding cloud computing technologies**

Defining Cloud Computing

More than a marketing term, *cloud computing* refers to flexible self-service, network-accessib computing resource pools that can be allocated to meet demand. Services are flexible because th resources and processing power available to each can be adjusted on the fly to meet changes in need based on configuration settings in an administrative interface, without the need for direct IT personn involvement. These resources are assigned from a larger pool of available capacity (for example memory, storage, CPUs) as needed, allowing an organization to spin up a proof-of-concep application, expand that to a full prototype, and then roll it out for full use without having to wor about whether existing hardware, data center space, power, and cooling are capable of handling th load. Cloud computing allows the allocation of resources to be adjusted as needed, creating hardware-independent framework for future growth and development.

Since the dawn of the networking age, when network diagrams depicted an enterprise and i extended components, the industry standard has been to use a simple cloud icon to identify the publ Internet, as shown in Figure 1.1. This cloud represents all of the various types of networking an functions that are necessary to bridge together various parts of the enterprise over the Internet becau the specific routing details are subject to change and are outside the enterprise network environmen That's where the term *cloud* originated, and when we discuss migration into the cloud, what w generally mean is applications and services being moved from the organizational or hosting da center to cloud service providers available through the Internet.

FIGURE 1.1 An example of the cloud symbol in network diagrams



Clouds Hold More than Just Rain

Almost anything can be hosted in the cloud, from databases and applications to complete virtual infrastructures encompassing data storage, networking, and all components of the server environment. The cloud can also host virtualized user desktop environments available from any networked client device, whether or not the client has sufficient local resources to host the virtualized desktop environment and its various applications.

Internet-based offsite-managed hosting services have been around for a while, available throug specialty providers such as Rackspace since 1997 and even provided as value additions by local ISP However, cloud computing goes beyond simply hosting a website or database service on a machin located in a remote data center, with early cloud services such as Google Gmail and Google App showing off the power of cloud computing starting in 2006. Cloud computing solutions have sever common characteristics, regardless of their form:

Managed by the provider Cloud computing services are managed by the cloud provider. Once applications and services have been moved to external cloud computing, an organization no longer needs to worry about local data center issues regarding power, space, and cooling, and developers need only know whether their applications will be running on one cloud service platform or another—for example, Amazon Elastic Compute Cloud (EC2) or Microsoft Azure—without having to consider where the services or application resources will be located. Knowledge of individual hardware characteristics and capacity measures is no longer important to the organization, while tech refresh and update becomes a background matter for the cloud provider to manage.

Flexible resource assignment The capacity and resources available to cloud computing services can be increased or decreased, with costs adjusted according to actual consumption. This allows an organization to spin up a new offering with only minimal costs for the resources used and then to

meet spikes or cyclic use patterns with increased capacity, paying for only the level of use needed. Traditional data centers must always plan for future growth, and a sudden success for a web-based offering can rapidly overrun available server and network capacity unless data center managers purchase sufficient "spare" resources beforehand. Cloud computing draws resources from a pool as they are needed, based on level of service consumption. This is similar to the way power companies supply power to individual organizations, billing each according to its individual use.

For example, a new cloud application might experience a sudden increase in use following mentio on a popular blog and require additional network bandwidth, data storage, server memory, or CP power to keep up with the sudden increase in demand. Traditional data centers would be limited b hardware constraints, while cloud computing alternatives can simply add CPUs or expand availab database file storage up to predefined limits when needed and then shrink back after the storm access has passed to manage on-demand costs.

Pay Only for What You Need

Instead of buying huge storage arrays just in case of later need, you can start out small and grow your cloud resources only when required. Automatic failover to public cloud services when local resources are insufficient, a practice termed *cloud bursting*, will be discussed in Chapter 2, "Cloud Models," as we review cloud deployment solutions.

Network accessible Cloud services are available via networked devices and technologies, facilitating rapid access by mobile customers and remote office locations. This provides an "anywhere, anytime" service model not possible in traditional data centers, where service downtime and local-area outages in power and networking can impact uptime. Because cloud computing vendors can be located anywhere in the world, they can host organizational services from areas outside of geopolitical turmoil or environmental threats. Before a hurricane, for example, a cloud service provider could transfer operations from Florida to Washington transparently to the service consumer.

