CLOUD COMPUTING

A practical approach for learning and implementation

A. Srinivasan | J. Suresh

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Cloud Computing: A Practical Approach for Learning and Implementation

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To my parents, Thiru. P. M. Arulanandam
and Smt. A. Amirthalakshmi—A. Srinivasan

To my beloved wife S. M. Lalitha,
who has been a source of inspiration all the way—J. Suresh

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Brief Contents

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FOREWORD

Cloud computing has changed the way mankind uses its technical expertise. Broadly speaking, it marks a transition in the use of computers as utility tools with extreme applications. With shrinking global boundaries and reorganized societies, unexpected results have evolved. A few decades back, the use of supercomputers called for huge investment in terms of cost and infrastructure were accessible only to few organizations. That scenario has now changed with rapid strides in technology making on-demand access to effective unlimited computer power available to all. Our growing requirements to process and store information and data perhaps, justifies our compulsion to innovate and come up with better technologies that fulfill these needs.

An emerging technology, cloud computing is rapidly changing the texture of the technology landscape and is now the focus of increased attention. Cloud computing promises to enhance the potency of the deployed applications and lower the cost, all the while increasing business agility. Cloud computing is not a revolution. It is an evolution that has been ongoing for well over a decade. Cloud computing offers a variety of ways for businesses to increase their capacity or functionality without having to add infrastructure, personnel or software.

The authors of this book have laid good foundation on what cloud computing is and introduced a set of fundamental ideas such as moving to cloud, types of cloud and working in cloud to enable the reader to grasp the essentials of the concept. They have explained the principles of convolution and correlation. In addition, they highlighted the basics of cloud modeling, while emphasizing how the cloud can be eco-friendly and utilized to build a cloud governance model. Virtualization, which seems to defy common sense, can be hard to understand. The authors have delineated this concept effectively as the practice of running several operating systems concurrently on a single computer. Virtualization is a contemporary topic spreading beyond servers, desktop computers and onto mobile phones.

Cloud storage is a young industry that shows great promise for growth. Large organizations have started showing interest in using it and are moving their data to the cloud. The unique architecture of the cloud not only offers unlimited storage capacity but also lays the groundwork for eliminating the need for periodic data backup.

Cloud services provide us with our own hard drive in the cloud or on the Internet. Such services have become popular because they are affordable, convenient and provide ample storage space. Enterprises are exploring ways to enhance cloud security, without which efficient usage of the cloud cannot be assured. Organizations seek to tap many advantages of cloud computing to streamline internal IT operations, expand on-premise infrastructure and add capacity such as servers on demand since, it is a cost-effective method for deployment of new services.

Service-Oriented Architecture (SOA) and Cloud Computing are complementary activities that play an important role in IT planning. Without SOA, organizations will find it almost impossible to reach the cloud. SOA, a flexible modular approach to delivering IT services is an essential foundation that enables fundamental concepts such as abstraction, loose coupling and encapsulation to facilitate access to the cloud.

For every new technology that is successfully adopted, several research frontiers are to be explored. Such frontiers pertaining to the concept of cloud computing are:

- Effective data protection in Internet cloud
- Innovative applications on the clouds and datacenter
- The Internet of Things (IoT)

The emergence of the 'mobile cloud' as the current trend in cloud computing has resulted in the development of an increasing number of applications for mobile devices.

Computing systems that are designed and built with capabilities to run on their own, adjusting to varying circumstances and preparing their resources for efficient handling of workloads are now being devised. The book deals at length with the ways in which these autonomic systems can be coupled with cloud computing. In addition, it also takes a close look at multimedia cloud computing and analyzes the applicability of Internet multimedia to generate, edit, process and search media contents such as images, video, audio and graphics.

The different cloud services discussed in this book include, but are not restricted to, the cloud concepts that are described above. Each chapter is amply supported by an exhaustive list of key words, questions and exercises to ensure that the reader gains an in-depth understanding of the subject.

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Preface

Cloud Computing enables simplified functionality of infrastructure and platforms used in IT and IT-enabled industries, so that the end-users can avail what they want and pay only for the service they use.

Cloud Computing can be characterized as Internet-based computing in which many remote servers are networked to enable shared data-processing ventures, centralized knowledge storage, and access to services or resources online. The term 'Cloud Computing' is relatively new but unknowingly, we have been engaging the cloud since 1996, when Hotmail and other Web-based emails gained popularity.

With the advent of business process outsourcing of IT and IT-enabled services, cloud computing has gained significant commercial interest, mainly because of its role in decreasing administration overhead costs and lowering entry-level barricades for new service providers. Several businesses exploit the advantages of cloud computing to capture a broad market with minimal application charges and infrastructure requirements. However, cloud technologies and models are yet to evolve to their full potential and the capabilities associated with clouds have not yet been fully studied to permit their optimum utilization. Further development of Cloud Computing calls for extensive trials in diverse areas to enable the acceptance of sophisticated technology due to the unprecedented scale and heterogeneity of the needed infrastructure.

This book spells out the basics of Cloud Computing and deals at length with its architecture and principle of storage. Virtualization concepts, cloud security aspects and cloud services are explained with examples. Distinct tools available to deploy the cloud are explained with succinct illustration of their applications and worked-out examples are discussed with adequate proof. The summary and short questions at the end of each chapter serve to encapsulate the concepts to aid quick recapitulation, as does the compilation of key terms.

Cloud Computing is an emerging concept and the book presupposes in its readers a working knowledge of the Internet and a passion to learn new technologies. It is as much intended for college students who have Cloud Computing as their core paper, and for teachers who handle the subject at the undergraduate and postgraduate levels. IT specialists and researchers who work in the field of Cloud Computing also stand to be benefited. Ardent students who meticulously assimilate the topics discussed in the book will be able to effortlessly deploy and develop various applications on the cloud platform.

Feedback from readers to enhance the contents of this book is welcome and may be mailed to feedback@gmail.com. While every care has been taken to ensure the correctness of our content, it is possible that errors may have inadvertently crept in. Any such errors, if detected, may please be brought to our notice. This would help us improve the later versions of this book.

ACKNOWLEDGMENTS

Writing this book has been a wonderful and overwhelming experience. It is hard to say what the actual learning experience was whether it was grappling with the topic itself, working in a group, staying up until the birds start their morning songs or remaining focused on the job.

We thank the members of our family for their support and encouragement though it often meant that we spent considerably less time with them than we did with our manuscript. It was a long and difficult journey for them.

This book would not have been possible had it not been for the help of many people to whom we are indebted for their contributions. We are obliged to them for making our effort an unforgettable experience.

We thank our publishers, Pearson Education, for guiding us through the book-writing process. Special thanks are due to Sojan Jose, Shankari and Balakrishnan for their help in making this effort a success.

A. Srinivasan
J. Suresh

About the Authors

Srinivasan Arulanandam earned his M.E. and Ph.D. degrees in Computer Science and Engineering from Madras Institute of Technology, Anna University, Chennai, before proceeding to complete his post-doctoral studies at Nanyang Technological University, Singapore. With 21 years of teaching and research experience in the fields of Computer Science and Engineering and one year of industrial experience, he is at present guiding six students in research leading to their Ph.D, and one scholar finished his Ph.D. He has published and presented over 54 research papers in journals and conferences, both at the National and International level. He is also a member of the editorial board of *Journal of Computer Science and Information Technology* and a reviewer to 14 reputed International Journals in Computer Science and Engineering.

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Suresh Jaganathan received his bachelor's degree from Mepco Schlenk Engineering College, Sivakasi, and Master's degree in Software Engineering from Anna University, Chennai. He was awarded a Ph.D. by Jawaharlal Nehru Technological University (JNTU), Hyderabad, for his work in the field of Grid Computing. With 17 papers published in reputed International Journals and numerous presentations at National and International Conferences to his credit, he is a researcher in the fields of Grid Computing, Distributed Computing and Neural Networks.

Backed by 18 years of teaching experience, Suresh is currently Associate Professor in the Department of Computer Science and Engineering at Sri Sivasubramania Nadar College of Engineering, Anna University, Chennai. He is a member of IEEE and life member of CSI and ISTE.

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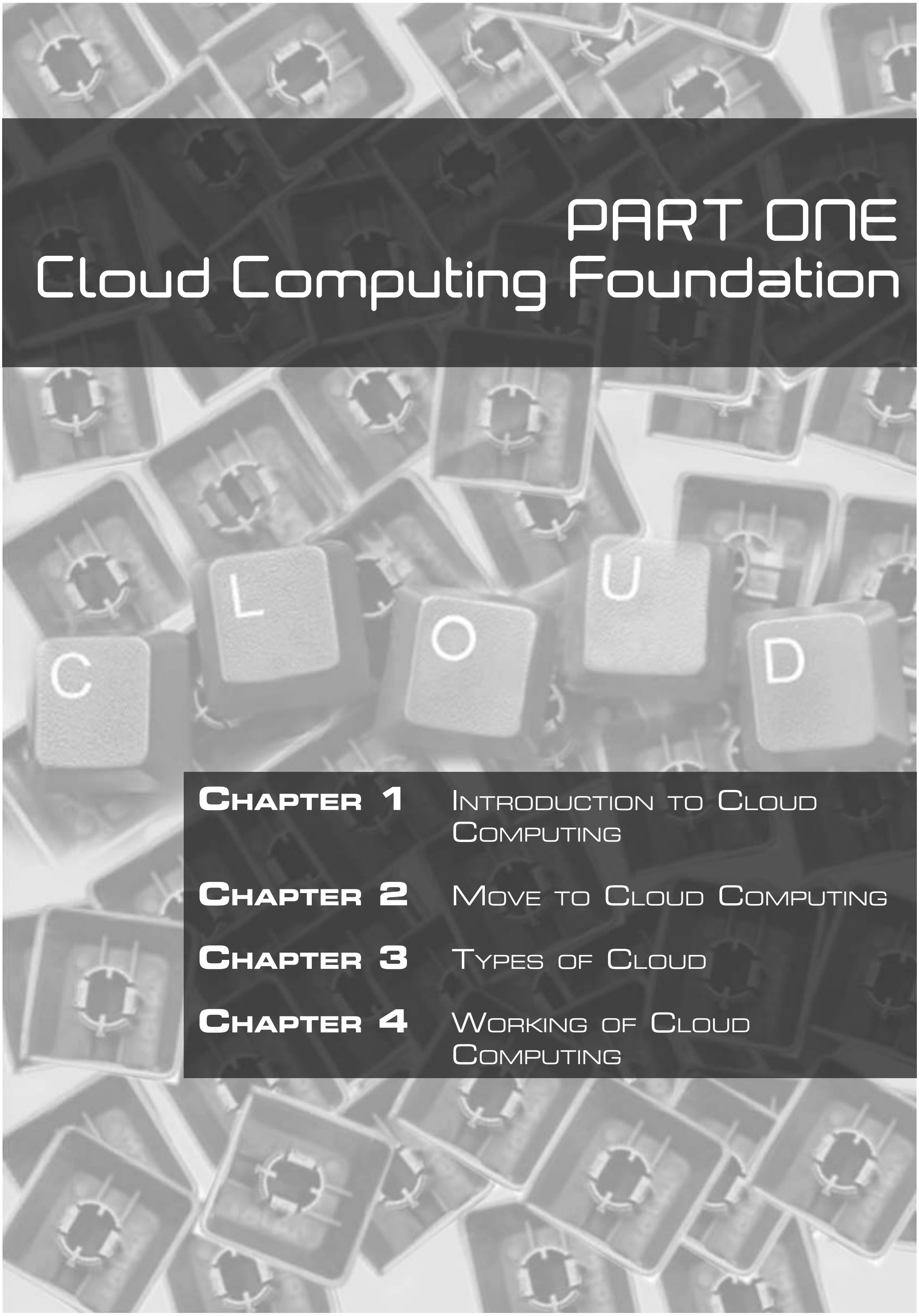
PART ONE
Cloud Computing Foundation



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CHAPTER 1

Introduction to Cloud Computing

1.1 Cloud Computing Basics

1.2 History of Cloud Computing

1.3 Importance of Cloud Computing in the Current Era

1.4 Characteristics of Cloud Computing

1.5 What Cloud Computing Really Is?

1.1 CLOUD COMPUTING BASICS

1.1.1 Introduction

Originally, cloud computing was a hazy term, in the sense computing would occur in remote locations without the need for human intervention. Certainly, there is no necessity for the users to know how the computers, their software or the network are functioning.

In the real world, computing developed progressively and can be viewed in two stages. One is more centralized and the other is the desktop. The limitations of centralized computing did not give users enough control and was inflexible. Distributed computing made every user a system administrator but it was still inefficient. In the last few years, as the cost of computing power continued to decrease, the cost of manpower to implement and manage computer systems have increased. Centralized computing facility needs more version upgradation to reach the cloud computing stage. Some computer scientists have suggested a vast grid of computers attached via the Internet, whose power is combined for large-scale tasks, when needed. In certain cases, large numbers of computing systems are used for particular tasks. Other scientists have recommended a computing utility which would offer just as much computing power as a society needs in an on-demand basis, as in the case of electricity.

Therefore, Google and Amazon web users have built enormous data centres for their own use. They have realized that they can allow others to access these data centres at reasonable prices. Thus began the era of cloud computing.

1.2 HISTORY OF CLOUD COMPUTING

Cloud computing comprises of various phases, which include grid and utility computing, application service providers (ASP) and Software as a Service (SaaS). Though the concept of delivering computing resources through a universal network was started in the 1960s, intergalactic computer network was introduced by *J.C.R. Licklider*. His dream was for everyone on the earth to be connected with anyone and be able to access programs and data at any location from any place. In 1960, the famous scientist John McCarthy predicts that the computation being available as pubic service. In 1960, the cloud computing evolved along with numbers of lines, Web 2.0 being the most recent development. Salesforce.com was the first cloud computing to have arrived in the 1999, which pioneered the idea of delivering enterprise applications through a simple website.

The concepts behind the cloud computing are not new, whereas all these concepts are really needed for the current trends. The influence and degree of the cloud have changed enormously from what it was in the commencement phase. Over time as the skills and business environments have progressed, the status quo of cloud computing has become untouched. The principle behind the cloud computing has not changed but the users approach have changed immensely.

There is no doubt that this type of processing power is certainly attracted by large companies that have an unappeasable hunger for the ability to process tasks such as crunching records and providing users with Web 2.0 functionality. To a greater extent, information is out there in the digital sphere and there is so much of it that desires to be structured in ways that we can fully understand and use it to our advantage.

The beginning of what was recognized as the concept of cloud computing can be traced back to the mainframe days of the 1960s, when the idea of ‘utility computing’ was propounded by MIT computer scientist and Turing’s medal winner John McCarthy. Utility computing ended up becoming a thing of large business units like IBM. The concept was so simple that the computing power could be wrecked down as a metered service for the business, similar to how telephone companies operate for their consumers.

‘The Computers of Tomorrow’ is an article which was published in *Atlantic Monthly* in 1964 by Martin Greenberger. He envisioned a future in which computers would become super powerful worldwide and major companies will be operating through wires all over the place in the due course of time. The ‘information utility’ would almost immediately grow but the issue was, “would it become regulated like the power manufacturing unit or be a private body?”. IBM, of course, foresaw the possibility of massive profit to be made in this type of business, and turned the wheel of fortune in providing computing services to companies of enormous scale.

Huge organizations (e.g., banks) find it difficult to access computing power from their enormous mainframes as is too costly and large to run on their own. Once the personal computer became ubiquitous, the concept of utility computing came to be known as more of an operational profligacy that most companies did not need. This also awakened the reality that computers were becoming reasonable and easily accessible.

The other major constraint in the design of utility computing which could shrink the growth of the usage of personal computer was the technical restrictions on bandwidth as well as disk spaces. The infrastructure for this type of technology was just not in place until now to support cloud computation, even though the use of rented mainframe processing still proved to be beneficial for quite some time.

It was in the late 1990s that companies such as Sun Microsystems decided to introduce the concept called ‘the network is the computer’. The idea that Oracle founder Larry Ellison stated was as follows ‘all these ideas were indeed profound but they never failed with consumers, who were looking for more complete personal computer solutions specializing with, some storage capacity availabilities’. As of now, the personal computer is not a dummy terminal. In reality, the rise of the Internet, in the mid 1990s, changed the usage of computers and information distribution. With the idea of utility computing, Amazon began to establish and control server farms, to offer apps to their buyers.

Essentially, Amazon is far from being a company that specializes in retail. Its assistance to cloud computing will be discussed shortly in a profile of companies using cloud technology, but it is clear to any IT expert that Amazon is the first company that built on the basics of technical innovation, particularly after the dot-com bubble time.

1.3 IMPORTANCE OF CLOUD COMPUTING IN THE CURRENT ERA

1.3.1 Example

- **21st Feb 2011, Sometime in ICC Cricket World Cup, India**

  Furious cricket fans slammed organizers of the World Cup on Monday as the official ticketing website crashed amid a scramble for 1,000 tickets available for the final. (Source: Times of India [Magazine])

The manager of ICC posted a message in his Facebook fan page:

We are facing absolutely unprecedented amounts of traffic from all over the world with hundreds of millions of people hitting at once. Some of you may have trouble accessing the site. It seems that cricket fever has surpassed all anticipations and expectations. Please bear with us as our global network team works on bringing you the tickets you all have been waiting for. (*Source: Kyazoonga FB page)*

- **Each day between 8:00 AM and 9:00 AM, Since when? Till Date, Online Ticket Booking: IRCTC, India**

  The bookings and enquiry requests are 6–7 times higher during the peak hours than the rest of the day. So while the existing infrastructure is well equipped to handle the daylong traffic, it is the peak hour traffic that clogs servers. (Source: http://www.techno-pulse.com/2011/01/what-irctc-learn-redbus-cloud-iaas.html)

  —What IRCTC can study from cloud?

- **In May 2009, India**

  The world's largest democracy, 1 billion+ people, goes for its general election. The Election Commission unveiled a new website for publishing results in real time. It showed off preparations, which indicated it was well arranged to handle 80.64 billion hits in eight hours (2,800 hits/second), clearly a decent number by any standard. Media reported on the election result day: 300,000 hits/second make Election Commission website crash. (Source: Times of India [Magazine])

Similarly, server crashes were reported across India when the online CAT examination was conducted by the esteemed IIMs (Indian Institute of Management) in 2009; although they were smartly attributed to a virus and not to the number of hits. It points to the fact that the cloud service without security aspect could also be powerless.

1.3.2 Reason for Server Crashes/Failures

The above said examples of server crashes are very few compared to the approximate of hundreds of incidents occurring all over the place in the world on a regular basis.

The circumstances can only get worst. At present, only 25% of the world population has Internet access. Compared to Television and other mass media, it is still adjudged as the best medium of communication. At present, India and China have roughly 15% or less Internet penetration. Even a reasonable increase in Internet access and usage, say 50%, will add more than a billion Internet users. Going by information backed up by approximately double digit GDP growth, they are only going to add to the number.

1.3.3 Solution to Prevent Server Crashes/Failures

The majority of us will answer as follows:

- Add additional servers to balance the load.

In view of these facts, it will help us to make a sensible guess.

- **Facebook** has 30,000 servers and is increasing its capacity on a daily basis.
- An **unofficial** estimate predicts Google servers to be unbelievable in numbers; with **1 million** servers across the world wide at present.

The above discussed websites are not as big as Facebook or Google but their spike in traffic on that particular day may have trampled these giants. Given these kind of information, in order to acquire the essential number of servers, the organizations/entities concerned will pay enough money to make them eligible to file insolvency protection. If the organizations are economically sound to add servers, before doing so, they have to check the following:

- The Red Cross may get that kind of traffic once in a decade.
- The website of the Indian Election Commission attracts visitors during elections, i.e., preferably once in 5 years.

The above description clearly shows the following trend:

- The majorities of the traffic spikes are predictable and can be easily planned. Even the Red Cross traffic was expected, but there was no enough time to respond and plan to handle the crisis.

1.3.4 The Scenario

An organization will face heavy traffic on some particular day or days. Thus, number of servers to face that kind of traffic needs to be enhanced, may be 1,000 times more than what they have in normal days. However, it is not wise to purchase extra servers and place it as standby to be used only on those heavy traffic days. This would be a sheer waste of valuable resources. There are no forecasters who can predict when the business will speed up. The reverse can also happen; a recession can hit and the infrastructure may have to be reduced significantly.

Technically, the competition and economics have led to a scenario where a business needs the following, when it comes to computing as a whole.

Dynamism

It is quite simple, similar to how you use your mobile phone connection. If you want to talk more, you will buy a top-up card. If you are a post-paid customer, you will change your plan to meet your requirement. Your need is dynamism. Therefore, your infrastructure should support your changing needs.

Abstraction

From an end user's point of view, they do not have to worry for the OS, the plug-ins, web security or the software platform. Everything is its place. The business/consumer should focus his attention more on its core competency rather than distressing himself over secondary resources such as the OS or the software.

Resource Sharing

The whole architecture should be implemented such that it provides you the flexible environment where it is possible to share applications as well as other network resources. This will provide you with need-based elastic architecture, where the resources will *grow* without any major configuration modifications.

1.3.5 The Solution

There is one model of computing which satisfies the three requirements mentioned above in business and is becoming the technology trend of the future, it is known as c*loud computing*. Have you ever used cloud computing? Most of you will answer in the negative. May be you have been hearing about the buzz created by cloud computing for the last few years, but you don't think it has anything to do with you. But if you are reading this page, we can assume that you are web savvy enough to have an e-mail account. That's it. You are already on the cloud. An e-mail like Gmail, Yahoo and Hotmail are cloud-based examples of **SaaS** (Software as a Service). SaaS is a piece of cloud computing. Cloud is an acronym of the phrase: Common, Location-independent, Online Utility that is available on Demand.

IT professionals recognized that there are eight basic components that are very important in enabling the cloud computing concept (Figure 1.1) for the cloud to work in the public or private sector, they are as follows:

1. *World wide connectivity*: users should have near-ubiquitous access to the Internet.
2. *Open access*: Users should have fair, open-minded access to the Internet.
3. *Reliability*: The cloud's performance should equal to or better than recent standalone systems.
4. *Interoperability and user choice*: Users must be able to progress among different clouds.
5. *Security*: It should ensure that data of users are safe.

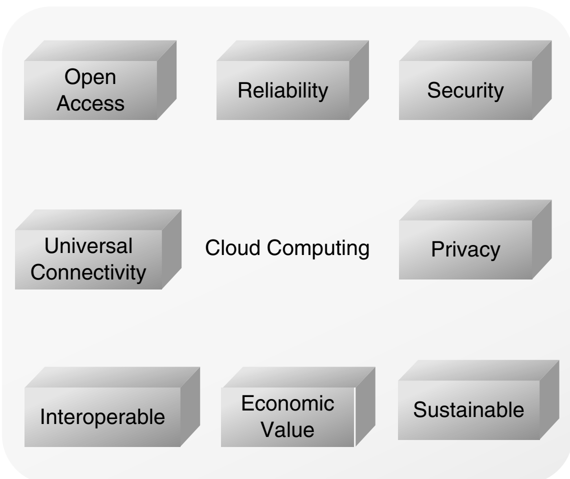


Figure 1.1 Basic Components of Cloud Computing

6. *Privacy*: Users' rights must be clearly defined and allow access based on rights.
7. *Economic value*: The cloud must provide substantial savings and benefits.
8. *Sustainability*: The cloud must increase power effectiveness and reduce environmental impact.

1.4 CHARACTERISTICS OF CLOUD COMPUTING

Server is the most important element in cloud computing. It plays a vital role since it is the brain behind the entire processing environment. In cloud computing, server environment need not be a high-end hardware. Rather, the key advantage of this technology is the ability of an organization to tie together the power of inexpensive hardware on a larger scale in contrast to using lesser amount of servers, high in quality.

It is helpful for a global organization to use cloud computing capabilities since it allows all of their customers to access the data from any computer when required, which prevents data loss or bad management of digital files. This makes an organization portable with improved data security.

It also can assist to break down the command structure in an organization into many systems located across the world, which is a managerial style that is gaining popularity as businesses are trying to grow internationally and have more flexibility at the same time.

The fact that all the data for a user is available in one physical location allows its hardware and software to be organized more effectively by a respective on-location team, who are responsible for updating of the hardware and software.

In fact, this process is perfect and not seeks any help to retain its features rather than the small difference in power usages. Only portions of processing power are down and an average user would have no idea about what was not going on, nor would they care. Along those lines, the managed care of the hardware is something that companies are looking for in a cloud computing solution. Because it is simply cheaper for them to have someone else managing the technology part so that they can focus on their core business.

Large-scale companies are always trying to economize their system. That is, they are convinced that someone who hosts a bigger server is going to do it faster with better efficiency than themselves. There are many activities that are no longer core of the business; while outsourcing the processing work to a group of servers responsibilities such as providing space for equipment, costs associated with hiring technicians and providing them with benefits are taken-care of. Generally a company may consider this an unnecessary overhead that can be trimmed.

The more the numbers of servers, higher will be the power consumption. Usually servers are placed near power plants or hydroelectric power plants. Apart from the large space occupation and energy consumption, they need large cooling towers to keep the machines operating at the right temperature. They also need to have solid base to access the Internet, so that information can flow freely connecting all the users globally. Data centre managers are increasingly concerned about power efficiency techniques within the server environment. One of their major administrative issues is to make sure that costs remain reasonable, particularly in the recent years on energy security. This has led to ineffectiveness of data centre environments to resort to air conditioning and energy consumption.

Following are the five characteristics of cloud computing.

Dynamic Computing Infrastructure

Dynamic infrastructure environment is needed for cloud computing. The basis of a dynamic infrastructure is standardized, scalable and secure physical infrastructure. There should be various redundancies to ensure high levels of availability, but mostly it must be easy to enlarge as the demand increases, without requiring architecture restructure. Next, it must be virtualized.

Virtualized environment uses server virtualization to run the services, these services needs to be easily provisioned and de-provisioned via software automation. These service workloads have to be switched over from one physical server to another as capacity demands increase or decrease. Finally, this infrastructure should be utilized by an external or an internal provider. The infrastructure must provide business value beyond the investment.

A dynamic computing infrastructure is complex in supporting the flexible nature of service provisioning and de-provisioning as requested by a client, still maintaining high levels of reliability and security.

IT Service-centric Approach

Cloud computing is service-centric business. This is in stark difference to more conventional system- or server-centric models. In the majority cases, users of the cloud usually want to run some business service or application for an exact timely purpose and they don't want to get bogged down in the system and network administration of the environment. They would prefer to rapidly and easily access a devoted application or service. By abstracting away the server-centric outlook of the infrastructure, users can effortlessly get access to pre-defined computing environments conceived especially around their service.

An IT service-centric advance makes customer acceptance and enterprise agility which is less difficult and speedier. A customer can perform an administrative work, the more expedient, the enterprise progresses, lessening are the charges or propelling is the revenue.

Self-service Based Usage Model

Interaction with the cloud needs some level of user self-service. Best of breed self-service creates the chance to the users to upload, build, deploy, schedule, manage and report on their business services on-demand basis. Self-service cloud must provide easy-to-use, intuitive user interfaces that help the users to effectively manage the service-delivery life cycle. The superiority of self-service from the users' purpose of business is a stage of empowerment and yields valued enterprise agility. One advantage often overlooked from the service provider's point of view is that the more self-service that can be delegated to the users, the least managerial participation is needed. This saves time and money and allows administrative staff to concentrate on strategic and high-valued responsibilities.

Minimally or Self-managed Platform

Self-managed platform is very essential for a service provider in cloud environment. Best-of-breed clouds make self-management through software automation, leveraging the following capabilities:

- A provisioning engine where the services are deployed should have high levels of reuse.
- Mechanisms for scheduling the resources and reserving resource capacity.

- Capabilities for configuring, organizing and reporting to make sure resources are allocated and reallocated to several groups of users.
- Tools must be available for controlling access to resources and policies for resources to be utilized or operations to be performed.

All of these competencies sanction finance agility while concurrently enacting valued and necessary administrative power. This balance of power and delegation maintains security and uptime, reduces the level of administrative efforts and maintains working expenses low, and releases resources to focus on higher-value projects.

Consumption-based Billing

At last, cloud computing is usage based. Users have to compensate for only for the usage and consequently they are assured or given an assertion supported on usage basis. Cloud computing platforms must deliver mechanisms to catch information about the usage that enables that charge is calculated and that should be integrated into the billing systems.

From a user's point of view, this scenario helps them in keeping their costs down. From a provider's perspective, it allows them to monitor usage for charge calculation and billing purposes.

In summary, all of these defining characteristics are necessary in producing an enterprise private cloud capable of achieving compelling business value, which includes savings on capital equipment and operating costs, reduced support costs and significantly increased business agility. All of these enable corporations to improve their profit margins and competitiveness in the markets they serve.

1.5 WHAT CLOUD COMPUTING REALLY IS?

In simple terms, cloud computing can be broken down to a browser-based application that is hosted on a remote server. To an average user, that is all he or she really needs to know about cloud computing, however, there is a lot more to it than just that. What cloud computing really represents is huge: it facilitates small organizations to compete with much larger ones, it helps in saving lot of money and to utilize energy efficiency in operations.

Cloud computing as it relates to Internet technology is all around us for example, accessing e-mail and searching for information in the *world wide web*. In these examples, the power of processing technology is used, which exists in distant locations and are not known to the users. Actually, network connection these days is so important to perform basic applications. As an example, the thesaurus operation in Microsoft Word needs a network connection to look up another word.

In effect, the cloud provides users of this network with an addition of their own machine. As long as a user is connected to the Internet, the capabilities of cloud computing comes into play and many advantages can be achieved. One example is processing power.

One of the biggest benefits would be storage. Large number of servers possesses massive amounts of storage. An example of this would be free e-mail services that are available on the web. Most often e-mail services offer a large amount of storage to their users because it is inexpensive for them to do so by using the unoccupied space that is in the cloud. This is a characteristic that is to be noted, because the prevalence of reduced storage on a group of servers will benefit users immensely in the future. One major benefit of this is data loss prevention. The less data loss in the transactions is the main feature of cloud computing that attracts the potential clients.

For the past few years, word spread that big companies like certain banks lost significant customer information. If this data had been stored in a cloud environment, theoretically the loss of data would be much lesser.

1.5.1 What Cloud Computing Really Isn't?

- Not a data centre, although they can certainly play a part. Users can deploy an environment that supports cloud computing in a data centre, but cloud computing is not about data centres.
- The cloud computing is an unique technique that incorporates even the basic client server computing concepts. With cloud computing, we have a generalized resource to which one can initiate the work and that could form part of a client/server application. The cloud computing has more autonomy.
- Not a grid computing, but again users can avail cloud computing environments to support grid computing.
- Not a comeback to mainframes and mini systems or centralized computing, cloud computing generally involves multiple computers rather than one and reduces computing power according to user needs.

SUMMARY

- ❖ Cloud computing is the use of computing assets (hardware and software) that are consigned as a service over a mesh (i.e., Internet).
- ❖ Cloud computing is a technology that values the Internet and isolated servers to sustain data and applications.
- ❖ Cloud computing permits buyers and enterprises to use applications without setting up and accessing their personal documents at any computer with Internet access.
- ❖ Cloud computing technology permits for much more effective computing by centralizing data storage, processing and bandwidth.
- ❖ Consumers assert that cloud computing permits businesses to bypass upfront infrastructure charges, and aims on tasks that differentiate their enterprises rather than the infrastructure.
- ❖ Cloud computing relies on distributing of assets to accomplish coherence and finances of scale alike to a utility (i.e., electrical power grid) over a network.
- ❖ The base of cloud computing is a broader notion of converged infrastructure and distributed services.

- Cloud computing is the result of evolution and adoption of surviving technologies and paradigms.
- The aim of cloud computing is to permit users to take advantage from all of these technologies, without the requirement of in-depth knowledge or know-how with each one of them.
- The major support technologies for cloud computing are virtualization and autonomic computing.
- Cloud computing is having more advantage over the latest distributed computing techniques in terms of QoS and Reliability.
- Tim Berners–Lee suggested the concept of distributing information known on multiple servers to be made accessible to the world via client computers. Thus, *world wide web* was born.
- Enterprise computing proceeds from a server-centric to an application-centric operations model.
- The cloud will assist IT rapidly to establish new capabilities—applications, services, accessibility—that will endow enterprises to function more effectively and efficiently.
- The salient characteristics of cloud computing defined by the National Institute of Standards and Terminology (NIST) are (i) on-demand self-service, (ii) broad network access, (iii) resource pooling, (iv) rapid elasticity and (v) measured service.
- Cloud computing permits enterprises to boost IT capability (or add capabilities) on the go and in less time without buying new infrastructure, staff or programs, and as a pay-per-use service.
- The renowned cloud deliver models are (i) Cloud Software as a Service (SaaS), (ii) Cloud Platform as a Service (PaaS) and (iii) Cloud Infrastructure as a Service (IaaS).
- The well-known cloud deployment models are (i) private cloud, (ii) community cloud, (iii) public cloud and (iv) hybrid cloud.
- Cloud computing is often far more protected than customary computing, because organizations like Google and Amazon have high-skilled employees who are updated in cyber security.
- Cloud computing actually is not (i) a data centre, (ii) a client/server computing, (iii) grid computing or (iv) a centralized computing system.

KEY TERMS

- Distributed computing is a system comprising of multiple programs that are on multiple computers, but run as a single system.
- Grid computing is a pattern of networking. Unlike startup network systems that aim on connection among devices, grid computing harnesses unused resources of all computers in a network for solving problems too intensive for any standalone machine.

- Cloud computing is a technology of computing which is being adapted fast by IT industry and is moving towards becoming the trend of tomorrow's technology.
- Autonomic computing is a model where the systems can self-heal, self-configure, self-protect and self-manage.
- Virtualization entails to create a virtual type of a device or asset, for example, a server, storage device, network or even an operating system where the structure splits up the asset into one or more execution environments.

REVIEW QUESTIONS

- What is a cloud?
- Define cloud computing.
- Give your opinion on adoption of cloud by operators around the world.
- Explain the benefits of cloud computing.
- Cloud computing can save money. Explain.
- Describe cloud computing as concisely and simply as possible in layman's language.
- Comment on the growth of online data.
- Why are professional clouds required in cloud computing?
- Explain the role of performance cloud in cloud computing.
- Name the three basic clouds in cloud computing.
- Why is cloud necessary?
- State the importance of cloud computing in IT sector.
- Explain the benefits of cloud computing.
- What are the uses of cloud computing?
- List the characteristics of cloud computing.

CHAPTER 2

Move to Cloud Computing

2.1 PROS AND CONS OF CLOUD COMPUTING

In the previous chapter, we discussed some basics of cloud computing, its history, characteristics, what is cloud computing all about and what isn't cloud computing. Cloud computing can enable constant flow of information between service providers and the end users. Other remote systems would struggle with such a task because they are based on database that is largely outdated. The ease with which information can be accessed gives confidence to the employees of the outsourcing organization, so that they can continue with their usual routine despite the introduction of cloud computing. As cloud computing relies on satellite facilities for the administration of information technology, the need for a physical address is transferred to another company. This means that the location manager has more elasticity in terms of the distribution of office space. Cloud computing is defined as the business of sharing some software from the 'cloud'.

Peter Coffee from *Salesforce.com*, says that cloud computing must necessarily involve 'multi-tenancy' (like a shared apartment block), be 'pay as you go' (like rent) and be transparent (services clearly priced by features). Microsoft is putting its old office software and file sharing application, SharePoint, on the cloud alongside developer tools in its Azure platform, which gives old customers the comfort of having their own stacks.

More and more businesses are finding ways to reduce capital expenditures and operating costs through cloud computing. As a result, they are moving business functions from onsite server to the Web. Cloud computing adopts Internet-based services to support business processes. Before making the decision to move your business in 'the cloud', make sure you know what you are getting into.

2.1.1 Advantages of Cloud Computing in IT Field

The interconnectivity of computer servers is the main advantages of cloud computing. This characteristic can allow an organization to carry out a variety of tasks in different locations.

Therefore, cloud computing can facilitate proper management of information technology resources within the organization. This advantage is also crucial to the multitasking demands that are part of modern business. In order to deal with a competitive market, there is an increase in the diversification of the activities that different companies undertake. This can place enormous pressure on the information systems. Once you install a good cloud computing system, then you will be in a position to carry out all your functions in a concurrent context. In fact, it is far easier to supervise these simultaneous activities under the cloud computing system because you can install a central command unit.

The second characteristic of the cloud computing innovation is that it allows outsourcing of a key function of the company's work portfolio. Just like the call centres that have decided to relocate to cheaper environments, implementing a cloud computing project can significantly reduce your IT budget. It is on the costlier side in terms of staff supervision, but overall you will be able to save in the long run.

Maintaining an in-house information technology team will require its own budgetary resources. At the same time, you will be facing market pressures to reduce the prices that your customers pay. If you are to reconcile these two pressures, then you have to rely on tools such as cloud computing. It enables you to continue reaping the benefits from a first class network management service, yet avoiding the obvious challenges that occur, when you are managing that system yourself. Other problems such as supervision can be handled through regular

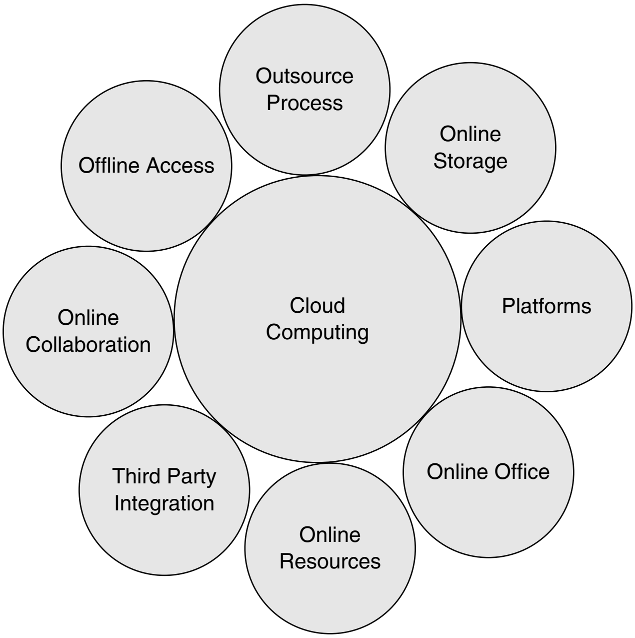


Figure 2.1 Advantages of Cloud Computing

contractual arrangements so that they do not take values from the advantages that have been accrued. Organizations that are sensitive to their information technology costs have no alternative, but to consider cloud computing mechanisms.

Figure 2.1 shows the merits of cloud computing and states the importance of migrating to cloud computing, as it supports/provides the following benefits:

- Online storage
- Accessible in different platforms
- Using online resources
- Online collaboration and
- Easy outsourcing processes

Initially, it is important to recognize that cloud computing is expected to bring in a higher level of automation than the ordinary systems of communication between the various sections of an organization. This means that, if you find that a lot of your time is spent doing manual trouble-shooting or dealing with configuration, then the deal is just not worth it. There are some organizations that have outsourced their information technology under the cloud computing scheme but have ended up with more work than ever before. Clearly, this indicates that they made the wrong decision in choosing to go with cloud computing.

The second element that you should look out for when you implement a cloud computing initiative is that there should be a level of virtualization of the processes. It means that the activities should be online. If you find yourself in the position, whereby you have to carry out the activities in the local vicinity, then you have to recognize that your cloud computing initiative has failed.

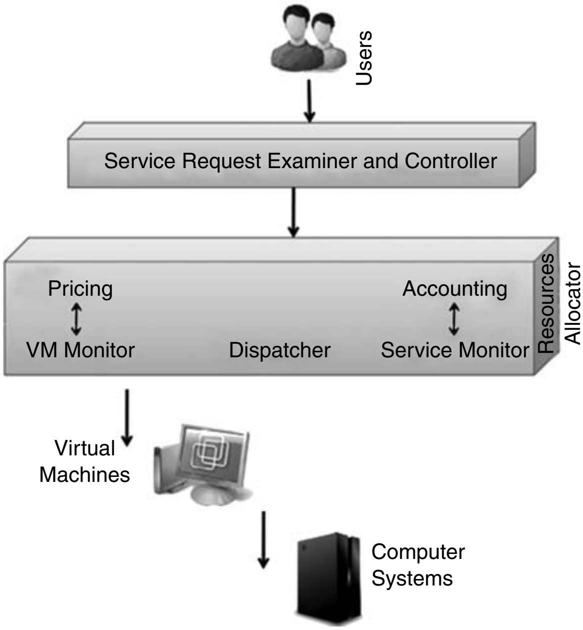


Figure 2.2 Key Elements of Cloud Computing

The company to which you outsource, the functionality must be able to deliver a seamless service via the Internet or else you have to review the contract. If they do not have the capacity to do this effectively, you might bring forward a suggestion for sharing costs and profits. Make sure that at the very beginning of the relationship, these issues are tested and clarified.

A good cloud computing package must only charge you for the services that you use. This is a fundamental advantage of cloud computing and if the other party cannot deliver then you really need to consider cancelling the contract. You might find that some providers want you to have a standing charge that covers their fixed costs.

This might be acceptable if they are providing a particularly excellent service but you must insist that, there is also an element of variability in the prices depending on how much you engage the service. If it appears that on a long-term basis, you will not be able to support the contract due to small usage and then you can consider down-scaling the operation.

Figure 2.2 shows some key elements of cloud computing, without which computing cannot be established. Elements are divided into four layers. Layer 1 contains the physical machines, where the required software and operating systems are installed. Layer 2 forms virtual machines. Layer 3 explains the service level agreements (SLA) and resource allocator to the virtual machines (VM). This layer also accounts for the job, prices it and dispatches the jobs to the VM. Layer 4 contains the users or brokers using the computing.

2.1.2 The Fixed Cost Advantage

Software provided online is upgraded and maintained by the provider, so that small business owner do not have to purchase the newest version of software program or download fixes and patches.

No need to buy a program, but entering into a monthly or annual contract is also attractive, as is the reality that several applications are offered for free.

Though the issue of security cuts both ways, which has been contradictory with the results. Individually, many small firms do not have the budget to spend on adequate on-site security and backup systems are subjecting their business data vulnerable to stealing, loss, hackers, power outages and natural disasters.

Chad Barr, president of CB Software Systems says, ‘Cloud is a very safe way of operating today and it’s going to get better and better’. On the other hand, the idea that extremely sensitive data, possibly including trade secrets or confidential legal documents, is not protected up on company premises but is side-lined anywhere in a cloud disconcerts to numerous business owners.

2.1.3 Keeping Data Safe

It is possible for anonymous computer hackers to gain access to the business information in the cloud. A discontented former employee known to the company may be able to guess passwords or answer your security questions and get into the accounts to do harm or worse. There have been a couple of such high-profiled incidents revealed in recent times, somewhere online services mislaid and secure data went offline for some period of time, during which their customers’ accounts were inaccessible. The key to using cloud hosting safely is finding a conscientious provider that provides back-up programs so your online data can also be stored domestically.

2.1.4 The Possible Disadvantages of Cloud Computing

The main trouble with cloud computing are interrelated to the loss of control to another party. This can lead to management problems and inconsistency within the information technology departments. Anyone can put up new systems for dealing with this divergence and will have to construct their communication systems as the basis as there is another company involved in their business.

Occasionally cloud computing will have so many teething problems that it might take years before you settle into an conformity with your supplier, whereby conflicts can be determined before they spiral down.

Industries that transact sensitive data will be anxious about security when it comes to cloud computing. The fact that the server is situated in a remote area means, that you have to entrust the security arrangements to somebody else. Now imagine, that functions of a passport office have to be located in a foreign country. Suppose war breaks out between the two countries. The connectivity between the servers will be stopped. These are some of the serious challenges to cloud computing.

2.1.5 Advantages of Cloud Computing

Cost reduction: Cloud computing lessens paperwork, enterprise deal charges and minimizes the financial endeavour in hardware. Moving your enterprise to ‘the cloud’ in addition lessens the want for an employee.

Scalability: *C*loud computing services sanction enterprises to only compensate for what they use like electrical power and water. As the business grows, user can put up by adding more server space.

Levels the playing field: Sharing IT resources with other companies reduces the cost of licensing software and retail servers.

Easier collaboration: *C*loud computing services allow to access any time from any computer, it is easy to work together with employees in remote locations.

Affordable: With cloud computing, it is possible to reduce operational costs and investment expenditures on hardware, software licenses and implementation services.

Scalable and flexible: Cloud computing can sanction to maximize supplies for better competence and lessen unused capacity. It can also scale up or downward to meet the varying demands of the business.

Efficiency: Cloud computing renders the gain of divided hardware, automated and recognizable technologies. The employees have the right to use the database from everywhere by using any PC, mobile device or browser. It also reduces overall energy usage and physical presence.

2.1.6 Disadvantages of Cloud Computing

Security concerns: The main concern with cloud computing is having your data easily reached via the web. Although security is stretched and is getting even more advanced as technology providers perfect the framework, it is still an anxiety.

Risk of losing internet connection: If there is no Internet connection, the database accessing is very difficult.

Limited resources for customizations: One can require in-depth customizations and integration with his current systems for his daily business functions. Cloud computing may not be accommodating to his needs.

Availability: If it happens, the cloud service goes down unexpectedly, leaving you without important information for hours or more? Then how is it possible to get reliability in retrieval of data is yet another challenge.

Data mobility and ownership: In cloud environment, it is possible get back the data safely even when the cloud service is stopped. How can you be assured that the service provider will wipe out your data once you have cancelled the service?

Privacy: How much data the cloud service companies are collecting and how are they using the information?

2.2 NATURE OF THE CLOUD

During earlier days, numerous shifts in business have been described and puffed up for better or for worse as 'disruptive'. Playing off was the term coined by author and Harvard Business School Professor Clayton Christensen in 1995; true disruption occurs when an innovation in technology or business model surprisingly displaces an established one. The growth of cloud computing could drastically change the way companies manage their technology assets and computing needs. This is why cloud computing is a striking option for enterprises and why the concept has built up, so much momentum in modern years.

Cloud computing reached widely because, its not a hype and also it adopts existing computing technologies. However, that is exactly what makes cloud computing work as not a disruptive technology per se but a disruptive IT delivery model which leverages key technology ideas (like grid computing, utility computing and Software as a Service) to deliver IT in a much more efficient model. Because of this, cloud computing has undeniable characteristics of a truly disruptive innovation.

Cloud computing curves the economics of IT business onto its head. Delivery of information technology services (including infrastructure, platform and applications) from the cloud has both capital expense advantages and operation disbursement advantages. The capability to pool resources virtualizes them and then dynamically provision from the resource pool yields a much higher consumption rate and thus better economics sometimes from 15% to 90% consumption, according to IBM research. The cloud aspects of standardization and automation greatly reduce the overhead required to deliver IT services. By focusing on a few common IT configurations (like software stacks, storage allocations and application options) and then automating the provisioning of these configurations, the amount of labour required to deliver that service is greatly reduced.

The cloud model can yield improved results to the consumer of an IT service. For example, at IBM, a compute cloud was built for researchers to develop and test applications. Cloud computing provides enterprises with two-fold solutions:

1. *Organizational perspective*, the cloud give services for client and enterprise needs in a simplified way, brought ahead of scale and high worth of service that drives the capability for expansion and innovation.
2. *User's perspective*, it enables computing services in a simpler, more responsive model without complete knowledge of the underlying technology. It is an effective service acquisition and delivery model for IT resources if properly implemented within an all-inclusive technology strategy. Cloud computing can help to improve overall business performance while controlling the costs of distributing IT resources to the organization.