Sustainable Because cloud providers can provision resources at need, it is possible to reduce power and cooling requirements during off-peak times, gaining economies of scale well beyond those available to single-tenanted hardware-based data services, which must stay on waiting for later use. The flexibility in cloud hosting location allows providers to shift operations without disruption to consumers. They can move data center activity north during summer months to save on cooling costs or transfer operations to areas with excess power production capability, such as Iceland.

Cloudy Skies Are "Greening" the Data Center

Cloud hosting supports green initiatives through the use of environmental cooling by transferring operations to cooler locations rather than requiring ever-larger refrigerated air systems to meet summer heat increases, reducing an organization's environmental footprint.

Managed through self-service on demand After limits for resource availability are configured within the cloud provider's systems, available resource capacity can be automatically expanded or managed by the client with minimal effort. Bringing up a test server no longer requires access to the physical system, loading software, and configuring networking by hand; instead, the customer

need only access their cloud provider and request a new resource allocation using the self-service user interface. As long as the organization's contractual limits on resources allow the addition, it is managed automatically without further technical assistance needed.

Understanding Distributed Application Design

Distributed design is one of the fundamental technologies supporting cloud computing. Early softwa had to operate on a single powerful system, together with its data and ancillary programs. Th development of distributed application designs using a standardized application programmin interface (API) model allowed one computer to host an application while others could hold the da and perform secondary tasks.

Once applications could work together to provide the consumer with a single interface, ne technologies were developed such as just-in-time (JIT) inventory management. In JIT, a user places a order on a single website where availability is verified before the order is placed, and then th application alerts the warehouse to prepare the item for shipping, the shipper is notified for a picku and the accounting software handles payment transactions all behind the scenes. The customer mere selects what they want, sees that it is available, and then receives their receipt with confirmation delivery date all in one seamless process.

Many CPUs Make Light(er) Work

Services such as eBay depend on distributed processing to integrate real-time bids with item availability and many other factors calculated and managed simultaneously across many systems. No single system could handle the volume of transactions occurring simultaneously as items are placed for bid, bids are submitted, notifications for winning bids are transmitted, and the various other aspects of online real-time auctions are carried out.

In cloud computing environments, even the location and type of hardware supporting a softwa application can shift from moment to moment as additional capacity is allocated or services a transferred between cloud provider data centers. An organization's services could not adapt to thes changes without a flexible link between services, resources, networking, and storage. Theoretical speaking, if an earthquake disrupted California's Internet services, services hosted in the cloud cou continue operating without interruption or be rapidly transferred to data centers outside of the affecte area.

The cloud is interconnected through standard APIs and XML web service interfaces, allowin developers to rapidly move their applications into the cloud without requiring a completely new set skills. This improves future planning for technology's constant evolution and update. Issues technical refresh are no longer based on hardware life cycles but instead are handled by the clou provider transparently as required. APIs still vary from one cloud provider to another, so application developed under Amazon's EC2 will not be able to directly transfer to Microsoft's Azure, whil Microsoft's own utilities and tools can manage both local and cloud equivalents of its own service Until cloud technologies mature into a common standard, application development will still reta some aspects of siloed technology/vendor lock-in. We will examine these issues in greater detail subsequent chapters.

Clouds Virtualize the Application Development Cycle

Application development in the cloud improves business agility to offer new services to customers by making services immediately available with whatever resources turn out to be needed rather than via the traditional model of application development, prototyping, testing, and then rollout to production systems after procurement.

Understanding Resource Management Automation

Another key function underlying the success of cloud computing is the management of resourc automatically. When demand nears capacity, the cloud hosting software is able to identify need an respond by adding resources up to predetermined levels based on an organization's contractual limi or limits configured in the management software. This protects application availability while als ensuring that attacks will not overrun an organization's budget.

Clouds Help Deal with Botnets and Distributed Denial-of-Service Attacks

Cloud services protect an organization by simply scaling up resources to meet growing demands during an attack while also ensuring that attacks, such as botnet distributed denial of service attacks, will not overrun an organization's resources. However, this defense comes at a cost for the added resource capacity.