2.2.1 Leveraging the Internet to Change the World

Considering the cloud computing as a disruptive force is the fact that it is transforming the way individual's harness, access and utilize technology. Services in Cloud computing are servered via Internet. Since the society knows the power of the Internet. It makes the people to realize the power of cloud computing. With an increase in use of cloud computing, this goal becomes more attainable as a result of innovative cloud projects and applications. Examples can be found across multiple industries, especially in higher education.

Educators and technological experts are currently embarking on an initiative to provide every student from the state, i.e. from kindergarten through college, with access to advanced educational resources. This is possible by VCL (virtual computing lab), which is developed using cloud-based technology. Through the VCL, students in schools, along colleges within the university system and other institutions within a state, will be able to access helpful learning content, select software applications besides other computing and storage resources. This initiative is designed to apply cloud computing technology to the broader objective of democratizing education for students in and around the world as similar project's modelling which move is emerging. At a more basic level of responding to day-to-day business demands, cloud computing is delivering innovative solutions to organizations in various fields, from healthcare to telecommunications to vendors and others, spanning enterprises of all sizes. Those taking advantage of cloud computing identify the substantial benefits of this unique technological approach. They are not standing stroke, while the world around them changes. They are obviously taking on the cloud computing services and ready to adopt it.

2.3 TECHNOLOGIES IN CLOUD COMPUTING

Now-a-days, the news about cloud computing is that the cost of the hardware is very high. International Data Corporation has predicted that the revenue is estimated to grow from $582 million, which was in 2009, to about $718 million in 2014. In addition, for the private cloud computing this revenue will spurt up from $2.6 billion to nearly about $5.7 during the same period. This increase in the income clearly indicates that the cloud computing, now will have to splurge much more funds on the server hardware.

Cloud computing is based on the advance distributed technologies. They may, although be a bit related to each other, but their functions are different from each other. The past few years, the concept of cloud computing is the only technology has evolved in the field of computer science. The name of cloud computing is being derived from the subsistence of data and applications on a 'cloud' of web servers. Cloud computing can be defined as getting the work complete by sharing and using resources and applications of a network environment without apprehending about the owner and manager of these resources and applications. Now with the help of this technology, resource and data required to do a job is no longer restricted by one's personal computer. The resources which are hosted elsewhere enable it to be accessible at any time and at any location and this benefit lift the bar of time and place on the work to be completed. Hence it helps the user to work on it anytime and from anywhere.

2.3.1 Other Cloud-related Technologies

Grid computing: It defined as an extension of distributed and parallel computing in which a super and virtual computer consists of a number of networked and loosely coupled computers that act together to perform enormous tasks.

Utility computing: When the resources used in computing process are packaged as a metered service similar to electricity—a traditional public utility.

Autonomic computing: It defines that systems are capable of self-management.

2.3.2 Working of Cloud

Cloud computing uses information technology as a service over the network. Cloud computing consists of Infrastructure as a service (IaaS), Platform as a service (PaaS), Hardware as a Service (HaaS) and Software as a service (SaaS). Cloud computing finally enables the user to rent a virtual server loaded with software and turn it on and off according to the need from the user and it can furthermore be cloned to meet an immediate workload demand. Cloud computing also stores a large amount of data that can be accessed by the certified users with the authorized applications. A cloud is used as a storage medium which handles applications, business and personal data.

Cloud computing has an important feature of a workload swing, so that the personal computers are no more required to run these applications. There is a network of computers that handles the cloud itself. It considerably declines the use of hardware and programs on the front of client as all the processing and management of data are taken care by the cloud. All the applications are being run by the interface software that is the only thing that the user's computer knows. The latest interface software used in today's world is Internet Explorer 9, apart from the previous versions such as Mozilla Firefox and Internet Explorer 8.

E-mail account holders such as Gmail, Yahoo mail and Hotmail will know, what cloud computing is?. In the latest e-mail working system very well used cloud computing techniques, due to this salient feature the service's computer keeps all the software and storage and the local computer is used to just display the information.

2.3.3 Key Characteristic of Cloud and its Role

As of now, there is no specific definition for cloud computing and it will take some time to develop its other characteristics and a standard definition based on the ongoing practices in this field. The two keys that enable technologies based upon the practices in the areas of service provisioning and solution design would play a very significant role in the revolutionary phase of cloud computing, they are: (i) virtualization and (ii) SOA.

Virtualization Technique

Virtualization works on the management of how the likeness of the OS, middleware and programs procreated and assigned to a personal system or part of the server stack away.

These technologies in addition helps in reusing certificates of OS, middleware or programs requests after the customer distributes their service from the cloud computing platform.

Service-oriented Architecture (SOA)

Cloud computing is basically a collection of services, which communicate with each other. Figure 2.3 displays the basic architecture of SOA and its components such as: (i) service providers, (ii) service requestor and (iii) contract details or in other words service level agreements. Normally services are used to pass the data and if some services integrated in a way to execute some specific activities. As opposed to the past decades, most of the applications are standalone and are designed for a single use only now the system is growing towards service orientation. Several big companies such as Google, Microsoft, Sun and even Amazon have the competence of providing services instead of directly promoting the software to the user. Those companies that desire cost cuts through choosing to rent rather than purchasing most definitely need these characteristics. Anyhow issues like security, cost, availability and integration of applications will play a vital role in adopting these architectures.

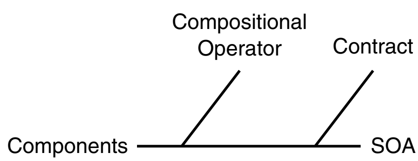


Figure 2.3 Service-oriented Architecture

2.4 MIGRATING INTO THE CLOUD

2.4.1 Cloud Computing Migration Issues: What You Need to Know?

Among the new technologies introduced in the IT market, the cloud computing buzz is an extended level of previous 'year-of' technologies such as application service providers, software as a service (SaaS) and utility computing. In this case, the hype may be true. As of the current survey indicates that the cloud CPU will be used by many industrial giants in near future. Our mission as an IT engineer is to understand:

- What is a cloud and what are the benefits it offers to clients?
- What challenges and obstacles clients might have to overcome to tap into the cloud?
- How their management of IT must change to secure and control their new cloud-driven infrastructure?

When you migrate from a client to the cloud, the issues you will face fall into the following overall categories.

Security

Security is an obvious threshold question, if the cloud is not secure, enterprises will not consider migrating to it fearing their sensitive data will be tampered. The external SAAS providers can also give satisfaction to the customers in security level, example the sales Force.com is rendering an excellent feature in Cloud security. It is possible because the public clouds are multi-tenant, user application could be affected by the vulnerabilities or defects of other neighbours' code. Users must ensure that they understand the underlying infrastructure of the cloud to which they migrate from their clients and must also advise clients to include security in their cloud SLAs and terms of service.

Vendor Management

As soon as you realize that the cloud is not in your IT platform and it is in the hands of an outside firm, how do you guarantee that their technical or business problems won't become yours? When the user is going to migrate with the outsource providers, then the service level agreements and its terms are thoroughly checked. While the whole idea behind cloud computing is to propose a standardized, multi-tenant infrastructure, cloud vendors may not offer the same level of custom SLAs as IT managers. Amazon's AWS Management Console, which is a monitoring interface, offers robust features and helpful to IT Managers.

Subsequently, additional cloud vendors and cloud management start-up firms are springing up to address cloud needs. At rest, we need to assist clients, so that the cloud services they dial up are convenient and can be monitored sufficiently to ensure that they will not have interruptions and performance issues.

Technical Integration

The technical issues are also complex. Now most firms that migrate to the cloud environment in a hybrid model, are keeping certain key elements of their infrastructure in-house and under their direct control, while outsourcing less susceptible or core components. Integrating internal and external infrastructures can be a technical concern. A VM template should incorporate infrastructure, application and security to fullfill the need of the user. Like Force.com and Salesforce.com's cloud offering, is leading the way by integration as a service on top of its cloud contributions.

Process and Culture

There is also the ever-present political and cultural landmine, when anyone with a credit card can surf the web site of a public cloud vendor and dial up teraflops of cloud capacity, how does IT maintain control of its application architecture?

We have seen that cloud services are offered with a credit card. When IT power becomes economical and easily accessed, it's control over its domestic customers can be liquefied.

The Business View

Enterprises around the world have invested trillions of dollars in technology, hoping to improve their execution potential, drive productivity, improve profitability and attain continued competitive advantage. Some have been more successful than others in getting the predictable returns from their technology investments but few, if any, have been able to recognize the full potential of their investments. In reality, many enterprise's IT organizations have developed in complexity as well as in size and are proving to become quite uncontrollable—a drain on their business margin structures and some are even viewed as inhibitors for sustaining the ever-changing needs of business.

2.4.2 Migrating to the Cloud: Deployment Considerations

The cloud migration has started. For many, the superiority of cloud computing outweigh the risks. Cloud computing straightaway addresses a massive measure of challenges. How many of the following complaints have you heard about your company?

- The IT environment is too large and complex.
- Sluggishness of the existing systems that do not meet user expectations.
- Inability to consistently and effectively scale to support rapid growing requirements.
- Composite rules to obtain performance metrics.
- Widening gap between available functionality and tangible features used.
- We can't find the aptitude to support new technology.
- High operating costs, high investment costs.

The cloud does suggest solutions to the glitches listed above, its actual efficiency for enterprises lie in, how they address the following key questions.

- What are the underlying drivers for patter into the cloud? Is it for new functionality/application or moving from an existing result? How clearly are these distinct and communicated to the project team?
- What business needs and solution do cloud serve?

- Will the cloud-based solution work in segregation or work with other systems?
- Is the planned solution part of a recognized cloud platform?
- How many customers will access the cloud? What are the training and support levels necessary?
- What is the total lifecycle cost of the solution and reason?
- Does the 'pay-per-use' model improve our cash flow?

The Process: Key Stages in Migrating to the Cloud

While implementing a cloud, migration expected at replacing on a premise major business application may look like, at times, a simple straightforward implementation. It is burdened with pit falls, which may undermine the true value to the investment, and in fact put enterprises in bad situation than before. Understanding and planning for these pitfalls is significant for a successful deployment of the solution. A well-planned and executed cloud computing solution cannot only provide needed functionality but can also propose an opportunity to improve processes that were supported directly or indirectly by inheritance systems. IT and business stakeholders must work together and have to:

- Clearly state business objectives for the cloud migration.
- Define project scope of the cloud migration.
- Provide a set of guiding principles for all to follow.

Cloud migration process can be divided into three areas:

1. Plan
   - Determine key business drivers
   - Define business objectives
   - Get executive sponsorship
   - Set project guiding principles
   - Form project team made up of IT and business representatives

   Develop a project plan by including the following:

   - Define business requirements
   - Set key success metrics
   - Set timeline
   - Identify decision-making authorities

2. Execute
   - Execute the plan
   - Stay away from 'scope creep'—stay focused on original project scope; this becomes a challenge particularly in cases, where a major legacy application with large users set is being replaced
   - Remember to follow the guiding principles at all times

- Communicate to all stakeholders regularly (no surprises!)
- Train users

3. Monitor
   - Monitor adoption
   - Track success metrics
   - Stay away from scope creep (this one may well decide the success or failure of the project)
   - Follow guiding principles
   - Only implement changes based on quantifiable business needs

Five Things to be Known While Migrating to Cloud

How to extract the maximum usage of cloud computing is one critical question? It gives rooms to the following points:

- Operational efficiency
- Reduced costs
- Application flexibility

However, you are probably worried about the problems and costs associated with the transition. Unless a company is smaller in size, migrating to the cloud can be a painful, labour-intensive process that opens you to many new risks. Fortunately, it does not have to. A little foresight and planning will go a long way. The below given five steps are very essential to reach migration and achieve ROI.

Start small: The latest trend is that people end up buying into the hype, hastening into full-scale projects as well, soon and forgetting to bring common sense along for the ride. Slow down, define your goals, identify potential obstacles and define what being cloud-enabled will do for your organization in the long run. As with any new trend of technology, it is important to verify the waters before leaping into it heads on. Like most of the organizations, if you don't have the skills and necessary knowledge to make fully informed decisions about how to handle identities, enforce application right to use, guard against data leaks, update software licenses and safeguard investments in inheritance hardware and software. One must be ready to identify a few easy applications to shift that will distribute immediate benefits from being cloud enabled. Start with the ideas such as, e-mail and messaging and use them as test cases for further implementation.

Trust cloud vendors to protect data: The weak point of cloud is its security. It actually can be cloud enabled and people can parse out the new risks and opportunities. Improvement in security features with respect to data protection helps the cloud providers to deliver their service effectively. Large cloud providers have the resources to tackle data protection in depth. They can try various approaches to provide best solutions. This trial-and-error method could help to improve the fault tolerance.

Importance of security features: Many cloud providers should deliver good job of protecting data but not all. As new providers pop up almost daily, it is important to do a comparison of these features, as follows: Do they have good security processes in place? Do they have both perimeter-based and behaviour-based security tools? Will they protect you against data leakage and IP theft? Do they have solid business continuity and disaster-recovery plans in place? Have they been hit with recent attacks and if so, how did they recover from them?

For example, the Google server had an attack before, although there is no publicly available evidence as to who was responsible, the fact that user accounts of Chinese's dissidents were breached. How did Google respond? They have applied many approaches. Among them, two are very important, they are:

1. They immediately brought in the NSA to help them address the problem of foreign security services penetrating their defences
2. They publicly discussed the attacks

Be an identity provider: There is one thing cloud providers cannot handle for customer that is, the integrity of their users. By definition, enterprise identities must be defined (and preferably handled) by the enterprise. You have to convey your cloud provider, whom to let in and what privileges each person should receive. You also have to define the mechanisms by which authentication, access and roles will be enforced.

Due to many reasons cloud computing got a bad reputation, in terms of security, because developers forgot about the importance of identity, with cloud-enabling different applications. This is not a fundamental flaw in the cloud model rather it is an age-old story of developers not thinking through the security implications of a new computing model. To protect sensitive data in the cloud, absolute verification of user's identity is very essential.

Plan for latency and outages: Latency and Outages are other two lapses for cloud other than security. The cloud providers are aware of these problems and are busily solving them. Nevertheless, when you pick applications to move to the cloud, you can not overlook the problems that arise when you rely on delivery over the public Internet. If you are running a large enterprise, you may have WAN optimization or route steering tools in your venture. With these directory services, it would be hasty to discard those investments. Keep latency-sensitive applications in-house and implement a hybrid cloud model.

You also need to have in-depth disaster recovery and backup plans that include how to overcome the situation when cloud provider is down. Another time, cloud providers are possibly better positioned to deal with outages than you, but most of the foremost cloud providers have suffered through a significant outage at one time or another. With its guarantee to cut costs and simplicity of scalability, the attractions of cloud computing for IT managers are straightforward, but the silver lining still eludes some enterprises unwilling to release sensitive data.

2.4.3 Benefits of the Cloud

Cloud computing has became an important technology for accountants of an organization. Since it takes a lot of expensive assets, whose true profit involvement is hard to measure off the balance sheet and converts them into current expenses. This is versatile in these capital-conscious times.

Cloud computing also appeals to line managers for the reason that it promises to let them dial up the computing resources they require on a pay-as-you-go basis. This allows them to budget and operate according to actual requirement, making their budgets more capable and flexible.

2.4.4 Communication Revolution

What makes cloud computing potential is the revolution in communications technology over the past 20 years. This has shifted from exclusive analogue telephony to economical digital Internet-based networking. Links are no longer point-to-point, thanks to mobile cellular and satellite networking. This trend is improbable to change. Google and Microsoft are locked in conflict for first rights to the users' desktop, with standard office and other applications, whereas online bookseller Amazon wants to store their records with archival processing and storage such as Elastic Cloud Computing (EC2).

The price war has engendered making cloud computing striking. EC2 offers chief service when compared to the other service provides like Windows. Although big mature by IT users have been justly suspicious of cheap cloud offers. If one's internal systems are running smoothly, why fix them?

2.4.5 Cloud Case Studies

Cloud computing introduces complexity almost at every IT level. *Dave Powers*, data analyst for *Eli Lilly,* the pharmaceutical's manufacturer has been experimenting with supercomputing in the cloud with some suppliers. A large-scale win for him would be a lone unified client persona and authentication scheme for accessing external and internal IT resources. He has tried OpenID, liked it but did not track it because the internal IT department was hesitant to give up its present, internally managed IDMS. The cloud can deliver simplicity but it takes away the loyalty factor. Google succeeded in persuading the publishers of the *Daily Telegraph* and the *Sentinel* to change to Google Apps for office workers and journalists.

CIO of Guardian News & Media (GNM) *Andy Beale*, said the new software bundle, which encompassed Google Calendar, Google Docs, Google Sites, Google Video and Google Mail, would yield for itself quickly. Initially, it was owned by a not-for-profit trust. This may give it greater opportunity to experiment than a firm with a more conventional ownership structure.

Secondly, the newspapers like all publishers are under severe pressure to incise costs. It is unpredictable to say how much it will save cost while switching from Microsoft Office products and Lotus Notes to Google Apps.

Thirdly, the *Guardian* has trumpeted the reimbursement of the 'inter Web Cloud' for a decade or more. This was likelihood to show that it practices what it preaches but also to gain real-world experience at a time when people rising access to fast broadband communications is changing the publishing business model.

Fourthly, as *Beale* noted, it means they rely less on virtual private network relatives to exchange information.

2.4.6 Cloud Inside the Firewall

At present, most cloud applications ran outside the organization's firewall. However, VMware introduced vSphere version 4, what it calls its operating system for the cloud.

vSphere version 4 allows CIOs to collective and manage their internal processors, storage and networks as a faultless, flexible and dynamic cloud operating environment. VMware claims any application will run more proficiently and with assured service levels on the system.

2.4.7 Secure Sensitive Data

Brobst said Teradata's pitch is not suitable for real-time OLTP environments. It manages to warehouse the data taken from OLTP systems and adopts business intelligence for best decision making. Data volumes were doubling-up every, year but verdict response times were dwindling. It was more and more noteworthy to a firm's competence, for instance, to run the enterprise smartness performance as close to the knowledge of current inhabitants and decision-making points and that signifies indoors the confidential cloud, he said.

He anticipates a three-tier structure emerging. First of all it is small, but highly secure internal IT shop, where the company processes and stores secret information, information that gives it spirited advantage, or for which it is lawfully liable and where it cannot set off the liability to third parties.

However, the internal picture may provide itself to a degree of private clouds, if user's firms implement VMware's view of that data warehousing and business intelligence dealer called Teradata. Teradata CTO *Stephen Brobst* says processing is no longer a bottleneck, credit to virtualization and tune-ability of server racks. This will permit the chips random-access memory to access data at the same rate as it processes it, wasting no cycles, whereas it waits for data to arrive. This will also make sufficient solid-state storage, which will act as a mass RAM store.

2.4.8 Trusted Partners

In advance deals, these relationships will be contractual and will comprise service level agreements. They may also include risk and profit-sharing targets and incentives. Information processed at this time will probably be a response time-dependent (hence the need for SLAs) and will perhaps deal in confidential or sensitive information. In the same way, few companies delete their own e-mails. They rely on firms like *Message Labs* to filter the net's spam and malware load fearing, they hit the corporate firewall.

2.4.9 Applications on Cloud Platform

The third level will deal in general purpose applications and non-confidential information including external data.

Microsoft, with its forthcoming Azure product set and Google with its Apps, will struggle. Likewise Salesforce.com, Apple, Google and Symbian have provided tools and standards. Other software developers can use to build applications that run on their platforms, so Azure provides standard web protocol and tools like XML, .Net, Soap and Rest. Microsoft promises that developers, who use these tools will end up with cloud-existing applications.

2.4.10 Consumer versus Enterprise

The problem is that providing platforms are good quality for the consumer market, in particular when it involves mobility. There are five mobile operating systems belligerent for market share.

Who wins depends on the platform that has the most popular applications? Although this is far off from the enterprise market, which is more mature and hence homogenous, conservative and geared for efficiency rather than novelty. As for this, the efforts of leading enterprise software firms such as SAP, Oracle, Siebel and the rest have become cloud-compliant and cautious at best.

2.4.11 Remotely Mirrored Servers

We have already seen these earlier in conventional remotely mirrored servers which don't have anything remotely alike the same flexibility. Solutions such as VMware's VMotion move virtual machines between physical devices routinely using hypervisors in remotely connected data centres. It tries to move the virtual machine between different companies. 'If you have a standard communication protocol across these two clouds, where you can, later communicate with the handlers of the other cloud, for the right security, networking, availability and orchestration, then only can you make it happen,' says *Radha Ratnaparkhi*, Director of Commercial Systems at IBM. Previously, the company experimented live relocation of SAP applications across remote IBM systems. Once you have identified, how to move the data around efficiently, you have to ensure that you can stop it from moving everywhere, he said. For example 'It may be significant for policy rule that data has to reside in Europe and not shift to the US,' he said. 'To define the location of that storage there are no methods available at present'.

2.4.12 Payment Procedure

If all of these have been worked out, we have to think of pure economics of cloud computing. How will the payment be made? Renowned 'pay as you go' model allow users to bid for time in the cloud.

Finally, we anticipate that the cloud will become a more ubiquitous part of each day computing life. Some hefty research work is needed to create confidence among enterprise users, which is the first and essential step.

2.5 SEVEN-STEP MODEL

The cloud has captured the interest and thoughts of many and it keeps progressing at a rapid speed. Whether the attraction is based upon a aspiration to acquire IT services on a 'pay as you grow' model and reduce principal expenses, or simply to acquire a method of filling gaps and relieving shortcomings, the cloud model is, at a minimum, on the radar screens of most IT organizations. It was inevitable. It is true that in the history, cloud promotion managed to get ahead of the reality. In reality, 'the cloud' is not a monolith and it has been usually understood that its products and services are in their teething stage and naturally require maturation time. As with the new thought, many variances are spawned and every one will not succeed. Keeping in mind that for every dot-com success, there were dozens of indistinct problems. In the interest of pursuing a more rational point of view, there are seven regions to think in evaluating and transitioning to cloud-based solutions.

Know that there are many different variances of cloud services: The term 'cloud' has turn out to be overloaded and now broadly characterized as a service-delivery model that can be applied to a range of services around multiple stage of IT: public and private variants. The discussion over, what comprise a cloud occupied a great deal of conversation in the earlier period? It is implicit that the significant first step is to become knowledgeable on the various cloud options and their shades.

Move towards the cloud as a tool or an additional option to supply IT functionality: Those who have effectively leveraged cloud technology have done so in a practical or opportunistic fashion rather than view cloud as some sort of computing model—'build it and they will come'. Think of cloud contributions as tools or alternative solutions to definite course of actions.

For example, in the storage space, an organization to address different service requirements may deploy multiple tiers of storage relating to performance and availability. Cloud storage can be viewed basically as one more option for addressing a set of requirements for one or more tiers. This provides a perspective from which rational conclusion can be made.

Recognize which constituent of your environment may be 'cloud compatible': The environment is not uniform in providing cloud services. It depends on the compatibility of the region in the environment. Some key factors that might restrict cloud compatibility are as follows:

- Hardware dependencies
- Governance and regulatory restrictions requiring controls, location of data or comprehensive chain-of-custody monitoring is probably excluded from the cloud

The objective should be to identify application and functional areas that fit a shape and have requirements that support well with the capabilities of a cloud service.

To better compute the advantage of cloud services lies on understanding about current costs: The most important attraction of the cloud is more cost-effective in delivering required IT functions. Unfortunately, many start their examination of cloud options without exactly understanding their present cost composition. When a cloud solution provider offers service costs based on usage, internal IT personnel struggle to classify their present costs and make them impossible to accurately compare or assess the differences.

To deal with this, IT organizations have started to think and work more like a service provider. They should be able to describe their help as services based on attributes such as business value, compliance, security, availability and performance. Technology options should be tied up to service offerings and the costs associated with those services. This approach can help out to force more proficient deliverance of IT services and raise user fulfilment, whether a cloud approach is eventually pursued or not.

Preparation of organization to 'manage' rather than 'operate': The majority of IT organizations are technology-focused rather than service-focused. They are driven by identifying new technologies and opportunities for incorporating them into their location rather than evaluating present service and efficiency gaps and then addressing these shortcomings. As a result, while they can articulate technical speeds and feeds, they are often foiled when an executive, having heard a pitch from a cloud seller, asks them about incremental unit cost and run rate.

An IT organization must be designed to offer infrastructure 'services' aligned with business requirements in the future. Many organizations accomplish this by combining delivery methods including the cloud. IT should be equipped to administer the entire group, regardless of whether a service is offered internally or externally.

To simplify and de-risk your migration: Arrangement of data is so crucial—Accepting a cloud-based solution will always require some amount of migration activity and suitable groundwork is essential. Successful migration needs understanding of present environment, which includes dependencies in-terms of application and data. This is usually done during discovery and analysis.

Aligning data starts by identifying application services, delineating their various sub-parts and then enumerating each part of the service. From this, it is then possible to efficiently plan and series the actual migration to the target cloud atmosphere. It is noted that migration costs influence the financial analysis and postpones due to inadequate migration planning.

Question to gain more knowledge: It is difficult to ask questions about cloud result provider to reach a acceptable comfort level with this technology, particularly, since the cloud is fresh and organizations are short of experience of it. Among the serious areas of focal point are:

- Service level agreements (SLAs)
- Security
- Data safety and availability

The cloud phenomenon has caught the attention and imagination of many people's and it keeps progressing at a rapid speed.

Understanding an organization's present natural environment, articulating its obligations and then designing and producing the transition are the scheme of things to effectively characterize and recognize in cloud. While it may not be simple, a systematic approach that incorporates the areas noted here will uplift the possibility of success.

SUMMARY

- ❖ Cloud computing can empower the unfailing flow of knowledge between the service provider and the end user.
- ❖ The pay as you go model of cloud computing adds ample reservation to the company's portfolio.
- ❖ Cloud computing is delineated as the enterprise of sharing some programs from the 'cloud'.
- ❖ Cloud computing adopts Internet-based services to support enterprise processes.
- ❖ It is important to know about cloud computing before making the decision to progress the enterprise in 'the cloud'.
- ❖ The interconnectivity of computer servers is the first constituent that identifies cloud computing.
- ❖ Cloud computing can alleviate the appropriate organization technical knowledge resources within the organization.
- ❖ Characteristic of the cloud computing is that it sanctions outsourcing company's work portfolio, which is the key component.
- ❖ Cloud computing is expected to carry in a higher stage of automation than the common procedures of making acquaintance between the assorted sections of an organization.

- A good cloud computing package must only charge you for the services that you use.
- Software provided online is upgraded and upheld by the provider, so no need to pay for or download fixes and patches.
- Chances are there for anonymous computer hackers to gain entry to the enterprise knowledge in the cloud.
- The key to employ cloud hosting carefully is finding a conscientious provider that provides back-up programs.
- Advantages of cloud computing are (i) Cost reduction, (ii) scalability, (iii) levels the playing field, (iv) easier collaboration, (v) scalable and flexible and (vi) efficiency.
- Disadvantages of cloud computing are (i) Security concerns, (ii) risk of losing Internet connection, (iii) limited resources for customizations, (iv) availability, (v) data mobility and ownership, and (vi) privacy.
- The growth of cloud computing could drastically change the way companies manage their technical assets and computing needs.
- The cloud model can yield enhanced effects to the client of an IT service.
- Cloud computing is developed from the existing advance distributed technologies.
- Other cloud-related technologies are (i) Grid computing, (ii) utility computing and (iii) autonomic computing.
- Cloud computing uses IT as a service over the network.
- Cloud computing contains Infrastructure as a service (IaaS), Platform as a service (PaaS), Hardware as a Service (HaaS) and Software as a service (SaaS).
- A cloud is employed as a storage medium which handles applications, enterprise and private data.
- Cloud migration process can be pulled apart into three environs, (i) plan, (iii) execute and (iii) monitor.
- Five things to be known while migrating to cloud are (i) Start small, (ii) trust cloud vendors to protect data, (iii) consider importance of security aspects, (iv) be an identity provider and (v) plan for latency and outages.
- There are seven regions to consider in evaluating and transitioning to cloud-based solutions.
- Understanding an organization's prevailing surroundings, articulating its prerequisites and then arranging and establishing the transition are the approaches to productively delineating and understanding in cloud.

KEY TERMS

- Organizational viewpoint is that cloud presents services for buyer and enterprise desires in a simplified way that consigns high QoS that guarantees development and innovation.

- User's perspective enables computing services in a simpler, more responsive model without complete knowledge of the underlying technology.
- Virtual computing lab is a concept, where educators and technological experts are currently embarking on an initiative to provide every student access to advanced educational resources. Cloud computing is used for this purpose.
- Utility computing is a type of computing, where resources used in computing process are packaged as a metered service similar to electricity—a traditional public utility.
- Autonomic computing is a type of computing, which defines that systems are capable of self-management.
- Software as a Service (SaaS) is a cloud model, where provider offers necessary softwares to consumers via WWW.
- Infrastructure as a Service (IaaS) is a cloud model, where resources such as hardware, storage, servers are outsourced by an organization.
- Platform as a Service (PaaS) is a cloud model, where an organization rents hardware, OS and storage via WWW.
- Cloud migration is the process of transitioning all or part of a company's data, applications and services from on-site premises, behind the firewall to the cloud, where the information can be provided over the Internet on an on-demand basis.

REVIEW QUESTIONS

- How would you save your applications, softwares and drivers for a long term without using any magnetic disk?
- Comment on cloud computing cost.
- Comment on cloud computing revolution.
- Mention about the top cloud applications now-a-days.
- Mention the basic components of a server computer in cloud computing.
- What are the concerns prevailing around cloud computing?
- How can these concerns be addressed?
- What are the basic characteristics of cloud computing?
- What is a cloud service?
- Comment on the security of cloud computing.
- What are the main features of cloud services?
- How many types of deployment models are used in cloud?
- Which services are provided by Window Azure operating system?
- What are the advantages of cloud services?
- How does cloud computing provide on-demand functionality?

- What are the different layers of cloud computing?
- What resources are provided by infrastructure as a service?
- How important is platform as a service?
- What does software as a service provide?
- What are the different data centres deployed for this purpose?
- What is the use of API's in cloud services?
- What are the different modes of software as a service?
- What are the security aspects provided with cloud?

CHAPTER 3

Types of Cloud

3.1 PUBLIC AND PRIVATE CLOUD

Today everyone is speaking about cloud computing, but the exact meaning of the term still remains vague. It can be loosely explained as follows: the operations of a business are carried out in one place and the functions in some remote place; it is possible with the help of technology, that is cloud computing. Cloud computing has an advantage for the businesses to increase their IT functionality without adding extra infrastructure or software.

3.1.1 Types of Cloud Computing

Cloud computing can be classified into four types based on the location of the cloud:

1. *Public cloud*: This computing infrastructure is hosted at the vendor's workplace. The end user cannot view the infrastructure. The computing infrastructure is shared between companies.
2. *Private cloud*: Here the computing infrastructure is dedicated to the customer and is not shared with any other companies. They are costly and highly secure than public clouds. Private clouds may be hosted externally as well as in their own premise hosted clouds.
3. *Hybrid cloud*: Organizations can submit less valued applications in public cloud and high valued applications in the private cloud. The combination is known as hybrid cloud. Cloud bursting is used to define a system where the organization uses its own infrastructure for normal usage and cloud is used for peak times.
4. *Community cloud*: The cloud infrastructure is shared between the companies of the same community. For example, all the government organizations in a city can share the same cloud but not the non-governmental organizations.

Six different types of cloud computing and their offering to businesses are listed as follows:

1. *WWW-based cloud computing service* is a type of cloud service that exploits certain web service functionalities, rather than deploying applications. For example, it can use Google Maps API.
2. *Software as a service* is an idea, where an application can be used by multiple tenants, using the browser. For example, SaaS solutions are used in sales, ERP and HR.
3. *Platform as a service* is a variant of SaaS, one can run their own applications but by executing on the cloud provider's infrastructure.
4. *Utility cloud computing services* offer virtual storage and server options, where the companies can access it on demand. This allows easy creation of virtual data centre.
5. *Managed services* are the oldest cloud computing solutions. In this, a cloud computing provider utilizes an application than the end customers. Examples are using anti-spam services and application monitoring.
6. *Service commerce* is a mix of SaaS and managed services. It provides a hub of services, where the end user interacts. Examples are tracking expenses, virtual assistant services and travel bookings.

3.1.2 Public Cloud

A public cloud is based on the standard cloud computing model, where the service provider makes the resources such as storage and applications available to the public over the WWW. These services may be free or on a pay-per-usage model. The advantages of using a public cloud computing service are as follows:

- Inexpensive and easy to setup
- Scalability
- No resources are wasted

Examples are IBM's Blue Cloud, Amazon Elastic Compute Cloud (EC2), AppEngine, Sun Cloud and Windows Azure Services Platform.

3.1.3 Private Cloud (Internal Cloud or Corporate Cloud)

Private cloud is a proprietary computing model that provides services to users who are behind a firewall.

Advances in distributed computing and virtualization allowed administrators of network and data centres to provide effective services that meets the needs of their 'end users' within the organization.

3.1.4 Difference Between Public Cloud and Private Cloud

Cloud computing and storage are not new topics. Cloud is one of the most recognized terms in the industry. As a service, it was offered, which earned recognition with Web 2.0. With the evolution of the technology to the level today, cloud computing is offered as public and private cloud services. We can distinguish between public and private cloud, and also customers can understand the difference based on various factors such as a pattern of usability, security and performance, which is insignificant with the costs.

3.1.5 Public versus Private Cloud

It is easy to distinguish between a private and the public cloud. The first difference will be the deployment location. Cloud can be offered as a service over the WWW is a public cloud, whereas a private cloud sits inside the firewall. The location of deployment is the main factor of distinction between the two.

Public cloud is charged on a monthly basis. Customers pay for the usage based on data size(GB) and for the bandwidth transfer fees. It is based on demand storage scalability and customers need not buy a storage hardware.

Private cloud is deployed in the customer location, providing all necessary hardwares and operating systems. The hard disk storage is shared only within the organization and is controlled entirely by the enterprise. Because of scalability, customers can add servers to the existing architecture. Furthermore, this architecture is fully managed by the customers.

3.1.6 Factors for Public versus Private Cloud

Elementary expense: Private cloud architecture does not require heavy investment, it can be built at a low budget by deploying the architecture effectively. Public cloud hosting is offered at an affordable price of ₹3,000. Initial expenditure is less as the customers need not buy any hardware or software.

Volume of data: Cloud storage's advantage is its scalability options. Private cloud can initiate from few TBs in size, also offering scalability out of capacity by adding additional nodes, where public clouds are smaller. Also it is easy to back-up in a laptop or deploy an application of size in few GBs.

Performance expectations: Private clouds are deployed within the firewall and are accessible using an Ethernet. Every addition of nodes increases the performance for this type of cloud. The only limitation to public cloud is accessibility via the Internet.

Some other factors include:

- Duration of data storage
- Access patterns and locations
- Security and data isolation
- Confidentiality and destruction of data
- SLAs (Service Level Agreements)
- In-house technical crew

3.2 CLOUD INFRASTRUCTURE

3.2.1 Cloud Computing Infrastructure

Cloud computing infrastructure functions like an electricity grid. When you need light in a room, you turn the switch on, the signal travels through the electricity grid, then power is transmitted to your switch and you have light. A cloud computing infrastructure works similarly. Whenever you need resources such as information on software, they are stored in a network called a cloud. You can find it in your cloud computing infrastructure and pull it up. If someone else is in need of the same information, then he or she can access it from that computer itself. Information is stored in the cloud computing infrastructure instead of on the computer. Figure 3.1 shows the basic infrastructure for a cloud, comprising of client and server machines. Application, platform and infrastructure services are used by two machines. Servers deploy services and act as a provider, whereas a client uses it and acts as a requestor.

Any business that requires multiple computers could benefit from a cloud computing infrastructure. Any business, ranging from online sports betting to major corporations with operations around the world, can personalize a cloud computing infrastructure to meet their specific needs. It eliminates the need for individual employees to backup data regularly, because the network administrator would be responsible for backing up data on the cloud computing infrastructure. It also allows each employee to access the same information, which makes operations run much more efficiently in an office environment.

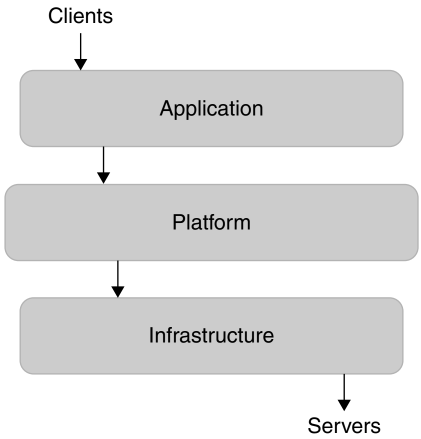


Figure 3.1 Cloud Computing Infrastructure

One can get cloud computing infrastructure for his business, within the following five steps:

1. Choose on-demand technology which will be the foundation for your infrastructure.
2. Determine how your employees can access information from the infrastructure.
3. Prepare the infrastructure with the necessary software and hardware.
4. Set up each computer to access the infrastructure.
5. Integrate all aspects of the infrastructure so that all employees can participate in resource sharing.

Setting up a cloud computing infrastructure is an investment but improved efficiency will make it worthwhile.

3.2.2 Status of Cloud Computing in India

India is the outsourcing capital of the world, but for cloud services it is far behind. Some companies are still in the application and platforms stage, and their share in lending to the cloud service market in India is limited. This is because, infrastructure services require major investment and also because of the unreliable facilities such as network and electricity. This has stunted the growth of cloud computing services in India.

Tata Communications (TCS) announced an expansion in their cloud computing service offerings, which was the first ever India-based cloud computing solution. In addition to the existing services, they added Instacompute and Instaoffice in their list of service offerings. This new services expanded the company's offerings in the cloud computing to deliver pay-as-you-use and self-service IT application services.

3.3 CLOUD APPLICATION ARCHITECTURE

The latest technology in sharing of resources is cloud computing. It maintains large numbers of servers and can be billed in terms of on-demand and pay-per-cycle. The end users have no idea about the location of the servers in the cloud network.

Cloud computing is fully enabled by virtualization (hypervisors). A virtualized application is an application that is combined with all the components for execution with an operating system.

This flexibility is advantageous to cloud computing and it is varies from other computing such as grid or utility and SaaS. Launching new instances for an application is easy and it provides the following:

- Scale up and down rapidly
- Increased fault tolerance
- Bring up development or test instances
- Speedier versions to the customer base
- Load and test an application

After deciding to deploy the application in a cloud computing environment, it is important to avoid the 'success disaster'. When your application becomes popular overnight, it may crash under an unanticipated load. Therefore, it is important to design the application for the cloud taking maximum advantage of the cloud environment.

3.3.1 Architectural Considerations

Designing an application and running it as a virtual application in a cloud computing environment is different from designing it for on-premise deployment. An application ought to be designed keeping in mind easy scalability, tolerate failures and incorporate management systems by successful deployment within the cloud.

Scale

The potential offered by cloud computing is nearly unlimited in scalability. For this purpose, some application design guidelines are discussed as follows:

Start simple: Avoid complex design, optimizations for simplicity and performance enhancements. It is a good idea to start with easiest application and checks the scalability of the cloud.

Split application functions and couple loosely: Separate systems should be utilized for different parts of program functionality and bypass the synchronous attachments between them.

Deployment cluster: Rather than a single system to serve all users, consider forming multiple clusters, each processing a subtask of an application. This is often called as 'sharing'.

The advantages of cloud computing in terms of scalability are as follows:

- Inexpensive testing
- Reduced risk
- Ability to segment the customer base
- Auto-scaling based on the application load

Fail

Sometimes and at some point, an application will fail. Some follow-ups should be considered while designing on-premise or SaaS application such as 'doomsday' scenarios.

Get back up quickly: The launching of new application clusters in order to recover data quickly must be automated.

Data considerations: When an application fails, data persistence and system cannot be ascertained. It is advisable to move all data to persistent storage and confirm it is replicated and distributed to ensure data preservation. The system state is restored and used for the recovery process, and thus the system can be restarted from the point of failure.

Manage

The management of making the deploying cloud applications as virtual appliances is very easy. The software which is needed for the entire lifecycle in the cloud should be brought by the appliances. Managements workload is reduced because of deploying applications in cloud. It should be developed in a systematic and consistent manner.

Operating system and middleware interface needs are to be combined while building appliances. The management system performs a vital role in the testing and deployment process. By automating the management and creation of appliances, one can tackle the most difficult and expensive problem called variability. Variability is removed from the release management and deployment process by producing a consistent appliance image. Chances of mistakes are reduced due to removal of variability.

The advantages of designing the application in the cloud include the following:

- Cost reduction
- Reduced overheads
- Eliminates application sprawl
- Reduces the chance for errors

SUMMARY

- Cloud computing is advantageous for organizations to advance their IT functionality without augmenting surplus infrastructure and software.
- Cloud computing can be classified into four types based on the location where the cloud is hosted.
- Cloud computing offers six types of enterprise services.
- Public cloud is charged on a monthly basis.
- Private cloud is deployed in the client's premises with all needed hardwares and OS.
- Private cloud architecture does not demand heavy investment, it can be assembled on a limited budget and also deploying of architecture is not hard.
- Cloud storage advantage is its scalability options.
- The private clouds are installed within the firewall and are accessible using an Ethernet.
- The only limitation to public cloud accessibility is the Internet.
- Cloud computing infrastructure for enterprises can be done in five steps.

- Tata Communications (TCS) was the first in India who started to provide cloud computing solutions for end users. Their products are Instacompute and Instaoffice.
- Cloud computing is entirely empowered by virtualization (hypervisors).
- A virtualized application is an application aggregated with all the elements for execution with OS.
- This flexibility is the advantage in cloud computing and this makes the variation with other computing paradigms such as grid or utility.
- Designing an application and running it as a virtual application in a cloud computing differs from designing it for on-premise deployment.
- Cloud computing offers the capability for nearly unlimited scalability heights.
- Deploying cloud application as virtual applications make organization pretty simple.
- By automating the organization and creation of applications, one can attempt the most arduous and high obstacle called variability.
- Variability is removed from the organization and deployment process by producing a consistent application image. Chances of errors are minimized due to deletion of variability.

KEY TERMS

- A public cloud is a cloud computing type, where the provider offers resources and applications via WWW.
- Private cloud is a type of proprietary computing, which provides hosting services to the users, who are behind a firewall.
- A hybrid cloud is a cloud computing type in which a governing body provides and supervises resources in-house and also to external users.
- A community cloud is a type of cloud computing, which is shared by one or more organizations forming a group with common computing concerns.
- Service commerce is a mixture of SaaS and managed services.

REVIEW QUESTIONS

- How cloud computing is classified?
- Differentiate between private and public clouds.
- State the business offers done by cloud computing.
- What are the factors to determine public or private cloud?
- With a neat sketch, brief cloud computing infrastructure.
- List the steps for developing cloud computing infrastructure.
- Define cloud application architecture.
- State the advantages of designing application for management using cloud computing.

CHAPTER 4

WORKING OF CLOUD COMPUTING

4.1 TRENDS IN COMPUTING

Information technology (IT) is evolving rapidly. It becomes outdated as fast as it evolves. Some of the technological inventions are promising in the initial phases and fizzle out once they are implemented, while others progress and gain popularity steadily. An IT professional will be able to distinguish between the hype created by a product and the real success of a product.

This chapter discusses about different IT strategies and technologies, how the emerging technologies can be adopted efficiently and how established technologies and strategies penetrate the IT market and what are the economic outcomes of early adopters of these initiatives. IT professionals calculate the potential risks involved in investing in these technologies by taking into account the adoption trends and economic outcomes.

4.1.1 IT Maturity Analysis

Figure 4.1 compares the technologies based on two parameters—the current investment rate and the current adoption rate. This assessment provides the success rate of the technology and its deployment and also the organizations, that will find this technology beneficial. Thus, these factors provide insight into how developed a technology is related to other technologies and how rapidly it will expand in the market.

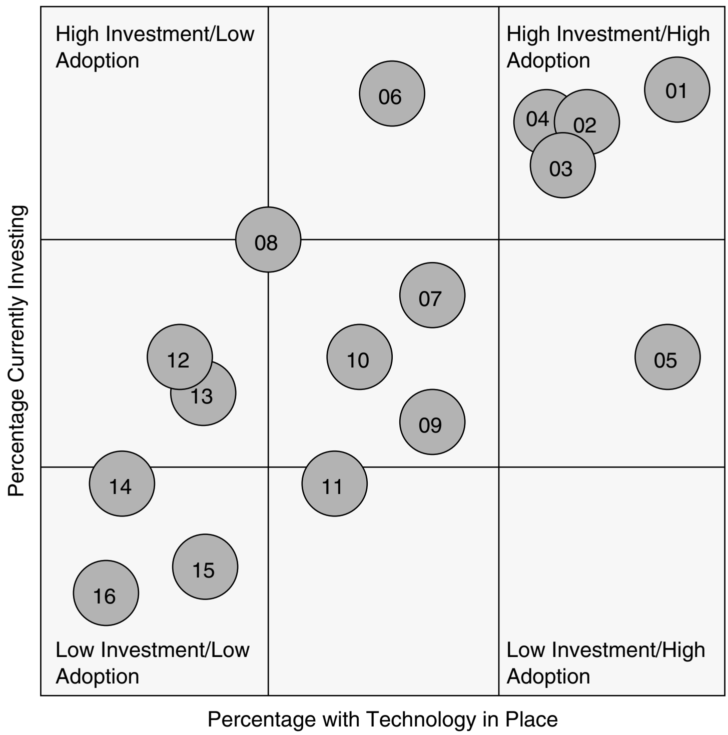


Figure 4.1 IT Maturity Analysis

The X-axis labelled 'percentage with technology in place' represents the rate of adoption. The vertical axis is labelled 'percentage currently investing' represents the rate of investment.

In this analysis, the terms 'low' and 'high' are relative to the technologies that are being developed. In the figure, the diagonal line represents technologies falling from low investment and adoption to high investment and adoption rate. Technologies falling in the upper right corner are more matured.

Figure 4.1 represents a chart with nine different parameters such as low, moderate and high rate of investment; and low, moderate and high rate of adoption. Each technology falls in any one of the nine parameters.

- *High rate of investment/adoption*: ERP, business intelligence systems, CRM systems and enterprise collaboration falls under this sector.
- *Moderate rate of investment/high rate of adoption*: Systems like human resource management systems (HRMS) fall in this sector.
- *High rate of investment/moderate rate of adoption*: When there is an increase in investment than the adoption, it results in growth of technology. Windows 7 falls in this sector.
- *Moderate rate of investment/moderate rate of adoption*: Technologies such as legacy system renewal, SaaS and unified communication fall in this category. These technologies will grow in a slow and steady pace.
- *High rate of investment/low rate of adoption*: Mobile applications falls in this sector, which has high rate of investment, but adoption rate is minimal.
- *Low rate of investment/moderate rate of adoption*: Supply chain management falls in this sector.
- *Low rate of investment/low rate of adoption*: Technologies like virtualization (desktop), tablet, IaaS, environmental management solutions and PaaS fall in this sector. When a technology has more capability, but adoption rate is low, then organizations will not be interested in adopting them.

Cloud computing technology changed its focus from industry to real-world problems. The major trends that emerged in cloud computing technology are:

- Small, medium business and micro-business
- Supply chains management, media and digital content, and legacy systems
- On-the-fly access
- Hybrid cloud model
- Growth in stack-as-a-service

4.1.2 Technology Trends to Watch

Virtualization

Infrastructure, applications, server, desktop, storage, network and hardware compose virtualization. Virtualization can supply extra power on demand and is compatible with today's environmental measures. For small and medium business (SMBs), virtualization affords incredibly easy migration.

Organizations need to review consolidation plans and check whether all virtualization bases are covered without delay. IT organizations are in pressure to find out new ways to store media using client-side virtualization concept. The virtual desktops that conceive a 'thick client' likeness by a 'thin client' consignment form a long, flexible workforce which decreases complexity and simplifies measures in alignment, review and command by adopting to new client virtualization.

Data Growth

According to Gartner, enterprise data growth is expected to increase more in the next five years and 80% will remain unstructured. Due to this trend in the IT, the complexity will also increase, despite continued budget constraints. More access will lead to more data, resulting in increased compliance, backup, audit and security. To keep up with the tide, companies must virtualize storage quickly, preparation of reduplication, calculate all data inputs, keep up the needs, segments and prioritize data. Thin provisioning, data reduplication, automated tiering, HSM (heterogeneous storage management) principles and virtual tapes are included in the key technologies to manage the data growth.

Energy and Green IT

In Green IT, performance and its effectiveness will play a vital role. Corporate social responsibility will become a primary concern as the power issue moves up the food chain.

Complex Resource Tracking

Complex resource tracking monitors energy consumption made by resources and automatically optimizes it by moving workloads dynamically. Organizations will have to manage new KPI (knowledge power infrastructures) based on power and there will be a growing demand for new vendors and skills.

Consumerization and Social Software

Social collaboration (wikis, blogs, Facebook, Twitter), social media (content sharing and aggregation) and social validation (social ratings, rankings and commentary) will continue to be a major force in shaping consumerization and the software, compelling organizations to focus on early pattern detection and 'collectiveness'. Establishing the rules of engagement, monitoring and looking for signals, becoming active participants in the social web and including some dimension to internal and external websites of the organizations, will need to respond to the distributed social web in next two years.

4.2 CLOUD SERVICE MODELS

Figure 4.2 shows the various cloud service models such as software, platform and infrastructure. Service models are types of services that are required by customers. Models are based on the kind of operation and requirement of the business. A cloud service can be replaced with any one of the following as *Cloud * as a Service—'Desktop, data, platform, IT, infrastructure, testing, computing, security, software, testing, storage, hardware, database, etc.'*

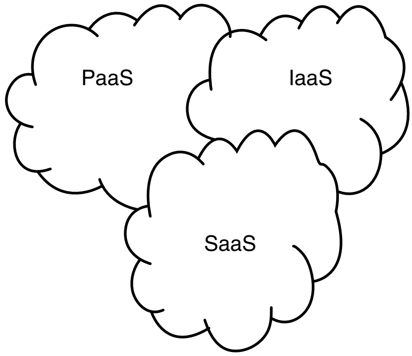


Figure 4.2 Cloud Service Models

4.2.1 Service Models

- *SaaS* (Software as a Service)
- *PaaS* (Platform as a Service)
- *IaaS* (Infrastructure as a Service)

SaaS

Provider of SaaS has full administrative rights for its application and responsible for activities such as deployment, maintenance and update. This type is suitable for customers, who want less management hassles and worries regarding installation of application, software and its updation.

Figure 4.3 shows the levels of rights between the subscriber and the provider, i.e., SaaS component stack and scope of control. From the figure, it is clear that a cloud provider has total control over the hardware, middleware and operating system. It also has administrative control over the application residing in the server. Cloud subscriber subscribes the service, it has limited admin and user level control. Cloud users do not have control over the OS or the hardware.

SaaS subscribers can be individual users, users from organizations and users from enterprises. If the focus in on improving of the business, SaaS is the best option.

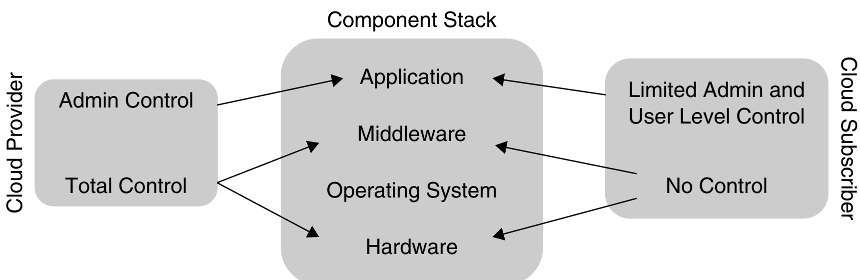


Figure 4.3 SaaS Component Stack and Scope of Control

By opting SaaS, replacing of old hardware and maintaining infrastructure can be avoided, thus saving on time and cost of hiring of technical staff.

Applications, which supports productivity and collaboration are the best options. For example, Google Apps. Other examples are as follows:

- Online project management apps such as Zoho Mail, Deskaway.
- CRM apps such as Salesforce.com, Impel CRM and Microsoft Dynamics.
- Cloud services such as Skydrive, Google Docs and Dropbox.
- Small and medium enterprises (SMEs)/small and medium business (SMBs) can user services such ase EazeWork.

PaaS

PaaS is service, where application/software can be build, tested and deployed as a single unit. PaaS is useful for application builders, developers, deployers and testers.

Figure 4.4 depicts rights of control between the subscriber and provider, i.e., PaaS component stack and scope of control. From the figure, we can understand that the cloud provider has total control over the hardware and operating system, admin control over the middleware and no control over the application. A cloud subscriber subscribes to the services and has full admin rights over the application deployed and minimal rights over the middleware. Cloud users do not have control over the OS or the hardware.

PaaS consists of environment for developing applications, languages for writing programs, compilers and tools for testing and deployment.

PaaS subscribers can be third party software vendors, individual developers and IT service providers.

Users can opt for PaaS, if his/her focus is only on application development and to finishing it before the deadline.

By opting PaaS, everything else (other than the application development) will be maintained by the provider.

Customers must choose the PaaS based on the platforms they work.

PaaS providers in India are Wolf Frameworks and OrangeScape. Developers working on PHP can choose PHP Fog or/and CloudControl.

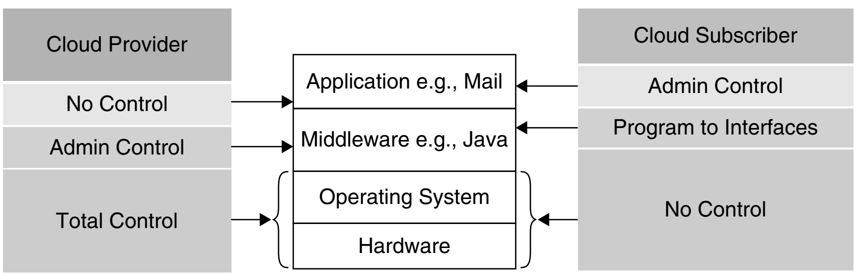


Figure 4.4 PaaS Component Stack and Scope of Control

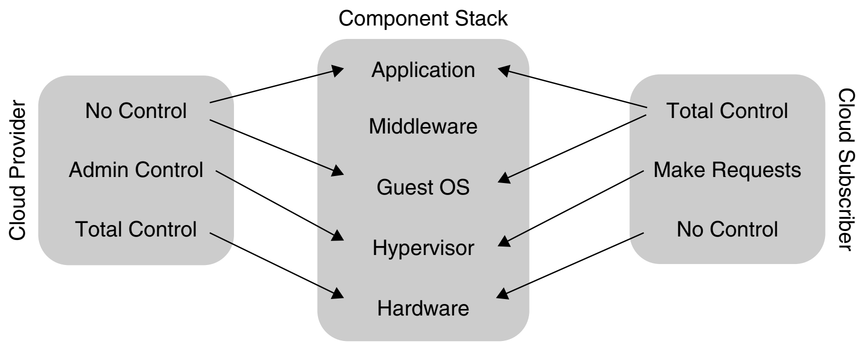


Figure 4.5 IaaS Component Stack and Scope of Control

IaaS

When the customer requires an end-to-end infrastructure such as computer resources, storages and network, he/she can opt for IaaS. The usage fee is billed at CPU hour, size (GB) of data accessed or stored/hour, bandwidth consumed, etc. Figure 4.5 depicts the IaaS component stack and scope of control.

Figure 4.5 depicts the rights of control between a subscriber and a provider, that is, IaaS component stack and scope of control. From the figure, it is clear that cloud provider has total control only over the hardware and has admin rights for virtualization part, that is, hypervisor. He/she has no control over the application, middleware and guest operating system. Cloud subscriber subscribes the service and has full admin rights for the application deployed, middleware and the OS. Cloud users can make requests to hypervisor but don't have control over the hardware.

Enterprises comprising of many servers can act as an IaaS provider such as Facebook, Orkut and Twitter.

IaaS is very useful for beginners, who are not in a position to predict the success rate of their application. IaaS customers can choose between different OS, databases and platforms.

IaaS providers in India are Amazon, Rackspace, Joyent, GoGrid, Verizon Teeremark and Rightscale. NetMagic Solutions and InstaCompute (from Tata Communications).

4.2.2 Cloud Service Models

Figure 4.6 depicts the levels of service provided by each service model. Service models are categorized into five types:

1. Business as a service
2. Software as a service
3. Platform as a service
4. Infrastructure as a service
5. Management as a service

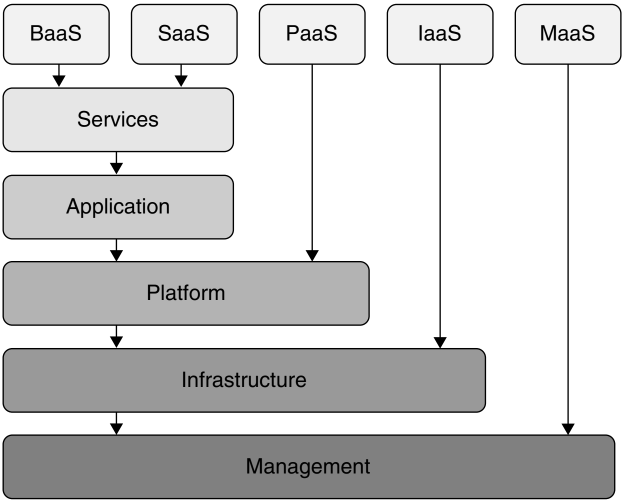


Figure 4.6 Cloud Service Models Comparison

Other aspects of cloud service models are as follows:

- It provides management as a part of the service. Managing multiple services, service models and on-premise applications and systems are management functions of large organizations.
- An infrastructure service from a cloud service provider, which can be built on top of your applications and services, and if a development platform is required, you can build this on the infrastructure service as well.
- A platform service includes the required infrastructure service to support the platform.
- An application (software) service includes the overall infrastructure and platform services to support the application.
- Business process systems facilitate the development of business processes including business process inventory, definition, development, deployment, management and measurement.

Probably the most interesting part are the service layers. Services (web services or business services) are reusable technical components made available internally and/or externally either to be consumed or to create new business processes and applications. Creating these reusable functions makes the business to be less reliant upon IT thus changing the existing systems to provide new functionality. Using Saas or BaaS layer, new functionality can be created by developing new service using the existing services. This is the definition of the services layer represented in Figure 4.6, it is a web or business service, which provides reusable technical components.

4.3 CLOUD DEPLOYMENT MODELS

The cloud is a simplified representation of the convoluted, internet-worked systems and attachments that form the Internet. Private and public clouds are defined based on their relationship and as a subset of the Internet, and also it is referred as internal or external clouds. The differentiation is based on the relationship of the cloud with the enterprise.

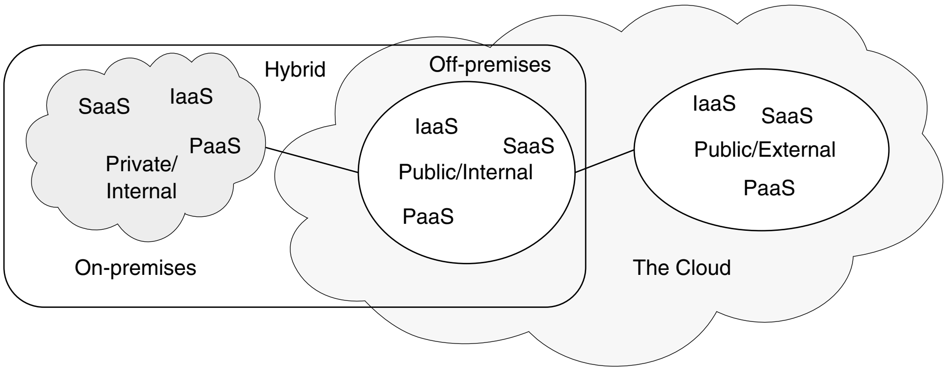


Figure 4.7 Cloud Deployment Models

The public and private cloud concepts are important because they support cloud computing. While working on the cloud, the user may not have to know about the technology or where about of the service provider's infrastructure. Cloud also supports resources in terms of dynamic, scalable, virtualized versions by paying some fee.

4.3.1 Cloud Computing Deployment Models

Many types of cloud deployment models are available; they are private, public and hybrid models as shown in Figure 4.7. Private cloud is an on-premises or internal cloud setup, whereas public cloud is off-premises or external one. Both private and public cloud set-up may provide three different services, that is SaaS, PaaS and IaaS. NIST (National Institute of Standards and Technology) provides a standard definition for cloud computing and its models.

Public cloud is a widely used model, where infrastructure comprising of hardware systems, networks, storages and applications are owned by the provider. If the organization is in need of security for their applications, they can opt for private cloud, which is behind the firewall and can be accessed only by customers belonging to that organization. Hybrid cloud solution is a combination of both public and private clouds.

4.4 PROS AND CONS OF CLOUD COMPUTING

4.4.1 Risks in the Cloud

Cloud computing has many benefits as much as the risks associated with it. The risks should be analysed carefully before making a decision to apply cloud computing in the business.

For any IT organization privacy and security are the two major concerns. This should be considered and checked thoroughly while moving to cloud, both as a consumer as well as a vendor. Instances regarding security concerns in cloud computing are epic.org, Salesforce.com and Google Docs.

Currently, no standards are set for operations between various cloud providers. Cloud consumers must be aware of these issues while moving to cloud ecosystem.

4.4.2 Cloud Storage as Service: Pros and Cons

Storage services based on cloud computing cuts cost however, increase in data transfer (bandwidth) is the main concern. Usage of bandwidth and its charge exceeds the cost incurred for storage. Although there are public clouds offering storage as a free service, IT organizations are apprehensive about choosing them due to security reasons. Some cloud services charge less than 4 cents/GB, whereas providers offering storage as a service offer less than the former service.

4.5 CLOUD COMPUTING AND SERVICES: PROS AND CONS

The much hyped cloud computing is slowly turning into a reality now. This is also evident from the fact that big companies like Google have already started gearing up for this upcoming boom and have launched their first cloud-based device named Google Chrome book. The terminologies of cloud computing and cloud devices have become common in the web world; curiosity has pushed people to explore it, specifically its advantages and limitations. Like any other technique, cloud computing also has its own advantages and disadvantages. Until cloud computing and cloud-based devices start penetrating into common household, the practical difficulties will not be understood. Until then, it is based on anticipations and speculations. Let us try to understand the top five most important pros and cons of cloud computing and cloud-based devices.

4.5.1 Centralized Data Storage in Cloud Computing

Pros: All of your data, applications and software reside on centralized servers, which can be accessed from anywhere, any time and from any device.

Cons: Everyone may not be comfortable to share all their confidential data and applications on a third party server. Moreover, accessing of the data is not possible if the Internet is not connected. There is no option to work offline in case of connectivity failure. Also, there may be limits to the amount of data a customer can store on these servers, especially for those using shared servers. The speed and bandwidth usage will also be limited for shared server.

4.5.2 Cloud Servers Maintenance and Security

Pros: The end user do not have to maintain the hardware, software and all the security and antivirus software updates, the responsibility lies with the service provider totally.

Cons: As the whole loads of data and applications of customers are centralized , in case of a cyber attack or hacking the entire data is susceptible to easy access.

4.5.3 Data Access and Network Connectivity

Pros: It endows the end users to use the utmost mobility without bothering about bearing their burdens of data from one location to another by any hardware. For example, we start editing a document in our office and we can continue to edit from the left out page from our home or even while travelling in a car or from anywhere.

Cons: The unavailability of connectivity may leave users with nothing to do as they will lose access to all the latest data and applications when the connection remains down.

4.5.4 Cost Factor

Pros: It will benefit corporates and multinationals more than anyone else as they can save substantially on their operation costs, which can be diverted for other purposes such as buying, maintaining and upgrading newer hardware and software. Similarly, they can also save a lot on hiring huge manpower and technical experts for providing hardware and software supports.

Cons: It may requires a detailed analysis to understand the real cost saving, if any. This is due to the fact that the major corporates and companies are concerned more on speedy access the data, security and availability. This would mean that they will have to look for dedicated server options rather than shared servers, which will only add to the cost rather than cutting it down. At this point, one could not come to the conclusion that the cost saving is possible. It may be even otherwise.

4.5.5 Cloud Servers Data Backup and Availability

Pros: Retaining a back-up of data is also a service provider's responsibility. It means that the back-up should be fool-proof enough for the user in terms of losing data or missed back-up routines.

Cons: Another complexity of the issue is centralized back-ups. There is a chance of losing the data updated during the period of taking two consecutive back-ups, because the back-up schedule of the customer's plan may vary. More so, since the same operator has the back-up responsibility, should there be some hiccups in their back-up process. This can prove quite fatal to customers relying only on their service providers for furnishing of data.

SUMMARY

- Information technology is continuously evolving.
- It becomes outdated as fast as it evolves.
- Technologies are based on two parameters: (i) the current investment rate and (ii) the current adoption rate.
- Cloud computing technology changed its focus from industry to real-world problems.
- Technology trends to watch for are: (i) virtualization, (ii) data growth, (iii) energy and Green IT, (iv) complex resource tracking and (v) consumerization and social software.
- A cloud service can be replaced with any one of the following as Cloud * as a Service, where '*' can be replaced as, 'Desktop, data, platform, IT, infrastructure, testing, computing, security, software, storage, hardware, database, etc.'
- Cloud service models are (i) SaaS (Software as a Service), (ii) PaaS (Platform as a Service and (iii) IaaS (Infrastructure as a Service).

- Private and public clouds are defined based on their relationship and as the subsets of the Internet.
- Many types of cloud deployment models are available; they are private, public and hybrid models.
- Cloud computing has many benefits and risks.
- Storage services based on cloud computing does cost cutting, but increase in data transfer (bandwidth), which is the main concern.

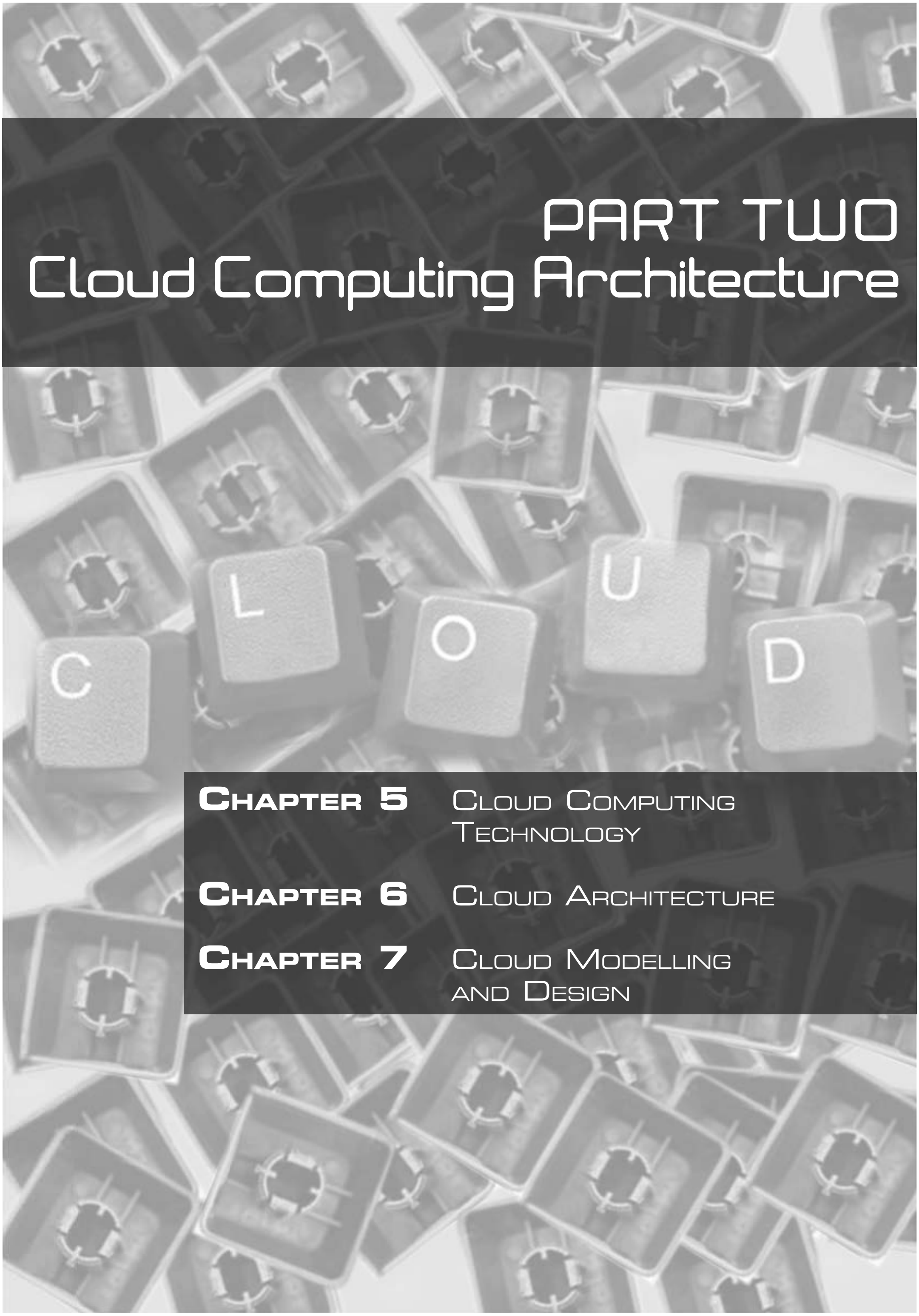
KEY TERMS

- IT maturity analysis provides an insight into how mature a technology is compared to other technologies and how quickly it is adopted and is expanding.
- Social software applications include communication and interactive tools based on the Internet.
- Power to performance effectiveness (PPE) is an important point, which reviews IT efficiency at the intersection between facilities and IT.

REVIEW QUESTIONS

- What is the difference between traditional data centres and a cloud?
- What are the three cost factors associated with cloud data centres?
- How are cloud services measured?
- What are the optimizing strategies used in a cloud?
- What are the different data types used in cloud computing?
- What are the security laws that govern data in the cloud?
- List out some large cloud providers and their databases?
- What are open source cloud computing platform databases?
- What are system integrators?
- What is the requirement of virtualization platforms in implementing cloud?
- What is the use of eucalyptus in cloud computing environment?
- How will users gain from utility computing?
- What are the differences between cloud computing and computing for mobiles?
- How do you secure your data for transport in cloud?

PART TWO
Cloud Computing Architecture



CHAPTER 5

Cloud Computing Technology

5.1 Cloud Lifecycle Model

5.2 Role of Cloud Modelling and Architecture

5.3 Reference Model for Cloud Computing

5.4 Cloud Industry Standard

5.1 CLOUD LIFECYCLE MODEL

Cloud computing technology is capable of significantly transforming IT and also enhances responsiveness towards business requirements concurrently providing cost-effective infrastructure, platforms and applications. Contrarily, it can scale up the IT and also add to complications. On one hand, the IT sector is dependent on virtual machines, and on the other, there is rapid progress in lively infrastructure, which implies that the IT sectors must take vital decisions on supported platforms, degrees of flexibility and scalability using a unified management strategy.

The answer lies in realizing a solitary, unified phase that can effectively supervise every part of the cloud lifecycle through both internal and external cloud supplies through self-service provisioning by providing support and decommissioning. The lifecycle should have the ability to consider the requirements of the business providing elasticity to deliver user-configured, multi-tiered cloud services. The management should ensure operational integrity of the cloud from start till end. It should also use a policy-driven provisioning process through a self-service gateway supported by a service directory.

The lifecycle management of cloud is so efficient that the IT sector can easily achieve the primary goals of a cloud environment such as agility, cost savings and optimal use of resources. Currently, many know-how associations are trying to adopt cloud computing for applying virtualization in their data centres. The traditional virtualized environment can be extended to cloud lifecycle management. It can deliver an operational model for the lifecycle of cloud services and deploy public clouds in a hybrid model. All resources in the environment go through a lifecycle if they are distinct and are appropriately programmed. It provides a flawless and customized service for both the IT and the business.

Cloud lifecycle management provides:

- Ease in administrating cloud and service portal
- Manageable service
- Established multi-tenancy
- Include performance and capacity management
- Support heterogeneity

Cloud lifecycle working group documents the observations for effective modelling and thereby helps in understanding the dynamical and thermo dynamical processes of the clouds in climate and weather analyses models. The objectives of this working group are as follows:

- To identify questions related to cloud lifecycles.
- To maximize the efforts of the investigator by answering the questions.
- To make understanding easy for cloud lifecycle process by prioritizing the strategies and observational data.

Cloud computing is an effective model which enables convenient on-demand network access for the shared resources thus reducing the burden of the management. The scope of cloud computing is to offer scalable and inexpensive on-demand computing infrastructures with high-quality services. A cloud engineering discipline has its own lifecycle model like other engineering disciplines, for a systematic and scientific development of the cloud known as cloud development lifecycle model. The Cloud Life Cycle (CDLC) is the repeated life cycle model for growth, deployment and delivery of cloud. Cloud is organized in a linear manner and every phase is processed individually. Therefore, it is the most simplest and flexible process model. The outcome of the one phase of CDLC becomes input to another phase. In this model, a cloud environment development begins with requirement and analysis phase. After effectively demonstrating and understanding the requirement, the architect phase starts. The quality assurance and verification phase continues after completion of implementation and integration, monitor and migrate. Audit begins after completion of the deployment, testing, maintenance and improvement.

5.1.1 Phases of CDLC

Figure 5.1 shows the different activities and feedback of CDLC in achieving the desired cloud. In this lifecycle model, feedback is used in which a phase gives the necessary information to the preferred upper phase. Among these phases, the second, fourth, fifth and sixth phase give response to the first phase.

Requirement and Analysis

Requirement and analysis method is used to evaluate and understand the requirements of an end user. This is done by taking up the significant complaints from the user, network solution, management and customers of the present system. Once these complaints are thoroughly studied, a tentative cloud computing solution is arrived, which minimizes the deficiencies and meets one's requirements. Solution such as computing cost, scalability, organizational agility and benefits can

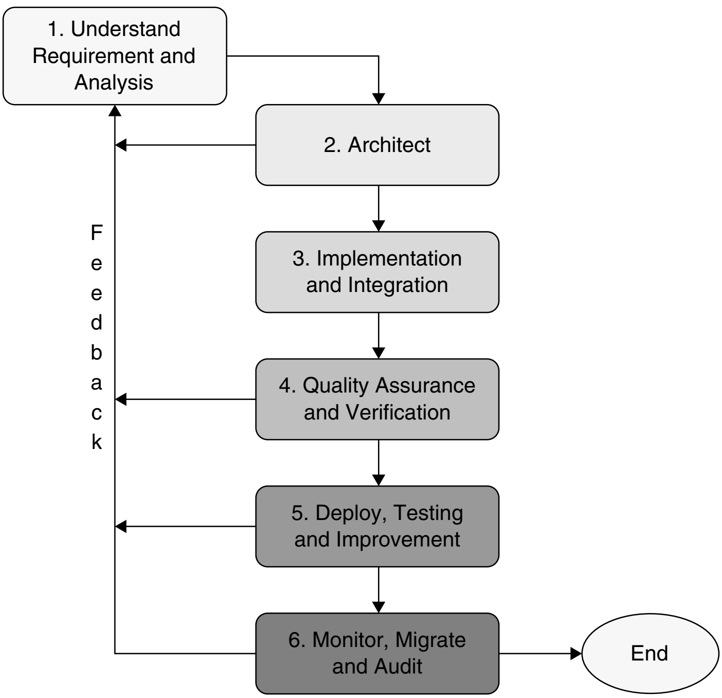


Figure 5.1 The Cloud Development Lifecycle

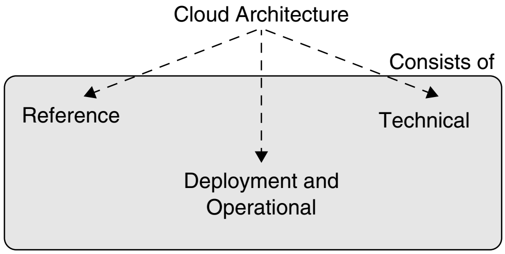


Figure 5.2 Cloud Architecture

be assessed through this phase. Cloud computing results such as privacy, security, maturity of the organization, risk involvement, reliability, performance and portability are different aspects to be considered before adoption.

Architect

The structural behaviour of the cloud architecture gives solution to the cloud system which comprises of on-premise resource, cloud resources, cloud services, cloud middleware, software components, data server location and externally visible properties of data server location. Figure 5.2 shows that the components of cloud architecture are reference architecture, technical architecture and deployment and operational architecture.

Implementation and Integration

Third phase of CDLC is the actual formation and enablement of the private, public, community, hybrid, inter and hosted cloud solutions to a computing problem.

Implementation: Events such as privacy, protection, regular, legality, mentality, inter-machine message and privacy theory are addressed within the implementation phase. Two components of cloud computing are implemented in this phase. The implementation of file system is the first case. The file system is the key component of the system to support massive data storage and management. The implementation of map-reduce system is the second case. This also performs the task of integrating the different cloud solutions in one cloud environment. This phase deploys different resources, services and applications to the cloud. This phase also gives training to the end user so that he/she can accept the new network solution easily.

Integration: Integration is intermediate between the source and target systems for extracting data, mediating and publishing it. In the present economy, businesses and enterprises are shifting to cloud technology due to the low costs, scalability and independent IT constrained resources. Large organizations integrate into cloud environment with their available systems. Five possibilities and recommendations for integrating into cloud effectively are as follows:

1. Plan and set realistic goals
2. Learn from other's experience
3. Require IT specialist team
4. Address security concerns
5. Maximize connectivity options

Quality Assurance and Verification

In this phase, cloud auditing is done to ensure the quality of the cloud network. It also confirms the performance, reliability, availability, elasticity and safety of cloud network at the service level.

Deploy, Testing and Improvement

Different platform service providers drastically reduce the deployment cost of the application by pre-building and pre-configuring a stack of application infrastructure in this phase.

Monitor, Migrate and Audit

This phase is marked by periodically monitoring the cloud environment and measuring the performance of the system. The extra cost and worth that a client incurs moving to cloud from the traditional SOA method and furthermore integration with the existing methods are considered in this phase.

5.1.2 Case Study: Oracle Cloud Management—An Overview

This section discusses the case study of Oracle Corp. dealing with cloud computing and the various service offerings and components available in its cloud platform. It lists the planner, cloud lifecycle capabilities of enterprise manager used by Oracle Corp for managing resources, usage of metering for charging.

The Oracle Cloud Solution

Organizations require an effective solution to support the thousands of parallel applications used for their business demands. The growth in their business has added to their cost in terms of the storage and server. Organizations can share resources such as storage, server and workloads using the IaaS, PaaS and DaaS models. The advantages using these models are reduced cost, agility and more QoS.

The other advantages of using or adopting cloud computing are increased QoS, rapid application development and deployment, elasticity and speed.

Cloud Management Lifecycle

The enterprise manager (Figure 5.3) manages the lifecycle such as planning, setting up, building, testing and deploying, monitoring, managing, metering, charging and optimizating.

- *Planning*: Enterprise manager helps in creating a cloud set-up with brand new hardware, new software and even a new data centre.
- *Set-up*: Enterprise manager adopts the IaaS, PaaS and DBaaS model clouds and the various services offered by these models.
- *Building*: Packing and publishing of applications are done with the help of the available cloud computing services.

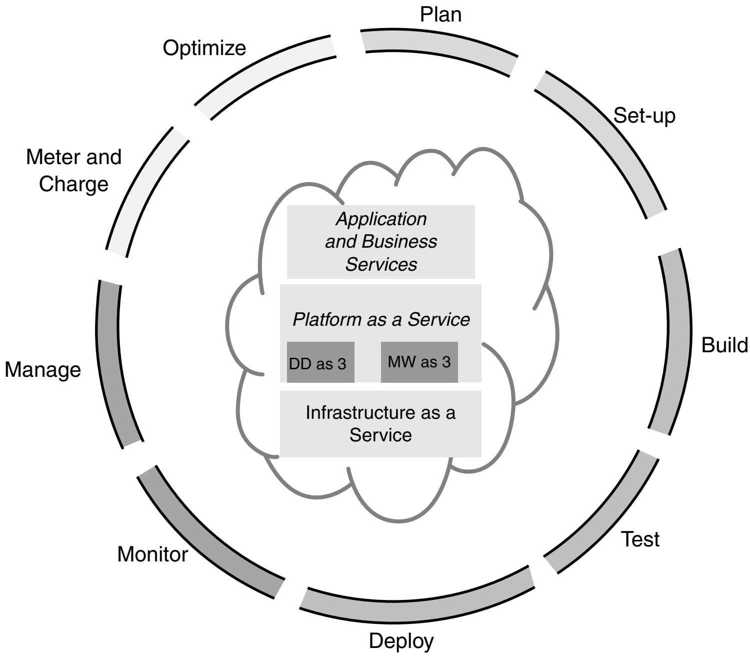


Figure 5.3 The Cloud Lifecycle

- *Testing and deploying*: After building an application, it has to be tested. The testing portfolio available in enterprise manager does this job. The resultant changes due to the testing are stored in the database. Testing also estimates the load capacity after deployment.
- *Monitoring and managing*: It monitors the settings, standards, policies and organizes for better management.
- *Metering, charging and optimization*: Usage of resources such as CPU, storage (GB) and memory are to be metered and charged accordingly.

5.2 ROLE OF CLOUD MODELLING AND ARCHITECTURE

5.2.1 Cloud Computing Model

Cloud computing model supports convenient, on-demand software using the Internet. The computing devices used are released after usage without any manual intervention. The model for cloud computing supports the availability comprising of five required characteristics, four deployments and three service structures.

5.2.2 Necessary Characteristics

- *On-demand self-service*: Any customers can unilaterally use computing capabilities such as network storage and server time as desired without human interaction with every service provider.

- *Broad network access*: Services are networked and can be accessed over standard mechanisms which promote use in mixed thick or thin user platforms (e.g., handheld devices such as mobile phones, laptops and PDAs).
- *Resource pooling*: Resources of providers are grouped to serve multiple users by means of a multi-tenant structure along with different virtual and physical resources assigned dynamically.
- *Rapid elasticity*: Services can be run elastically and rapidly to speed up scale out and fast release. As for the customer, the services available for running often, appear to be unlimited that can be bought in any amount at any point of time.
- *Measured service*: In cloud system, controlling and optimization of resources happen automatically and it is done by controlling and metering at some stage of abstraction appropriate to the kind of service, for example, the bandwidth, processing, storage and accounts of active users.

5.2.3 Service Models

- *Cloud software as a service*: These are capabilities provided to the customer to deploy applications in the infrastructure provided by the service provider. Deployed applications can be accessed by any device supported by WWW. In this case, controlling or managing the network, server, operating systems, storage, memory or even single application with the possible payment of user-specific application setting and configuration are not done by the customer.
- *Cloud platform as a service*: The service includes installation on the cloud system infrastructure created by the user itself or is an acquired application that may be written in some programming language using tools that are supported and/or provided by the service provider. The end user does not control or manage the infrastructure of cloud computing system that comprises servers, networks storages or operating systems.
- *Cloud infrastructure as a service*: In this, same capabilities and resources are provided but the consumer can deploy and run the software. The user does not control the infrastructure.

5.2.4 Deployment Models

- *Private cloud*: These are functions within the organization and behind the firewall.
- *Community cloud*: This cloud infrastructure is common to several organizations.
- *Public cloud*: This cloud infrastructure is available to public or large industries.
- *Hybrid cloud*: It is a composite of two and more clouds.

5.3 REFERENCE MODEL FOR CLOUD COMPUTING

A reference architecture (RA) provides the blueprint and/or architecture reused by others with some changes. A reference model (RM) explains what the reference architecture comprises and its various relationships. RA and RM help cloud computing in terms of quick formation of framework. The detailed and generalized version of reference framework is shown in Figure 5.4.

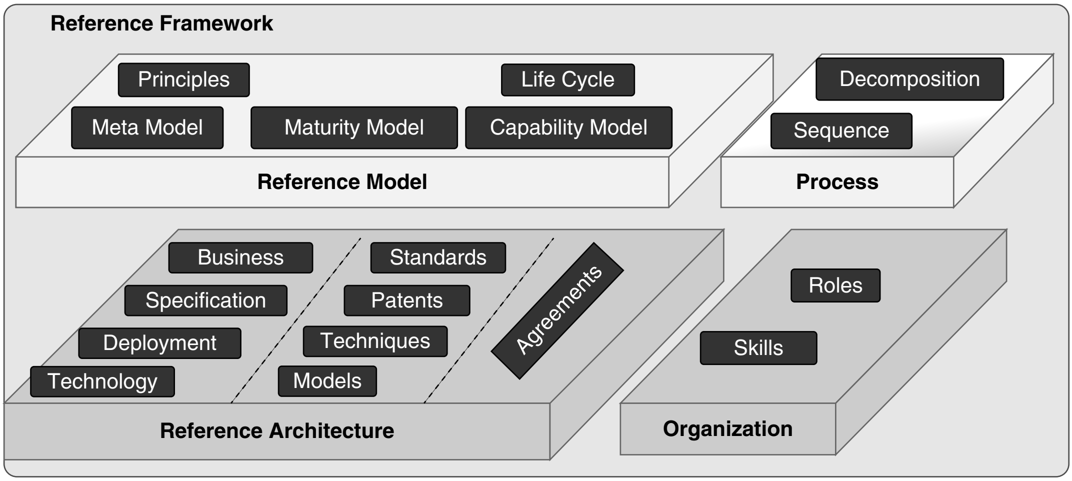


Figure 5.4 Generalized Reference Framework

A reference framework consists of reference model, reference architecture, process and organization. Reference model takes care of laying foundations in principal and designs models such as meta model, maturity model and capability model. Reference architecture is divided into two parts:

1. Views in-terms of business, implementation, deployment and technology
2. Practice in-terms of standards, patterns, deliverables and models

Process does decomposition of the given job and sequences it. Organization specifies the roles and responsibilities of the in-house staff according to their skills.

The advantage of this framework is that elements can be mapped in different ways, that is, different problem scenarios and solutions, but a single framework.

5.3.1 Reference Architecture, Frameworks and Models for Cloud Computing

There are many frameworks and models for cloud computing. Reference models are of two types—role based and layer based. In role-based model, cloud provider and consumer are considered as roles. Examples are DMTF, IBM and NIST cloud models. In layer-based model, application and resources are considered and layers and their capabilities are mapped. In both types, they contain roles, activities and layered architecture.

5.3.2 Case Study 1: Cloud Computing Model of IBM

Figure 5.5 shows the architecture of cloud computing reference model. It provides a technique to understand the multiple offerings and demonstrates the company's experience in addressing such a complex subject, and it is important. IBM has very reputed customers like HP and Fujitsu; in fact, private cloud was built by IBM for their customers.

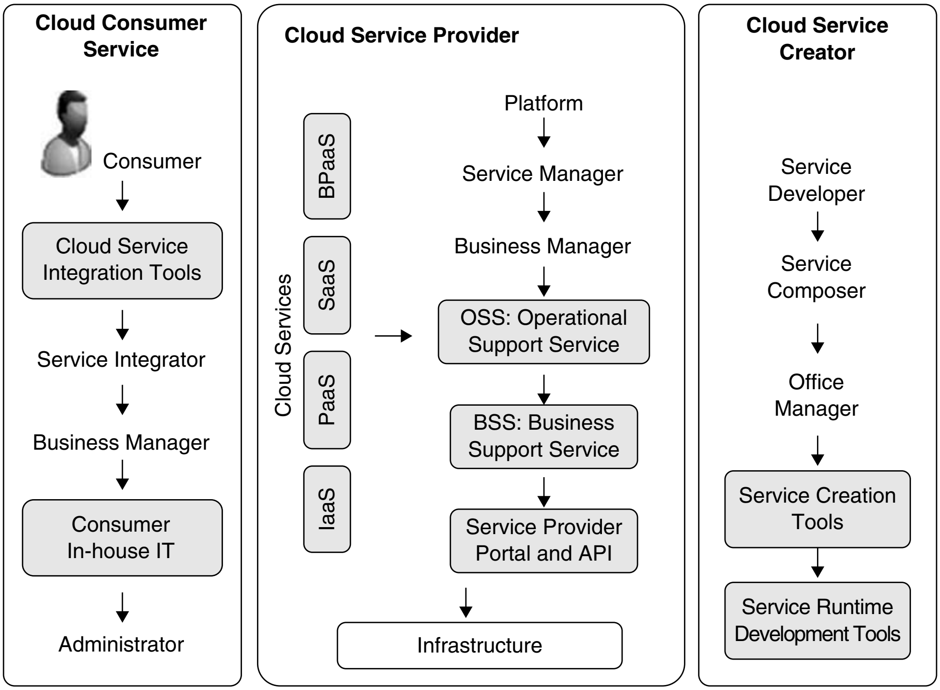


Figure 5.5 Cloud Computing Model of IBM

A Customer-focused Approach

The architecture has more than 14 user types and their interest varies from creators to end-users in cloud computing. In particular:

- In the left part in the above reference model, that is, 'Cloud Service Consumer', it comprises of the end-user, service integrator, business manager and administrator function.
- In the centre, that is, 'Cloud Service Provider's part', it consist of services and business manager roles cooperating at the top with the common cloud management policy, while includes deployment architect, security and risk, operations and transition manager and customer care roles.
- On the right side in the above reference model part, that is, 'Cloud Service Creator' area, it includes service component developer, service composer and offering manager roles.

Four types of cloud services available in IBM cloud architecture are as follows:

1. *IaaS*: This was the earliest offering from system vendors like Google, Amazon and other public cloud suppliers. The introduction of a standard architecture should encourage users to benefit by off-loading peak workloads to their providers for many years.
2. *PaaS*: In IBM's model, focus is more on supplying tools for consumers to build, deploy, manage and integrate applications in a public or virtual private cloud with the support of processing, storage and networking.

3. *SaaS*: Apart from LotusLive contributions IBM has a number of middleware, which is available ‘as a service’, for example, Tivoli Live (SaaS monitoring) and Blueworks Live (BPM). Additionally, it has number of Smarter Commerce SaaS offerings, which includes Sterling Commerce, Unica, Coremetrics and SPSS. Success in these services makes IBM the most important software broker, while its partners address the mid-market and SMB region.
4. *Business process as a service (BPaaS)*: This approach is unique to IBM. IBM incorporates all its technical and business services contributions here.

IBM’s own research exhibits the extent to which cloud computing is becoming one of the top subjects for CIOs and it has been very popular that many large companies have started to virtualize their data centres from where their internal cloud services are running. On the other hand, cloud computing remains a perplex and potentially expensive investment for most businesses. Its RA is significant as it helps to demonstrate the interconnections between developers, partners, users and IBM itself. In future, Cisco, VMWare, Oracle, HP, Fujitsu, Intel may come up with alternative suggestions apart from IBM’s reference model.

5.4 CLOUD INDUSTRY STANDARD

In any web-based technology the application programming interface (API) is the most important part. Without APIs, the technology involved would be restricted and severely limited in its capabilities. Cloud computing using APIs have interesting ways of storing and transferring data, and it would not have developed to what it is today without the use of APIs. As Cloud Computing nurtures and expands, so will APIs grow to give developers better accuracy in communication. Although APIs are necessary in the cloud, it does not come without a hitch.

One of the main considerations is the standards. Although development is going on in the API standards within cloud computing, it will take several years to complete a fully developed project of this scale. Some of the developers believe that developing a set of cloud API standards is most crucial for the future of cloud computing, while others don’t think so. However, without standards it could be incomplete. For example, if every cloud systems were based on different standards, transferring the code used to manage a particular cloud may become impossible. Irrespective of the standards, if you want to transfer to a different cloud provider, you have to take the risk of rewriting your application to suit your requirements. This is time consuming and a very costly process.

In 2010, the website *ReadWriteWeb* conducted a polling of their visitors and they came up with the result, that nearly 50% of the responses stated that Amazon S3’s API is a standard one, while around 11% of responses pointed out that API standards were not necessary at all. There is no doubt that Amazon has made huge contributions to development of cloud computing but they have done it for a price, and not for the welfare of the cloud computing society.

While some developers think standards stop innovation, there are others who will accept that the cloud computing industry is ready for API standards. Cloud computing is still in its formative stage and there is still a long way for it to go. There is no end to innovations but there will be a point, where the cloud will be manure enough that it will need standardization. Organizations like VMware are seriously working towards creating a bright future for cloud computing by developing platforms. The OpenStack project with the support of more than 100 companies is working towards building a cloud ecosystem.

5.4.1 IEEE Outlines Cloud Computing Standard for Industry

IEEE initiated the process for the development of standards in cloud computing.

David Bernstein, Chairman of IEEE commented that governments and IT organizations are using their own reference model for cloud. A well-established, published document would help IT industry in defining the cloud computing process better.

The first and foremost step for creating standards is to publish it in the Internet and compare the queries. This will polish the standards and can be used to request comments from visitors, that is, RFC (request for comment).

Groups preparing the standard should interact with IT organizations at the drafting stage, and the organizations should also use the standards. The ideas proposed in the standard should focus everybody involved including consumers, participants and vendors.

The cloud computing industry has prepared to accept some standards. Collectively, the industry is trying to prove that cloud is a secure, reliable and attractive way to travel. Problems of one vendor had reflected on the entire industry and therefore it is time to set standards by fixing minimum levels of redundancy and also a backup.

SUMMARY

- Cloud computing is capable of transforming the IT sector and enhance responsiveness towards business requirements.
- IT organizations are approaching cloud computing for implementing virtualization in their data centres.
- The traditional virtualized environment can be extended to cloud lifecycle management that can deliver an operational model for cloud services and deployment.
- Cloud lifecycle management provides five services.
- Cloud computing is an effective model, which enables convenient on-demand network access for the shared resources.
- There are five possibilities and recommendations for integrating into cloud effectively.
- Organizations require an effective solution to support the thousands of parallel applications used for their business demands. Organizations can share the various resources such as storage, server and workloads using cloud computing models such as IaaS, PaaS and DaaS.
- The advantages of cloud computing are (i) increased QoS, (ii) rapid application development and deployment, (iii) elasticity and (iv) speed.
- Cloud computing model supports convenient, on-demand software using the Internet.
- Cloud computing supports availability and comprises of five characteristics, four deployment and three service structures.
- A reference architecture (RA) provides a blueprint and/or architecture, reused by others with slight modifications.
- A reference model (RM) explains what the reference architecture comprises and its various relationships.

- In cloud computing, RAs and RMs help in forming frameworks speedily.
- APIs are using for storing and transferring data in cloud computing.
- A well-established document if published would help the IT industry in defining the cloud computing process better.

KEY TERMS

- Cloud lifecycle management software enables IT organizations to choose either private or hybrid cloud.
- MapReduce is a programming model for processing vast information sets via Google.
- The cloud computing type saves cost aggregated with advanced IT agilities.
- An application programming interface (API) is a description by which one piece of software asks another program to perform a service.

REVIEW QUESTIONS

- List the benefits of cloud lifecycle management.
- Explain the objectives of cloud lifecycles.
- What are the phases of CDLC?
- List the recommendations for solving the integration puzzle.
- What is the use of quality assurance and verification?
- Give an overview of Oracle's cloud management model.
- What is a cloud computing model?
- What are the characteristics of cloud computing model?
- List the deployment models.
- What are the parts of reference architecture?
- Give examples for cloud service reference architecture.
- Discuss in detail IBM's cloud computing reference model architecture.
- What are the significances of IBM's cloud computing reference model?
- What is the use of API in cloud computing?