Botnets are collections of individual computers remotely controlled by the "bot herder" to perform tasks as directed. Most bots are standard personal computers located in people's homes and businesses and infected with viruses and remote control software that lets the bot herder issue commands. By commanding all of the individual bots to connect to a target server, the bot herder consumes all of the targeted server's resources trying to handle the attack, preventing legitimate use.

Organizations can configure resource limits so that an attacker cannot generate uncontrollable costs by adding more bots into the attack. Botnets of a million or more controlled systems have been identified and shut down by law enforcement, and these could easily run up the cloud bill for a targeted organization if there were no limits to resource allocation.

In addition to handling periods of high use, cloud computing can automatically reduce resourc allocations during off-peak periods. Periodic and cyclical resource requirements have long presente problems for data center managers, who must make sure that equipment has sufficient resources f peak load periods but then must power and cool those systems even when they are minimally utilize Defensive planning for cloud services includes a new aspect in the strategies planners will need f managing automatic resource provisioning, which we will discuss in greater detail in Chapter 1 "Privacy and Compliance."

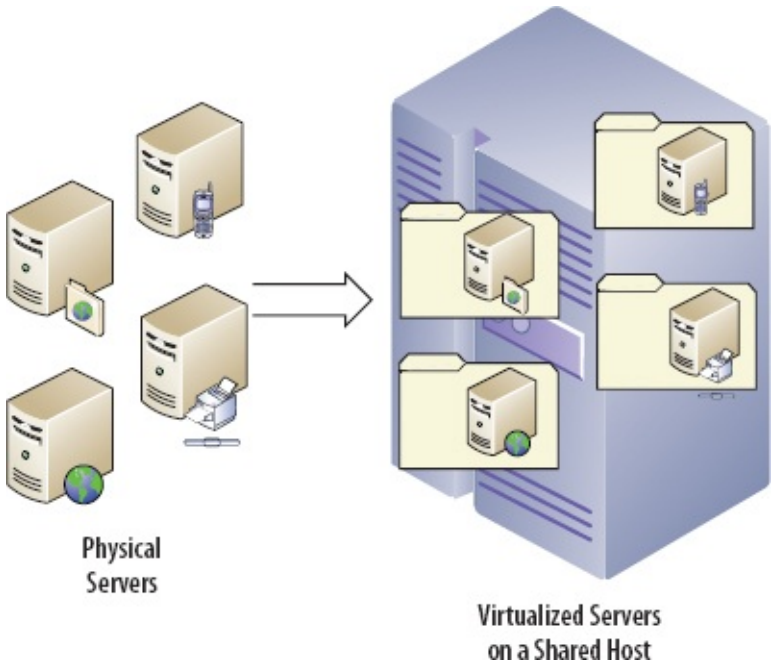
CPA firms might see a peak once a year during tax time, while a website featured in the news might need expanded resources only one time ever.

Because cloud resources are managed automatically, an organization can meet increasing need whi also saving on costs during periods of reduced need without requiring constant management by huma resources. The flexibility of Internet-accessible cloud computing applications will allow a sing service to be utilized by many components of an organization's geographically distributed sites. single call center service could be used around the clock to support users within the local time zone, a cloud service could transfer its operations to cloud hosting sites based on time of day statutes provide the lowest latency to consumers in New York, London, and Hong Kong for one shared set c centrally negotiated licensing costs.

Understanding Virtualized Computing Environments

Virtualization of storage systems in early storage area networks and of entire computer systems form the backbone of cloud computing. Because an organization no longer needs to worry about where da is located or what hardware resources are available on a particular server, focus can be turned business uses of technology rather than on technology itself. Cloud computing also makes extensiv use of server virtualization to better utilize cloud hosting servers by allowing multiple systems to ru on a more powerful server, as shown in Figure 1.2. This is referred to as *multitenancy* and allov system resources to be fully utilized before another server is brought online, further reducin operating costs and data center cooling requirements.

FIGURE 1.2 Virtualizing individual physical systems onto a shared powerful server



Because cloud hosting providers use virtualization to expand capacity and to provision new services, automated deployment speeds capacity expansion and tech refresh operations.