CHAPTER 6

Cloud Architecture

6.1 CLOUD COMPUTING LOGICAL ARCHITECTURE

6.1.1 Cloud Computing Architecture

Cloud computing is an Internet-based technique using shared resources available remotely. In this computing technique, the internal functions are kept away from the end users. This technique is new to the IT field and is a product where applications are accessed via the Internet.

So far no exact definition for cloud computing is available, however, it can be defined as: '*cloud computing is a type of computing environment, where IT businesses outsource their computing needs, which include software application services to outside vendors when they are in need of computing power or other resources like storage, database, e-mails, etc., which are accessed via WWW.*'

Cloud computing system can be divided into two parts: front end and back end. The interconnection between them is done via the Internet. Front end is used by the customers and back end refers to the service providers.

The front end contains customer's devices comprising of computers and a network and applications for accessing the back end system, that is, the cloud systems. Front end refers to the interface through which a customer can make use of the services rendered by the cloud computing system.

Back end contains physical devices or peripherals. It also contains various computer resources such as CPU and data storage systems. A combination of these resources is termed as cloud computing system. A dedicated server is used for administration purpose. It monitors the consumer's demands, traffics, etc.

A provider who renders service may have multiple consumers requiring large storage space. When we adopt cloud computing, the size of storage has to be increased, as it tries to store all the information about the clients. Cloud computing is no more a new technology due to its multifarious nature it has gained popularity among small- and medium-sized enterprises. In cloud computing, all of the consumer's data are not stored in his premises, but in the service providers storage premises. When the consumer is in need of any data, he can retrieve it via the Internet.

6.1.2 Examples of Cloud Computing

Gmail and Yahoo are examples of cloud computing technology. When a user sends or receives e-mails, he does not use any application software available in his computer, he just uses the Internet connection. The operating cost of cloud computing is comparatively low considering an individual infrastructure. The only concern in the cloud computing technology is security and privacy.

6.1.3 Cloud Computing Types

Cloud computing environment can be broadly classified based on its infrastructure—public cloud, private cloud and hybrid cloud.

- *Public cloud*: This is off-premises or external. Public cloud is a widely used model where infrastructure comprising of hardware systems, network, storage and applications are provided and owned by the provider. When the organization needs some kind of security for its applications and data, they resort to private cloud, which is behind the firewall and accessed only by customers belonging to that organization.

- *Private cloud*: It is an on-premises or internal cloud set-up.
- *Hybrid cloud*: It is a combination of both public and private clouds.

6.1.4 Why do We Need Cloud Computing?

The main purpose of cloud computing is to save on the consumer's infrastructure and maintenance cost. A consumer has to pay service charges for usage of various resources. Moreover, consumers opting for cloud computing technology need not worry about updating software, backups and anti-virus.

6.1.5 Problems with Cloud Computing

Cloud computing is cost-effective for IT organizations in terms of maintenance and operation, however, the major concerns are security and privacy. Besides the security concerns, compared to the other existing computing solutions, there is scope for cloud computing to become a matured computing system because of its cost effectiveness and reliability. As the data are outsourced and resides in vendors premise, there are chances for an element of doubt always about the security and privacy of data.

Especially, sensitive data of banks and governments. In case there a leak in consumer's information, for example, credit card details, it is problematic for the service provider as well as the consumer. Cloud computing will be opted mostly by the business enterprises which have strict rules and standards for its operation.

6.1.6 Cloud Computing Service Architecture

Google Apps is a computation service of Google's business solution. Other big names in cloud computing services are Microsoft, IBM, Amazon, HP and DELL.

The following three types of services are available with a cloud service provider (Figure 6.1).

1. *Infrastructure as a service*: The service provider takes care of the cost for the resources such as servers, equipments for networking, backups and storage.
2. *Platform as a service*: The provider only renders the platform or solutions for the consumers.
3. *Software as a service*: The provider will provide the consumers with software applications available in his/her premises.

6.1.7 Understanding Cloud Computing Architecture Models

The major challenge in cloud computing is that, there is no defined standard or architecture. Cloud architectures can be viewed as a collection of different functionalities and capabilities. A cloud computing system has various IT resources deployed in remote places designed to run applications dynamically.

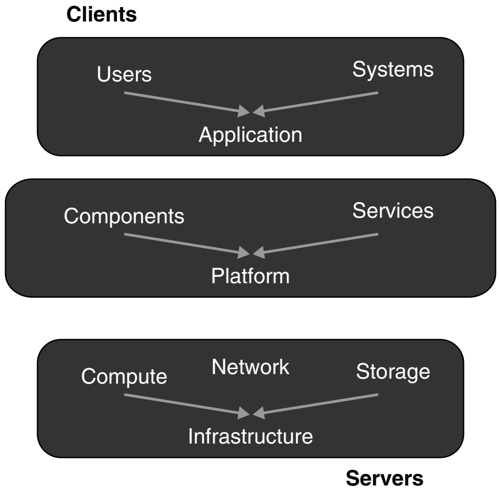


Figure 6.1 Cloud Computing Stack

Cloud Computing Models

The potential of cloud computing is interesting and limitless in terms of its applications.

A simplest cloud computing model consists of a collection of servers, which are virtualized using a tool. This model appears to be a single pool having many servers. Problems persist in these types of models, where servers are dedicated to a particular set of application.

Cloud architectures use a tool, that deploys the cloud supported applications. An example is PaaS model which is used in Salesforce.com.

The other model is meant for network providers, who need storage and server technology. The providers will render these resources and consumers will create an image or instance and make use of it. The original server and storage will be residing in the provider's premises.

The full version of cloud computing model uses virtualization technology for making the resources virtual. The resources such as network, storage, computing power, etc., are virtualized. Examples are IBM/Google cloud computing model developed by Cisco.

6.2 DEVELOPING HOLISTIC CLOUD COMPUTING REFERENCE MODEL

The term 'cloud' in cloud computing refers to a combined set of hardware, storage, networks, services and interfaces.

Consumer cloud computing services are widely used in the Internet. Examples are e-mails and social networking sites. Usage of cloud computing by the IT organizations sector is low, because of security risks in terms of privacy of data.

While adapting to the cloud services, documentation of data is essential and the same should be shared with the consumers. The documents should cover governance, compliance and risk factors.

Data are stored in servers across boundaries. Every country has different cyber laws, and this has to be taken in account while transferring data across borders.

6.2.1 Cloud Computing: Taking a Complete View

Cloud computing is not just a technology play in fact, it may be hard to identify a single piece of technology, that is fundamental to cloud. Cloud computing makes much more efficient use of resources. In olden days, resources were essentially used for processing power and storage but increasingly the focus of cloud converged on efficient use of software resources. The concept of payment per usage attracted users to opt for the service, because of its cost-effectiveness.

Over the next 10 years, this technology will be in use until it backfires and a new replacement technology is invented. What makes cloud so interesting currently is, that every one of the global vertical industries has two questions: firstly, how do we become a cloud user to enable more efficient operations and secondly, how do we leverage our existing platforms to become a cloud provider.

6.2.2 Complete View of Cloud Management

Cloud computing has not yet reached its full potential. Obstacles for cloud adoption lie in the confusion among different delivery models and deployment methods. Other concerns on risking outsourcing of cloud management are data legislation issues, inability to assess service providers, etc. In addition to cloud environment as a concept, it also has technological obstacles, making service provisioning a complicated process.

The five top level research areas for analysing obstacles in cloud computing are as follows:

1. Optimization in deployment and construction of cloud services.
2. Self-preservation in resource management.
3. Self-management for various cloud services and decision making.
4. Support for service deployment.
5. Market and legislative issues.

6.2.3 Cloud Computing Reference Model

The cloud computing reference model (CC-RM) facilitates the process of modelling cloud architecture and planning the deployment activities. It also establishes a foundation for modelling cloud and its architecture, from which an IT organization can plan, architect, model and deploy to address business and technical challenges. Cloud is not a problem-solving architecture, it is a collection of services, which can be used to solve problems.

The cloud reference model consists of the following four elements/models:

1. *Cloud enablement model*: This model describes the various layers of cloud and its advantages for business operations. This model comprises of various cloud computing technologies and solutions for the consumers.
2. *Cloud deployment model*: The cloud deployment model (CDM) describes the various cloud models such as private, public, hybrid and community clouds.

3. *Cloud governance and operations model*: The cloud governance and operations model defines the requirements for cloud computing such as governance, privacy, security operations, management, support and monitoring.
4. *Cloud ecosystem model*: The cloud ecosystem takes cares of development and sustenance. It consists of cloud providers, consumers, intermediaries and networks.

The cloud computing reference model has four sub-models, they are as follows:

1. *Cloud virtualization tier*: Cloud virtualization tier focuses on the tools that provide hardware and infrastructure virtualization, computing, storage, network and security virtualization.
2. *Cloud operating system tier*: Cloud operating system tier focuses on the technologies that enable virtualization of resources as cloud-enabled capabilities. Cloud OS tier provides provisioning, billing and metering, load balancing, resource management, monitoring and management, workflow and orchestration of cloud-enabled resources.
3. *Cloud platform tier*: It focuses on enabling the PaaS oriented services and includes SOA and Web services concepts.
4. *Cloud business tier*: Cloud business tier focuses on the various range of business capabilities and business solutions, that are designed and provisioned to consumers as services via the cloud.

Cloud Deployment Model (CDM)

The CDM provides an open framework for identifying the necessities and differences of various cloud deployment environments.

The CDM l and the CEM are key decisions that determine aspects such as security, architectural and management challenges. The various CDM scenarios are private internal cloud, public external cloud, hybrid integrated cloud and community cloud.

The CDM and CEM are central necessities of the cloud computing reference model.

Cloud Governance and Operations Model

This model helps in making choices in cloud enablement approaches in terms of cloud deployment model. The primary elements of the cloud governance and operations model are cloud governance, security and privacy, management and monitoring and operations and support.

Cloud Ecosystem Model

The last model in CC-RM is the CEM. Cloud ecosystem is the physical, logical and virtual environment in which the cloud providers, consumers, solution and technology providers help cloud computing to run smooth and legitimate business and technology trend. The key elements of the cloud ecosystem model are cloud network/dial tone, cloud ecosystem enablement and cloud consumers and cloud providers.

6.3 CLOUD SYSTEM ARCHITECTURE

Figure 6.2 depict the examples of cloud-based architectures. These architectures can be deployed using the existing templates available in MultiCloud Marketplace.

Points to Consider

Factors to be considered while designing cloud-based architectures are highlighted as follows:

- *Cost*: Clearly understand the pricing details for various cloud models.
- *Complexity*: Analyse the complexity before customizing the cloud solution and check the requirements thoroughly before deployment.
- *Speed*: Check the speed for cloud model. Speed in terms of advanced CPU architecture, high memory, lowest latency and network infrastructure.
- *Cloud portability*: Check the portability. This allows the consumer to move from one vendor to another without making much changes in the architecture.
- *Security*: Check for the security measurements provided by the vendor.

6.3.1 Example Reference Diagram

Figure 6.2 shows the progress from simple to complex reference architectures.

Single Cloud Site Architectures

Figure 6.2 shows that, in the single cloud site architecture, load balancer, application logic, databases and storage are located in the cloud, that is, the load balancing server, application server and database server. If the user is only testing the interactivity between the tiers, he may use

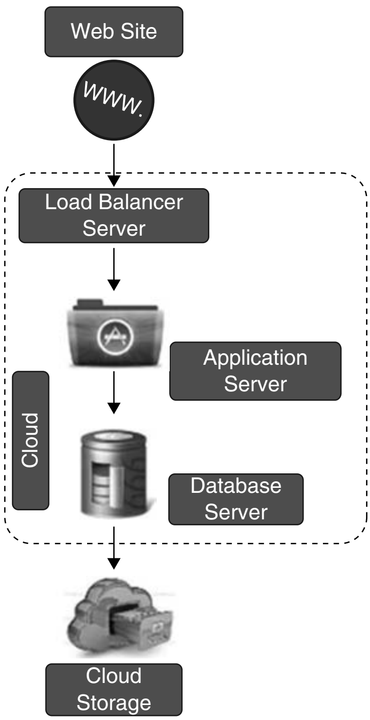


Figure 6.2 Single Cloud Site Architecture

this architecture to cut-short the resources costs. As shown in Figure 6.2, dedicated servers are available for each tier of the application which forms a non-redundant architecture. For manufacturing industry this kind of architecture is not recommended.

Redundant 3-tier Architecture

In Figure 6.3 we can see that two servers in load balancer, application and database are available. System downtime is reduced while adopting redundant architecture.

The figure demonstrates using of a striped volume set in redundant 3-tier architecture at the database, when it is huge and need faster backups for data storage.

Multi-datacentre Architecture

If the cloud infrastructure has many datacentres, it is recommended to distribute the system architecture to the datacentres for redundancy and protection.

Figure 6.4 shows the multiple datacentres in reference architecture. It shows the multiple datacentre architecture in which it has two datacentres, each having a load balancing applications, volume and master database. When one datacentre goes down, then automatically the other datacentre can be used.

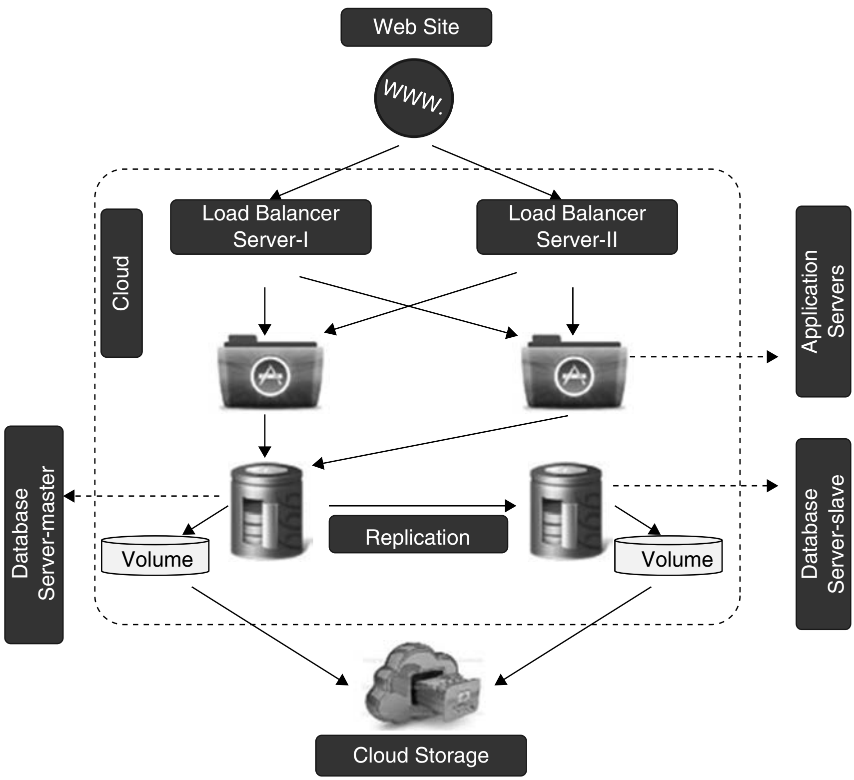


Figure 6.3 Redundant 3-Tier Architecture

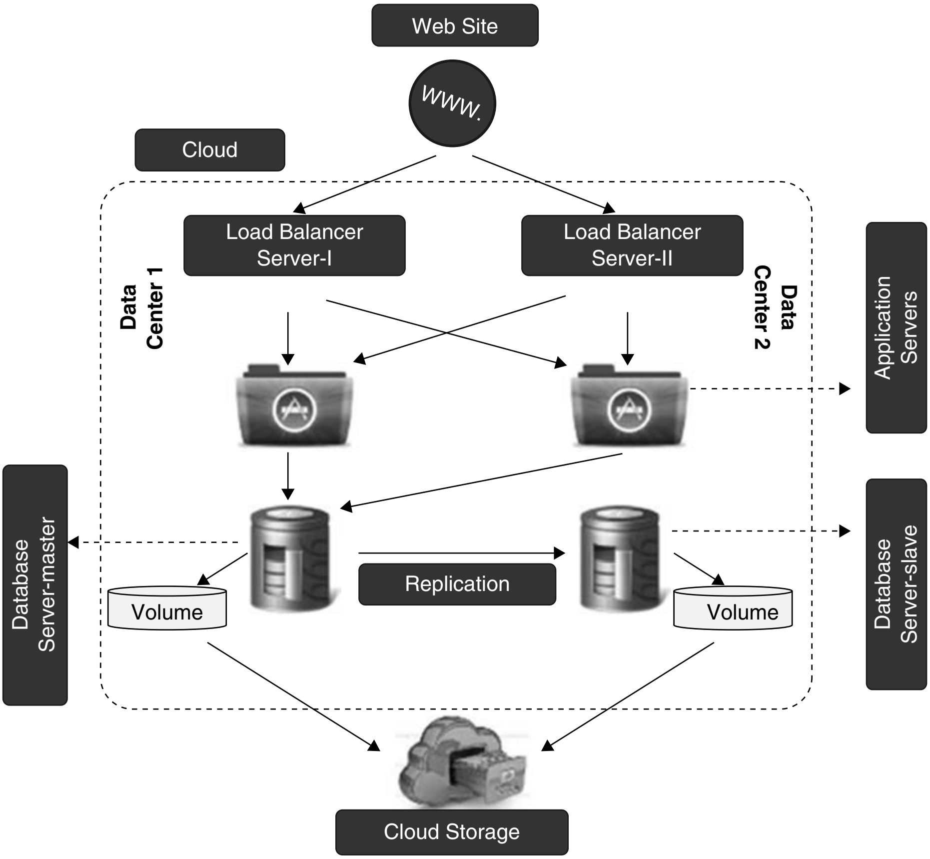


Figure 6.4 Multi-Datacentre Architecture

6.4 CLOUD DEPLOYMENT MODEL

6.4.1 Cloud Computing Deployment Models

NIST has standardized the characteristics of cloud computing as ubiquitous network access, on-demand self-service, elasticity, resource pooling and pay per use.

Private Cloud

Private cloud infrastructure is dedicated to a single organization. It is not shared with other organizations. Private cloud can be owned or leased. It can be managed by the IT organization or a vendor, who provided the service and can exist at on-premises or off-premises. Private cloud is more expensive and secure compared to the public cloud. Private cloud are flexible and service-based. Firewall protects private cloud from outsiders. It can be accessed by users within the organization via the intranet as shown in Figure 6.5.

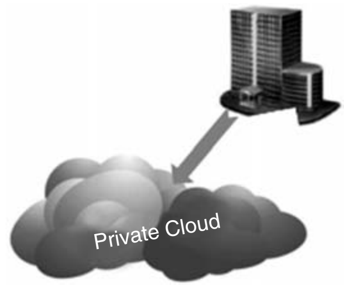


Figure 6.5 Private Cloud

Figure 6.6 Public Cloud

Public Cloud

Adopting public cloud type has an advantage in terms of cost, deploy time. Public cloud infrastructure is offered via web applications and also as web services over the Internet to the public as shown in Figure 6.6. Example of public cloud are CRM, Messaging and Microsoft Office products. In this environment the service provider have control over their clients.

Hybrid Cloud

Hybrid cloud deployment model exists due to varied needs of an organization. It is a combination of private, public and community cloud service deployment models as shown in Figure 6.7. Security is given more important in private cloud than in public cloud.

A combination of a public and a private cloud is put together for the purpose of keeping business-critical data and services in their control on private cloud and outsourcing less-critical processing to the public cloud.

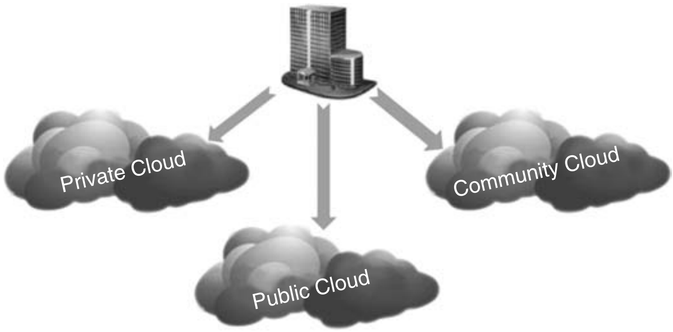


Figure 6.7 Hybrid Cloud

Figure 6.8 Community Cloud

Community Cloud

IT organizations share the infrastructure using community cloud as shown in Figure 6.8. Community cloud supports a particular community, that has common issues such as security requirements, missions, compliances, considerations and policies.

Combined Cloud

Combining internal and external providers termed as combined cloud. By integrating multiple cloud services, consumers can ease the transition to public cloud services.

Inter Cloud (Cloud of Clouds)

Mesh of cloud is called as inter cloud, which is interconnected using open standards to provide a universal acceptance.

6.4.2 Types of Cloud Deployment Model

There are three types of cloud deployment models; however, there is yet another type of cloud deployment model known as community cloud, which is being used in some instances. Table 6.1 lists the various cloud deployment models and highlights its characteristics.

Table 6.1 Cloud Deployment Models

Public Cloud	**Private Cloud**	**Hybrid Cloud**
• Provider owned and managed • Access by subscription • Economic benefits • Reduced IT service • Delivery cost • Reduced HW, systems, software, management and application costs	• Client dedicated • Access defined by client • Data governance rules/regulations • More secure • Economic benefits • Reduced capex • Reduced opex • Service level discipline	• Consume more resource in peak hours • Economic benefits • Scale private cloud for BAU • Maintain service levels by scaling externally • Share cost with vertical with charge back options
	Key Patterns	
• Users initiate the amount of use of resources • Scalability for compute resource is automated • Pay per use metering and billing	• Resource-driven provisioning of development, test and production systems, managing E2E lifecycle • Ease of deploying applications	• SLA exists and policies are driven based on SLA • Consumption of resources (storage, compute) are done automatically

SUMMARY

- ❖ Cloud computing is a type of computing environment, where IT businesses outsource their computing needs which includes software application services when they are in need of computing power or other resources like storage, database, e-mails, etc., which are accessed via WWW.
- ❖ Cloud computing system can be divided into two parts: front end and back end.
- ❖ A good example is Gmail and Yahoo, both use cloud computing technology.
- ❖ The operating cost of the cloud computing is comparatively low considering personal infrastructure.
- ❖ The only concern in the cloud computing technology is security and privacy.
- ❖ Cloud computing environment can be broadly classified based on the infrastructure: (i) public cloud, (ii) private cloud and (iii) hybrid cloud.
- ❖ The main advantage in cloud computing is that consumers need not pay for the infrastructure and its cost for maintenance.

- Mainly three types of services are available from a cloud service provider: (i) Infrastructure as a service, (ii) Platform as a service and (iii) Software as a service
- Cloud architectures can be viewed as a collection of different functionalities and capabilities.
- Simplest cloud computing model can be viewed as a collection of servers, which are virtualized using a tool.
- The cloud computing reference model (CC-RM) facilitates the process of modelling the cloud, architecture and planning the deployment activities.
- The cloud reference model consists of four elements/models: (i) cloud enablement model, (ii) cloud deployment model, (iii) cloud governance and operations model and (iv) cloud ecosystem model.
- The CC-RM has four sub-models: (i) cloud virtualization tier, (ii) cloud operating system tier, (iii) cloud platform tier and (iv) cloud business tier.
- Cloud-based solution architecture are (i) single cloud site architectures, (ii) redundant 3-tier architecture and (iii) multi-datacentre architecture.

KEY TERMS

- Public cloud is a widely used model where infrastructure comprising of hardware systems, network, storage and applications are provided and owned by the provider. This type of model provides an elastic, cost-effective way to deploy IT solutions.
- Private cloud is deployed on-premises or internally. This model is dedicated to a single organization.
- Hybrid cloud is a combination of both public and private clouds. Hybrid cloud deployment model exists due to varied needs of an organization. It is a combination of private and public cloud models.
- Community cloud supports a particular community, that has common issues such as security requirements, missions, compliances, considerations and policies.
- Infrastructure as a service: Here the service provider takes care of the cost for the resources such as servers, equipments for networking, backups and storage.
- Platform as a service: Here the service provider only provides the platform or solutions for the consumers.
- Software as a service: Here the service provider will give the consumers the software applications available in their premises for use.
- The ‘cloud’ in cloud computing refers to a set of hardwares, storages, networks, services and interfaces that are combined to deliver as a service.
- Cloud enablement model (CEM) describes the various layers of cloud and its enablement for business operations.

- The cloud deployment model (CDM) describes different types of cloud deployment models available to the various cloud models such as private, public, hybrid and community clouds.
- Cloud governance and operations model defines the requirements for cloud computing such as governance, privacy, security operations, management, support and monitoring.
- Cloud ecosystem model takes cares of developing and sustaining the model consisting of cloud providers, consumers, intermediaries and the network.

REVIEW QUESTIONS

- What are the parts of reference architecture?
- Give examples for cloud service reference architecture?
- Draw IBM's cloud computing reference model architecture.
- What are the significance of IBM's cloud computing reference model?
- What is the use of API in cloud computing?
- What are the types of cloud?
- Give examples for cloud computing.
- What are the concerns of cloud computing?
- Draw a neat sketch on cloud computing stack.
- What is a 'ultimate' cloud computing model?
- Explain the obstacles of cloud computing in five high-level research challenges.
- What is cloud computing reference model?
- List out the elements of the cloud ecosystem model.
- Define community cloud.
- Write about combined cloud.
- What is inter cloud (cloud of clouds)?

CHAPTER 7

Cloud Modelling and Design

7.1 CLOUD COMPUTING: BASIC PRINCIPLES

Cloud computing is a means to reduce cost and complexity of the IT, and helps to optimize the workload in hand. Cloud computing uses the infrastructure designed especially to work on the vast computing services with limited resources.

The rapid growth of cloud computing offers efficiency in cost saving for businesses and individual users. The main advantages of cloud are ability to scale data storage and dynamic computing power saving cost. These benefits will

- Improve government services and citizens' access.
- Transform businesses.
- Provide new innovations to consumers.
- Create energy savings.

To utilize cloud computing to the fullest cooperation between governments, industries and individual users is important. In cloud computing environment we have to

- Build assurance in cloud by protecting users' interests.
- Support the developments of standards and required infrastructure.
- Simplify laws and policies to promote investment to achieve usage of cloud computing.

Factors for promoting the cloud computing are as follows:

- Cloud users need assurance regarding security risks. To achieve this, cloud service providers must adopt comprehensive security practices and procedures which include:
  - Well-defined, transparent and certifiable security criteria.
  - Strong identity, authentication and access organized mechanisms.
  - Comprehensive testing of security measures before and after deployment.
- Illegal activities such as digital theft, fraud and malicious hacking are a threat to both the consumers and the service providers.
  - Cyber laws should be updated.
- Data portability is a key consideration of cloud consumers.
  - Cloud providers must ensure interoperability and portability are available to the consumers. Government agencies should authorize standards for interoperability and portability.
  - While government develops and deploys cloud computing solutions, it must disclose its needs to the public.
- Cloud provider need to give assurance to their clients that their private information stored, processed and communicated is not publicized.
  - Cloud providers should establish privacy policies.
  - Governments should ensure that the cloud providers are protecting the data of the customers.

- Cloud technologies go beyond boundaries, and their success is based on, how far it extends globally. Countries should commit to implementing policies for evolution of cloud computing and should assess existing international trade rules and update them, if needed.

7.1.1 Key Principles of Cloud Computing

Three key principles of cloud computing are abstraction, automation and elasticity.

Abstraction

IT providers are in need of standardizing their IT operations, so optimizing their operation will be made easy. Cloud computing gives some basic but well-defined services.

Managing the software services is passed onto the developer or user. A well-defined abstraction layer acts a as grease between clouds and developers or users, which helps to work efficiently and independent of each other. The three abstraction layers in clouds are:

1. Application as a Service (AaaS)
2. Platform as a Service (PaaS)
3. Infrastructure as a Service (IaaS)

Automation

The developers or users have complete control over their resources, this is said to be automation in the cloud. There is no human interaction, even from a developer's or user's side. In this environment, when the user needs more servers, the load balancer intimates the cloud as to the extra numbers be provided. There is no need to wait for unpacking, connect your machine and install, all will be done automatically.

This automatic process reduces cost and complexity, and it puts the developer or user in control. Now the user can reduce his time to market for the next rollout because, he can do it himself, no intervention of professionals needed or waiting period.

Elasticity

In the early years, people had expensive servers and waited for long time to use the full capacity of their server. This is a highly inefficient model as most of the time the server was underutilized. In the dot-com era, people started scaling horizontally, which allowed them to add capacity according to their needs.

Using elasticity, people can easily scale up and down according to their daily usage.

7.1.2 Examples of Cloud Environment

IBM Power Systems is in an ideal example for cloud environments.

- *Workload optimization*: The core capability of cloud computing is optimizing of workload. This allows the users to make the most of their IT resources while increasing the overall flexibility.

- *Limitless virtualization*: With PowerVM (available in IBM Power Systems), users can virtualize resources such as processor, memory and I/O.
- *Automated management*: Utilizing IBM Systems Director Enterprise for Power Systems, user can manage their physical and virtual servers in an automated fashion. This helps to reduce total cost of owner (TCO) and management costs.
- *Solutions of all kinds*: Irrespective of the shape, the IBM Power Systems gives solution for the size or composition of the cloud. Few offerings done by IBM Power Systems are:
  - IBM CloudBurst
  - IBM WebSphere CloudBurst Appliance
  - IBM Smart Business Development and Test Cloud

7.2 MODEL FOR FEDERATED CLOUD COMPUTING

7.2.1 Cloud Federation

Cloud federation is interconnecting the cloud computing environments with two or more service providers for balancing the traffic load and to surge spikes while there is demand.

Cloud federation offers two benefits to the cloud providers. First, it generates revenues from the idle computer resources to providers. Second, it enables providers to move across borders.

7.2.2 What is Cloud Federation?

Federation means different cloud flavours are interconnected and so are their internal resources. IT organizations can select their flavours based on their needs such as computing and workload.

Federation acts as a bridge between two cloud environments.

Enterprise users analyze them in terms of application and not in terms of federation. The key issues in federation are bridging the differences, setting consistent rules, streamlining cloud management and bringing vision to life.

7.2.3 Two-layer Connectivity for Cloud Federation

Hybrid clouds are achieving almost worldwide publicity because of the way enterprises utilize the cloud. As the hybrid model interconnects internal and external resources, consumers can choose the most appropriate requirements for their workload. This kind of approach enables dynamic deployment of applications, for example:

- Using multiple clouds and multiple applications based on business needs
- Allocating components to an application in different environments
- Moving an application based on their requirements and lifecycle stages
- Moving workloads closer to consumers

With innovations and secure extension of the internal environment, CloudSwitch technology will bring hybrid cloud to reality.

7.3 CLOUD ECOSYSTEM MODEL

7.3.1 Cloud Ecosystem

Cloud ecosystem is a term, which defines the complexity of the systems in terms of its interdependent components that work together to enable cloud services.

The complex inhabitants of organisms and its running as an ecological unit is said to be the ecosystem. In cloud computing, convoluted period encompasses not only customary components, for example programs and infrastructure, but furthermore advisors, integrators, partners and vendors.

7.3.2 Cloud Broker/Cloud Agent

- A cloud broker is a third-party person or commerce, that acts as an officer between the consumer and sellers.
- A cloud broker is a software application, that facilitates the sharing of work between various cloud service providers. Another name for cloud broker is cloud agent.
- The broker's job may be to basically save the clientele time by examining services from assorted vendors and imparting the customer with knowledge about how to use cloud computing to support the enterprise. Cloud broker, in addition, gives the buyer supplementary services such as reproduction and security in terms of encryption.

7.3.3 Cloud Outlook

We can experience a phenomenal growth in the coming years in cloud adoption and implementations, etc. Figure 7.1 shows the same. Areas such as big cloud data, business cloud, mobile cloud and gamification cloud are the key trends. The following are the areas that highlight the key trends.

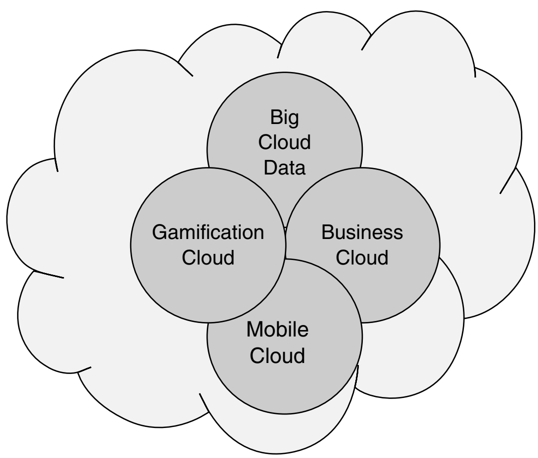


Figure 7.1 Cloud Outlook

Big Data Cloud

The amount of data created and replicated in 2012 surpassed 1.9 ZB. It is estimated by IDC that the total size of data in the universe will reach 9 ZB within four years and nearly 21% of the information will be touched by the cloud. The big data cloud enables an economical way to extract value from very large volumes of data by high-velocity capture, discovery, transformation and analysis.

Business Cloud

Business cloud is not like SaaS, PaaS, IaaS and BPaaS. It is more than that.

Mobile Cloud

Mobile applications will continue to develop with the social pressure, which will accelerate the progress of cloud computing to empower the users and increase consumerization anybody, anywhere, anytime and any device. The mobile cloud will push several organizations to reorganize their business models.

Gamification Cloud

The gamification cloud will make technology edutainment, guide a participant with a path to mastery and autonomy, encourage users to involve in desired behaviours and make use of human psychological predisposition to engage in gaming.

7.3.4 Cloud Unified Process (CUP)

We need to fundamentally reengineer the way we design, configure, teach, adopt and deploy process, said Ivar Jacobson, inventor of UML (unified modelling language). This becomes true for cloud computing paradigm. A complete process model for systematic cloud adoption and deployment is lacking. This leads to the need for a cloud unified process (CUP).

An end-to-end iterative and incremental process structure for the development and operations of cloud services in a lifecycle fashion is called as CUP. The main characteristics are goal-oriented, use case-focused, role-based, architecture-centric, risk-aware, iteration-centred, model-driven, product-neutral, vendor-agnostic and technology-independent.

The CUP framework is composed of a hierarchical structure. The top level of CUP comprises five components: Strategize, Transform, Operationalize, Run and Enrich (STORE) (Figure 7.2). Second level is more coarse grained. Further, the inputs, activities and outputs for every step are prescribed in the framework, coupled with other artefacts, such as key objectives and practice guidance. Biggest challenge for the cloud adopter is to device an action plan.

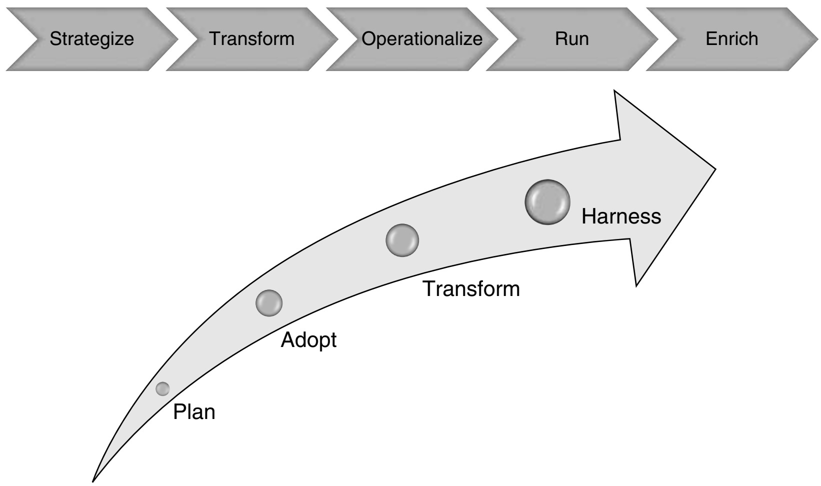


Figure 7.2 Cloud Unified Process (CUP)

To develop a unified road mapping structure that systemizes the comprehensive strategization and operationalization of cloudification, four incremental stages are needed: plan, adopt, transform and harness (PATH). The best road mapping practices to execute PATH are: alignment, blueprint, checklist and discipline (ABCD).

7.4 CLOUD GOVERNANCE

7.4.1 Taking Steps to Clarify Cloud Governance

- The concept of 'governance' means different opinions for different people. However, governance has to play a crucial role in the cloud computing.
- Cloud services are standardized and are delivered as a service. The services are executed rapidly and delivered out from an infrastructure with high elasticity and scalability and also as a pay-as-you-go model.
- In cloud computing, providers should be transparent in providing services, with clear SLA (service level agreements). At the same time, IT organization or enterprises need some kind of assurance and responsibility that business applications are safe when using this technology, and also there must be a minimal loss of data.
- Governance in the cloud means service level must be more important. Developers must know about their provider's SLAs.
- IT organizations are ready to adopt the benefits of cloud computing, it is important that they do it in a right way aligning with IT governance strategies. Cloud adoption must be done in a way that it does not disturb the governance process instead it should improve it.

- One of the unique benefits of cloud computing is re-introducing the centralized control enjoyed during the mainframe phase. Some SalesForce customers are using the cloud to eliminate rogue applications in their organizations that can cause compliance issues including databases and spreadsheets.
- Software-as-a-service and platform-as-a-service have massive potential for managing applications. Xactium produces a sales force-hosted service for running corporate governance, risk and compliance requirements.
- The cloud enables enterprises to provide central points of information for sharing and managing risk data. When the user turns a spreadsheet into a cloud application, that part of multi-tenant platform becomes controllable and manageable by the IT department and data is accessible across the organization or can be invisible. While the cloud may offer advantages in enforcing governance processes, the onus is still on the developer to manage services from the easiest stages of development.
- Customers should do some due diligence on development technologies that help to maintain governance regardless of what environment they run. Cloud databases still must have built in audit trails.
- Organizations that use cloud services also need a means to validate services and have rules and policies framed around the users. Cloud server templates should be trustworthy enough to be launched predictably and automatically and thus they become a tool for governance and compliance management. On-demand vendors operate a myriad of data centres that have extraordinary policies for redundancy and security, including physical security, which most enterprises lack. However, cloud services are most often used to handle front office data and the most sensitive information in the enterprise, for example, consumer credit card data still resides on internal servers.
- Some people think that it is a fad and don't have a cloud strategy but when a user is focused on IT governance and do the right things with the architecture and strategy they have basically built a cloud. Cloud computing is the evolution of optimized and well-defined IT infrastructure.

7.4.2 SOA and Cloud Governance

Cloud computing picked up very well, especially in SMB's and consulting firms. Yet, the number of success stories, in-terms of simplistic consumption services and compute resources are not large enough. The reason why usage of the cloud computing is still low in the SMBs, is due to the following reasons:

- Cloud availability
- Cloud security
- Erosion of data integrity
- Data replication and consistency issues
- Potential loss of privacy
- Lack of auditing and logging visibility
- Potential for regulatory violations

- Application sprawl and dependencies
- Inappropriate usage of services

The above issues can primarily and be solved by applying governance rules. We can apply SOA governance directly to these issues. However, SOA and cloud are not the same. Cloud computing will be a successful if cloud governance succeeds.

7.4.3 Cloud Governance: Design Time

Designing services for deployment in the cloud is much like designing services for SOA. In the early days of SOA development, IT organization faced an incompatible, unwanted bunch of web services on the network, the same is true for cloud services.

As the cloud service development, deployment and consumption are simplified, the developers used cloud capabilities without any interference.

In cloud computing SOA governance tools are missing. There is no dedicated central point for a cloud consumer or developer regarding services and its policies. Furthermore, design-time policies are easily breakable and quality assurance process are lacking in cloud computing environment. Hence design-time policies are to be enforced on the client side and IT needs to provide a standard, service-centric across the enterprise data centre and the cloud.

7.4.4 Cloud Governance: Run Time

Run-time policy issues are complicating the cloud computing infrastructure. Furthermore, all the systems are not having the same security standards. This means that security policies need to be more granular. Users cannot count on using area-based approaches to secure data or service access. The cloud does not simplify security issues, instead it complicates them. Security approaches in SOA like ‘trust nobody’ approach can be adopted in cloud to enforce security policies.

An effective cloud governance approach must provide to control, monitor and adopt services, both in on-premises and off-premises.

7.4.5 Stages of a Service Lifecycle: SOA and Cloud

In the life of every SOA-enabled or cloud service, there are 11 stages that can help to identify the difference between the services and business agility. They are: SOA adoption planning, service inventory analysis, service-oriented analysis (service modelling), service-oriented design or service contract, service logic design, service development, service testing, service deployment and maintenance, service usage and monitoring, service discovery and service versioning and retirement.

7.4.6 Successful Cloud Governance and Adoption

Cloud computing provides unified, application-centric view of IT right through the corporate data centre and into the cloud. And it furthermore inserts new security risks and compromises the customary command of IT. Cloud governance is a logical version of SOA governance and it offers asset control for both internal and external applications and data. Cloud governance gives ways for managed, secured and incremental adoption of cloud computing. The following are 10 tips to be followed for a successful cloud governance:

1. Start with enforcement
2. Form factors
3. Distributed, virtualized management
4. Maintaining record for critical assets
5. Loose coupling
6. Deploy globally, but acts locally
7. Global view in terms of application network
8. Flexibility
9. Applying lessons learned in SOA
10. Applying the solution in the cloud

SUMMARY

- Cloud computing is a means to reduce the IT cost and complexity, and helps to optimize the workload in hand.
- Factors needed for promoting the cloud computing are: (i) assurance regarding security risk, (ii) no illicit activities, (iii) data portability and (iv) SLA regarding authentication of consumer data and (v) way to go beyond boundaries.
- Three key principles of cloud computing are (i) abstraction, (ii) automation and (iii) elasticity:
- Cloud federation is the interconnection the cloud computing environments with two or more service providers for balancing the traffic and to surge spikes while there is demand.
- Cloud ecosystem characterizes the complexity of the schemes in terms of its interdependent constituents that work simultaneously to endow cloud services.
- The concept of 'governance' means different opinions for different people.
- Governance in the cloud means, service level should be given importance. Developers must know about their providers SLAs.

KEY TERMS

- Abstraction layer act as a grease between clouds and developers or users, which helps to work efficiently independent of each other.
- Automation in cloud means that the developers or users have complete automatic control over their resources.

- Elasticity provides consumers to scale up and down their infrastructure according to their daily usage.
- Cloud federation is interconnecting of the cloud computing environments with two or more service providers for balancing the traffic and to surge spikes while there is demand.
- A cloud broker is a third-party person or commerce that acts as an officer between the consumer and seller, it is also called as cloud agent.
- Big information cloud enables an economical way to elicit quality from very great volumes of information via high-velocity capture, innovation, revolution and analysis.
- Business cloud delivery model delivers beyond the traditional software (SaaS), platform (PaaS), infrastructure (Iaas) and business process (BPaaS) to a more business-oriented cloud model.
- The mobile cloud pushes several organizations to reorganize their business models to mobility.
- Gamification cloud makes technology edutainment, guides a participant with a path to mastery and autonomy, encourages users to involve in desired behaviours and makes use of human psychological predisposition to engage in gaming.
- Cloud unified process is an end-to-end iterative and incremental process structure for the development and operations of cloud services in a lifecycle fashion.

REVIEW QUESTIONS

- What is cloud federation?
- What is cloud ecosystem?
- Who is cloud broker?
- What is cloud enablement model (CEM)?
- What is cloud deployment model?
- What is mobile cloud?
- What is gamification cloud?
- What is cloud governance?
- List the issues in cloud resources.
- What is application-level abstraction of cloud resources?
- What is the role of cloud governance?
- State the important of SOA governance in cloud computing.
- Define cloud unified process (CUP).
- Differentiate cloud governance at design time and run time.
- List the stages of service lifecycle in SOA and cloud.
- List the 10 points to be followed for successful cloud governance.

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PART THREE
Virtualization

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CHAPTER 8

Foundations

8.1 DEFINITION OF VIRTUALIZATION

'Virtualization is a methodology for dividing the computer resources to more than one execution environment by applying more concepts like partitioning, time-sharing, machine simulation and emulation.'

Virtualization can be expressed as a brand new trend in IT, which includes autonomic computing and utility computing. This new trend helps the IT environment to manage itself and every available resource is seen as a utility, where a client pays per use. Virtualization reduces the burden of workloads of users by centralizing the administrative tasks and improving the scalability and workloads. Figure 8.1 provides an illustration of the concept of virtualization. It contains three layers: layer 1 comprising of network, layer 2 comprising of virtual infrastructures and layer 3 contains virtual machines where different operating system and applications are deployed. A single virtual infrastructure can support more than one virtual machine, that is, more than one OS and application can be deployed. Physical resources of multiple machines of entire infrastructure are shared in virtual environment. Resources of a single computer are shared across many virtual machines for maximum efficiency. By optimizing resource, flexibility and reduced costs in capital and operations are achieved. A virtual infrastructure consists of the following components: hyper visors, virtual infrastructure services and automated solutions to optimize IT process.

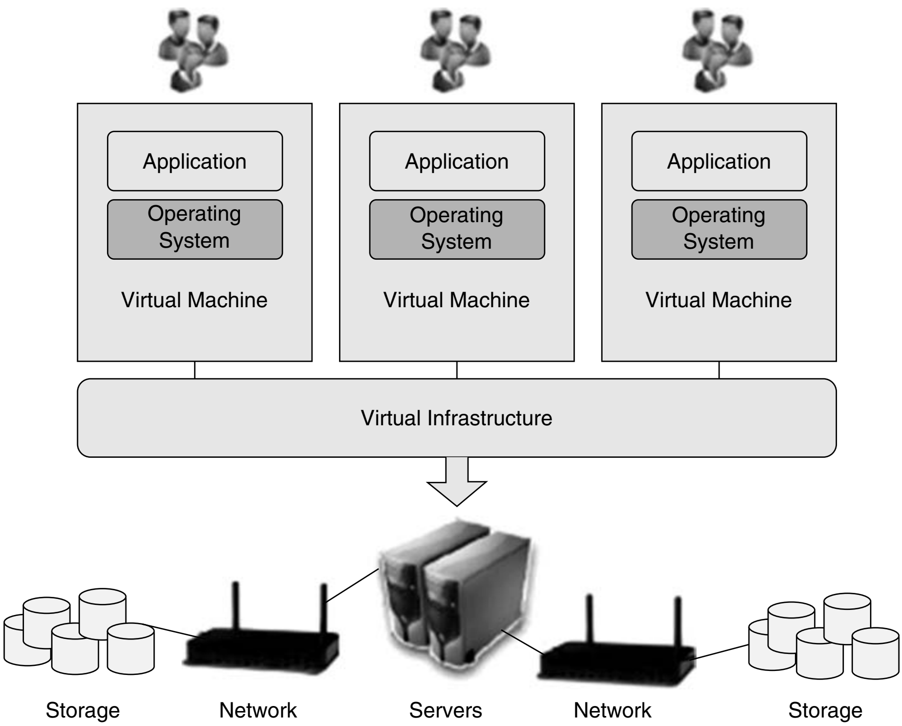


Figure 8.1 Diagrammatic Representation of Virtualization

Virtualization is a method in which multiple independent operating systems run on a physical computer. It maximizes the usage of available physical resources. By adopting this method, one can achieve high server usage. Essentially, it increases the total computing power and also decreases the overhead. We can exploit this new trend to increase the number of logical operating systems in a single host, which in turn reduces the hardware acquisition and maintenance cost for an organization. Following are some reasons for using virtualization:

- Virtual machines (VM) consolidate the workloads of under-utilized servers. Because of this one can save on hardware, environmental costs and management.
- To run legacy applications, VM is used.
- VM provides a secured and sandbox for running an untrusted application.
- VM helps in building secured computing platform.
- VM provides an illusion of hardware.
- VM simulates networks of independent computers.
- VM supports to run distinct OS with different versions.
- VMs are uses for performance monitoring. Operating systems can be checked without disturbing the productivity.
- VM provides fault and error containment.
- VM tools are good for research and academic experiments.
- VM can encapsulate the entire state of a system by saving, examining, modifying and reloading.
- VM enables to share memory in multiprocessor architecture.
- VM makes the job easier for the administrative staff in migration, backup and recovery.

8.2 ADOPTING VIRTUALIZATION

Virtualization is a perfect solution for small to medium-scale enterprises. It does not suit high-performance applications and should be avoided. It may be possible to add overheads, complexity and reduce the performance. In virtualization, the IT industry has a high CPU utilization number indicating optimum usage of hardware; and based on this number one should not come to the conclusion about the application usage. By using virtualization, CPU utilization during peak hours will shoot up to 50% and it should not override the SLA (service level agreement) of an organization. At present, in virtualization, the CPU and I/O overhead for storage and networking throughput are minimal, when high storage or more hardware I/O requirements are needed, then avoid using VM.

8.3 TYPES OF VIRTUALIZATION

Virtualization is a very powerful tool that drives significant benefits for cost, agility and the environment. Today virtualization is applied in many places—server virtualization, client/desktop/application virtualization, storage virtualization and service/application infrastructure virtualization.

Figure 8.2 depicts the various types of virtualization. A broad mixture of virtualization technology has been conceptualized, developed and enhanced. An end-to-end virtualization strategy impacts all features of the IT infrastructure. This gives the consumer flexibility, greater efficiencies and cost-effectiveness. Various virtualization types shown in Figure 8.2 are as follows:

- *Server virtualization* is a kind of virtualization, used for masking of server resources, which includes number of physical servers, processors and operating systems. The intention of using this method is to spare the complicated server resources and hence increasing the sharing, utilization and maintaining the capacity of servers.
- *Network Virtualization* is a method where network resources are combine based on available bandwidth. Each channel is assigned to a particular server. By adopting this method of virtualization, a true complexity of network is hidden and managed like partitioning the hard drive. Because of network virtualization, lower TCO, higher return of investment, security and dynamic computing are obtained.
- *Storage virtualization* is a type of virtualization, where a pool of physical storage from different network of storage devices appears as a single storage device. Usually this kind of virtualization is adopted in SAN (storage area networks). Storage virtualization

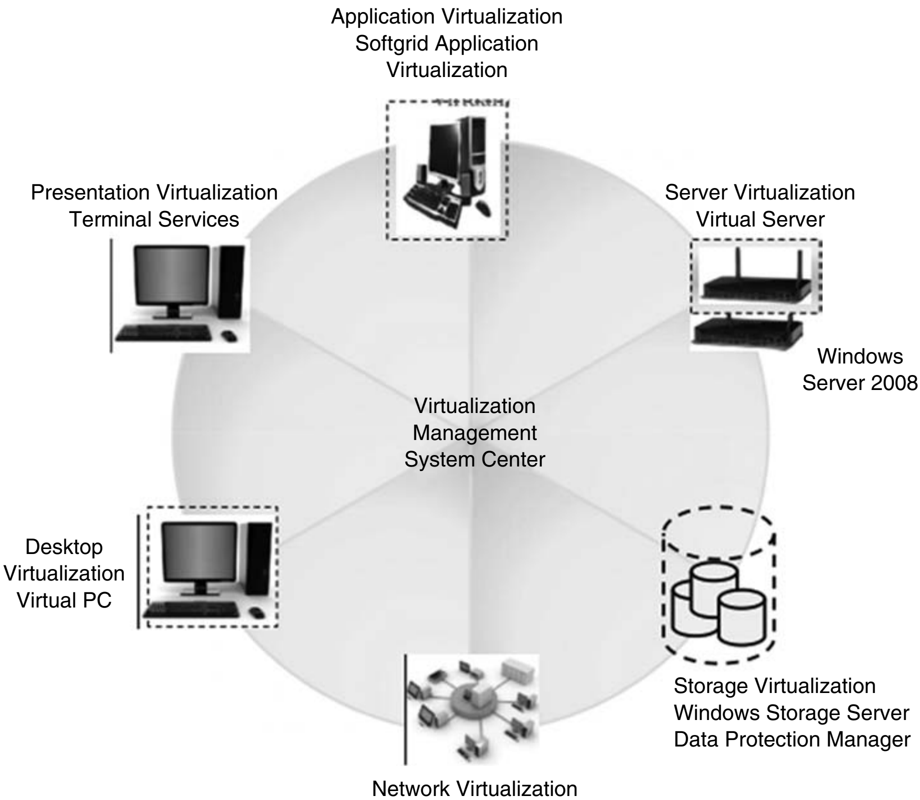


Figure 8.2 Types of Virtualization

is advantageous in disaster recovery, business continuity, lower TCO, higher return of investment, dynamic computing, security, testing and development.

- *Desktop virtualization* supports various computing such as utility and dynamism, testing, development and security.
- *Application virtualization* allows server consolidation, application and desktop deployment, and business continuity. Apart from this, recovery when disaster, lower TCO with higher ROI, dynamic computing, testing and development are possible.
- *Management virtualization* allows variety of features which are as follows: server consolidation, centralized policy-based management, business continuity and disaster recovery, lower TCO with higher ROI, utility and dynamic computing, testing and development and security.

8.3.1 Examples

Virtualization provides multiple environments for execution termed as virtual machine. Each virtual machine looks like an actual machine to its user, but it is isolated and is in virtualized form of running the existent machine under the supervision of a virtual machine monitor (VMM). Some frameworks, which use virtualization, are discussed as follows:

Wine

Wine is a software, where the user can execute windows *applications* on FreeBSD, Linux and Solaris. Wine is developed with x86 architecture and does *not* emulate as a processor.

Figure 8.3 illustrates x86-based virtualization architecture. This architecture consists of four layers with x86 as a base layer. This layer acts as base infrastructure for deploying virtualization above the virtualization layer where virtual machine is deployed. Various operating systems are installed in virtual machines and applications are executed using the available operating systems. Virtualization has become a common trend for IT organizations. Modern x86-based virtualized solutions first found acceptance in the data centres and have now spread to clients and applications. An operating system and application are packed together to form a virtual machine and these virtual machines are created on physical machines. Virtual machines are also known

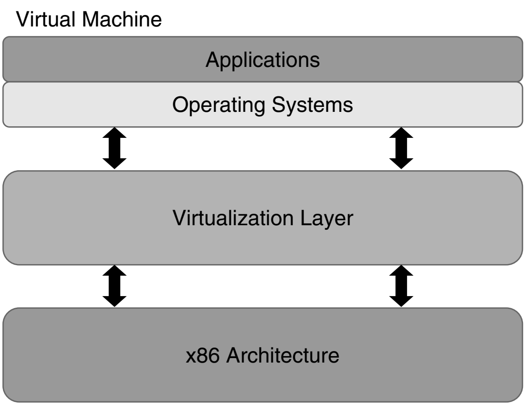


Figure 8.3 Wine—x86 Virtualization

as 'guests'. All guests hosted on a physical server running on a host operating system is called a hypervisor. The concept of virtual machine contained both OS and applications operating independently of OS on the standalone server. This enables many virtual machines to run on a single standalone server, providing isolation and security.

FreeBSD

The FreeBSD operating system allows the user to create an isolated environment through software. It uses a command c*hroot* and each one has its own 'root'. This feature is implemented by making various components of the FreeBSD kernel, such as the *tty* driver, the system call API, the TCP/IP stacks and so on.

Hive

Hive is an internally distributed system which has multiple independent *kernels*. It improves the reliability and does not affect the running processes. In a hive, each memory page has a little write permission, which helps the system to throw away the damage pages after fault detection.

Microsoft Virtual Server

Microsoft's Windows NT had several subsystems using virtualization such as virtual DOS machine (VDM), Windows with Win32 virtual machine for 16-bit, OS/2 subsystem, POSIX and Win32 subsystem. OS/2, POSIX and Win32 subsystems are server processes and DOS and Win16 are client processes. Applications of Microsoft and many enterprise software vendors are virtualized. Microsoft's SQL Server 2000 has multiple instance capabilities like Microsoft's Exchange Server, IIS Server, File/Print Servers, Terminal Server.

Nemesis

Nemesis is an operating system tool designed and supported by the computer laboratory of University of Cambridge. Its kernel is extremely small and lightweight and its codes are executed in the application process itself. A scheduler and a monitor is present in the kernel to take care of CPU. Apart from the global page table, a separate table is allotted for each process. The scope for wrong process in applications is very least, due to the less contributions of a kernel.

SimOS

SimOS is a *machine simulator* developed at Stanford. It has a feature of modelling complete computer systems such as CPU, caches, multiprocessor memory buses, network devices, disk drives and other I/O devices and it allows controlling the level of simulation.

8.3.2 Virtual Machines Programming Languages

Programming languages are implemented for getting the benefits of isolation and portability using virtual machines. UCSD P-System and JVM are the two examples for virtual machines languages.

The UCSD P-System was very popular in late 1970s and early 1980s. It was a virtual machine running *byte-code*, is the most popular programming language with UCSD PASCAL.

The Java Virtual Machine (JVM) is an abstract computer and it includes register set, a stack, a heap, a method area and an instruction set. Implementing JVM in micro-code or even directly in silicon is also possible, but JVM can be used only as *single-user* virtual machine.

8.3.3 Server Virtualization

The newest major technology trend in the data centre is server virtualization. It will be the highest-impact trend in IT infrastructure and operations in coming years. Despite its limits, it has both positive and enormous impacts on corporate power, cooling expenses and data centre capacity. It helps to extend the life time of data centres and even forced some huge organizations to close some of their data centres.

With server virtualization, a physical server can be partitioned into multiple virtual servers. Each virtual server has its own operating system and applications and acts as an individual server. Because of this technology, one can complete his development using more operating systems on one server, supporting multiple business forms. Server virtualization stacks multiple virtual workloads such as servers, applications that run on a single physical host. To do so, server virtualization softwares such as Hyper-V or VMware encapsulates an operating system and its applications to run in isolated processors and memory spaces of the host.

Figure 8.4 shows the working concept of virtualization software, containing many virtual servers and many operating systems and applications installed on it. In the old design, there will be one server/one application and has one line and all the applications have to use that single line to access the services. In the new design, using virtualization software, servers are virtualized and hence all the applications share them and are more efficient.

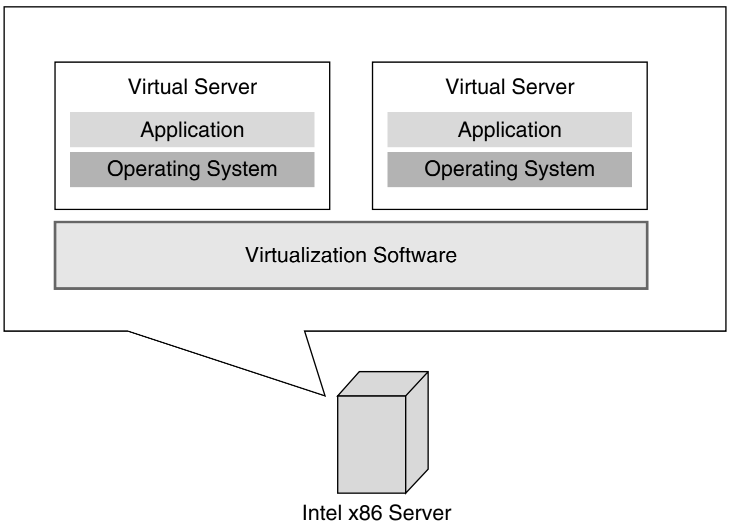


Figure 8.4 Server Virtualization

Server virtualization masks the server resource which includes the servers, processors and operating systems from the server users. Server administrator isolates the application into many virtual environments. The virtual environments are called as guests, instances, containers or emulations. It allows multiple applications to run on one server with equal importance. Moreover, it permits one application to utilize resources across the company network. Virtualization can allow applications to dynamically move from one physical server to another when the demands and resource availabilities vary, without service disturbance.

Importance of Server Virtualization

Server virtualization paves the way for cost cutting incurred in IT industry, which is facing the challenges of worldwide recession, increased energy costs and maintenance of data centres. Only 20% adopt non-virtualized environments for server. This also has serious implications for the duration of data centres as growing numbers of facilities run shortage of power, cooling and floor space. When adopting virtualization this problem is avoided by automating the issues in multiple applications and while sharing resources. This helps organizations to increase the utilization of their server up to 80%.

Figure 8.5 shows that an organization which uses server virtualization. It contains a single server which is virtualized into four virtual machines and different OS are installed. When there is more access to the server, the virtual machines will take care and jobs are handled efficiently and thus increase in productivity. Even smaller organizations can be benefited by using virtualization, particularly, when they need to upgrade their servers. One large server is less expensive to buy,

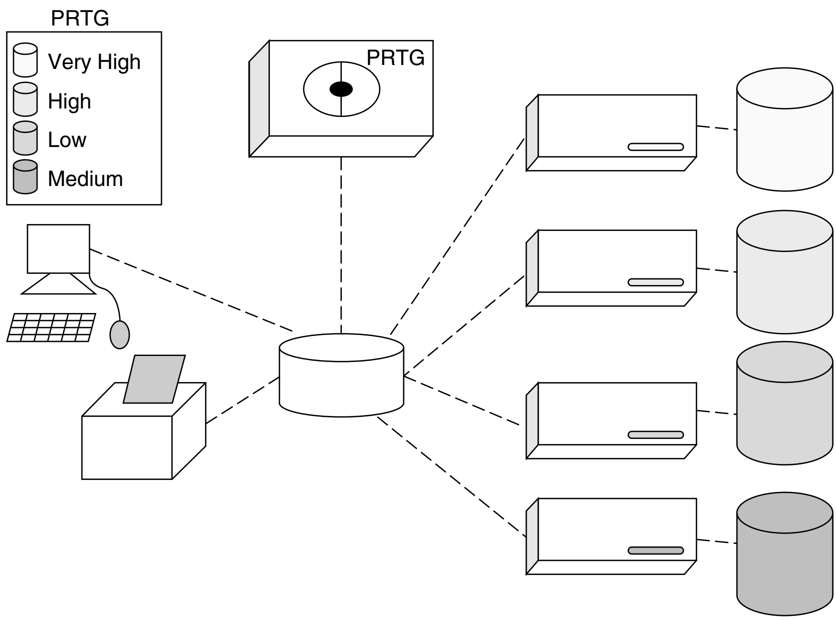


Figure 8.5 Need of Virtualization

operate and maintain than a small population of small servers. An up-coming new approach, 'application virtualization,' presents a more efficient result in these cases and allows numerous virtualized applications to share a single copy of an operating system. Servers are capable of host files and applications on networks. Network administrators allocate an individual application to a server depending upon its requirements. Allocating applications to peculiar machines has the following problems:

- *First*, it does not use the latest technology in processing power and most of its resources will be in idle state and
- *Second*, as the server occupies larger user space, date centre will be overcrowded with racks of servers producing heat and consuming lots of power.

Server virtualization attempts to address both issues. By using software, administrators can change one physical server into multiple virtual machine instances.

Need for Server Virtualization

The need for server virtualization is consolidation, redundancy, legacy systems and migration.

- Server virtualization reduces space through *consolidation*. For IT organizations that have large number of servers, the need for single physical space can decrease the workload.
- Server virtualization supports *redundancy* without purchasing more hardware.
- *Legacy systems* using server virtualization the outdated systems services can be virtualized, hence the programs work as if it is executed in old systems.
- *Migration* is a new trend in server virtualization. Migration moves a server environment from one place to another. With the help of suitable hardware and software, it is possible to migrate a virtual server from one physical machine to another in a network.

Three Kinds of Server Virtualization

There are three ways to create virtual servers—*full virtualization*, *paravirtualization* and *OS-level virtualization*. *Host* is the physical server. *Guests* are the virtual servers. The virtual servers are like stand-alone machines.

Complete virtualization utilizes software called *hypervisor*. The connection point between server's CPU and its storage space is hypervisor. It serves as a *platform* for the virtual server's OS. Virtual servers operate independently and are not aware of other virtual servers using hypervisor. The physical server's resources are monitored by the hypervisor. When any application runs on the virtual servers, the hypervisor passes resources from the physical machine to the proper virtual server. Hypervisors have their own processing requirements and physical server reserves processing power and resources to be executed by the hypervisor application. This will impact the overall server performance and slow down applications.

The paravirtualization approach is somewhat different. The virtual servers in a paravirtualization system are aware of each other not like in the full virtualization technique. A paravirtualization hypervisor uses less processing power to manage virtual OS.

Adopting a type of server virtualization is decided based on the requirements of network administrator. If the administrator's personal servers function on the identical functioning scheme, then an functioning scheme will work excellently. If the administrator wants to install different OS, then para-virtualization is the best option. Many industries support full virtualization, but interest in paravirtualization is also growing; soon it may replace full virtualization.

Visualizing a single physical server as multiple logical servers is called server virtualization. Some of the uses of server virtualization are summarized as follows:

- Cost reduction in infrastructure such as hardware and its maintenance
- Utilization of resource to the fullest
- Increased efficiency of server
- Increased security
- Space saving in data centres

Limitations of Server Virtualization

The benefits of server virtualization are more than its limitations. It is important for a network administrator to learn server virtualization concepts before implementing it in his premises.

Virtualization is not a good choice for servers with applications demanding high on processing power, as it divides the processing power among the virtual servers. Too many virtual servers will reduce the server's ability in storing the data. Another limitation is migration.

Many organizations are investing in server virtualization in spite of its limitations. As server virtualization technology move forward, the need for massive data centres could decline. As a green initiative, investing in server virtualization results in power utilization and heat reduction. Virtual servers could lead to a complete revolution in the computing industry and this will give a wide opening to researchers to develop high end tools and to use it in Server Virtualization.

8.3.4 OS Virtualization

OS virtualization somewhat differs from server virtualization. Here, the host runs a single OS kernel and exports different operating system functionalities to every visitors. In this model, common binaries and libraries are shared on the same physical machine, which permits an OS level virtual server to serve huge number of visitors.

OS virtualization is probably the easiest model to understand. In this situation, the physical computer system runs a standard unchanged operating system such as Linux, Windows, MacOS-X or Unix. In this mode, running an application is same as any other application, for example, a word processor would run on the system. For starting, stopping and managing every virtual machine and significantly access control on physical hardware resources on behalf of the individual virtual machines, etc., virtualization application is responsible.

Figure 8.6 provides an illustration of guest OS-based virtualization. As depicted in the figure, the guest operating systems work in virtual machines inside the virtualization application, which in turn, runs on top of the host operating system similar to any other application. This method has the greatest advantage that no modifications are required to either host or guest operating system and no particular CPU hardware virtualization support is required.

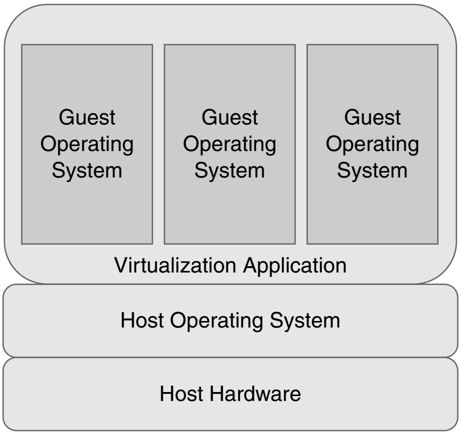


Figure 8.6 OS Virtualization

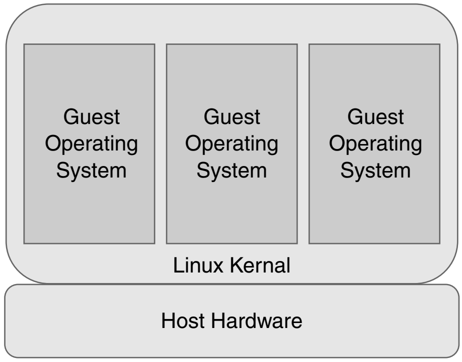


Figure 8.7 Kernel Level Virtualization

Figure 8.7 provides an overview of the kernel level virtualization architecture. In kernel level virtualization, the host operating system operates on a specially customized kernel, which includes extensions designed to manage and control several virtual machines each have a guest operating system. Unlike shared kernel virtualization each visitor operates their own kernel, even though similar limitations apply, in that the visitor operating systems must have been compiled for the same hardware as the kernel in which they are running. User Mode Linux (UML) and Kernel-based Virtual Machine (KVM) are examples of kernel level virtualization technology.

Hardware virtualization leverages virtualization characteristic construct into the most recent generations of Intel and AMD CPU.

Figure 8.8 illustrates the hypervisor approach to virtualization. Under hypervisor level virtualization the host operating system contains an administrative environment to manage and control multiple virtual machines each containing a guest operating system. An administrative operating system and/or management console also runs on top of the hypervisor in addition to the virtual machines which allows the virtual machines to be administered by a system administrator. Hypervisor-based virtualization solutions include Xen, VMware ESX Server and Microsoft's Hyper-V technology.

To achieve the best performance, management and efficiency of OS virtualization is streamlined. A standard host operating system resides at the bottom that includes Windows and Linux. Virtualization layer with the help of file system and abstraction layer guarantees resource

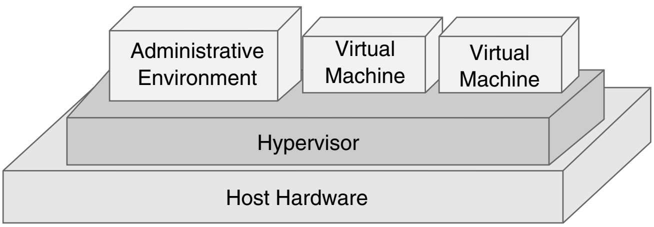


Figure 8.8 Hypervisor Virtualization

isolation and security. The virtualization layer creates every container appearing as an individual server and holds the workload.

In OS virtualizaiton, nothing exists. All tasks runs from the network using a virtual disk. In the present implementations, this virtual disk is just an image file stored on a distant server, SAN or NAS. The client will be connected to this virtual disk through the network and it will boot with the operating system available in the virtual disk. The two types of virtual disks in most implementations are private virtual disk and shared/common virtual disk.

1. *Private virtual disk*: A private virtual disk acts as a key for a client, he can use it to store information, based on the rights assigned to him. Therefore, when the client's disk is restarted, the settings are retained, just like working with a physical local hard disk.
2. *Shared/common virtual disk*: Multiple clients use a shared virtual disk simultaneously. During access, changes are stored in to a special cache. But the cache content will be cleared when the client is shut down or restarted.

Working of OS Virtualization

The components for using OS virtualization in the infrastructure are server and client. They are discussed as follows.

The first component is the OS virtualization server. This component initializes which virtual disk and establishes the connection with the client. Apart from this, server can host the storage for the virtual disk locally or the server is connected to the virtual disks via a SAN or File Share.

Client is the second component, which establishes link with first component to run the OS.

Virtual disk have an image of a physical disk from a system which mirrors the configuration of those systems and also the settings. The disk needs to be assigned to the client which uses this disk to start when the virtual disk is created. When a client has a disk assigned, the machine can be started with the virtual disk using the following steps as given in Figure 8.9.

- *Step 1—Connecting to the OS virtualization server*: Start the machine and set up a connection with the OS virtualization server.
- *Step 2—Connecting the virtual disk*: During connection establishment between the client and the server, the server goes through its database to check whether the client is known and checks if the virtual disk(s) are allocated to the client. If a disk is allocated, this disk will be associated to the client in the next step.
- *Step 3—VDisk connected to the client*: Once the preferred virtual disk is chosen, it is connected to the client through the OS virtualization server.
- *Step 4—OS is 'streamed' to the client*: Once the disk is connected to the server, it starts streaming the content of the virtual disk. Many OS provide several approaches to cache this information, for example, the client memory, on the disk of the OS virtualization server and locally on the hard disk of client.
- *Step 5—Additional streaming*: Once the first part streaming is over, operating system starts as expected (e.g., starting an application which is there within the virtual disk).

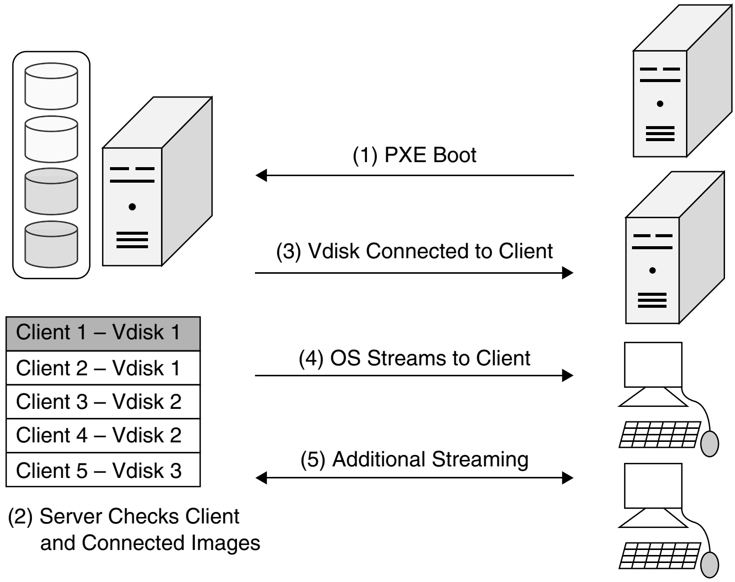


Figure 8.9 Operating System Virtualization and Streaming Process

OS Virtualization: Pros

- *Flexible provisioning*: It is very simple and easy to connect different virtual disks to a system through OS virtualization. Starting another operating system or any other application can be done easily by the client.
- *Rapid software deployment*: Adding a new server or workstation happens within few seconds. Using deployment tools to install and configure the system or doing it manually takes at least a few hours, with a few steps the client is allocated to a virtual disk and can be used in production.
- *Easy and efficient implanting updates and hot fixes of the operating system and applications*: In OS virtualization, it is enough to add an update to the virtual disk image and not to all servers.
- *Easy rollback scenarios*: Rollback to previous state is easy in OS virtualization.

OS Virtualization: Cons

- *No work off-line capability*: OS virtualization products must be connected to the virtualization server for using the operating system virtually.
- *High-speed LAN recommended*: A high-speed LAN is needed as the virtual disk is connected to the OS virtualization server through the network.
- *Limited numbers of operating systems are supported*: Limited number of OS supports virtualization. Some Linux distributions do not support the OS virtualization technique.
- *Imaging disadvantages apply to this technique*: Virtual disk is created using image-based techniques. All disadvantages of imaging techniques are also applicable for the OS virtualization component.

OS Virtualization: Sample Scenarios

We learned how OS virtualization works and some OS virtualization scenarios are described as follows:

- *Citrix XenApp/terminal servers*: Citrix XenApp/terminal server-based infrastructures OS virtualization is a good solution. After each reboot the terminal server is back in its default state and changes are applied to all servers by using the shared virtual disks.
- *VDI/DDI solutions*: Virtual desktop infrastructure solutions are also becoming increasingly fashionable today. With the OS virtualization, the same virtual disk can be used by virtual machine and no expensive disk space is required on the SAN.
- *Back-up servers*: Back-up servers are used only for few hours a day, and the hardware is idle most of the time. Therefore, the hardware can be used for other roles during business hours and it can also be assigned to the back-up server role.
- *Development/test environments*: OS virtualization can easily provide the machines to run development and test tasks on virtual hardware by flexible provisioning.
- *Educational environments*: Using OS virtualization, multiple virtual disks can be created and assigned with multiple OS environment. The user can select the required environment using the boot menu.
- *Secure environments*: OS Virtualization can be used for secure environments, as no data is available on that machine.

8.3.5 Storage Virtualization

Storage virtualization (SV) is a new concept under virtualization. Storage systems use virtualization concepts for better functionality and have more features within the storage system.

The other name for storage system are storage array, disk array or filer. Storage systems use special hardware and software, which provides fast and reliable storage for computing and processing data. Storage systems are complex and specially designed to accommodate storage capacity with data protection. Storage systems provide block and file accessed storage. Examples for block accessed are Fibre Channel, iSCSI, SAS, FICON; File accessed examples are NFS and CIFS. There are two primary types of storage virtualizations:

1. *Block virtualization* separates the logical and physical storage. This gives greater flexibility for the administrators in managing storage for consumers.
2. To eradicate the dependencies between the facts and numbers accessed at the document level and the position where the documents are retained, *file virtualization* method is utilized. This method optimizes usage of storage and server consolidation.

Storage virtualization contributes high in traffic mirroring, and migrates LUNs from one disk array to another without downtime.

Virtualization is the pools multiple physical storage as a single storage device that can be managed from a central console. The managing storage devices can be tiresome and time-consuming.

Structure of storage virtualization will be in the form of what are created, where the virtualization is done and how it is implemented. Mainly storage virtualization is structured in three ways: host-based, storage device-based and network-based.

1. *Host-based*: Traditional device handles physical drives.
2. *Storage device-based*: Pooling and managing metadata.
3. *Network-based*: Device which uses fibre channel.

8.3.6 Network Virtualization

The procedure of blending the accessible assets in a mesh by dividing up the accessible bandwidth into channels is called network virtualization. As depicted in Figure 8.10, all subscribers can access all the resources of the network using a single computer. A virtual machine can be configured with one or more virtual Ethernet adapters. Virtual switches which permit virtual machines on the same virtualization hardware host to communicate with everyone through the same protocols that would be used over physical switches, without the need for extra hardware.

Network management is a time-consuming process for a network administrator. Network virtualization can improve productivity and efficiency by performing tasks automatically. Sharing or reallocation of storage space can be done among the servers. Adding or reassigning the storage media such as hard drives and tape drives can be done easily. Network speed, reliability, flexibility, scalability and security can be optimized using network virtualization. Two main scenarios focused by network virtualization are as follows:

1. A shared experimental facility, i.e., running multiple experiments at the same time.
2. Long-term solution for the future Internet.

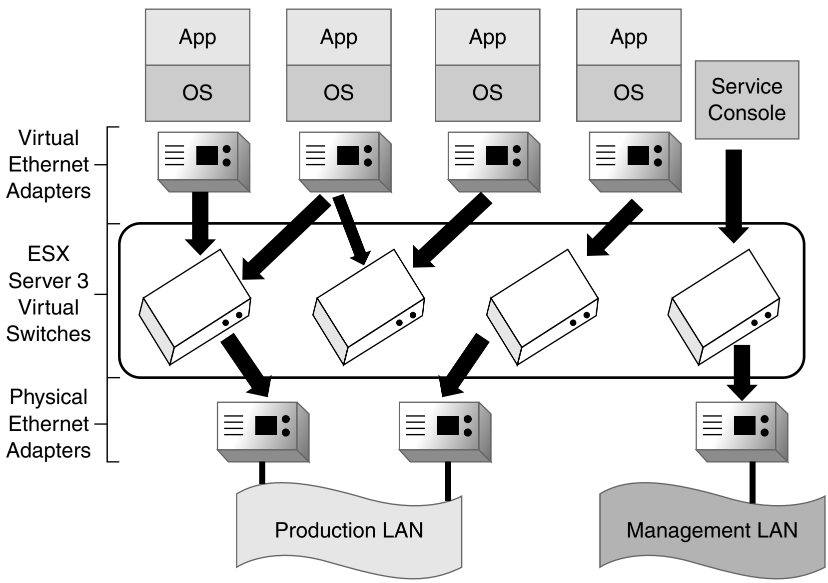


Figure 8.10 Network Virtualization

Virtualization is categorized as either internal or external based on the implementation given by vendors that support the technology.

Following is a common network virtualization scenarios and examples:

- *External network virtualization*: In this situation, to achieve the objective of improving the efficiency of a large corporate network or data centre by combining one or more local networks or subdivided into virtual networks.
- *Internal network virtualization*: A single system is configured with containers using Xen/KVM domain and combined with hypervisor control programs, for example, VNIC (Virtual Network Interface Card) to create a 'network in a box'. Examples of internal network virtualization are NetworkStack project, OpenSolaris network and Microsoft virtual server.

8.4 VIRTUALIZATION ARCHITECTURE AND SOFTWARE

8.4.1 The Virtualization Architecture

MultiNet Protocol Driver (MPD) (shown in Figure 8.11) is used to implement virtualization of wireless adapter and placed as an intermediate layer between MAC and IP. The figure explains how MPD can be used to share a wireless network adaptor and its MAC. MPD sits in between IP layer and physical layer (MAC). When an application wants to use more than one network than using TCP/IP, the path is sent to MPD, which is responsible for switching and allocating the network and appropriate MAC address. MPD exposes the wireless LAN media adapter as always active. IP stack checks the adapters, whether they are active always, even though only one is connected at a given time. Switching and buffering of packets across networks is done by MPD.

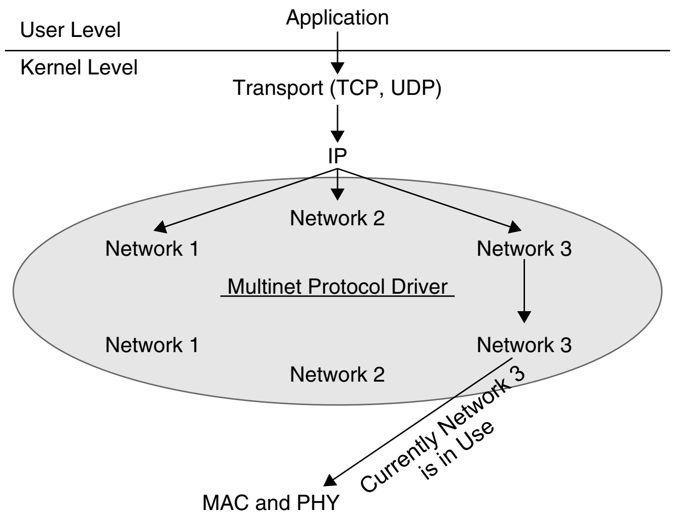


Figure 8.11 Modified Network Stack

Figure 8.11 illustrates the virtualization of a WLAN card, where a user needs to connect to three networks (wireless). The MPD represents three virtual adapters, and everything appears active to IP even though only Network 2 is active at the moment as depicted in the figure.

IT organizations are validating the benefits of desktop and server virtualization, from energy efficiency to better resource utilization. If we want to fork big dollars for the technology, there are low-cost and no-cost models to try the virtualization. Freebies for virtualization tools are available from Microsoft and VMware and they are from the open source community. Some examples are listed as follows:

- *OpenVZ*: This is a Linux-based software where the administrator can create protected virtual environments. Every virtual server can be rebooted separately. SWsoft supported this project and markets this in the name of 'Virtuozzo'.
- *Q*: It is a FOSS kind of software for running other programmers on Macintosh. It enables the users to exchange files between host operating system and the guest OS. Q is based on the QEMU open source CPU emulator.
- *QEMU*: QEMU can run operating systems and programs developed for one machine on a different machine. Only restriction for QEMU is host and the guest machine must use x86-compatible processors.
- *VMware Server, Player and Converter*: VMware Server is VMware's starter kit for Windows and Linux server virtualization. It can host Windows, Linux, NetWare and Solaris as guest operating systems.

8.5 VIRTUAL CLUSTERING

8.5.1 Introduction to Cluster

The theoretical definitions of clusters and cluster-based developments are vague. According to the economic theory, clusters are defined as collection of organizations and institutions, co-located in a geographic entity and linked by interdependencies in order to provide a product and/or service.

8.5.2 Definition of Clustering

According to the book titled *In Search of Clusters*, cluster is defined as 'a type of parallel or distributed system that consists of a collection of interconnected computers and is used as a single, unified computing resource'. Forming a cluster refers to a collection of computers bounded together to form a common resource pool. A task or job can be executed on all computers or a particular computer in the cluster.

8.5.3 Benefits of Clustering

- *Scientific applications*: Applications running on supercomputers can be migrated to Linux cluster (which is more cost effective).
- *Large ISPs and E-commerce enterprise with large database*: Internet service providers or e-commerce web site that requires high availability and load balancing and scalability.

- *Graphics rendering and animation*: Film industry is benefited because of clustering, in particular for rendering quality graphics and animation scenes. Examples include *Titanic, True Lies* and *Interview with the Vampire*.
- *Fail-over clusters*: Using clusters, network services are increased in terms of availability and serviceability and when a server fails, its services are migrated to another system. For example, failover servers are database servers, mail servers and file servers.
- *High availability load balancing clusters*: Application can run on all computers and can host multiple applications. Individual computers are hidden to the outside world as they interact only with the clusters. This kind of clustering produces best results with stateless application and when executed concurrently.

8.5.4 Virtual Cluster Description

A virtual workspace is composed of workspace metadata, which is represented as an XML Schema and implementation-specific information like pointer to the image in VM which implement a given workspace. The aim of the metadata is to capture workspace requirements in terms of virtual resource, software configuration and features. In this part, we illustrate the addition to the workspace metadata and implementation which is necessary to characterize a new type of workspace called a virtual cluster.

Head nodes and worker nodes are two kinds of nodes in a virtual cluster. A head node differs from worker nodes in principle and configuration, particularly in software and operational setup. Though worker node configurations are similar, they may be given different names or their position may be different.

8.6 VIRTUALIZATION APPLICATION

Application virtualization is a term, which describes a new software technology has a technical edge over improving portability, compatibility and manageability of various applications by encapsulating them from its base OS, on which they are executed. A virtualized application is not installed as in case of any other software/application, but it is executable as it is installed. We make the application at runtime so that it directly interfaces with the needed operating system and resources it needs. Here the virtualization refers to 'encapsulated application', whereas in hardware virtualization is referred as 'abstracted hardware'.

8.6.1 Technology Types Under Application Virtualization

- Application streaming
- Desktop virtualization/virtual desktop infrastructure (VDI)

8.6.2 Benefits of Application Virtualization

- Non-native applications can be executed (i.e., windows applications in Linux)
- Protection for the operating system
- Lesser resources are used

- Able to run applications with bugs (i.e., accessing read-only system owned location for storing user data)
- Incompatible applications can be executed with lesser regression testing
- Migration of various operating systems is simplified
- Faster application deployment and on-demand application streaming
- Security is improved as applications are isolated from operating systems
- Enterprises can easily track license usage
- Tracking license usage is done easily for applications
- No need to install the applications, as it can be imported from portable media to client computers

8.6.3 Limits for Application Virtualization

- All softwares cannot be virtualized. Examples include device driver and 16-bit applications.
- Anti-virus packages require direct OS integration, these packages cannot be virtualized.
- For legacy applications, file and registry level compatibility issues can be resolved using virtualization in newer operating systems. For example, Windows Vista applications will not run where they don't manage the heap correctly. For this reason, application compatibility fixes are needed.

8.7 PITFALLS OF VIRTUALIZATION

8.7.1 Definition

'Using virtualization organizations are able to cut cost, utilize assets and reduce time for implementation and complexity, which are more important for now-a-day environment.'

—Alan Dayley, Gartner

8.7.2 Introduction: Virtualization Benefits

In the technology category, virtualization has been in the field for about a decade, but it is only been in the past few years that it has become a core technology for more organizations. Though there are many technologies that come under the broader classification of virtualization, the prime focus has been on server virtualization, since it has multifaceted value proposition. If deployed correctly, server virtualization will serve the following purposes:

- *Improve the server's utilization*: When non-virtualization, servers utilization is about 25%. After deploying virtualization utilization increases to 70% and goes close to 90%.
- *Reduce the number of physical servers*: It is typical to see consolidation of servers be in the ratio of 5:1 up to 10:1 range.
- *Contribute to corporate 'green' initiatives*: Number of servers can be reduced through server virtualization. It will not only require less physical data centre floor space but also use a lesser power and need fewer cooling machines for the same workloads.
- *Give a fast return on investment (ROI)*: Business leaders demand one year of less time for ROI. According to survey, a new technology should give ROI immediately (56%) and in a

span time of one year (44%). It shows its speed in the field. Another 44% indicated an ROI ranging from one month to one year, a necessary condition for technology deployments today.

8.7.3 Best Practices in Setting Virtualization

Virtual servers are deployed in more businesses to save money on equipment and time for system maintenance. Because of reduced overhead, the management can free up resources, which in turn can be applied towards innovation and other projects which will benefit the organization. However, virtualization does have its drawback. Creation of new virtual servers can easily lead to uncontrollable server sprawl. Keeping a lot of applications on one node can leave them contending for resources. And managing your virtual resources among your physical machines can get complicated, especially for IT people managing only one application per physical server. Following are few tips to help you to tackle some common challenges of virtualization.

Avoid Monopoly

Getting started with virtualization is not always simple or predictable as it needs new skills, tools and new ways of viewing the available IT infrastructure. The first important step in virtualization standards and best practices is to employ an experienced partner to work for the organization.

Proactively Engage Stakeholders

In a conventional server environment, business units expect maximum use of whole server box which generally provides more than adequate capacity, making it seem like a bottomless resource. But the dynamic nature of virtualization means that resources are shared, as well as the cost of organizing or obtaining them. Without clear strategy and support from the rest of the organization, there is a chance for conflicting requests to virtualize certain assets. Involve business stakeholder and get help to manage the transition to virtualization and ensure that it supports the overall business goals. Be proactive about instructing all affected stakeholders and users about how resources will be assigned, shared and also clarify about the benefits of moving the business to virtualization.

Balance Resource Needs

Increased resource utilization is one of the major advantages of virtualization. But too many applications requesting for the same resources may leave those applications contending for inadequate RAM, processor capacity, disk I/O or network bandwidth.

Take stock of your applications and their computing requirements before moving everything to a virtual server.

Do not Overload Physical Servers

Getting your virtual assets to function smoothly and jointly is one objective. They still exist in a physical host server, which also needs periodical maintenance and upgrades. If you are operating multiple physical hosts, ensure that you distribute your mission critical applications strategically. So that while taking a single host server down for maintenance, multiple mission critical applications are not down at the same time. Also keep in mind that virtual servers like physical servers have cyclical resource needs that can spike dramatically when business processes are most demanding, whether it be weekly or once in four months.

Prevent Virtual Server Sprawl

Scalability is one of virtualization's major strengths, but if managed badly can wreak chaos. New virtual machines can be created so simply and rapidly, that it can feel like a free and limitless resource. They can quickly hit the highest capacity of your physical hosts and turn server administration into a complicated chaos when too numerous virtual servers are added. Found standard practices and requirements to justify and control the design of new virtual servers.

8.7.4 Pitfalls of Virtualization: Adoption and Strategies

Introduction of virtualization has brought additional complexity into compliance and security efforts. The understanding and management is the key for achieving security and realizing the benefits of virtualization. Some pitfalls of virtualization adoption and strategies are given as follows:

- *Religious battles*: Choosing platforms based on requirements and standards that can be created.
- *Procurement and business changes*: As a first step, adopt and train the business people only by using resources such as memory, CPU, network and storage. Do not use by server. Then virtualize it. Offer the business people by saying, 'I can get you a physical server and storage for few thousands of rupees with a 3 or more year lease or I can get you virtual assets that we can bill month by month based on utilization and scale up or down depending on when you need to scale up or down'.
- *Myopic virtualization strategy*: Virtualization begins in server consolidation. Server, desktop, application, presentation and management are the five facets of virtualization.
- *Physical cost recovery models*: Practice real numbers and resource-based cost recovery. Practice a base building block as a cost unit and drive from that point.
- *Physical asset-based security*: Virtualization unlocks some new security challenges. At the same time, it also provides solution to some challenges.
- *Over-virtualization*: Virtualizing everything is wrong. It is not everything must be virtualized. Virtualization is not a shiny gunshot. Virtualization is attached with a great ecosystem, appropriate operational processes and organization itself.

8.7.5 Pitfalls in Server Virtualization

Some common drawbacks to watch for and avoid are discussed in this section. Everyone speaking about virtualization and server consolidation nowadays and many companies are taking action, with large enterprises in the top. Server consolidation over virtualization is a recognized way to save money in numerous ways such as a smaller amount of hardware, lesser power consumption, less floor space, etc. Apart from server virtualization to obtain significant economic and performance benefits, there are data centre virtualization, application virtualization and desktop virtualization. No doubt, virtualization is the future of computing, since it decouples computing operating systems and applications from the hardware, offering massive flexibility and agility to an enterprise's computing system. The objective is to avoid potential pitfalls, many of which are described as follows:

- *Poor preparation*: Any virtualization project is almost the first step towards a completely virtualized network that is going to be much different than the tried and tested hardware-centric system. Adding virtual OS to boost computing power may create problems.
- *Insufficient server capacity*: Virtualization does not increase the computing resources, but only the usage. Substantial processing power, input/output capacity, memory and disk capacity needed when multiple operating systems are virtualized.
- *Mismatched servers*: When multiple servers are virtualized which uses different chip technologies (Intel and AMD), there will be various problems while migrating VMs between them. It is recommended to standardize servers on a single chip technology.
- *Slow network communications*: One of the main objectives of virtualization and its main advantage is an enormous bound in computing capacity for a specified amount of hardware. However, latency and network bandwidth can give away much of the proposed gain. Upgradation of network's communications capabilities are required.
- *Slow mechanical disks*: Present disk technology cannot retain with the read/write demands of multiple servers in high-demand peak hours, you will face some latency. Storage caching is solution to this problem, whereby repeatedly accessed data is served from faster memory instead of disks. Another solution is solid state disks, which ensures read/write speeds up to 30 times quicker than spinning-disk technology.
- *Uneven workload distribution*: Finetuning the distribution of processing requirements across all physical servers is needed to maximize usage of data centre computing power. It means, there is need to monitor usage of application to detect daily, weekly or monthly highest usage and control response times and so on. This will permit you to assign applications accordingly.
- *Security risks*: Virtualization does not improve network security by itself. Firewalls, antivirus needs to be installed and keep them repaired and updated. And also virtualization applications are updated and patched. Finally, design of virtualized infrastructure is required to separate significant data as much as possible.

Virtualization is establishing rapidly in all forms and is difficult to even realize, especially because new products and technology developments are publicized almost every day.

SUMMARY

- ❖ Virtualization is a methodology for dividing the computer resources to more than one execution environments by applying concepts such as partitioning, time-sharing, machine simulation and emulation.
- ❖ Virtualization eases the work of users by centralizing the administrative tasks and improving the scalability and workloads.
- ❖ Virtualization is a very powerful tool that drives significant benefits for cost, agility and the environment.
- ❖ Virtualization provides multiple environments for execution termed as virtual machines; examples are (i) Wine, (ii) FreeBSD, (iii) Hive, (iv) Microsoft Virtual Server, (v) Nemesis and (vi) SimOS.

- Examples of virtual machines programming languages are (i) UCSD P-System, (ii) JVM.
- The needs for server virtualization are (i) consolidation, (ii) redundancy, (iii) legacy systems and (iv) migration.
- There are three ways to create virtual servers (i) full virtualization, (ii) paravirtualization and (iii) OS-level virtualization.
- OS virtualization somewhat differs from server virtualization. In this, the host runs a single OS kernel and exports different operating system functionalities to every visitors.
- Storage systems use virtualization concepts for better functionality and have more features within the storage system.
- Common network virtualization scenarios and examples are (i) external network virtualization and (ii) internal network virtualization.
- Some pitfalls of virtualization adoption and strategies are given are (i) religious battles, (ii) procurement and business changes, (iii) myopic virtualization strategy, (iv) physical cost recovery models, (v) physical asset-based security, (vi) still support programs and (vii) over-virtualization.
- By avoiding the following potential pitfalls can be overcome: (i) poor preparation, (ii) insufficient server capacity, (iii) mismatched servers, (iv) slow network communications, (v) slow mechanical disks, (vi) uneven workload distribution and (vii) security risks.

KEY TERMS

- Virtualization is a methodology for dividing the computer resources to more than one execution environments by applying concepts such as partitioning, time-sharing, machine simulation and emulation.
- Virtual machines (VM) consolidate the workloads of under-utilized servers.
- Server virtualization is a kind of virtualization, used for masking of server resources, which includes number of physical servers, processors and operating systems.
- Network virtualization is a procedure for blending all the assets in a mesh into channels founded on accessible bandwidth and producing them unaligned of the others.
- Storage virtualization is a type of virtualization, where a pool of physical storage from different network of storage devices appears as a single storage device.
- Desktop virtualization supports various computing such as utility and dynamism, testing, development and security.
- Hypervisor is a program which interacts exactly with the personal server's CPU and storage space. It assists as a stage for the virtual server's OS.
- External network virtualization improves the efficiency of a large corporate network or data centre by combining one or more local networks or subdivided into virtual networks.
- Internal network virtualization improves the overall effectiveness of a system by isolating applications to separate containers or interfaces.
- Cluster is characterized as a kind of aligned or distributed scheme that comprises of an assemblage of interconnected computers and is utilized as a lone, unified computing resource.

- Application virtualization describes a new software technology that has a technical edge over improving portability, compatibility and manageability of various applications by encapsulating them from its base OS, on which they are executed.

REVIEW QUESTIONS

- What is virtualization?
- Define virtualization.
- What are the layers of virtualization?
- What are the types of virtualization?
- What is server virtualization?
- What is network virtualization?
- What is storage virtualization?
- What is desktop virtualization?
- What is application virtualization?
- What is presentation virtualization?
- What is management virtualization?
- State the importance of server virtualization.
- What are the problems in allocating applications to peculiar machines?
- What are the three kinds of server virtualizations?
- Explain paravirtualization.
- What are the uses of server virtualization?
- Explain OS level virtualization.
- What are the types of virtual disks? Explain.
- Explain the structure of storage virtualization.
- What are the disadvantages of OS virtualization?
- What are the advantages of OS virtualization?
- Define network virtualization.
- Define clustering.
- List out the benefits of clustering.
- What are the benefits of application virtualization?
- What is meant by application virtualization?
- What are the benefits of server virtualization?
- What are the limitations of application virtualization?
- What are the pitfalls in virtualization adaptation and strategies?
- What are the pitfalls in server virtualization?
- In which context virtualization is being used?

CHAPTER 9

GRID, CLOUD AND VIRTUALIZATION

Virtualization is a core technique for many applications in the computing systems. In the mainframe days itself, virtualization concept was used, but only in the recent years it has come under lime light. The powerful virtualization solutions helped in managing data centres both for commercial and academic purposes. The main goal of these activities is managing a server and/or storage consolidation for better system utilization and ownership at low cost. On the other hand, virtualization also offers new and powerful features with regards to service-based infrastructures.

Virtualization is often coupled with virtual machines and corresponding CPU abstractions. However, the plan and current trends show a broader meaning which also comprises various types of resources. The majority of current applications are in the area of CPU, storage and network virtualizations. In general, the physical characteristics of resources are hidden from the resource consumers (end users or applications) through virtualization. Usage of virtualization can be grouped in two types: platform virtualization and resource virtualization.

From the grid computing's part, virtualization gets more and more attention, but not in terms of service consolidation and growing server utilization. In case of grid resources with heterogeneity, different software versions, additional features in grid computing systems such as check pointing and migration in resource management are the problems to be addressed and raised while opting for virtualization. Adopting virtualization makes us real grid computing with more flexible in applications and the resources usage.

9.1 VIRTUALIZATION IN GRID

9.1.1 Grid Computing

The main focal point in grid computing lies in secure resource sharing in accessing computers, software and data in a dynamic atmosphere. Sharing of those resources has to be fine-tuned and handled in a highly controlled manner. Moreover, Foster projected the following three points to describe a grid more in detail:

1. Nontrivial qualities of service delivery
2. Habit of using standards in all places
3. Resources coordination

9.1.2 Grid Computing and Virtualization

Virtualization is not a solution for enterprises to manage their resources although it provides richer capabilities in managing and moving the OS in different hardwares. It helps to run multiple workloads in a single machine with clear distinction between them. Virtualization can do suspending, resuming and migrating images in run-time.

Like grid, virtualization is also a trend. Instead of having more hardwares to meet peak demands, organizations can use virtualization approaches to get better utilization out of the existing hardwares which are not fully utilized. Also virtualization is possibly becoming a mainstream approach in managing network resources.

9.1.3 Using Virtualization in Grid Computing

- Virtualization integration and grid computing can be encouraged at various levels.

9.1.4 Grid Computing Level

The gLite Middleware has strong dependencies to Scientific Linux as operating system which is used by the LHC (Large Hadron Collider) Computing Grid High Energy Physics Virtual Organizations (VO). Making gLite to work with other operating systems is not a easy task. Resource providers can support the VOs with minimal effort by encapsulating the Grid Middleware into a virtual appliance. The only requirement is support of a virtualization platform like XEN or VMware. Grid Middlewares can be packaged as virtual appliances similar to the gLite Middleware. Then resource providers no longer want to consign to a designated grid middleware, but can setup middlewares on demand. User-based dynamic deployment of the middleware services is the most preferable approach. This makes the resource providers' interference in the deployment of process and he no longer has to deal with software administration and application requirements.

LRMS Level

The key research work in grid computing is to use virtualization in resource management system locally. When virtualization is adopted locally, it supports job managements and migration for virtual machines instead of jobs. In fact, virtualization exhibits with live and delayed migration of virtual machines even on added feature.

Merging the above mentioned LRMS features (suspension, check pointing) with migration, helps the LRMS in varying the current resource allocation dynamically. In addition, alteration of resources (e.g. number of CPUs, RAM) allocated to a virtual machine is possible and also it allows dynamic updating in service quality that can be done on-the-fly or by suspending and resuming depending on the virtualization platform.

Virtual Machines

Virtual machines can check the execution of applications and also they are useful tool grid system administrators. VMs can easily manage the systems in terms of isolating and partitioning the amount of resources needed.

Figure 9.1 shows the architecture developed for dynamic provisioning of computational services in grid. It also explains, how computational services can be deployed virtually in grid. The architecture consists of physical machines, physical worker nodes, infrastructure manager, GridWay, virtual workspace service (VWS) and grid middleware components such as monitoring and discovery of services (MDS), grid resource allocation manager (GRAM) and GridFTP. User's requests are submitted to GridWay (meta-scheduler). Depending on the policies, SLAs and the grid load, an infrastructure manager deploys it in worker nodes (VO-specific). The deployment of the VMs supporting the worker node is done through the virtual workspace service (VWS). When worker node is up, it registers the information stored in information service (MDS). Now GridWay can detect the slot and jobs are submitted through GRAM.

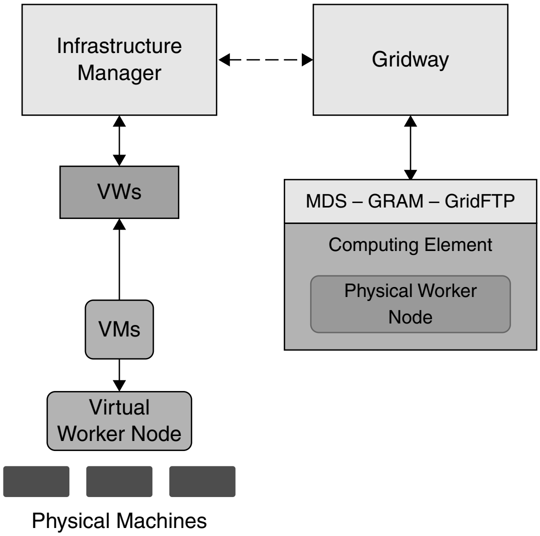


Figure 9.1 Dynamic Provisioning of Computational Services in Grid

9.2 VIRTUALIZATION IN CLOUD

Virtualization is a tool for system administrators, which has many technical uses than a cloud. Virtualization allows IT organizations to perform multiple operations using a single physical hardware. Multiple OS instances running on single device is cost-effective than multiple servers for each task.

Cloud computing is accessed through the WWW and takes advantage of virtualization. Cloud computing can also be used without virtualization.

Cloud computing and virtualization will modernize IT organizations. By combining them, companies can run their applications without the need of running updates and backups, as they all will be done by the provider.

Virtualization and cloud computing can go hand in hand. Virtualizing everything started a year ago when processing power, software and servers are virtualized. Now-a-days virtualization means cloud computing. Cloud computing refers to IT organizations using remote servers for storing data and accessing information from anywhere. This is done in three ways—public cloud, private cloud and hybrid cloud.

Virtualization has various forms, for example, one can virtualize a desktop which means, that the desktop is stored virtually in the clouds and that can be accessed from anywhere. We can virtualize an operating system, that is running Mac OS in the latest Windows OS.

Virtualization got more familiar in 2009 and 2010 because of the recession. IT organizations used virtualization to save infrastructure cost.

Cloud was implemented as outsource model first and then gradually was implemented within the enterprise firewall as an architecture. On the other hand, virtualization was started within the limitations of enterprise firewall and then was operated in hosted environments. Even if there are differences and similarities, many people in the industry use them interchangeably.

Table 9.1 Similarities Between Cloud Computing and Virtualization

	Cloud Computing	**Virtualization**
Location of virtual machine	On any host	On a specific host
VM/instance storage	Shortly lived	Persistent
VM resource (CPU, RAM, etc.)	Standard	Customizable
Resource changes	Spin p new instance	Resize VM itself
Recovery from failures	Discard instance spin up new one	Attempt to recover failed VM

Cloud computing and virtualization are two different technologies that work independently. Although cloud computing is better utilized if desktop virtualization is done first it requires multiple virtual servers and storage devices, that is multi-tenancy. Virtualization saves on their infrastructures, that is resources are virtualized. For example, server X is only utilized by 20% and server Y is utilized only by 45%. These two can be combined using virtualization, that is Server X in Server Y. Table 9.1 shows the similarities between cloud computing and virtualization.

Virtualization splits the link between processing and physical machines. Cloud computing facilitates the use of scalable processing services offered by online providers, through virtualization. From an architectural point of view, the question of what is supposed to run, where it should run and a clear understanding of the relative cost of processing is necessary. Figure 9.2 shows the cloud computing adoption model. Cloud computing adaptation model consists of layers such as:

- Hyper cloud where dynamic sharing and self-service application provisioning are done.
- Cloud foundations where cloud environments, deployments ways, load balancing are done.

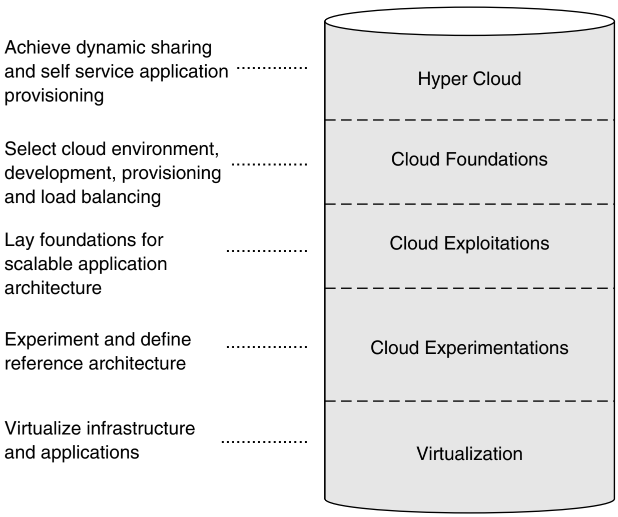


Figure 9.2 Cloud Computing Adoption Model

- Cloud exploitation where foundations for scalable application architecture are carried out.
- Cloud experimentations where architectures are experimented.
- Virtualization where infrastructure and applications are virtualized.

9.2.1 Virtualization as an Element of Cloud Computing

Cloud computing is a technology. Private cloud does not adopt virtualization. It uses technologies that are highly flexible and provide multiple services. Virtualization and cloud computing are associated closely. VMware, Microsoft and Citrix Systems are the major hypervisor vendors trying to adopt it in the cloud. They modified their products with tools (i.e. hypervisor), promoting the usage of private cloud computing.

9.2.2 Need of Virtualization in Cloud Computing

Benefits of Virtualization and Cloud Computing

Cloud computing has the ability to deliver resources on demand. Users can choose and pay for the services consumed. A cloud service can act as an infrastructure for applications, data storage and as a development platform which can be received on demand from the provider.

The primary technology in cloud is virtualization. Virtualization has the ability to save cost in infrastructure, isolates OS and application from the hardware, which can be delivered as an on demand cloud services.

Adopting virtualization lowers TCO, simplifies management and SLAs. Virtualization can play a vital role in cloud computing. It is the technology that make service providers to deliver low-cost hosting environments to IT organizations including SMBs. Virtualization has enabled us to consolidate the servers and do more with fewer infrastructures.

9.3 VIRTUALIZATION AND CLOUD SECURITY

Security in the cloud is achieved due to virtualization. Since virtualization combines all physical components as a single unit, the complexity of monitoring these components is made easier. Trust zones are created and personalized by the IT administrator. These zones watch workloads in terms of information, application and endpoints. Zones created are watched through the cloud by means of infrastructure virtualization. Automated SLAs can then evaluate risk and instigate remediation when security troubles arise instantaneously.

SUMMARY

- Virtualization is a core technique for many application environments in computing systems.
- Virtualization is often coupled with virtual machines and corresponding CPU abstraction.

- In grid computing, virtualization gets more attention, but not in terms of service consolidation and growing server utilization.
- Virtualization is not a solution for the enterprises to manage their resources although it provides richer capabilities in managing and moving OS in different hardwares.
- Virtualization helps to run multiple workloads in a single machine with huge separation between those workloads.
- Virtual machines can check the execution of applications and also they are a useful tool for grid system administrators.
- Virtualization is a tool for system administrators, which has many technical advantages than in cloud.
- Virtualization allows IT organizations to perform multiple operations using a single physical hardware.
- Cloud computing and virtualization modernizes IT organizations. By combining them, companies can run their applications without the need of running updates and backups, as they all will be done by the provider.
- Virtualization has enabled consumers to consolidate the servers and do more with fewer infrastructures.

KEY TERMS

- In grid computing resources of volunteer computers in a network are used to solve a major problem, which cannot be solved by a single machine and require more CPU cycles.
- Virtualization is a technique where resources are virtualized to optimize it. Virtualization is applied in hardwares, OS and storages.
- Virtual machine is an environment where guest OS can be installed and executed inside the main OS.

REVIEW QUESTIONS

- How is virtualization used in grid computing?
- State the use of gLite.
- Define virtual machine.
- How many virtual machines can you run on one host?
- State the importance of virtualization in cloud computing.
- What are the similarities between cloud computing and virtualization?
- What are the layers of cloud computing adoption model?
- What are the components of virtual network?

CHAPTER 10

VIRTUALIZATION AND CLOUD COMPUTING

10.1 ANATOMY OF CLOUD INFRASTRUCTURE

10.1.1 Anatomy of Cloud Computing

Cloud computing is changing itself to meet the demands of customers in terms of software and hardware. These changes have benefitted developments in web-based applications and facilitated decisions-making in business.

Thomas J. Watson of IBM has said 'there may be a demand for five in world market for computers.' IBM designed computers for 20 companies, expecting to get orders only from five companies. Surprisingly, IBM got order for 18 companies for the IBM 701 system. Operations in terms of hardware and data are the main players and they are not cost effective. Cloud's on-demand infrastructure will make it cheaper and efficient.

Microsoft and Google are the new players using cloud computing technology. Microsoft's Windows Azure platform will provide best results for C# and ASP.Net development. Google's App Engine and its Python language has powered distributed web applications.

The most famous cloud computing provider is Amazon's EC2. AMI (Amazon Machine Image) is the block used in EC2 virtualization and is the point of interaction to users of Amazon's EC2.

10.1.2 Cloud Stack

Infrastructure stack for delivering web applications by the providers of cloud computing. Figure 10.1 shows the managed cloud stack consisting of two parts: first part consists of cache, dynamic code and attached storage and logic for the dynamic code; second part consists of stable and efficient OS, security features and business logic written using some programming language. Cloud computing environment separates the computing environment away from the developers and helps them focus on improving their application.

Every cloud platform includes a virtual machine language and a gateway for web services. Language functions are closely linked with parent OS and their native libraries are taken away.

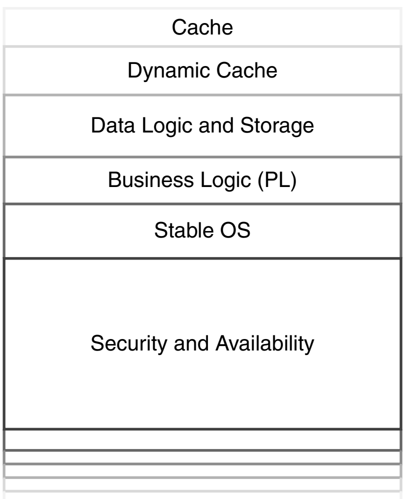


Figure 10.1 Cloud Stack

External tools and ordinary compilers will not function in the cloud language layer. Cloud services always bundles language runtime dynamically for efficient interpretation across many application instances.

Dynamic applications resides in application state and logic through database and file storage. In cloud computing, the database and the file server are placed inside cloud services, which are operated in an isolated and specialized layer. This isolation layer makes the storage layer inter-changeable from cloud stack.

Static files are categorized based on their size. Files <1 MB can be consumed in a single request. File >1 MB need to be chopped into parts for an easier and sequenced download. Static cloud storage can be broken up according to their file size and type, thus providing best solution for storage and delivery.

10.1.3 Cloud Consumers

Web Application Developers

New small web applications may experience exponential growth. Web developers use cloud computing stack for faster web performance and their applications. Enterprise applications have deployed different cloud models. SMBs and large-sized IT companies are replacing their in-house maintenance and relying on IaaS. Project management, employee tracking, payroll and some common functions are deployed as SaaS.

Windows Azure, Salesforce's Force.com and Google App Engine has strong support for back office add-ons. Microsoft and Google support Exchange Online and Google Apps, respectively. Force.com tied to the popular Salesforce CRM application for sales and marketing teams.

Companies such as Aptana, CohesiveFT, RightScale are some examples for cloud hosting providers.

10.2 VIRTUAL INFRASTRUCTURES

In the present scenario, the Internet provides services such as research, mining, e-mail and maps. In the near future, it will converge communication and computation as a single service.

Hence the Internet cannot be considered as a huge shared and unreliable communication enabling data exchanges between users. Instead, it will become a pool of interconnected resources that can be shared.

Grid'5000, an experimental facility, gathers clusters and gives access to nearly 5,000 CPUs distributed over remote sites and inter-connected by super fast networks.

Virtualization abstracts services and physical resources. It simplifies the job of managing the resources and offers a great flexibility in resource usage.

The vitrual machine

- Provides an environment where non-trusted applications can be run
- Adopts isolation techniques
- Allows dynamic deployment of application (portability)
- Applied optimization in OS
- Manages as a single service

10.3 CPU VIRTUALIZATION

Virtualizing a CPU is an easy job. For virtualizing a CPU, the following points are to adhered:

- Privileged instructions runs only in privileged mode.
- Control sensitive instructions that tend to change memory mappings, communicating with other devices.
- Behavior-sensitive instructions that tend to change resource configuration.

By adopting CPU virtualization, two separate CPUs resemble a single CPU, i.e., two systems running in a single system. By adopting this concept, user can run two OS in a single system. The most important part of the computer is the central processing unit(CPU). The main objective of CPU virtualization is to make a CPU function similar to that of two separate CPUs. CPU virtualization allows the users to run different operating systems simultaneously. For example, Apple Mac can be virtualized to run Windows as well.

CPU virtualization is not multitasking or multi-threading. Multitasking is concept of running multiple applications at a time. Multi-threading is where more than one CPUs can run applications in a way that carries out two actions at the same time.

10.4 NETWORK AND STORAGE VIRTUALIZATION

10.4.1 Network Virtualization

Network virtualization facilitates running of multiple networks, multiple consumers over a shared substrate.

Network virtualization is a method which combines the available resources by splitting up the bandwidth into channels and assigned to device or user in real time. Each channel is independently secured. Every consumer will have shared access to all the resources on the network.

By adopting network virtualization, managing the network will be an easier job and less time-consuming for network administrators. Productivity and efficiency are improved using network virtualization. Files, images, programs and folders can be managed centrally. Storage media such as hard drives and tape drives can be added, removed and shared easily. Network virtualization is categorized as: *external* and *internal*.

- *External format*: In this format, multiple local networks are combined or subdivided into virtual networks to improve the efficiency. VLAN and network switch are the components of this format.
- *Internal format*: In this format, a single system is configured with containers or hypervisors, such as the Xen/KVM domain to control VNIC. By adopting this format, overall efficiency of a single system is improved since applications are isolated.

Components of a virtual network consists of:

- Network hardware components such as network switch, adapters (NIC)
- Network elements e.g., firewalls
- VLANs and VMs
- Network storage devices

- Network mobile elements e.g., tablets, mobiles
- Network media e.g., ethernet cards and fibre channels

10.4.2 Storage Virtualization

Storage virtualization is a concept where storage devices are virtualized. As a result of this concept better functionality, proper maintenance of storage devices and efficient backup procedures can be achieved.

A storage system is also called as storage array or disk array. Storage systems are complex and are controlled by special systems providing high data protection for the data stored in it.

There are two types of storage virtualization: block virtualization and file virtualization.

1. *Block virtualization* separates the logical storage from physical storage. Accessing can be done without the knowledge of where the physical storage is located and its nature (heterogeneous). Storage virtualization allows storage administrators greater flexibility in managing the storage devices and the users.
2. *File virtualization* takes care of NAS by eliminating the dependencies between file level and the location. Due to file virtualization, optimization of storage and migrations of storage devices can be done easily.

Benefits of Storage Virtualization

- *Non-disruptive data migration*: Ability to migrate data without disturbing concurrent I/O access.
- *Improved utilization*: Utilization can be increased by pooling and migration. When all storage media are pooled, the administrator can easily maintain the devices and also assign disks for the users.

Risks and Complexities

Risks in block virtualization are:

- Backing out a failed implementation
- Interoperability and vendor support

Complexity affects several areas, they are:

- Management of environment
- Infrastructure design
- The software or device itself
- Performance and scalability

10.4.3 Using Virtualization to Achieve Green Data Centres

Green IT and virtualization are the two important topics that will impact the change in solution providers and value-added resellers (VARs).

The hardware resellers, probably they will lose hardware order because of server virtualization. With server virtualization, instead of buying more servers, 8–15 virtual systems can be deployed on one physical server. Overall impact, because of virtualization is to reduce the hardware and power consumption. Desktop virtualization is also becoming popular. Thin clients will replace the normal desktops.

In future, cloud computing will act as a delivery mechanism for the services provided in that area. The biggest problem involving green data centres are because of humans, changing of their minds, their behaviour towards the new model in accepting, trusting and working with it.

There are number of cost benefits in using virtualization and adopting to green data centres. They are:

- Power consumption to run the system and to cool it
- Space for systems is reduced
- Administrative work—managing the systems will be easier

Overall virtualization is rapidly expanding for IT companies, seeking lower operating costs and higher asset utilization. The flexibility of virtualization also has pitfalls that can eliminate all return of investments. If an organization is going for virtualization, these are the steps to be followed:

- Virtualization is not server consolidation. Virtualization is a technology that improves efficiency and operations then just adding more servers. A good understanding of virtualization will help to utilize its possibilities more.
- Ensure the required resources both in implementation and resource persons are available and in place.
- While selecting virtual environments, it should satisfy the management policies.

SUMMARY

- ❖ Cloud computing is changing itself to meet the demands of customers in terms of software and hardware.
- ❖ Amazon, Microsoft and Google are the players using cloud computing technology.
- ❖ Cloud computing environment separates the computing environment away from the developers and lets them to focus on improving their application.
- ❖ Cloud services always bundles language run-time dynamically for efficient interpretation across many application instances.
- ❖ Companies such as Aptana, CohesiveFT, RightScale are some examples of cloud hosting providers.
- ❖ Virtualization abstracts services and physical resources. It simplifies the job of managing the resources and offers a great flexibility in resource usage.
- ❖ CPU virtualization is not multi-tasking or multi-threading.
- ❖ Network virtualization provides a way to run multiple networks, multiple consumers over a shared substrate.
- ❖ A storage system is also called as storage array or disk array.

KEY TERMS

- ❖ Cloud computing is changing itself to meet the demands of customers in terms of software and hardware These changes led to many benefits in developing web-based applications and eased decision-making in business.

- Cloud computing environment separates the computing environment from the developers and allows them to focus on improving their application.
- Cloud stack is an entire stack of infrastructure required to deliver web applications at scale handled by managed cloud providers.
- Virtual machine (i) provides an environment where non-trusted applications can be run, (ii) adopts isolation techniques, (iii) allows dynamic deployment of application (portability), (iv) applied optimization in OS and (v) manages as a single service.
- Network virtualization is a method which combines the available resources by splitting up the bandwidth into channels and assigned to devices or users in real time.
- Storage virtualization is a concept where storage devices are virtualized. As a result of this concept better functionality, proper maintenance of storage devices and efficient backup procedures can be achieved.
- Block virtualization separates the logical storage from physical storage. Accessing can be done without the knowledge of where the physical storage is located and its nature (heterogeneous).
- File virtualization takes care of NAS, by eliminating the dependencies between file level and the location. Due to file virtualization, optimization of storage and migrations of storage devices can be achieved.

REVIEW QUESTIONS

- Why is centralized storage so important for enterprise virtualization products?
- What are the best online resources for virtualization knowledge?
- What are the best training options for learning virtualization?
- Why should I try virtualization on my desktop PC?
- What is a virtual datastore?
- What is the open virtual machine format?
- Can I virtualize all my servers or should some servers or applications kept unvirtualized?
- How much do virtualization products cost?
- How much money can my company save with server consolidation using virtualization?
- Where can I download pre-built virtual machines?
- What are virtual machine additions and integration components?
- What is a hypervisor?
- What are the risks associated with block virtualization?
- What is block virtualization?
- What is a host, guest and virtual machine?
- What is Hyper-V?
- What are the products available with server virtualization?

PART FOUR
Data Storage and Cloud Computing

CHAPTER 11

DATA STORAGE

Storage is a resource to be allocated to organizations to add more value. Data storage management includes a set of tools to configure, backup, assign to users according to defined policies. Service level agreements (SLA) support clear business objectives, reduced risk mitigation levels and legal issues.

11.1 INTRODUCTION TO ENTERPRISE DATA STORAGE

Understanding storage system is an important point in building effective storage system. This will yield cost effective, high performance and ease in managing the systems. The various types of storage subsystems are:

- Direct Attached Storage (DAS)
- Storage Area Network (SAN)
- Network Attached Storage (NAS)

DAS is the basic in a storage system and employed in building SAN and NAS either directly or indirectly. NAS is the top most layer, having SAN and DAS as its base. SAN lies between a DAS and a NAS.

11.1.1 DAS: Direct Attached Storage

DAS is the basic storage system providing block-level storage and used for building SAN and NAS. The performance of SAN and NAS depends on DAS. Performance of DAS will always be high, because it is directly connected to the system. Storage devices used to build a DAS storage subsystem are SCSI, PATA, SATA, SAS, FC, Flash and RAM.

11.1.2 SAN: Storage Area Network

When multiple hosts want to connect a single storage device, then SAN is used. SAN provides block-level storage and simultaneous access is not permitted and hence it is suitable for clustering environment. SAN technologies are FC (Fibre Channel), iSCSI (Internet SCSI) and AoE (ATA over Ethernet).

11.1.3 NAS: Network Attached Storage

For file-level storage, NAS is used. SAN and DAS act as base system for NAS. NAS is also called as 'File Server'. The main advantages of NAS are that multiple hosts can share a single volume at the same time, whereas when using SAN or DAS only one client can access the volume at a time.

11.2 DATA STORAGE MANAGEMENT

Data storage is expensive; therefore, storage administrators are trying to use tiered storage. Using fibre channel for storing data for a network user gives better performance but storage devices used are small and are expensive. SAS or DAS is cost effective performance-wise it is of lower grade. Today IT organizations are implementing tiered storage as a mix of storage technologies that meet the performance needs and are cost effective.

11.2.1 Data Storage Management Tools

Maintaining storage devices is a tedious job for storage administrators. They adopt some utilities to monitor and manage storage devices. Management level tasks are configuration, migration, provisioning, archiving and storage monitoring/reporting. Storage Resource Management (SRM) tools include configuration tools, provisioning tools and measurement tools.

- *Configuration tools* handle the set-up of storage resources. These tools help to organize and manage RAID devices by assigning groups, defining levels or assigning spare drives.
- *Provisioning tools* define and control access to storage resources for preventing a network user from being able to use any other user's storage.
- *Measurement tools* analyse performance based on behavioural information about a storage device. An administrator can use that information for future capacity and upgrade planning.

11.2.2 Storage Management Process

Data storage management tools must rely on policies which governs the usage of storage devices and its procedures. Storage management encompasses three areas—change management, performance and capacity planning and tiering (tiered storage).

The process used to request, schedule, implement and evaluate adjustments to the storage infrastructure is called *change management*. The change management process defines the way a request is made and approved and documents the steps used to configure and provision the requested space on a storage array or server. Change management may also document processes such as data migration and maintains the integrity and availability of that data for network users.

Performance and capacity planning are used to measure the performance of a system in-terms of storage and utilization. The result of performance and consumption analysis is used to make sensible decisions about subsequent storage purchases.

11.2.3 Data Storage Challenges

In depth, understanding of storage devices will minimize the risks, and an administrator can easily handle challenges like finding out the reason for performance degrading, cost check, etc. Managing traditional storage devices is a complicated task because of high operations cost, performance and scalability issues. Some challenges are massive data demand, performance barrier, power consumption and cost.

Massive Data Demand

An industry survey estimates the digital world to increase by 45 zettabytes by 2020, that is, one terabyte is equal to 1024 gigabytes, one petabytes is equal to 1024 terabytes, one exabytes is equal to 1024 petabytes and one zettabytes is equal to 1024 exabytes.

Performance Barrier

Rapid growth in data has caused a parallel increase in the size of databases. In the traditional storage method, the response time taken for queries is slow and it should be increased. Be it a social networking site, an enterprise database or a web application, all requires faster disk access to read and write data.

Power Consumption and Cost

Because of increase in storage demands, IT organizations and data centres need larger storage with minimal cost. Performance lags with minimal cost but has other expenses like licensing and maintenance. Apart from this, other factors such as power consumed by storage devices, cooling systems, man power for managing it and space for data centres are to be considered.

11.2.4 Unified Storage

A new innovative solution 'Unified Storage' is developed and addresses the issues discussed earlier. Basically this type of storage solution is a combination of NAS and SAN and termed as NUS (network unified storage). This type of storage system handles both file and block level accessing and hence storage devices can be accessed by single and multiple hosts. The main advantage of this system is reduced cost and it supports fibre channel and iSCSI.

11.3 FILE SYSTEMS

A file system is a structure used in computer to store data on a hard disk. When we install a new hard disk, we need to partition and format it using a file system before storing data. There are three file systems in use in Windows OS; they are NTFS, FAT32 and rarely-used FAT.

11.3.1 FAT File System

FAT system was first devised in the so-called computer environment in the early years. FAT was planned for systems with very small RAM and small disks. It required much less system resources compared to other file systems like UNIX.

Essentially, the FAT system has made a come back. Thumb or flash drives have become very common and have smaller size that makes the FAT system useful. The smaller sizes are even formatted in FAT16.

11.3.2 NTFS

In the 1990s, Microsoft recognized that DOS based Windows was inadequate because of demands in business and industry. They started working for better software which can suit larger systems.

NTFS is much simpler than FAT. While files are used, the system areas can be customized, enlarged, or moved as required. NTFS has much more security incorporated. NTFS is not apt for small-sized disks.

11.3.3 Cloud File System

In cloud file systems, the considerations are:

- It must sustain basic file system functionality.
- It should be an open source.
- It should be grown-up enough that users will at least think about trusting their data to it.
- It should be shared, i.e., available over a network.
- It should be paralleling scalable.
- It should provide honest data protection, still on commodity hardware with only internal storage.

Organizations that use cloud computing outsource massive amounts of data and workloads to cloud providers. Due to its low cost, lower management overhead and elasticity, organizations move towards using cloud computing.

In cloud storage, systems host or consumers can find only corruption or loss of data from their service provider's report, when a system failure occurs. This consumer–provider gap creates business risk and complicates compliance SLAs.

A cloud file system should be scalable enough to adopt large organizations file systems under different workloads with good performance requirements. Cloud file systems should have high throughputs then local file systems. Cloud file system should have minimal operation latency. The system should also be scalable to multiple hosts operating in parallel. Transparency and backwards compatibility is important to facilitate migration to the cloud with less effort. Following are some of the cloud file systems.

Ghost File System

Ghost cloud file system is used in Amazon Web Services (AWS). It gives high redundant elastic mountable, cost-effective and standards-based file system. A fully featured scalable and stable cloud file systems is provided by ghost cloud file system. GFS (Ghost File System) run over Amazon's S3, EC2 and SimpleDB web services. When using GFS, user can have complete control of the data and can be accessed as a standard network disk drive.

Benefits of Ghost CFS

- *Elastic and cost efficient*: Pay for what you use from 1 GB to hundreds of terabytes.
- *Multi-region redundancy*: Aiming to take advantage of AWS's 99.99% availability
- *Highly secure*: Uses your own AWS account (ghost cannot access your data).
- *No administration*: Scales elastically with built in redundancy—no provisioning or backup.
- *Anywhere*: Mount on a server or client or access files via a web page or from a mobile phone.

Features of Ghost CFS

- Mature elastic file system in the cloud.
- All files and metadata duplicated across multiple AWS availability regions.

- WebDav for standard mounting on any Linux, Windows or Mac server or client in the world.
- FTP access.
- Web interface for user management and for file upload/download.
- File name search.
- Side-loading of files from torrent and from URL.

Gluster File System

GlusterFS is an open source, distributed file system capable of handling multiple clients and large data. GlusterFS clusters storage devices over network, aggregating disk and memory resources and managing data as a single unit. GlusterFS is based on a stackable user space design and delivers good performance for even heavier workloads.

GlusterFS supports clients with valid IP address in network. Users no longer locked with legacy storage platforms which are costly and monolithic. GlusterFS gives users the ability to deploy scale-out, virtualized storage, centrally managed pool of storage.

Attributes of GlusterFS include scalability and performance, high availability, global namespace, elastic hash algorithm, elastic volume manager, gluster console manager, and standards-based.

Hadoop File System

A distributed file system designed to run on commodity hardware is known as Hadoop Distributed File System (HDFS). In HDFS, files are stored in blocks ranging from 64 MB to 1024 MB. The default size is 64 MB. The blocks will be distributed across the cluster and replicated for fault tolerance.

XtreemFS: A Distributed and Replicated File System

XtreemFS is a distributed, replicated and open source. XtreemFS allows users to mount and access files via WWW. Engaging XtreemFS a user can replicate the files across data centres to reduce network congestion, latency and increase data availability. Installing XtreemFS is quite easy, but replicating the files is bit difficult.

Kosmos File System

Kosmos Distributed File System (KFS) gives high performance with availability and reliability. For example, search engines, data mining, grid computing, etc. It is deployed in C++ using standard system components such as STL, boost libraries, aio, log4cpp. KFS is incorporated with Hadoop and Hypertable.

CloudFS

CloudFS is a distributed file system to solve problems when file system is itself provided as a service. CloudFS is based on GlusterFS, a basic distributed file system, and supported by Red Hat and hosted by Fedora.

There are really three production level distributed/parallel file systems that come close to the requirements for the cloud file systems: Lustre, PVFS2 and GlusterFS.

11.4 CLOUD DATA STORES

A data store is a data repository where data are stored as objects. Data store includes data repositories, flat files that can store data. Data stores can be of different types:

- Relational databases (Examples: MySQL, PostgreSQL, Microsoft SQL Server, Oracle Database)
- Object-oriented databases
- Operational data stores
- Schema-less data stores, e.g. Apache Cassandra or Dynamo
- Paper files
- Data files (spread sheets, flat files, etc)

11.4.1 Distributed Data Store

A Distributed Data Store is like a distributed database where users store information on multiple nodes. These kinds of data store are non-relational databases that searches data quickly over a large multiple nodes. Examples for this kind of data storage are Google's BigTable, Amazon's Dynamo and Windows Azure Storage.

Some Distributed Data Stores use to recover the original file when parts of that file are damaged or unavailable by using forward error correction techniques. Others download that file from a diverse mirror.

11.4.2 Types of Data Stores

Established IT organizations have started using advanced technologies for managing large size data, which come from social computing and data analysis applications.

BigTable

BigTable is a compressed, high performance and proprietary data storage system construct on Google File System, Chubby Lock Service, SSTable and a small number of other Google technologies.

BigTable was developed in 2004 and is used in number of Google applications such as web indexing, Google Earth, Google Reader, Google Maps, Google Book Search, MapReduce, Blogger.com, Google Code hosting, Orkut, YouTube and Gmail. Advantage for developing BigTable includes scalability and better performance control.

BigTable charts two random string values (row and column key) and timestamp into an associated random byte array. BigTable is designed to scale into the petabyte range across multiple machines and easy to add more machines and automatically start using resources available without any configuration changes.

Other similar softwares are as follows:

- *Apache Accumulo*: Construct on top of Hadoop, ZooKeeper and economy. Server-side programming mechanism deployed in Java environment.
- *Apache Cassandra*: Dynamo's distributed design and BigTable's facts and numbers form adds simultaneously in Apache Cassandra, which uses Java.
- *Hbase*: Supports BigTable and Java programming language.
- *Hypertable*: Designed for cluster of servers especially for storage and processing.
- *KDI*: Kosmix stab to make a BigTable clone and is written in C++.

Dynamo: A Distributed Storage System

Dynamo is a vastly offered, proprietary key-value structured storage system or a dispersed data store. It can act as databases and also distributed hash tables (DHTs). It is used with parts of Amazon web services such as Amazon S3.

Dynamo is the most powerful relational database available in World Wide Web. Relational databases have been used a lot in retail sites, to make visitors browse and search for products easily.

It is difficult to create redundancy and parallelism with relational databases which is a single point failure. Replication is also not possible.

Dynamo is a distributed storage system and not a relational database. Similar to a relational database it stores information to be retrieved; however, it stores the data as objects and not as tables. The advantage of using Dynamo is responsive and consistent in creating a distributed storage solution.

11.5 USING GRIDS FOR DATA STORAGE

11.5.1 Grid Storage for Grid Computing

Grid computing established its stand as an understood architecture, as it provides users and applications to use shared pool of resources. The compute grid connects computers both desktops and servers and storage across an organization. It virtualizes heterogeneous and remotely located components into a single system. Grid computing allows sharing of computing and data resources for multiple workloads and enables collaboration both within and across organizations.

Demand for storage requirement prevails in gird computing. Storage for grid computing requires a common file system to present as a single storage space to all workloads. Presently grid computing system uses NAS type of storage. NAS provides transparency but limits scale and storage management capabilities.

To set the unique demands of the compute grid on its storage infrastructure, storage for the grid must be abnormally flexible. DAS is basically not an option. Virtualization is a start, providing the single unit behaviour where the global filing system requires data compute grid. Due to this, SAN architectures are used. However, the scale of these SANs is beyond the capabilities of fibre channel.

11.5.2 Grid Oriented Storage (GOS)

Grid Oriented Storage (GOS) is a dedicated data storage architecture connected directly to a computational grid. It supports and acts as a data bank and reservoirs for data, which can be shared among multiple grid clients.

GOS is a successor of Network-Attached Storage (NAS) products in the grid computing era. GOS accelerates all kinds of applications in terms of performance and transparency. A GOS system contains multiple hard disks, arranged into logical, redundant storage containers like traditional file servers.

GOS deals with long-distance, heterogeneous and single-image file operations. GOS acts as a file server and uses file-based GOS-FS protocol. Similar to GridFTP, GOS-FS integrates a parallel stream engine and Grid Security Infrastructure (GSI). GOS-FS can be used as an underlying platform to utilize the available bandwidth and accelerate performance in grid-based applications.

SUMMARY

- Storage is a resource to be allocated to the organizations to provide more benefits.
- Understanding storage system is an important point in building effective storage system.
- The various types of storage subsystems are (i) Direct Attached Storage (DAS), (ii) Storage Area Network (SAN) and (iii) Network Attached Storage (NAS).
- Data storage is expensive, therefore, storage administrators are trying to use tiered storage.
- Managing traditional storage devices is a complicated task because of high operational cost, performance and scalability issues.
- A file system is a structure used in computer to store data on a hard disk. There are three file systems in use in Windows OS, they are: NTFS, FAT32 and rarely-used FAT.
- A cloud file system should be scalable to adopt large organizations file systems under different workloads with good performance requirements.
- Cloud file systems should have high throughputs then local file systems. Cloud file system should have minimal operation latency.
- Examples of cloud file systems are: (i) Ghost File Systems, (ii) Gluster File System, (iii) Hadoop File System, (iv) XtreemFS: A distributed and replicated file system, (v) Kosmos File System and (vi) CloudFS.
- A data store is a data repository where data are stored as objects. Data store includes data repositories, flat files that can store data.
- A distributed data store is like a distributed database where users store information on multiple nodes.
- Grid computing established its stand as an understood architecture, as it provides users and applications to use shared pool of resources.

- Storage for grid computing requires a common file system to present as a single storage space to all workloads.
- GOS is a successor of Network-Attached Storage (NAS) products in the grid computing era. GOS accelerates all kinds of applications in terms of performance and transparency.

KEY TERMS

- Storage is a resource to be allocated to organizations to add more value.
- Understanding storage system is an important point in building effective storage system. This will yield cost effective, high performance and ease in managing the systems.
- Configuration tools handle the set-up of storage resources. These tools help to organize and manage RAID devices by assigning groups, defining levels or assigning spare drives.
- Provisioning tools define and control access to storage resources for preventing a network user from being able to use any other user's storage.
- Measurement tools analyse performance based on behavioural information about a storage device. An administrator can use that information for future capacity and upgrade planning.
- Performance and capacity planning are the benchmarks used to measure the performance of a system in-terms of storage and utilization.
- Unified storage answers the challenges such as (i) massive data demand, (ii) performance barrier, (iii) power consumption and cost.
- A file system is a structure used in computer to store data on a hard disk.
- A cloud file system is scalable to adopt large organizations file systems under different workloads with good performance requirements.
- Ghost cloud file system is used in Amazon Web Services (AWS). It gives high redundant elastic mountable, cost-effective and standards-based file system.
- GlusterFS is an open source, distributed file system capable of handling multiple clients and large data.
- A distributed file system designed to run on a commodity hardware is said to be Hadoop Distributed File System (HDFS).
- Kosmos distributed file system (KFS) gives high performance with availability and reliability. KFS is used to backend storage infrastructure for data-intensive applications.
- CloudFS is a distributed file system to solve the problem when file system is itself provided as a service.
- A distributed data store is like a distributed database where users store information on multiple nodes.
- BigTable is a compressed, high performance and proprietary data storage system construct on Google File System, Chubby Lock Service, SSTable and a small number of other Google technologies.

- Dynamo is a vastly offered, proprietary key-value structured storage system or a dispersed data store.
- Grid Oriented Storage (GOS) is a data storage used in computational grids.
- GOS is deals with long-distance, heterogeneous and single-image file operations. GOS acts as a file server and uses file-based GOS-FS protocol.

REVIEW QUESTIONS

- List the types of basic storages.
- What is DAS, SAN and NAS?
- What are the storage devices used to build a DAS?
- What is SCSI?
- What is PATA?
- What is SATA?
- Explain SAS.
- What is FC?
- List data storage management task.
- What is unified storage?
- List the features of cloud file system.
- What is the use of ghost file system?
- List the benefits of ghost CFS.
- What is a gluster file system?
- What are all the attributes of GlusterFS?
- What is Hadoop file system?
- Explain data node and name node.
- What is CloudFS and why it is used?
- List the production level of distributed/parallel file systems.
- Explain Kosmos file system.
- List the types of data stores.
- List software similar to Bigtable.
- Explain requirements of grid storage.
- What are grid computing and grid storage?
- What is compute grid?
- What are the advantages of SAN in grid computing?
- What is the usage of global file system?

CHAPTER 12

CLOUD STORAGE

12.1 WHAT IS CLOUD STORAGE?

Most of the organizations in an effort to cut cost are switching to taking cloud computing and cloud storage solutions. Cloud computing is a model which wraps around current technologies, for example, server virtualization to make use of resources more efficiently. The benefits of cloud storage are: a high point of scalability and elasticity alongside management. When virtualized storage is offered on demand in a network, an organization can be free from the need to buy its storage capacity before opting for data storage.

Predicting growth of storage is not possible. IT organization has to provide enough capacity for storing data that are generated. With traditional storage hardware, expanding the capacity immediately is difficult and also expensive. Apart from this, maintaining these storage devices is tedious and time consuming. For solving these problems, the best practices adopted are listed as follows:

- *Unpredictable storage growth*: IT organizations should constantly monitor storage consumption to track whether the actual growth rates are in line with initial projections.
- *Cost and complexity of conventional storage*: Enterprises must think Storage-as-a-Service solutions for remote and branch offices when it is possible.
- *Security*: As employees move between offices all over the world and take their data with them, enterprise should ensure that in-house and customer data is always protected and safe.

IT organizations with less staff members cannot depute staff for their remote offices. Such IT organizations can end up with a series of problems in terms of structures that operate differently and inefficiently.

To avoid these problems, the following solutions can be applied:

- IT organizations should aim to centralize data storage and protection.
- IT organizations should eliminate the need for personnel on-site and establish a single point-of-control.
- Need a clear service level agreement between remote organization and the central organization.

The abstract meaning for cloud is any-to-any connectivity using network. The cloud abstraction acts as a base upon which other features are built. In general, cloud model expands this base by adding a pool of resources. An important part of the cloud model is the recent innovation called virtualization that made the sharing of pool of resources ineffective and with reduced complexity. Cloud storage is nothing but virtualized storage on demand called as Data storage as a Service (DaaS).

Cloud storage is data storage hosted remotely using data storage devices in WWW and maintained by the third party (service provider). Cloud storage is a part of cloud computing. It is deployed using WAN infrastructure which includes hardware components such as switches and routers.

Cloud storage can be deployed in many ways. For example:

- Local data (desktop/laptop) can be backed up to cloud storage.
- A virtual disk can be ‘sync’ to the cloud and distributed.
- The cloud can be used as a reservoir for storing data.

12.2 OVERVIEW OF CLOUD STORAGE

Cloud storage is a subset of cloud computing. Standards and services pertaining to cloud storage have to be understood before its implementation. Resources that are exposed to clients are called as functional interfaces, that is, data paths. Resources maintained by the service providers are called as management interfaces, that is, control paths. A standard model is to be developed and proposed for both interfaces, that is, consumers and providers. That standard should be mapped to various services rendered by the provider. This standard should act as a base for cloud storage interfaces.

Cloud storage came under the limelight because of the following attributes available in cloud computing: pay-as-you-use, elasticity and simplicity (management). It is important that any provider providing storage as a service should also provide these attributes to the consumer. Following are some additional cloud storage attributes:

- *Resource pooling and multi-tenancy*: Multiple consumers can use shared single storage device. Storage resources are pooled and consumers can be assigned and unassigned resources according to their needs.
- *Scalable and elastic*: Virtualized storage can be easily expanded on need basis.
- *Accessible standard protocols* including HTTP, FTP, XML, SOAP and REST.
- *Service-based*: Consumers no need to invest, that is, no CAPEX (Capital Expenditure) and only pay for usage, that is, OPEX (Operational Expenditure).
- *Pricing based on usage*
- *Shared and collaborative*
- *On-demand self-service*

Cloud storage can be accessible through web-based applications or through web services Application Programming Interfaces (APIs), and using this data are stored. IT organizations have started developing personalized web applications for easy access of cloud storage services.

12.3 DATA MANAGEMENT FOR CLOUD STORAGE

In the early stages, cloud storage focused on the best effort service. To support enterprise applications, quality of service has to be increased and extra services deployed. Cloud storage will lose its abstraction and its benefits such as simplicity, heterogeneity and good performance, if complex management services are added. Cloud storage should incorporate new services according to change of time.

For cloud storage, a standard document is placed by SNIA Storage Industry Resource Domain Model (SIRDM). It states the importance of simplicity for cloud storage. Figure 12.1 shows the SIRDM model which uses CDMI standards. SIRDM model adopts three metadata: system consisting of storage metadata, data metadata and user metadata. By using these metadata, cloud storage interface can offer services without adding unnecessary complexity in managing the data.

Storage system and data system metadata are used to meet the requirements of the data and the simplicity required is maintained.

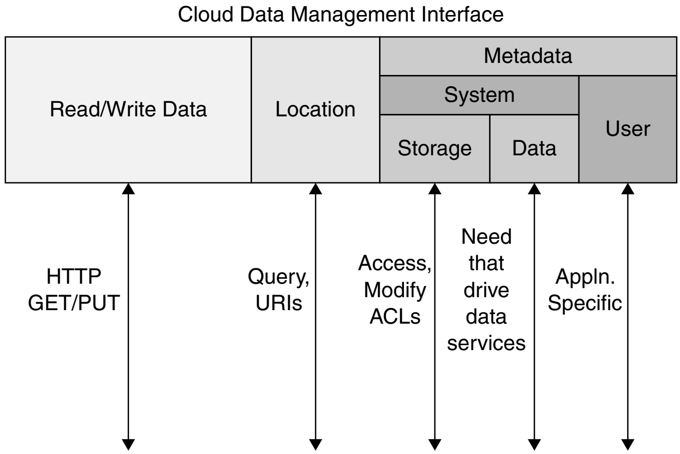


Figure 12.1 Cloud Storage Usage of SIRDM Model

User metadata is used by the cloud to find the data objects and containers.

Storage system metadata is used by the cloud to offer basic storage functions like assigning, modifying and access control.

Data system metadata is used by the cloud to offer data as a service based on user requirements and controls the operation based on that data.

12.3.1 Cloud Data Management Interface (CDMI)

To create, retrieve, update and delete objects in a cloud the cloud data management interface (CDMI) is used. The functions in CDMI are:

- Cloud storage offerings are discovered by clients
- Management of containers and the data
- Sync metadata with containers an objects

CDMI is also used to manage containers, domains, security access and billing information. CDMI standard is also used as protocols for accessing storage.

CDMI defines how to manage data and also ways of storing and retrieving it. 'Data path' means how data is stored and retrieved. 'Control path' means how data is managed. CDMI standard supports both data path and control path interface.

12.3.2 Cloud Storage Requirements

Multi-tenancy

In a multi-tenancy model, resources provided are pooled, so that it may be shared by multiple customers based on their needs. Due to the elasticity property in cloud computing, shared pool of storage model makes the provider cost effective and billing is made easy.

Security

Secure cloud storage requires a secure transmission channel and methods. Securing data can be done using encryption, authentication and authorization.

- *Encryption* is the process of scrambling data in such a manner as to make it unreadable without special information, called a key, to make it readable again.
- *Authentication* is the process of determining their identity. Authentication can employ passwords, biometrics, identifying tokens and other means.
- *Authorization* determines access rights on the data and the levels of authorization. To provide secure cloud storage, access must be restricted for the communication channel, the data source and the cloud storage sites.

Secure Transmission Channel

The four primary methods used to secure network communications are as follows:

1. Transport Layer Security (TLS) and Secure Sockets Layer (SSL)
2. Hypertext Transfer Protocol Secure (HTTPS)
3. Private Networks
4. Virtual Private Networks (VPNs)

Performance

Cloud storage performance can be categorized into two: speed and latency. Factors that affect cloud storage performance are: available network bandwidth, types of systems available in provider's end, method adopted for compression and caching.

Quality of Service (QoS)

Quality of service (QoS) refers to levels of performance and efficiency of the system that they can provide.

Data Protection and Availability

To ensure that data is protected from loss and theft, providers must take some precautionary measures:

- Physical site security
- Protection against power loss
- Protection against loss of network access
- Data redundancy
- Server redundancy and server fail-over
- Redundant data sites
- Levels of redundancy

- Versioning and data retention
- Accessibility of cloud storage as live data
- Backup to tape or other media
- Data availability, when contract disputes

Metering and Billing

Metering and billing in cloud storage are done based on: data uploaded, data downloaded, data stored and depends on requests and types of request.

12.4 PROVISIONING CLOUD STORAGE

Cloud means sharing third party resources via the Internet. This sharing can be done on need basis and there is no need to invest any infrastructure at consumers end.

Storage clouds increase the efficiency of storing data in remote places, by sharing the storage devices provided by the service providers. Capacity of storage can be increased on need basis and can be done using multi-tenancy methods.

Private storage clouds reside at the back of an organization's firewall that is deployed for in-house customers and is designed for providing elasticity and simplicity in cloud model.

By adopting Cloud Data Management Interface (CDMI), standard service providers can implement the method for metering the storage and data usage of consumers. This interface also helps the providers for billing to the IT organizations based on their usage. Advantage of this interface is that IT organizations need not write/use different adapters used by the service providers. By using this interface, they can connect with different service providers.

12.5 DATA-INTENSIVE TECHNOLOGIES FOR CLOUD COMPUTING

Data-intensive computing is a lateral type of computing which use parallelism concept for processing large volumes of data, called big data. Applications which need more execution time for computational requirements are termed as compute-intensive. Data-intensive is a term used to describe applications which seeks large volume of data and time in process.

Parallel processing approaches are divided into two types: compute-intensive and data-intensive. Application programs that are compute bound described using compute-intensive requires more execution time. Parallel processing of this type of application involves running individual algorithms parallel within a process.

12.5.1 Processing Approach

Data-intensive computing platforms use a parallel computing approach. This approach combines multiple processors and disks as computing clusters connected via high-speed network. The data that are needed to be processed are independently done by computing resources available in the clusters. This improves the performance and scalability. A cluster can be defined as a parallel and distributed system, consisting of multiple inter-connected standalone computers working as a single computing resource. In parallel computing, this move is suitable for data-intensive computing.

There are many common characteristics of data-intensive computing systems compared with other forms of computing, they are:

- The principle mechanism used for collection of the data and programs or algorithms to perform the computation
- Programming model used
- Reliability and availability
- Scalability of both hardware and software

12.5.2 System Architecture

For data-intensive computing an array of system architectures have been implemented. A number of solutions have come out, one among them is MapReduce concept which is developed by Google and available as open-source implementation known as Hadoop. This project is used by Yahoo, Facebook and others. Apart from this, proprietary system architecture for data-intensive computing is developed by LexisNexis Risk Solutions called LexisNexis.

MapReduce

The MapReduce architecture and programming model is an example for data-intensive computing, pioneered by Google. To create a map function, the MapReduce architecture uses a functional programming style using key-value pair. This pair is connected with the input data to produce a set of intermediary key-value pairs. Reduce function merges all intermediate values using intermediate keys. System takes care of particulars like partitioning the input data, scheduling and executing automatically. Hence programmers who do not have experience in parallel programming can simply use a large distributed processing environment without any problem.

HPCC

LexisNexis Risk Solutions independently developed and implemented a solution for data-intensive computing called the HPCC (High-Performance Computing Cluster). The LexisNexis method structure clusters with commodity hardware that runs in Linux OS. Custom system software and middleware parts were created and layered to provide the execution environment and distributed file system support that is essential for data-intensive computing on the base of Linux operating system. A new high-level language for data-intensive computing called ECL is also implemented by LexisNexis.

SUMMARY

- Cloud computing is a model which wraps around current technologies, for example, server virtualization, to use resources optimally.
- The benefits of cloud storage are scalability and elasticity, along with management.

- Cloud storage is nothing but virtualized storage on demand called as Data storage as a Service (DaaS) and also a subset of cloud computing.
- Cloud storage attributes are (i) resource pooling and multi-tenancy, (ii) scalable and elastic, (iii) accessible standard protocols, (iv) service-based, (v) pricing based on usage, (vi) shared and collaborative and (vii) on-demand self-service.
- CDMI defines how to manage data and also means to store and retrieve them. 'Data path' means how data stored and retried. 'Control path' means management of data. CDMI standard supports both data path and control path interface.
- CDMI is capable of the following: (i) cloud storage offerings are discovered by clients, (ii) management of containers and the data and (iii) sync metadata with containers as objects.
- Cloud storage requirements are (i) multi-tenancy, (ii) security, (iii) secure transmission channel, (iv) performance, Quality of Service (QoS), (v) data protection and availability and (vi) metering and billing

KEY TERMS

- Cloud computing is a model which wraps around current technologies, for example server virtualization, to utilize resources efficiently.
- Cloud storage is nothing but virtualized storage on demand called as Data storage as a Service (DaaS).
- Cloud storage is data storage hosted remotely using data storage devices in WWW and maintained by the service provider.
- SNIA Storage Industry Resource Domain Model (SIRDM) is a standard document to simplify cloud storage.
- To create, retrieve, update and delete objects in a cloud the Cloud Data Management Interface (CDMI) is used.
- Multi-tenancy model, where resources provided are pooled and shared by multiple customers on the basis of their need.
- Data-intensive computing a lateral type of computing uses parallelism concept for processing large volumes of data, called big data

REVIEW QUESTIONS

- Why is virtualization used in cloud storage?
- Define DaaS.
- What is the need for international standards in cloud store?
- How is data deployed in cloud storage?
- What is SIRDM?
- What is data path and control path?

- What is the use of cache in cloud data store?
- State the importance of CDMI.
- List all cloud storage requirements.
- List all functions available in CDMI.
- Define multi-tenancy.
- What are the ways in which security is provided in cloud storage?
- What is data-intensive computing platform?
- Define big data.
- Where and how are MapReduce and HPCC used?

CHAPTER 13

Cloud Storage from LANs to WANs

13.1 INTRODUCTION

Data management applications are promising for candidates who opt for deployment of the cloud. This is because an on-premises enterprise database system usually comes with a large, occasionally prohibitive up-front cost, both in hardware and in software. For multiple businesses, the pay-as-you-go cloud computing form is very attractive. Thus, cloud computing is reminiscent of the Application Service Provider (ASP) and Database-as-a-Service (DaaS) paradigms.

Web Services, AT&T's Synaptic Hosting, AppNexus, GoGrid, Rackspace Cloud Hosting, and to some extent, the Intel Cloud Computing Testbed and the IBM/Google cloud start working distinctly than ASPs and DaaS. Instead of owning, establishing and managing the database programs, cloud computing vendors normally maintain little more than the hardware and give their clients a set of virtual appliances to establish their own software. Resource accessibility is normally elastic, with an apparently infinite allowance of compute power and storage accessible on demand, in a pay-only-for-what-you-use model.

13.2 CLOUD CHARACTERISTIC

There are three characteristics of a cloud computing natural environment that are most pertinent to be considered before choosing storage in cloud.

1. Computer power is elastic, when it can perform parallel operations. In general, applications conceived to run on the peak of a shared-nothing architecture are well matched for such an environment. Some cloud computing goods, for example, Google's App Engine, supply not only a cloud computing infrastructure, but also an entire programs stack with a constrained API so that software developers are compelled to compose programs that can run in a shared-nothing natural environment and therefore help elastic scaling.
2. Data is retained at an unknown host server. In general, letting go off data is a threat to many security issues and thus suitable precautions should be taken. The very title 'loud computing' implies that the computing and storage resources are being operated from a celestial position. The idea is that the data is physically stored in a specific host country and is subject to localized laws and regulations. Since most cloud computing vendors give their clientele little command over where data is stored, the clientele has no alternative but to expect the least that the data is encrypted utilizing a key unavailable with the owner, the data may be accessed by a third party without the customer's knowledge.
3. Data is duplicated often over distant locations. Data accessibility and durability is paramount for cloud storage providers, as data tampering can be impairing for both the business and the organization's reputation. Data accessibility and durability are normally accomplished through hidden replications. Large cloud computing providers with data hubs dispersed all through the world have the proficiency to provide high levels of expected error resistance by duplicating data at distant locations across continents. Amazon's S3 cloud storage service replicates data over 'regions' and 'availability zones' so that data and applications can survive even when the whole location collapses.

13.3 DISTRIBUTED DATA STORAGE

Distributed storage means are evolving from the existing practices of data storage for the new generation of WWW applications through organizations like Google, Amazon and Yahoo. There are some reasons for distributed storage means to be favoured over traditional relational database systems encompassing scalability, accessibility and performance. The new generation of applications require processing of data to a tune of terabytes and even peta bytes. This is accomplished by distributed services. Distributed services means distributed data. This is a distinct giant compared to traditional relational database systems. Several studies have proposed that this is an end of an architectural era and relational database systems have to take over. Emerging answers are Amazon Dynamo, CouchDB and ThruDB.

13.3.1 Amazon Dynamo

Amazon Dynamo is a widely used key-value store. It is one of the main components of Amazon.com, the biggest e-commerce stores in the world. It has a primary-key only interface. This demands that data is retained as key-value in twos, and the only interface to get access to data is by identifying the key. Values are anticipated to be barely there (less than 1 MB).

Dynamo is said to be highly accessible for composing as opposed to reading, since malfunction of composing inconveniences the end-user of the application. Therefore any data confrontations are finalized at the time of reading than writing.

13.3.2 CouchDB

CouchDB is a document-oriented database server, accessible by REST APIs. Couch is an acronym for 'Cluster Of Unreliable Commodity Hardware', emphasizing the distributed environment of the database. CouchDB is designed for document-oriented applications, for example, forums, bug following, wiki, Internet note, etc. CouchDB is ad-hoc and schema-free with a flat address space.

CouchDB aspires to persuade the Four Pillars of Data Management by these methods:

1. *Save*: ACID compliant, save efficiently
2. *See*: Easy retrieval, straightforward describing procedures, fulltext search
3. *Secure*: Strong compartmentalization, ACL, connections over SSL
4. *Share*: Distributed means

The storage form is a Multiversion Concurrency Control (MVCC) scheme with hopeful locking. A purchaser sees a snapshot of the data and works with it even if it is altered at the same time by a distinct client.

CouchDB actually has no apparent authentication scheme, i.e., it is in-built. The replication is distributed. A server can revise others once the server is made offline and data is changed. If there are confrontations, CouchDB will choose a survivor and hold that as latest. Users can manually suspend this surviving alternative later. Importantly, the confrontation tenacity yields identical results comprehensively double-checking on the offline revisions. This also promises to compose a storage motor for MySQL founded on CouchDB.

13.3.3 ThruDB

ThruDB aspires to be universal in simplifying the administration of the up-to-date WWW data level (indexing, caching, replication, backup) by supplying a reliable set of services:

- *Thrucene* for indexing
- *Throxy* for partitioning and burden balancing
- *Thrudoc* for article storage

ThruDB builds on top of some open source projects: Thrift, Lucene (indexing), Spread (message bus), Memcached (caching), Brackup (backup to disk/S3) and also values Amazon S3.

Thrift is a structure for effective cross-language data serialization, RPC and server programming. Thrift is a programs library and set of code-generation devices conceived to expedite development and implementation of effective and scalable backend services. Its prime aim is to enhance effective and dependable connection over programming languages. This is finished by abstracting the portions of each dialect that are inclined to need the most customization into a widespread library that is applied in each language. Specifically, Thrift permits developers to characterise data types and service interfaces in a sole language-neutral document and develop all the essential cipher to construct RPC purchasers and servers.

Thrudoc arrives with some data storage engines: Disk and S3. In this implementation, the data is persevered on localized computer disk, which bestows us an unbelievable throughput capability and a slave gist that calmly replays all of the instructions to the S3 backend as well, therefore giving us a provoke-free persistence and recovery form for virtual environments, for example, EC2.

There are some more systems out in the untamed as well as appearing systems. Prominent amidst them are:

- *Amazon Simple Storage Service* is a straightforward data storage scheme with a hash-table like API. It is a hosted service with interior architecture minutia not available. It is proclaimed that the conceive obligations of S3 are scalable, reliable, fast, inexpensive and simple.
- *Amazon SimpleDB* is a hosted WWW service for running queries on organized data in real time. It has the prime functionality of a database, real-time lookup and straightforward querying of organized data.
- *MemcacheDB* is a distributed key-value storage scheme conceived for persistence. It conforms to the memcache protocol. Memcachedb values Berkeley DB as a saving backend, so allotments of characteristics encompassing transaction and replication are supported.

Distributed storage has numerous anxieties, scalability, hardware obligations, query form, malfunction management, data consistency, durability, reliability, effectiveness, etc.

The future of data storage can be viewed in addition, for example, CouchDB Integration with Abdera, an Atom store.

13.4 APPLICATIONS UTILIZING CLOUD STORAGE

13.4.1 Online File Storage

Being capable of accessing documents from any location and from any computer is one of the large conveniences of the Internet. Online document storage has been around for a while now, but the latest generation of services is so simple to use. Most online storage providers moreover give us the proficiency to share these documents with associates and colleagues.

DropBox

Few online storage services integrate desktop as well as DropBox, which was only recently opened up to the public after a comprehensive beta test. Users have to establish a little program on their appliance to run DropBox, it is well worth it. DropBox permits us to upload any kind of document, as long as it is lesser than 350MB. DropBox values Amazon's S3 service as its storage option and presents its users with 2GB of free storage.

The important feature of DropBox is that it can preserve revision for each file. DropBox supports Windows XP and Vista, Mac OSX and Linux.

Box.net

Box.net has been around for rather a while, and is still one of our very most preferred locations to shop articles online. Thanks to its integration with other online services, encompassing Gmail, Zoho, picnick and Scribd, Box.net cannot only shop all articles, but can also function as a hub. The other friendly characteristic of box.net is that clients can share the documents and folders with 'collaborators,' which makes it a good service to exchange documents inside a small business enterprise or amidst friends.

Live Mesh

The online storage constituent of Live Mesh is only a part of Microsoft's newest project of cloud computing, but it is also one of its most convincing characteristics at this point. Live Mesh devotes 5GB of online storage and an online desktop that examines like Windows Vista. Users can upload any kind of document to Live Mesh, but will not edit any of the documents through the online desktop. In addition, clients can share folders with associates, allowing working jointly on projects. Live Mesh works on both Windows PCs and Macs.

Oosah

Oosah's major trading concept is simple: client gets a whopping 1 terabyte of storage for newspapers files. The limitation of Oosah is that client cannot use it for text articles, spreadsheets or productions, which appear a bit strange, provided that these kinds of documents are usually small.

One intriguing facet of Oosah is that it acknowledges RAW alike documents from most camera manufacturers although it mechanically converts them into JPGs. Users can also connect to Picasa, Flickr, Facebook and YouTube anecdotes and view the pictures and videos from these services in one centralized location.

While Oosah is best for general use, the one contradictory fact is that uploading documents appears to be endlessly hard. Oosah does not supply any desktop, vendors and clients can use the WWW uploader to choose multiple files. Uploading multiple directories at a time is not possible.

JungleDisk

JungleDisk is the only service in this category that is not accessible for free, and it is not exactly an online storage service. Instead, it presents a front-end to Amazon's S3 storage service. JungleDisk charges $20, and client buys Amazon for the storage and moves the files. JungleDisk also permits us to chart Amazon S3 storage space as a mesh support on the computer so that client can just pull and push documents back and forth between online storage and the localized desktop. JungleDisk is accessible for Windows, Mac OSX and Linux.

13.4.2 Cloud Storage Companies

It seems like there is a new cloud business popping up every day, and the variety of services they offer are endless. Following are some cloud storage companies that are worth noting. Most of these service providers have a free test or offer some sort of free storage space.

Box cloud storage: Box makes it straightforward to set-up a cloud storage account. Surprisingly, clients can start the cloud and run it within few minutes. The best thing about box is that it works like any other document system. Users easily logs in through the browser (Chrome, Safari, Firefox and Internet Explorer) and start uploading or downloading files.

Amazon cloud: The Amazon Cloud Drive was one of the pioneering technologies in the cloud industry. This may be the most -preferred business for a client looking to backup his files on a daily basis. Now consumers use the Amazon cloud to run large-scale data processing centres or to back up the whole business. Amazon is proposing a large free package for the individual cloud users.

SugarSync online backup: SugarSync permits not only backup for the documents but also links up the multiple devices. Sync iPad to iPhone and to the live computer all with one program. SugarSync is a one-stop-shop for your photographs, melodies and documents needs.

Hubic online storage: Hubic gained popularity because it is expressly conceived as an submission for both the iPhone and the Android platforms. With the help of Hubic, clients can upload and download documents on their Smartphone. He can also backup the pictures, melodies, video and other documents that are utilized on the Smartphone.

Google cloud drive: Google Cloud Drive may be outdated but they are proposing a good 5 GB for free. For a couple of bucks per month clients can shop a ton of devices by utilizing Google's Cloud Drive.

13.4.3 Online Book Marking Service

Social bookmarking is the best method in which client, use bookmarks and organize the sheets they wish to recall or share with their friends. These collective bookmarks are generally community-based and can be kept in confidence, only with specific persons or assemblies, distributed only to internal reliable systems, or another grouping of public and individual domains. Only the approved persons can observe these communal bookmarks in succession, by class or tags, or by a search engine.

Advantages of Social Bookmarkings

- Users can profit from Google supported connections for the WWW sites.
- Useful connections can be provided to the visitors of libraries through community publication marking.
- Can turn heavy traffic for the web site.

- It presents good view for Internet aided marketing.
- Social publication assessing completion of millions of sheet outlooks on a monthly basis. It attracts the tourists from all over the world, and therefore the Internet marketers use this WWW traffic to attract targeted customers.
- It assists in assimilation of bookmarks from numerous computers, association of bookmarks, distributing of bookmarks with associates and so on.
- This scheme is capable of grading a specific asset based on the number of times it has been bookmarked by the users.

Microsoft Labs lately launched Thumbtack, a new bookmarking application. It comprises of intriguing take on bookmarking and keeping online data, though it often runs short on consigning some of the basics from online bookmarking services.

According to Microsoft, Thumbtack was evolved on client response the business obtained after issuing Listas. Unlike Listas, Thumbtack does not aim on community bookmarking but rather on conceiving online study libraries.

The original Thumbtack location is rather well-conceived and permits us to pull and push pieces to distinct collections, edit and tag bookmarks and share the bookmarks by Internet note and through a public WWW.

Qitera's characteristics looks similar to Thumbtack's although Thumbtack has a more alluring client interface, the original bookmarking and data retrieval through Qitera is far better than Microsoft's product. Thumbtack also needs any of the community bookmarking facets that make Twine, Delicious or Qitera interesting. Not everyone, of course, is involved in distributing bookmarks and for those users, Thumbtack is unquestioningly worth pursuing, we would suggest Qitera, Delicious or Magnolia, or the Google Notebook over Thumbtack.

13.4.4 Online Photo Editing Service

Cloud computing is a phase that encounters a wide range of services and programs applications that share one common fact that they all run on the Internet and not on a user's PC. Cloud computing has been around for years: instant messaging and web posted letters are only two examples. New applications and services emerge almost every day in the form of new community networking sites, SaaS (Software as a Service), web posted letters and many others.

Cloud computing contributes numerous valuable and helpful services, and applications and for many of these, it is a flawless venue. For instance, the cloud is perfect for distributing images, community networking, instant messaging, online data storage, non-sensitive data, online photograph revising and many other applications and services which needs no uploading individual or perceptive data. Cloud computing presents a very good natural environment and structure that boosts and makes collaboration between parties convenient.

Online Photo Editors

Cloud computing and SaaS are both are in the middle of the most hyped phase in the IT sphere right now, and numerous professionals accept for fact that they there is a tendency that is just about to change the way we use and get access to programs for ever. In its simplest form, cloud computing is just a flexible computing application accessible as a service on a pay-per-usage similar to electrical power in the power socket. SaaS is a software and application provided by the cloud rather than being established locally on a PC. Usually conceived to be multifarious, it ensures that multiple users get access to the identical applications. This form cuts cost, eliminates the need for in house maintenance and ensures that users start using it much faster.

While the Cloud and SaaS signal are growing, a numerous user-friendly Photo Editors accessible on a SaaS form absolutely free. Generally, they are neither as unique nor very fast as Photoshop, but they are developing, and in most cases they have the usual characteristics and much more. Another good thing about Online Photo Editors is that they can be accessed from any location and any computer with Internet connection. Let us take a close look at some of the most useful Online Photo Editors accessible right now.

Photoshop Express Editor

It has been constructed on the convention of Photoshop minus the technicalities. It is ideal for amateur photographers who don't wish to get involved into the complicated features of the Photoshop. In spite of all this, it has its own limitations. The publishing choices are absent. Also, it does not support photographs from high mega pixel cameras.

Picnik: It has the responsibility of extraordinary consequences, a variety of fascinating fonts and shapes. It enables red eye decrease and also edits the exposure which is most challenging for photographers. It is very speedy and works well on distinct platforms such as Mac, Windows and Linux. One of the most compelling characteristics of Picnik is the support of the photograph distributing sites and the community networking sites.

Splashup: A free online tool for editing photos. It is browser friendly and carries various photograph sharing services as Picasa, Flickr and Facebook. Splashup comprises of numerous photograph revising tools such as lasso, distort, brush load up, crop, etc. Multiple windows are permitted, which entrusts its demonstration compared to the other tools. Besides, it also presents us a Splashup Light, a free offline photograph reviewer, which works flawlessly on our desktop as well as on wireless PCs.

FotoFlexer: It is one of the best choices for photograph editing. It has all the rudimentary characteristics and supplements numerous sophisticated tools. It offers upfront animations that most of the online devices don't offer. Other characteristic that makes Fotoflexer to stand out is that it has 25 filters and it can make flat images.

Pixer.us: Pixer.us is a straightforward and direct device for revising quickly. It does not need signup. It has all the rudimentary devices such as crop, rotate, flip, resize with hue rectify, and resize. A positive feature is that it permits unlimited undo options.

SUMMARY

- Characteristics of cloud are as follows: (i) compute power is elastic, (ii) data is stored with a trust-worthy host and (iii) data is duplicated.
- Distributed storage means are evolving the de facto procedure of data storage by using WW W applications by organizations like Google, Amazon and Yahoo.

- Amazon Dynamo is a widely used key-value store. It is one of the main components of Amazon.com, the biggest e-commerce store in the world. It has a primary key-only interface.
- CouchDB is a document-oriented database server, accessible by REST APIs. Couch is an acronym of 'Cluster of Unreliable Commodity Hardware', emphasizing the circulated environment of the database.
- ThruDB aspires to be an entire package to simplify the administration of the up-to-date WWW data level (indexing, caching, replication, backup) by supplying a reliable set of services: Thrucene for indexing, Throxy for partitioning and burden balancing, and Thrudoc for article storage.
- Distributed storage has numerous anxieties, scalability, hardware obligations, query form, malfunction management, data consistency, durability, reliability, effectiveness, etc.
- Applications utilizing cloud storage are (i) DropBox, (ii) Box.net, (iii) Live Mesh, (iv) Oosah and (v) JungleDisk.
- Examples of cloud storage companies are (i) Box Cloud Storage, (ii) Amazon Cloud, (iii) SugarSync Online Backup, (iv) Hubic online Storage, (v) Google Cloud Drive.
- Social Bookmarking is a method in which client uses bookmark and manages the sheets they wish to recall or share with their friends.
- Cloud computing is a period that recounts a broad kind of services and programs submissions that share one widespread facet they all run on Internet and not on a user's PC.
- Example Online Photo Editors are (i) Photoshop Express Editor, (ii) Picnik, (iii) Splashup, (iv) FotoFlexer and (v) Pixer.us.

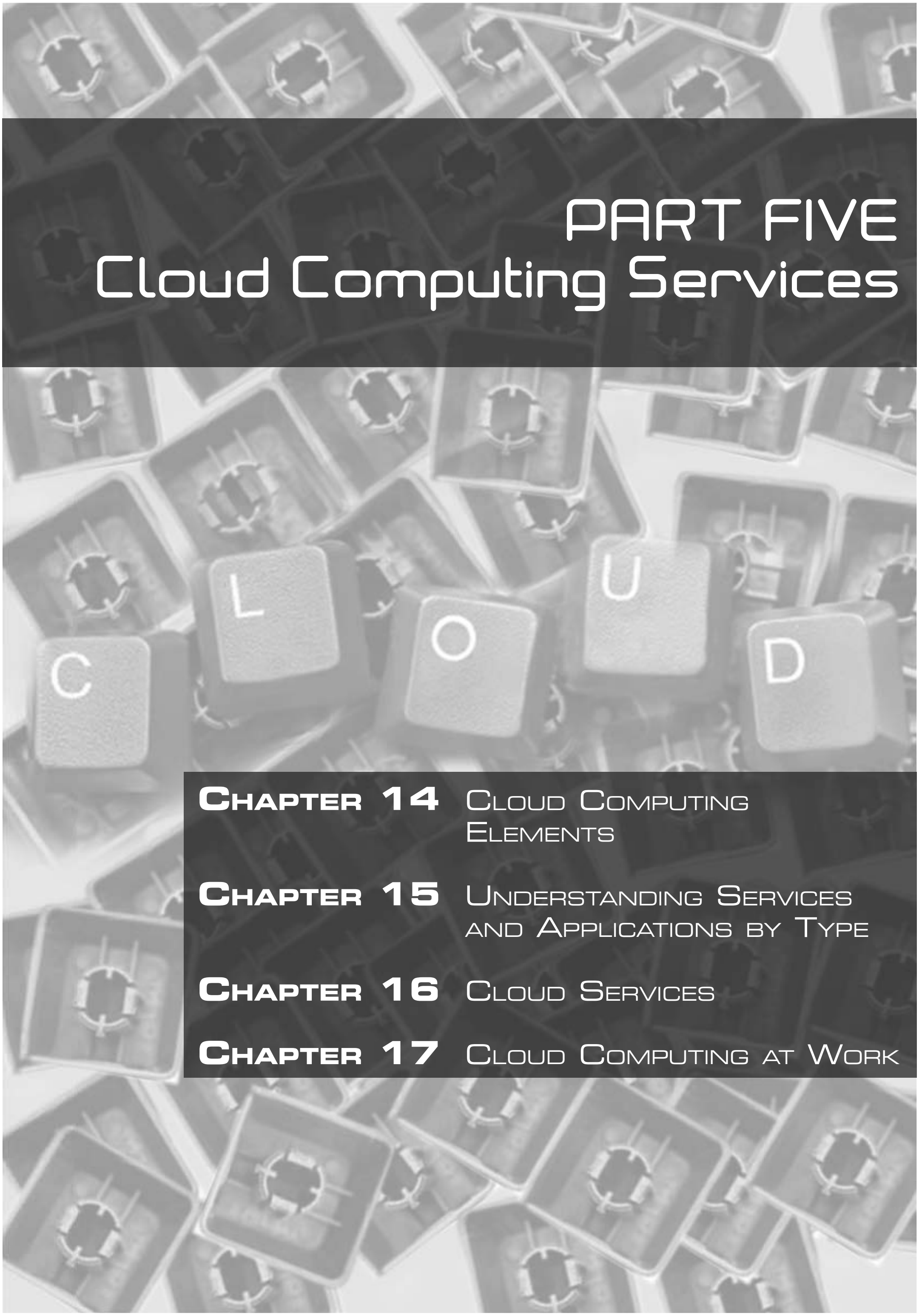
KEY TERMS

- Distributed storages are evolving from the existing practices of data storage for WWW applications through business houses like Google, Amazon and Yahoo.
- Dynamo is said to be highly accessible for reading, because errors while writing causes inconveniences to the end-user of the application.
- CouchDB is designed for document-oriented applications, for example, forums, bug following, wiki, Internet note, etc. CouchDB is ad hoc and schema-free with a flat address space.
- ThruDB builds on top of some open source projects: Thrift, Lucene (indexing), Spread (message bus), Memcached (caching), Brackup (backup to disk/S3) and also values Amazon S3.
- Thrift is a structured for effective cross-languages and numbers serialization, RPC and server programming.
- MemcacheDB is a circulated key-value storage scheme designed for persistence.
- Thumbtack is a new bookmarking application. It comprises of interesting take on bookmarking and keeping online data.

REVIEW QUESTIONS

- What is QoS?
- What are redundant data sites in cloud data store?
- What is the need of versioning in data storage?
- What is the use of data-intensive in parallel computing?
- State the characteristics of cloud computing.
- Define distributed storage.
- Define MVCC.
- What are the usages of online book marking services?
- What is thrift and are its importance?
- Describe couch in couch DB.
- What is the need of ThruDB?

PART FIVE
Cloud Computing Services



CHAPTER 14

Cloud Computing Elements

14.1 THE CLOUD

Cloud computing entails high scalable computing assets that are distributed and supplied by third party providers. These assets are accessed through the Internet on a pay-as-you-use basis. The major advantage is that buyers only use what they require and pay only for what they use. Consumers are not concerned about how the services are processed; they readily buy the needed IT service and use them. Cloud computing is also called ‘utility computing’ or ‘on-demand computing’.

The concept behind cloud computing is straight-forward: to establish the application on a large grid of product hardware cartons which comprises levelled applications. Each carton values identical set of established schemes and behaves alike. It balances ahead a demand to any one carton and is processed and no state is maintained. Advantage of cloud computing is its scalability, that is, multiple boxes can be scaled up.

From Figure 14.1 we can see that the rudimentary compute cloud comprises of three elements: a worldwide web server/application level, a distributed storage level and a distributed line layer. Each one of these levels is a cloud in itself, significance being that cartons are all equal and present identical functions. The primary advantage of the cloud is its proficiency to support on-demand computing as it assists IT sectors to assess development and cost incurred due to scalability.

Cloud computing can be visualized as a box consisting of three sections as shown in Figure 14.2.

Cloud application: This is the top most layer of the cloud box, where applications are run and interacted via a web browser, and hosted on a remote client. Another advantage of cloud computing is that consumers need not buy expensive software licenses. Instead, the cost is incorporated

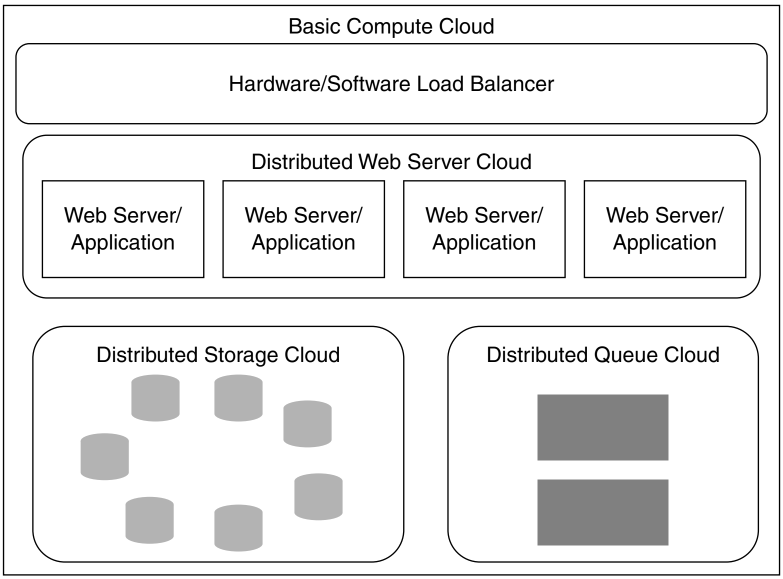


Figure 14.1 Basic Compute Cloud

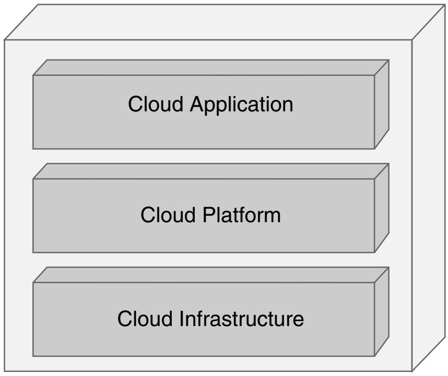


Figure 14.2 Cloud Computing Box

into the subscription fee and is taken care by the service providers. By using cloud computing, consumers need not install any software in their computer, thus reducing the burden of software installation, maintenance and support.

Cloud platform: This is the middle layer is a computing platform or framework as a service. This layer dynamically provides a computing platform for configuring and provisioning of resources on demand. In real time, it can act as a distributed computing model, where an application is computed using many computing systems.

Cloud infrastructure: This is the foundation and first layer in the delivery of IT infrastructure through virtualization. Virtualization allows dividing the single hardware resources into independent, self-governed environments. The resources that can be slatted are CPU, RAM and storage disk. The cloud infrastructure includes servers, networks and other hardware appliances.

14.2 VALUE OF CLOUD COMPUTING

Cloud computing is a pool of resources such as computing power, memory, storage capacity, applications and managed services which are delivered as a service via WWW. The benefits of using cloud computing are: pay-as-you-go billing, scalability, flexibility, efficiency and cost-effectiveness.

Cloud computing gained popularity due to virtualization and dynamism. Many attempts were made to map out what more can cloud computing do in terms of consuming IT infrastructure resources.

Figure 14.3 shows the value and elements of cloud computing. Basically the value types are classified into three: economic, architectural and strategic. Seven elements depicted in the figure either fall in one of the above three value types. These elements include utility computing, elastic resource capacity, virtualized resources, management automation, self-service provisioning, third party ownership and managed operations.

The economic value deals with investments of IT organizations referred as ‘pay-as-you-go’ and ‘pay-as-you-grow’.

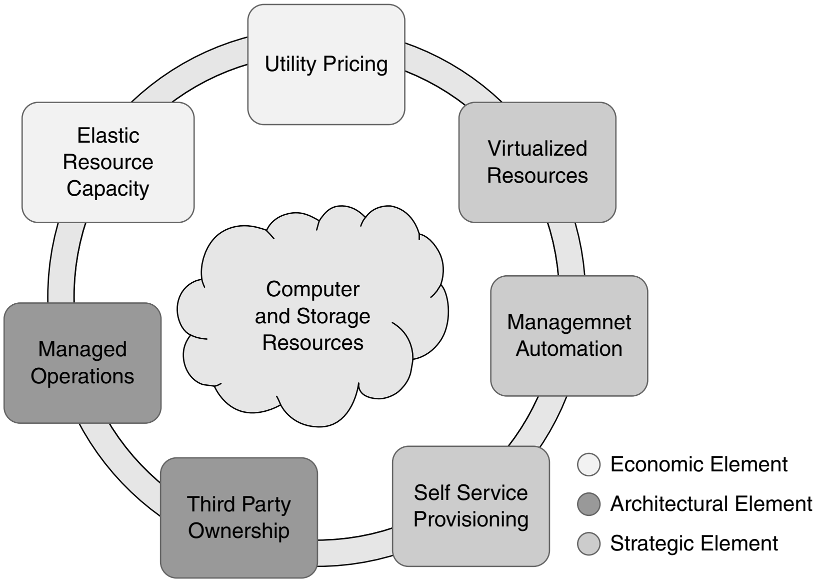


Figure 14.3 Value of Cloud Computing

The architectural value deals with abstraction in cloud environment which hides the complexity and facilitates development and deployment of applications.

The strategy deals with finding means to increase the economic value by using cloud computing. Cloud platforms help the IT organization to focus on the work and leave the rest to a third party.

What makes cloud computing the most preferable solution by many IT organizations, when there are other reliable computing solutions? The reasons are cloud separates organizations from their servers and offers them secure access to servers. This made third party providers to add services on request, that is, full outsourcing of IT operations.

This aggregation of scalable computing and services rightly lets down the technological and cost hurdles to application in the web-facing request in the paid job market. The largest savings comes from reduced capital (from utility billing) and staffing (due to sharing of manpower resources with other customers) to arrive at enterprise-class service deliverance benchmarks needed to run a SaaS business. This is rightly the advancement that cloud computing bids: letting everyone with a concept and a little programming skill to run a commercially viable website. In addition, it signifies that there will be a manager of other cloud providers other than the Big Three giving both computing and services with tailor-made offerings.

There are many services that can be consigned through cloud computing, taking advantage of the distributed cloud model. Following are some of the most preferred cloud-based IT solutions:

Hosted desktops: Hosted desktops eliminate the requirements for customary desktop (PC) in the agency natural environment and reduce the cost of supplying the needed services. A hosted desktop examines and behaves like a normal desktop, but the programs and data accessed by clients are housed in isolated, highly protected data hubs, apart from their own machines. Users can easily access their hosted desktops through Internet connection from any location in the world, utilizing either a live PC or laptop, or for greater cost effectiveness a focused apparatus called a slim client.

Hosted e-mail: As more organizations are looking for consistent e-mail solutions that are cost-effective, they are increasingly turning to hosted Microsoft Exchange® e-mail plans. E-mails are stored centrally on handled servers which provide redundancy and quick connectivity from any location. This permits users to access their e-mail, calendar, acquaintances and shared files via a range of mechanism, encompassing Outlook®, Outlook Mobile Access (OMA) and Outlook Web Access (OWA).

Hosted telephony (VOIP): VOIP (Voice Over IP) is a mechanism of supporting telephone calls and services across digital web networks. A hosted VOIP system can displace expensive telephone networks, installations, handsets, BT queues and figures with a plain, cost-efficient choice that is available on a monthly subscription basis. Typically, a pre-configured handset has to be plugged into the broadband or office network to permit access to qualities such as voicemail, IVR and more.

Cloud storage: Cloud storage is growing in popularity due to the advantages it provides such as plain, CapEx-free expenses, anywhere access and saving on in-house maintenance and management. It is fundamentally the delivery of information storage as a service from a third party provider, with access by web mechanism and billing calculated on volume accustomed in a sure term (e.g., per month).

Dynamic servers: Dynamic servers are like the generation of waiter habitat, replacing the devoted waiter concept. A provider like ThinkGrid gives its customers access to resources that appear and touch directly like a devoted waiter but are fully scalable.

There are lot of reasons why organizations of all sizes and breeds are embracing this model of IT. It provides a means to boost volume or add capacities on the flutter without investing in fresh infrastructure, training fresh personnel or licensing fresh software. Ultimately, it can save corporations a substantial amount of money. Some purposes are registered as follows:

Reduction of expenditure: Customers can save good amount of revenue on purchasing and installing their IT infrastructure or entries by shifting to the cloud model. Cloud computing provides a plain operational expense that is easy to budget on a month-on-month basis and save on resources wasted on depreciating assets.

Reduced authorities expenses: IT solutions can be deployed very rapidly and handled, preserved, patched and upgraded remotely via the service provider. Technical advocate goes around the clock via respectable providers for no extra commission, dampening the load on IT staff. The IT giant IBM has discovered that cloud computing permits organizations to streamline procurement processes and removes the need to, replicate computer administrative proficiencies related to set-up, configuration and support.

Improved resource utilization: Combining resources into clouds reduces the expenses and maximizes utilization by delivering resources in short turnaround time as needed. Businesses need not fear approximate over-provisioning for a service whose exert does not encounter their predictions or under-provisioning becomes unexpectedly popular. Moving more and more entries, infrastructure and even the cloud service can increase valuable time, exertion and budgets to concentrate on revising the vision of the company.

Scalability on request: Scalability and freedom are highly valuable advantages presented via cloud computing, approving customers to react quickly to altering IT needs, adding or subtracting volume to users as quickly as possible answering real-time project requirements.

Quick and easy implementation: Without the need to buy hardware, software licenses or implementation services, a corporation can obtain its cloud-computing arrangement off the ground in minutes.

Anywhere access: Cloud-based IT services enable us to access the entries and information safely from any place by web mechanism. It is also simpler to collaborate with both the entry and the information stored in the cloud, multiple users can labour jointly on the same venture, allocation calendars and acquaintances, etc.

14.3 CLOUD DO'S AND DON'TS

Cloud computing is prepared to crop up the changing demands of business needs. Cloud computing in offshore outsourcing services are anticipated to grow step-by-step over time. The influence of the change in cloud on the offshore outsourcing services depends on the delineation of outsourcing. Going by the tendencies, change in cloud on enterprise method outsourcing businesses is inescapable and its influence on the identical is unavoidable. Cloud computing will assist in moving the consignment of enterprise method outsourcing services other than consignment of IT demands, which in turn, presents new business model service lines and forms for both clients and international service providers. Cloud computing is the means in which even international call centre procedures can be incorporated and deployed since every expertise needs some location.

Do not be reactive: Many businessmen who desire to make a quick buck are tempted to shut down their data centre and put all computing into a public cloud. Although this might sound healthy temporarily, this isn't a complete approach. You need to do your homework thoroughly. For instance, if there are compliance matters to consider. What is the distinction in cost between a public, personal, hybrid, or even a customary data centre. You need to confirm that all the possible influences have been considered before you get into action.

Do consider the cloud in financial issues: You might start looking at some advantages of the cloud that may sound good. But before you leap in, you need to do some research. How large is your company? What is the environment of your computing? How many applications do you need for support? How much does your present natural environment cost? What is the replacement capability in your data centre? Are there applications that can cost competently if shifted to Software as a Service model? Before you finalize, consider the financial aspect.

Do not go alone: Although some businesses can afford to construct their own cloud, which is an exception, most businesses require assistance, so do not proceed into it alone. A whole business centre is just waiting out there to assist you. Don't disregard it, but get help. Consult with schemes integrators, expertise businesses and other advisors who have in depth knowledge of the best practices.

Do think about your architecture: Just because you are considering going into the cloud does not imply architecture is no longer important. In reality, it is more significant than ever. You will possibly have enterprise services that are conceived for reuse, these should be retained in a personal or public cloud.

Do not neglect government: If you don't take care of compliance and government regulations, you are putting your business at risk. For instance, some businesses require that you shop data in a particular manner. Some nations will never allow their clientele data to go out of its territory. You still have to obey the government regulations. These compliances should be applied to cloud computing services as well.

Do not forget about business process: Start with the business process that you aspire to automate into your cloud initiatives. No matter which pattern of cloud you are contemplating, business process is the major construction block. If you haven't figured out how business process will be organized in this new diversified business world, your organization could be at risk.

Do start with a pilot project: Cloud computing will be around for a long time, so get to know it better. Start with a pilot project. For instance, you may wish to start with Software as a Service platform. You might use a public cloud for checking a new application before it proceeds into production. This makes the clear understand of the consequences regarding control.

Do not apply the cloud to everything: Do not get carried away. Not everything revolves around a cloud. For instance, your data centre might have a large, convoluted and customized application utilized by a dozen people. It may be critical to your business. If you have no financial or business advantages in deploying the cloud, do not go for it.

Do your research thoroughly so that you have guidelines to assist you, whether the application or function pertains to a data centre, a public cloud or a personal cloud.

14.4 CLOUD COMPUTING: LEGAL IMPLICATION

Cloud computing is a package of information expertise services (Software as a Service, Platform as a Service and Infrastructure as a Service) over the Internet without the necessity for organizations to buy or establish programs or run their own application and data servers. Although this service provides organizations with huge financial gains, it presents some intriguing legal matters, such as:

- The risk of completing contracts inadvertently
- The risk of data protection compliance
- The risk of intellectual property infringement
- Intellectual property indemnity
- Use of open source software
- Jurisdiction and prevailing law

14.5 OVERVIEW OF AMAZON WEB SERVICES

Amazon Web Services (AWS) is one of the early and importantly the most thriving implementations of the public cloud. Amazon primarily propounded a cloud founded message queuing service called Amazon Simple Queue Service (SQS). They finally supplemented services such as Mechanical Turk, Simple Storage Service (S3), Elastic Compute Cloud (EC2), A CDN service called CloudFront, and a flexible and distributed database service called SimpleDB. Amazon lately launched the accessibility of MySQL in the cloud through a service called Relational Data Service (RDS).

Figure 14.4 shows the infrastructure of Amazon web services. AWS consists of three layers:

1. Layer 1 contains physical infrastructure
2. Layer 2 contains the cores of AWS such as Simple DB, RDS, EC2, S3, SQS and cloud front
3. Layer 3 is the place where users write applications to use the AWS cores. AWS cores are briefly explained as follows.

Simple Storage Service (S3): Amazon's simple storage service or S3 is the primary means to shop data on the cloud that can be accessed by any application on the Internet. S3 can shop any random data as things are escorted by metadata. These things can be coordinated into buckets. Every bucket and object has a set of permissions characterized in the Access Control List (ACL). S3 can also be treated as a virtual document scheme to supply persistence storage capabilities to applications.

Elastic Computer Cloud (EC2): In normal periods, EC2 is a chartered server running at an isolated location. These servers are actual VMs running on Amazon's mighty data centres. Amazon calls these virtualized server samples as Amazon Machine Images or AMI. These samples arrive in distinct dimensions. Due to its dynamic nature it is called elastic compute cloud; it commences multiple samples of identical AMIs to scale up and scale down for termination.

Simple Message Queue (SQS): SQS is the note line on the cloud. It carries programmatic dispatching of notes by WWW service applications as a means to broadcast over the Internet. Message-Oriented Middleware (MOM) is a preferred means of double-checking that the notes

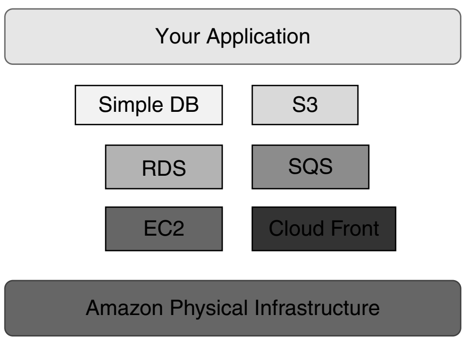


Figure 14.4 Amazon Web Services

are consigned one time and only once. Moving that infrastructure to the WWW individually is costly and hard to maintain. SQS provides this capability on demand and through the pay-by-use model. SQL is accessible through REST and SOAP founded API.

CloudFront: When the web application targets the global users, it serves the static content through an attendant that is closer to the user. One of the solutions grounded on this guideline is called Content Delivery Network (CDN). CloudFront is CDN as a service. Amazon is spreading its knowledge across the globe by serving content through these perimeter locations. CloudFront utilizes S3 by reproducing the buckets across multiple perimeter servers. Amazon bills you simply for the knowledge that is served through CloudFront and there is no condition for upfront payment.

SimpleDB: If S3 provides storage for arbitrary binary data, SimpleDB is an efficient way to store name/value pairs on the cloud. This minimizes the overhead of maintaining a relational database consistently. SimpleDB supports REST and HTTP and can parse the HTTP response. Several Web 2.0 applications built using AJAX, Flash and Silverlight can simply retrieve data from SimpleDB. It is the only service from Amazon that is free up to a specific point.

Relational Database Service (RDS): Amazon RDS boasts relational database on the cloud. It is founded on the most preferred MySQL database. When you are going through a customary line of business applications to the cloud and desire to sustain high fidelity with the living schemes, you can select RDS. The benefit of RDS is that you may not establish, configure, organize and sustain the DB server; you only spend it and Amazon takes care of the rest. Routine procedures like patching the server and endorsing up the databases are taken care and you only spend on the service. RDS requires you to pay-as-you-go form and there is no upfront payment required. It is accessible through the REST and SOAP founded API.

Amazon Web Services (AWS) offer IT infrastructure services to organizations based on the WWW services, now popularly known as cloud computing. Today, Amazon web services presents a highly dependable, scalable, low-cost infrastructure in the cloud that forces hundreds of thousands of organizations from 190 nations around the world to utilize it. With data centre positioned in the United States, Europe, Brazil, Singapore and Japan, clients over all business world are taking advantage of the following benefits: low cost, agility and instant elasticity, open and flexible and secure. Amazon provides important capabilities to execute a complete web application or sequence of business applications as 'Infrastructure as a Service (IaaS)'. AWS is the platform of the platforms. We can select an OS, App server and the programming language of our choice. AWS SDK (Software Development Kit) and API are in existence for many popular languages such as Java, .NET, Python and Ruby.

SUMMARY

- Cloud computing entails high scalable computing assets that are distributed and supplied by third party providers.
- Virtualization allows dividing the single hardware resources into independent, self-governed environments.

- Cloud computing is a pool of resources such as computing power, memory, storage capacity, applications and managed services which are delivered as a service via WWW.
- The architectural value deals with abstraction in cloud environment which hides the complexity, facilitates development and deployment of applications.
- The strategy deals with how the economic value can be increased by using cloud computing. Cloud platforms help the IT organization to focus on the work and leave the rest to a third party.
- A hosted desktop examines and behaves like a normal desktop (PC), but the programs and data accessed by clients are housed in isolated, highly protected data hubs, other than on their own machines.
- Cloud storage is growing in popularity due to the advantages it provides such as plain, CapEx-free expenses, anywhere access and reduces the responsibility of in-house maintenance and management.
- Cloud computing supports the changing needs of business today.
- Cloud computing is the means in which international call centre procedures can be incorporated and deployed.
- Some do's and don'ts of cloud computing are (i) do start with a pilot project, (ii) do consider the financial implications of cloud, (iii) do think about your architecture, (iv) don't go for it alone, (v) don't neglect government regulations, (vi) don't forget about business process, (vii) don't be reactive, (viii) don't apply the cloud to everything
- Cloud computing is a combination of information expertise services (SaaS, PaaS and IaaS) over the Internet without the need for organizations to buy or establish programs or run their own application and data servers.
- Amazon Web Services (AWS) is one of the early, and significantly the most thriving implementations of the public cloud.

KEY TERMS

- Cloud computing is also known as 'utility computing' or 'on-demand computing'.
- Cloud application is the top most layer of the cloud pyramid, where applications are run and interacted via web browser, hosted on remote client.
- Cloud platform is middle layer in a computing platform or framework as a service. This layer dynamically provides a computing platform for configuring and provisioning of resources on demand.
- Cloud infrastructure is the foundation and first layer in the delivery of IT infrastructure through virtualization.
- Hosted desktops eliminate the requirements for customary desktop PCs in the agency natural environment and reduce the cost of supplying the services that are needed.
- Amazon presents services such as Mechanical Turk, Simple Storage Service (S3), Elastic Compute Cloud (EC2), CloudFront a CDN service, database service called SimpleDB.

REVIEW QUESTIONS

- What is meant by cloud?
- Do cloud really work? Justify.
- What are the benefits of cloud computing?
- What are the do’s and don’ts of cloud?
- What are the legal implications of cloud computing?
- What are the layers of Amazon web services?
- What are the benefits of Amazon web services?
- State the cores of Amazon web services.
- State the importance of cloud storage.
- What are hosted desktops?
- Lists the benefits of cloud computing.
- Brief cloud computing box with a diagram.

CHAPTER 15

Understanding Services and Applications by Type

15.1 WEB-BASED APPLICATION

A World Wide Web-based application is a collection of programs that can be accessed through a web browser. The programs and database resides on a centralized server rather than being established on the desktop and is accessed over a network.

Web applications are the means to take advantage of today's expertise to enhance the productivity and efficiency of organizations. Web application permits access to the organization's data from any part of the world at anytime. It also helps to save time and revenue and enhances interactivity with the clients and partners. Web-based applications are so straightforward that they can be applied without interrupting the live work in progress. Be it a content organized solution or an e-commerce solution; users can evolve a customized WWW application that fulfills the organization's requirements.

World wide web can be defined as '*a World Wide Web application is an application utilizing World Wide Web and [web] browser technologies to complete one or more jobs over a mesh, normally through a [web] browser*.'

15.2 WEB SERVICES

Web services are designed to supply the messaging infrastructure needs for connection over stages utilizing business standards. Web services moreover use asynchronous connection to address the latency topic that arises due to demands from isolated positions over the Internet. This permits the execution of backdrop jobs for the purchaser (such as responding to client queries) until the genuine culmination of Internet service request arrives.

The major benefit of a web service is that its buyers can use the service without understanding about the minutia of its implementation, for example, the hardware stage, programming dialect, object form, etc. Web service presents a loose coupling between heterogeneous systems with the help of XML notes, supplying interoperability.

15.2.1 Introduction to Web Services

The buzzword of business today is 'Web Services,' and numerous businesses have started to depend on them for their applications. Web services are *yet another* distributed computing expertise (like CORBA, RMI, EJB, etc.). They permit us to understand client/server applications.

Figure 15.1 depicts the procedure of a WWW service. The *clients* (programs that desire to get access to the climate information) would then communicate the *web service* (in the *server*) and send a *service request* inquiring for the climate information. The server would come back with a *service response*.

Web services are phased and language-independent, since they use the benchmark XML languages. This entails that the purchaser's program to be programmed in C++ and running under Windows, while Internet service is programmed in Java and running under Linux.

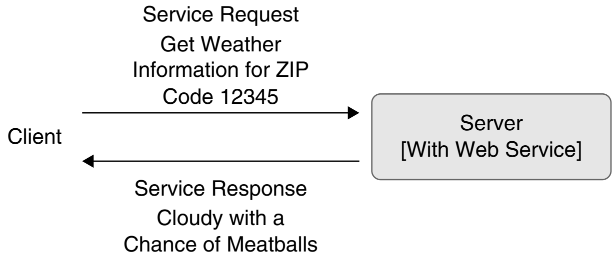


Figure 15.1 Web Services

15.2.2 Demerits of Web Services

At present, web services are not very flexible, since they only permit for some very rudimentary types of service invocation. CORBA, for instance, boasts programmers carrying services such as persistency, notifications, lifecycle administration, transactions, etc. And also conveying all our data in XML is conspicuously not as effective as utilizing a proprietary binary code. What we win in portability, we misplace in efficiency.

However, there is one significant attribute that distinguishes web services. While technologies, for example, CORBA and EJB, are equipped in the direction of *highly coupled* distributed systems, where the client and the server are very reliant on each other, web services are more apt for *loosely coupled* systems, where the client might have no former information of Internet service until it really invokes it.

15.3 INFRASTRUCTURE SERVICES

15.3.1 Cloud Infrastructure Services

Cloud infrastructure services can be utilized by applications running on either on-premises or a cloud establishment. At first, the most extensive users of cloud infrastructure services will be on-premises, because there are not enough applications constructed on a cloud organization. Ultimately, anticipating this change to a greater extent cloud-based applications use cloud infrastructure services.

Storage

Applications routinely use some kind of localized storage; therefore, storage is part of both on-premises and cloud foundations. Remote storage is also useful. Accordingly, it is sensible to anticipate that supplying a storage service in the cloud will be appealing for numerous applications. As for on-premises stages, isolated storage in the cloud arrives in distinct styles. For example, Amazon's Simple Storage Service (S3) presents rudimentary unstructured isolated storage. The form it reveals to developers is straightforward: things, which are just assortments of bytes, are retained in buckets. Applications can conceive, read and delete things and buckets. Objects will not be revised although they can only be entirely replaced. It is yet another example of how stage services should change to support Internet-scale usage, as in numerous cloud services.

Connecting many applications has become a skill of computing, and vendors have provided a means to supervise on-premises infrastructure services. They vary from straightforward technologies like note lines to rather convoluted integration servers. As integration services proceed into the cloud, a variety of technologies are surfacing.

Identity

Whether an application sprints on-premises or in the cloud, it normally desires to understand certain qualities about its users. From this viewpoint, the application routinely claims that each client presents a digital persona, a set of bytes that recounts that user. Based on what these bytes comprise and how they are verified, the application can be worked out, for example, who is this client and what are they permitted to do.

Many on-premises applications today depend on an on-premises infrastructure service, for example, active directory, to supply the information. When a client accesses a cloud application, if an on-premises application accesses a cloud service, an on-premises persona generally won't work. Accessing Amazon cloud services, for example EC2 or S3, needs an Amazon-defined identity, or utilizing Google AppEngine needs a Google account. Microsoft presents Windows Live ID, which can be utilized for Microsoft applications.

15.4 ON-DEMAND COMPUTING

On-demand computing (ODC) is an enterprise-level expertise and computing in which assets are supplied on a need basis. ODC makes computing expertise, for example, storage capability, computational speed and programs accessible to users as and when required for exact provisional tasks, renowned or unforeseen workloads, usual work, or long-run technological and computing requirements.

Web services and other focused jobs are occasionally referenced as types of ODC. ODC is characterized as 'pay and use' computing power. It is also known as OD computing or utility computing. The foremost benefit of ODC is reduced primary cost, as computational assets are vitally leased when they are required.

In the late 1990s, computer data hubs were topped up with thousands of servers, and utility computing emerged. On-demand computing, Software-as-a-Service and cloud computing are all forms for repackaging computational programs and mesh services.

15.4.1 Future of On-demand Computing

Based on the types of business, some visionaries forecasted the future of on-demand/utility computing, which are as follows:

- *Standards needed*: Virtual pools of assets will malfunction except there are measures for cross-vendor management—*Corey Ferengul, Analyst, Meta Group Inc., Stamford, Conn.*
- *The open-source competitor*: Adoption of utility computing on a very broad scale has an improbable competitor: the open-source programs. Over the next two years, the more the open-source does well, the more probable is that clients will hold their IT work in-house, to the clear detriment of utility-style providers—*Doug Tuttle, Controller of the Global High Technology Practice, Deloitte Consulting, Boston.*

- *Doubling your utility*: Utility computing is in its infancy. IT doesn't have a high scale investments that amortizes repaired charges as capacity grows. We require working on the systemic matters in order that when somebody inquires you to twice the dimensions of your utility, you don't have a failure—*Greg Papadopoulos, Head Expertise Agent, Sun Microsystems Inc.*
- *Built-in manageability*: Utility computing assembles and consigns IT services on the go to advance the scale, flexibility and productivity of enterprise operations. To accomplish this aim, IT will require organizing itself on the go like service, compared to customary systems, with its centralized controlled IT resources—*Mike Maples, Co-founder and Head Scheme Agent, Motive Inc., Austin*.
- *Back to the future*: Utility computing will motivate a comeback to factual capability designing and there will be a foremost demand for persons with capability designing and enhancement knowledge—*Corey Ferengul, Meta Group*.
- *Virtually no difference*: Virtualization programs will be a usual part of the functioning scheme, encompassed at no added ascribe and supplying no differentiation for vendors—*Corey Ferengul, Meta Group.*
- *Third World benefits*: Over the next four years, the adoption of the utility computing form will accelerate the advancement of evolving countries much quicker than off-shoring. It's far simpler for evolving nations to take up the utility computing form, since they don't have to revamp 20 years of living mechanical infrastructure to get the benefits. The analog to this is the fast adoption rates of cellular telephones in China—*Doug Tuttle, Deloitte Consulting*.

15.5 WEB APPLICATION FRAMEWORK

A web framework is a kind of structure or base expressly conceived to assist the developers to construct W WW applications. These frameworks normally supply core functionality widespread to most WWW applications, for example, client meeting administration, data persistence and template systems. By utilizing a suitable framework, a developer can often save time to construct a WWW site.

Each framework is distinct, but numerous frameworks supply helpful features. By utilizing a framework, a developer avoids having to re-implement these identical characteristics for each WWW application they create. Features encompass: data persistence, session management and user authentication, security, caching, administrative interface and implementation.

15.5.1 Data Persistence

The core characteristics of all WWW applications are to share data and construct WWW sheets founded on retained information. Unlike a set of static sheets, most WWW application pages are dynamically developed from continual data.

Obviously each WWW application has its own choice of accurate data for organizations to persist. A framework can aid in data persistence with the following features:

- A reliable API to get access to multiple data storage systems.
- Self-acting or simplified storage and retrieval of data things.

- Presentation enhancements, for example, caching overhead the database level.
- Data integrity tests, for example, validating connections or affirming needed areas are topped up.
- SQL construction.

15.5.2 Session Management and User Authentication

Static public websites can generally treat every user as absolutely anonymous. Web applications often need client anecdotes and persistence of data over page views. Frameworks can supply generic client anecdotes, occasionally extendible, so that users can list, login and reset passwords. They can also supply client management for administrators.

15.5.3 Security

Sometimes WWW pages are to be exhibited only to authenticated users. Frameworks can mechanically ascertain and need authentication before developing a page.

Once a client is authenticated, a framework can ascertain the exact permissions for that user. These permissions may be organized by different means. A framework might supply role-based access to command, or other security features. These are normally organized by a developer in a cipher or a location manager through an administrative interface.

15.5.4 Administrative Interface

It is very common for dynamic WWW sites to require an expressively constructed site for administrators. Here the site can be configured and data can be altered. Administrators might conceive client anecdotes, organize permissions, change page content, develop accounts, or additional services as required. Web application frameworks can aid in construction of administrative interfaces by:

- Generating a navigation framework
- Providing common interface components to pattern areas
- Automatically develop edit and register page from continual data frameworks

15.5.5 Implementation

All WWW applications take individual HTTP demands and construct customized responses. This can be managed with different kind of modes, rather be reliant on the server platform.

Probably the most preferred general convention of WWW application frameworks is Model-View-Controller (MVC). The primary code of the framework assesses the URL and passes responsibility to the customized program *controller*. The manager then presents any essential activities with the application's *model* and then permits the *view to* construct the content.

Another concern is its execution. Often, all demands to WWW programs are passed through a set of codes supplied by a framework.

The procedure of conceiving and applying an entire WWW application framework can be a convoluted task. Without a couple of clear goals, development can effortlessly get bogged down with inconsistencies and code bloat. Enquiries to be made at the onset of framework conception include the following:

- What difficulties can WWW programs constructed with this framework suffer?
- What grade of modularity will the framework supply and support?
- What development directions will the framework enforce? Will any specifically conceived patterns be firmly followed?
- What is the learning curve for application developers in discovering the framework? The more complicated the APIs, the better accomplished will be the developers who use it.

There are numerous prominent WWW application frameworks:

- *For Java*: Apache Struts, JavaServer Faces, Jt Design Pattern Framework and Apache Wicket.
- *For PHP*: CakePHP, CodeIgniter, Symfony and Zend Framework.
- *For Python*: Django, Flask, Pyjamas, web2py, Pylons—Aims to be like Ruby on Rails, Turbogears—Similar to Django, Twisted—More of a lower-level networking framework, Web.py—Simple and Pythonic, Zope—Very mighty and baroque framework conceived for large content administration systems and Pyroxide—Full MVC framework atop mod_python with a really object-oriented ORM (object relational mapping) level constructed in.
- *For Ruby*: Ruby on Rails and Ramaze
- *Other*: .NET

SUMMARY

- ❖ Web applications are means to take advantage of today’s expertise to enhance the productivity and efficiency of organizations.
- ❖ Web-based applications are so straightforward that they can be applied without disturbing the existing work in progress.
- ❖ Web services are designed to supply the messaging infrastructure needed for connection over stages utilizing business standards.
- ❖ Web services are also distributed computing expertise such as CORBA, RMI, EJB, etc. They permit to create client/server applications.
- ❖ Web services are platform and language-independent, since they use benchmark XML languages.
- ❖ Cloud infrastructure services can be utilized by applications running on either an on-premises or a cloud establishment.
- ❖ Amazon’s simple storage service (S3) presents rudimentary unstructured isolated storage.
- ❖ On-demand computing (ODC) makes computing assets, for example, storage capability, computational speed and programs accessible to users as and when required.
- ❖ ODC is characterized as ‘pay and use’ computing power. It is also known as OD computing or utility computing.

- Future of on-demand/utility computing will based on three parameters, (i) standards needed, (ii) the open-source competitor, (iii) doubling your utility, (iv) built-in manageability, (v) back to the future, (vi) virtually no difference and (vii) Third World benefits.
- A web framework is a kind of structure or base expressly created to assist the developers to construct WWW applications.
- All WWW applications take individual HTTP demands and construct suitable responses.

KEY TERMS

- A WWW application is an application utilizing WWW and [web] browser technologies to complete one or more jobs over a mesh, normally through a [web] browser.
- Web services are also distributed computing expertise such as CORBA, RMI, EJB, etc. They permit us to conceive client/server applications.
- On-demand computing (ODC) is an enterprise-level expertise and computing in which assets are supplied as and when needed.
- A web framework is a kind of structure or base expressly conceived to assist the developers to construct WWW applications.

REVIEW QUESTIONS

- Define web-based applications.
- Define web services.
- State the demerits of web services.
- Differentiate loosely coupled and tightly coupled systems.
- State the various cloud infrastructure services.
- Define on-demand computing.
- List the characteristics of ODC.
- List the competitors for ODC.
- What is web application framework?
- List the characteristics of web application frameworks.
- List the various web applications frameworks.

CHAPTER 16

CLOUD SERVICES

16.1 CLOUD TYPES AND SERVICES

The evolution of the twenty-first century has brought with it new dimensions. Like any other change cloud computing was also resisted by people initially. Once its advantages were brought under the right light, people became desperate to implement it. Virtualization is one such expertise that is around for a decade but only recently has it been appreciated and treasured for its benefits.

16.1.1 What is Cloud Computing?

It is a mesh network which values virtualization technologies to permit computing applications and data to be flexibly supplied from a pool of hardware resources. In cloud computing, there is no point-to-point connection between the client and the computing infrastructure. Data and applications are not held on one PC/server/mesh, they are held on circulated computing resources.

16.1.2 Advantages of Cloud Computing

- *Resilience*: Cloud computing eliminates single points of collapse. The malfunction at one node of the system has no influence on data accessibility and does not result in perceivable downtime.
- *Scalability*: Cloud computing endows organizations to rapidly scale up their operations.
- *Flexibility and effectiveness*: Cloud computing permits organizations to elaborate or agree computing power as required and permits ‘bursts’ of computing power to be utilized on an on-demand basis.
- *Outsourcing*: Cloud computing makes outsourcing of undertakings straightforward and controllable to some extent. For numerous rudimentary organizational applications, outsourcing becomes a straightforward method, with fee only being paid for the computing power or data storage that is utilized, with no hidden cost or administration fees.

Cloud computing made the IT sector, for example, Microsoft, Amazon, Google, IBM and others, to invest billions of dollars in this new system of computing, because of its promise in terms of responsiveness, effectiveness and efficiency in IT service delivery. Generally, the cloud can be envisaged as any Internet-accessible service that could be leverage as a business.

There has been exponential growth in processing data and obligations to support businesses. This has resulted into expanded power utilization and enhanced data centre capacity. The cloud has provided an alternate to large capital investments needed for data centre expansion, infrastructure hardware and software purchase and application programs purchases. The following doubts may arise: ‘How to leverage the Internet to continue the infrastructure to the cloud? How to use the Internet as a stage to construct programs and products? How to use the cloud to run key business processes?’

Following responses can clarify the aforesaid doubts. Cloud computing can be categorized into IaaS, PaaS and SaaS.

- *Infrastructure as a Service (IaaS)* presents infrastructure hardware for data centre and program assets over the Internet. IaaS also presents server, functioning system, and computer disk storage and database resources.
- *Platform as a Service (PaaS)* presents infrastructure on which programs developers can construct new applications or continue already present applications without having to buy a new server.
- *Software as a Service (SaaS)* is the most established, widely used, renowned and adds *flavour* of cloud computing. It can be characterized as a program in which applications are hosted by a vendor or service provider and made accessible to clients over the Internet.

Before contemplating of migrating to cloud computing, following are the benchmarks to be followed:

- *First*, assess the vast economic influence it will have on the business.
- *Second*, it is important to address the network bandwidth considerations and understand how much data will be required for the network, as well as the network solutions for a specific service.
- *Third*, understand the security issues and how accessible the existing capabilities are in contrast to that of the cloud provider.
- *Finally*, one of the most significant considerations is examination of the ongoing service and support provided by the application. For example, most SaaS applications are traded under a subscription form, which is large for the clientele because it envisages the provider to support they ongoing work. The subscription is not just about getting access to a set of expertise but get as much access to resources that provide clientele support, change management and overall organization 24/7.

16.1.3 Classification of Cloud

Cloud computing is classified into four types on the basis of the location, where the cloud is hosted. Figure 16.1 shows the types of cloud computing: public, private and hybrid clouds. If the cloud is established on-premises, it is a private cloud and if it is made accessible to the public, it called public cloud. Hybrid cloud has both possibilities, that is, private and public or on-premises and off-premises.

- *Public cloud*: Computing infrastructure is hosted at the vendor's premises. The clientele has no access over the position of the cloud computing infrastructure. The computing infrastructure is shared between organizations.
- *Private cloud*: Computing architecture is dedicated to the clientele and is not shared with other organizations. They are costlier and are more protected than public clouds. Private clouds may be hosted internally or externally.
- *Hybrid cloud*: Organizations keep some critical, protected applications in private clouds, and not so critical applications in the public cloud. This blend is known as hybrid cloud.
- *Community cloud*: The cloud infrastructure is shared between organizations of identical nature. For example, all the government bureaus in a city can share the identical cloud but not the non-government agencies.

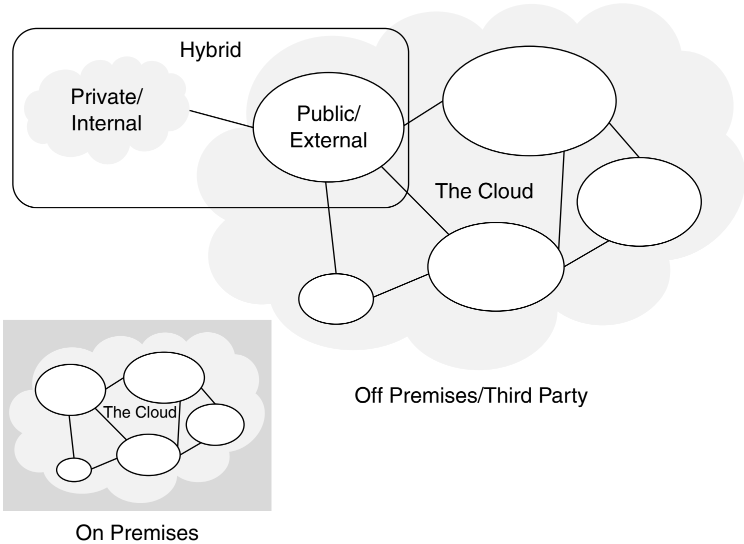


Figure 16.1 Cloud Computing Types

16.1.4 Classification of Cloud on the Basis of Services

Infrastructure as a Service (IaaS)

These are hardware associated services supplied and utilizing the values of cloud computing. These constitute disk storage and virtual servers. Amazon EC2, Amazon S3, Rackspace Cloud Servers are some of the premier vendors. Figure 16.2 shows how a virtual appliance is constructed for an IaaS natural environment, uploaded, configured and then established inside the environment. IaaS has two actors, that is, the proprietor and an end user. Software programmer values virtual appliance and it is uploaded and configured to use the accessible storage. Software programmer also has command over virtual application automation where they are established and started. End user submits a job or task to the virtual appliances, wherein balancer splits up the task into subtasks and submits it to the virtual applications and obtains the end result. The final outcome is dispatched back to the end user.

Platform as a Service (PaaS)

Platform as a Service (PaaS) acts as a deal between computing stage and solution for a service. PaaS promises deploying applications without the cost and complexity of buying and organizing the inherent hardware and software. PaaS may encompass amenities for application concepts and development, checking, deploying and hosting. Application services, for example, group collaboration, WWW service integration and marshalling, database integration, security, scalability, storage, persistence, state administration, versioning, instrumentation and developer community facilitation are also offered. These services may be provisioned as an incorporated solution over the web. Google App Engine, Microsoft Azure and Saleforces.com are the examples in this category.

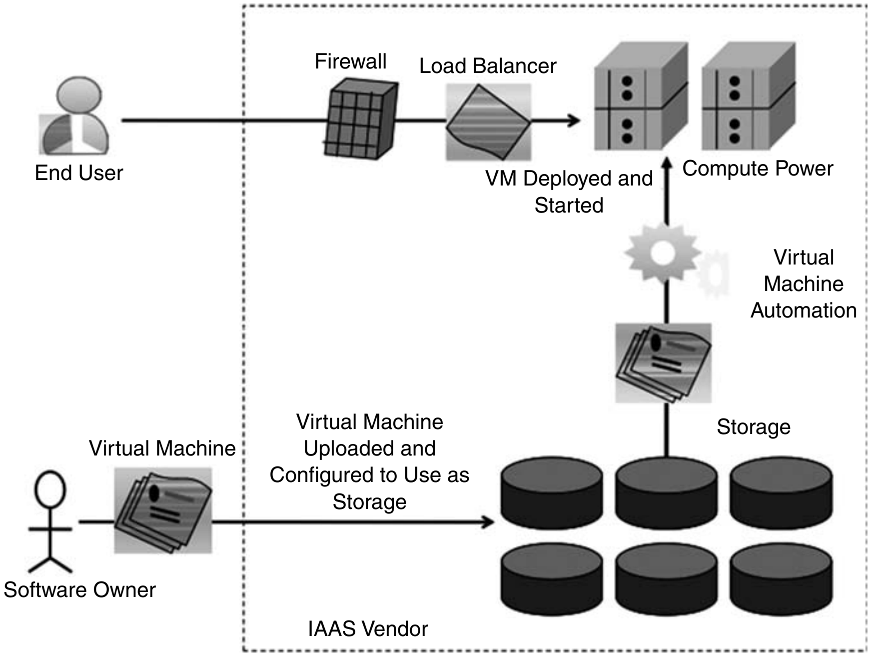


Figure 16.2 Sample IaaS

Figure 16.3 displays a PaaS model. PaaS has two actors, that is, developers and users. Developers evolve a stage comprising of IDE, security, supervising of application and hardware infrastructures to evolve an application. End users use the stage and establish their enterprise applications herein. PaaS presents all the amenities needed to support the entire life cycle of construction and consigning WWW applications solely on the web. As PaaS is accessible as a service, the developer and requestor get full command over the development and deployment of application. PaaS endows developers and customers to conceive WWW applications and consign it speedily as the hassles such as setting up hostings, servers, databases, client interaction methods and frameworks are prepackaged.

Software as a Service (SaaS)

This is the most widespread pattern of cloud computing which is in force. Its entire programs are proposed on the cloud. They are accessed by the clients on pay- per-use basis. Salesforce.com's CRM, Google apps, Salesforce.com's CRM, Gmail and Hotmail are major examples of SaaS. Figure 16.4 displays the diverse constituents accessible in SaaS. The constituents encompass metadata services, security services and directions services. Apart from these services, there are method and enterprises which are placed in between metadata and security services.

Security services are used for commanding access to end-user and back-end programs. Metadata services are used for organizing application configuration for each and every tenant. Services and intelligence purchasers combine with the metadata services to get data that recounts configurations and additions that are apt for every tenant.

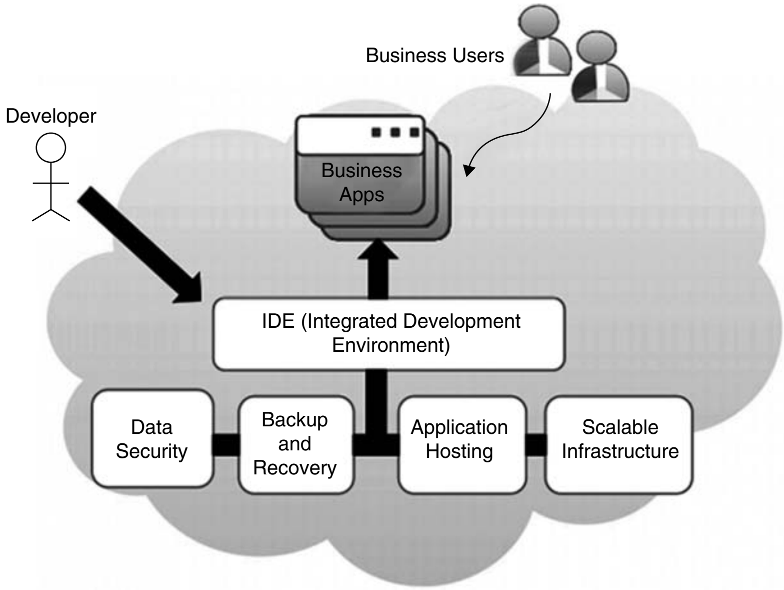


Figure 16.3 Sample PaaS

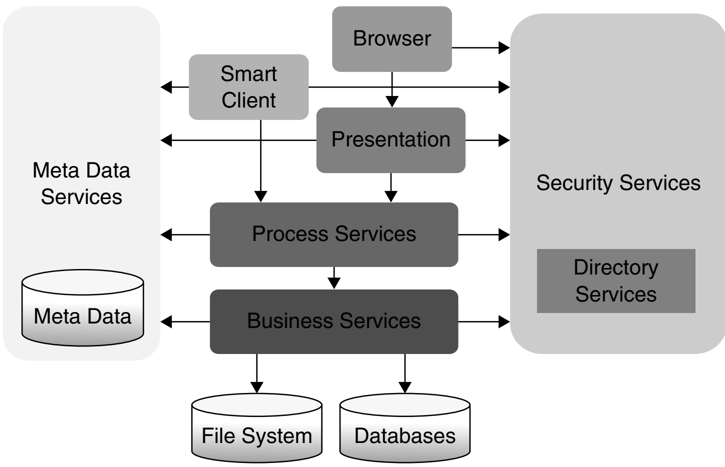


Figure 16.4 Sample SaaS Architecture

16.2 SOFTWARE AS A SERVICE (SaaS)

16.2.1 What is SaaS?

On-premise applications are rather costly, because of the heavy investment made in the Total Cost of Ownership (TCO). On-premise applications need numerous accomplished developers to maintain it. SaaS is apt for small and medium-sized enterprises (SMEs/SMBs). They can

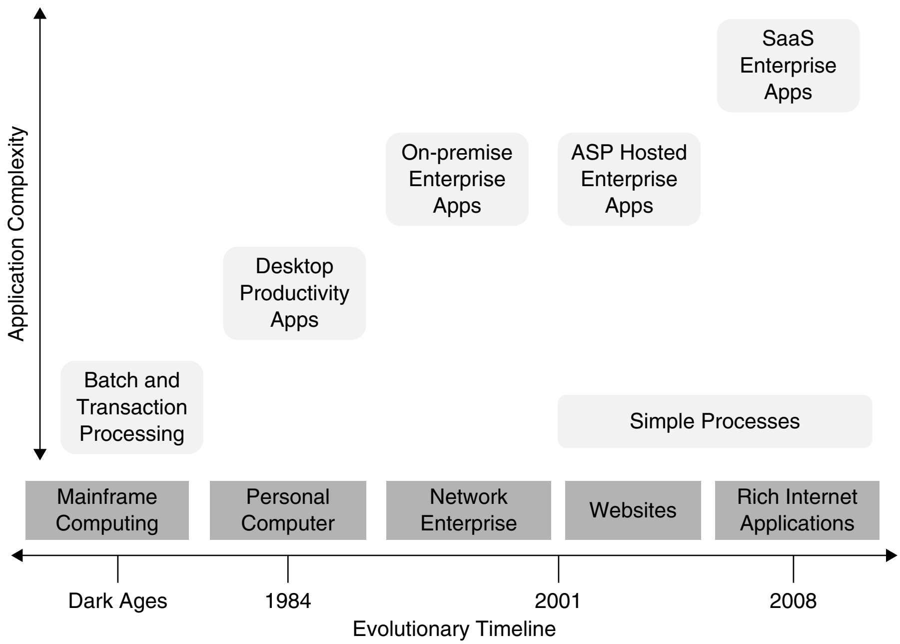


Figure 16.5 Software as a Service

afford to pay for the best solutions without having to spend on the infrastructure, development or recruiting expertise manpower.

Figure 16.5 displays the evolutionary timeline vs. application complexity for SaaS. It started with mainframe computing times where batch processing ended and personal computer (PC) evolved for desktop activities. Networked organizations relied on-premise applications, for example, CRM and ERP. After the evolution of the Internet, WWW applications appeared; its services evolved which assisted the program developers to package their programs utilizing off-the-shelf products. When cloud computing paradigm evolved, WWW services took a new form as SaaS.

16.2.2 Why SaaS?

- No upfront payment
- Web browser is sufficient to access the application
- Quick deployment or it is readily established for use
- Better scalable
- Multi-tenant makes SaaS highly efficient

16.2.3 Who Can Use SaaS?

SaaS is a flawless answer for SMEs/SMBs. Most SMEs/SMBs have little or no legacy programs moving forward. A monthly basis usage can be subscribed similar to electrical power or telephone services. Currently you can find the following SaaS players:

- CRM (Customer Relationship Management)
- Collaboration applications
- Security

Human Resources (HR) can also make good use of SaaS. However, there are several other segments that require inexpensive apps, which can take advantage of SaaS.

Best SaaS Examples

- SalesForce CRM
- Google Apps
- DeskAway
- Impel CRM
- Wipro w-SaaS

16.2.4 Categories of SaaS

Software as a Service (SaaS) is an application hosted on an isolated server and accessed through the Internet. Simple examples of SaaS are the 'free' Internet note systems, for example, Microsoft Hotmail, Google Docs and Yahoo Mail. Every program encounters the rudimentary criteria of a SaaS application, a vendor (Microsoft, Google, or Yahoo) hosts all of the programs, and centralized data and users get access to this data and programs through the WWW.

Two Main Categories of SaaS

1. *Line of enterprise services*, which means solutions provided to businesses and organizations on a subscription basis. Applications enclosed under this class encompass organization methods, for example, provide string of connected administration programs, clientele-related applications, etc.
2. *Customer-Oriented Services* are suggested to the general public either on a subscription (more often than not) or for free. Web-based Internet note services fall under this general category.

16.2.5 Usage of SaaS

Software ownership: Traditionally, the client spends one-time to buy a software package and license. The client, who makes the purchase thereby, becomes the proprietor for the software. SaaS, on the other hand, does not require licenses. Rather than ascribing for an upfront payment, programs used are paid through subscription. The users get access to the programs and pay only for the usage, and subscription is suspended when the client doesn't use it. Examples are Gmail or Hotmail, which are not 'resident' on the user's computer. Rather, it is accessed and utilized through the Internet.

Key advantages for the user:

- Lower costs
- Lesser storage requirements
- Minimal number of programmers

Key advantages for the vendor: The prime advantage for the vendor is the relentless flow of revenue more than anticipated in the customary programs setup.

16.2.6 Characteristics of SaaS

Not all SaaS applications share the same traits. The following characteristics are widespread amidst numerous SaaS applications configuration and customization.

SaaS applications likewise support what is conventionally known as application *customization*. The application can be customized to a stage where it was conceived on a set of predefined configuration options.

SaaS applications are revised more often than customary softwares. This is endowed by the following factors:

- The application is hosted centrally, so new add-ons can be put in place without installing a new software.
- The application has a single configuration, developing and checking faster.
- The application vendor has access to all clientele data, expediting conceive and regression testing.
- The solution provider has access to client demeanour inside the application (usually by WWW analytics), making it simpler to recognize areas where there is scope for improvement.

16.2.7 SaaS Examples

An example of SaaS in today's business environment is Fortiva's Internet note archiving service which locates the requirement for e-mail recovery. The setting up of an application in-house and hosting on Fortiva's building helps explorations of applicable e-mails. Additionally, LiveOffice promises alike SaaS-based services which assist associations of all dimensions, which adhere to FRCP (Federal Rules of Civil Procedure) amendments.

16.3 PLATFORM AS A SERVICE (PaaS)

16.3.1 Introduction

Cloud computing altered the means of executing organizations applications. It eradicates the complexity and cost incurred in buying, configuring, organizing and assessing hardware and programs required to run applications. Cloud computing encompasses stage-wise running and construction called PaaS. PaaS applications are on-demand and WWW based. PaaS is an expanded version of SaaS, where encompassing programs applications are established and accessed by clients over the Internet. PaaS has some advantages for programs developers. Some of them are recorded as follows:

- Off location programs development
- Working on heterogeneous stages without bothering upgradation
- Initial and ongoing charges are minimized as the infrastructures are not bought

- Combination of development programmings minimize the overall costs
- Platform as a service (PaaS) is a combination of a computing phases and gurantess deployment of applications without the cost and complexity of buying and managing inherent hardware and software. Some examples of PaaS are as follows:
- Google's AppEngine, which is based on Python
- Force.com from SalesForce, based on the SalesForce SaaS infrastructure and Apex language
- Bungee Connect: visual development studio based on Java
- LongJump: based on Java/Eclipse
- Winemaker: A studio based on Java and hosted at EC2

16.3.2 The Traditional Model

Building and running on-premise applications have traditionally been convoluted, costly and risky. Every application needs a hardware, a functioning system, a database, middleware, web servers and other softwares. Once the stack is arranged, a group of developers have to evolve a convoluted programming system utilizing J2EE and .NET. Sometimes, an organizations vision would need a change, which would kick start long development, check and redeployment cycle. Large businesses often need dwelling of their data centres. Enormous amount of electrical power is essential to run the servers as well as to keep them cool. Finally, a suplimentary location is required to reflect the data centre, so data could be duplicated in case of a disaster.

16.3.3 The New Model

PaaS takes pride in the fact that it is quicker and more cost-effective method for application development and delivery. PaaS presents the whole infrastructure, which is required to run applications over the Internet. Users easily 'sign in' and take what they require without being concerned about the complexity behind the scenes. As the PaaS is founded on a subscription form, users pay only for what they use.

16.3.4 Definition of PaaS

Where businesses lease hardware and programs from a third party is said to be Platform as a Service (PaaS).It is one of the three major types of cloud computing. The stage is accessed over a personal network or the Internet and utilized to construct applications other than owning, running and evolving on an interior IT infrastructure.

PaaS is in its development stages; the development device itself is hosted in the cloud and accessed through a WWW browser. With PaaS, developers can construct WWW applications without establishing any devices on their computer.

16.3.5 Need of PaaS

To establish WWW applications, one has to resort to Eclipse or Microsoft Access and then manually establish those applications on cloud through some providers. When PaaS is utilized, the work is drastically reduced saving on money and time. A PaaS stage has distinct dissimilarities from customary development platforms. Some are recorded as follows:

- *Multi-tenant development tool*: Traditional development devices are meant for single users. A cloud device has to support multiple users, each with multiple projects.
- *Multi-tenant deployment architecture*: In PaaS, scalability of the application and data tiers should be in-built.
- *Integrated management*: Traditional development generally does not function on run-time supervision, but in PaaS, it is advisable if the supervising proficiency is embedded into the development platform.
- *Integrated billing*: PaaS needs means for billing payment on pay-per-usage.
- *Standalone development environment*: Standalone PaaS environments do not encompass mechanical, authorizing or economic dependencies and are proposed to supply a generalized development environment.
- *Application environment*: A few kinds of PaaS are needed in development, debugging and checking capabilities and provide only hosting-level services, for example, security and on-demand scalability.
- *Open stage as a service*: Developers value diverse programming dialect, database, functioning system and server, etc.

The components of PaaS are:

- Browser-based development studio
- Seamless deployment to host run-time environment
- Management and supervising tools
- Pay contrary to billing

16.3.6 Types of PaaS

Figure 16.6 shows the types of PaaS:

- Social application platforms
- Computation platforms
- Web application platforms
- Business application platforms

It also furnishes some examples associated to diverse PaaS types. Orkut and Facebook are categorized as social applications, Google Apps as Web, Wolf and Force.com as organization, and Microsoft Azure and Amazon WWW services as computation platforms.

Social Application Platforms

Social application platforms are used to develop applications on community networks. Platforms such as Facebook, Orkut, Yahoo and MySpace supply APIs for third parties to compose new application functionality that are made accessible to all users.

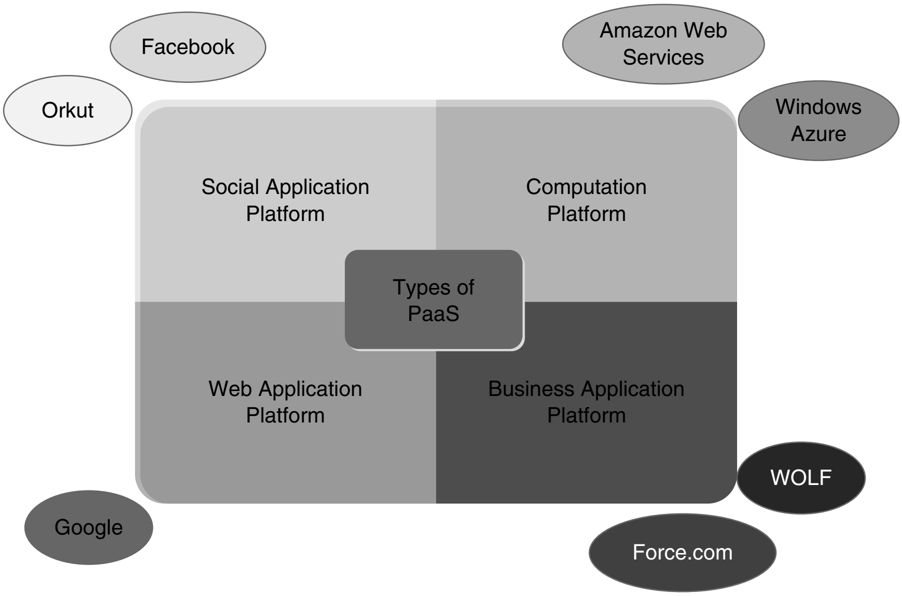


Figure 16.6 Types of PaaS

Computation Platforms

Computation platforms are hardware architecture types and programs structure (including application frameworks) that permits programs to run. Amazon Web services and Microsoft Azure supply storage, processor and bandwidth functions as a service. Developers can upload their stack programs and applications that can be executed on these platforms.

Web Application Platforms

Web application platforms like Google provide APIs and functionality for developers. It uses to construct web applications that leverage its mapping, calendar and spreadsheets in addition to YouTube and other services.

Business Application Platforms

Business application platforms supply application infrastructure expressly for transactional applications, for example, database, integration, workflow and user interface services. They address unique requirements, for example:

- Applications that are constructed for selective users
- Applications that are utilized for only a couple of weeks or months
- Applications that address a small part of functionality

Situational applications are a powerful blend of devices, concepts and methodologies. They supply a formidable force that assists the association to meet today's enterprise trials quickly and cost-effectively.

16.3.7 Characteristics of PaaS

Different PaaS vendors supply distinct set of services to support the application development.

PaaS normally supply some grade of support to alleviate the creation of client interfaces, for example, HTML and JavaScript or other Rich Internet Application technologies. Rich, interactive, multi-user environments and scenarios can be characterized, performed by the non-programmers, with devices that make it so straightforward to access possible features.

Multi-tenant Architecture

PaaS normally tries to support application usage by numerous parallel users by providing concurrent administration, scalability, fail-over and security. The architecture endows characterizing the 'trust relationship' between users in security; get access to, circulation of source code, navigation annals, client profiles, interaction annals and application usage.

Support for Development of Group Collaboration

The proficiency to pattern and share code with ad-hoc or pre-defined or circulated groups substantially enhances the productivity of PaaS offerings.

16.3.8 Benefits of PaaS

The advantages of PaaS multiplied the number of users by evolving, sustaining and establishing WWW applications. In short, PaaS guarantees to democratize development of WWW applications like Microsoft Access democratized development of client/server application. Currently, construction of WWW application needs professional developers with two highly focused abilities called

1. Back end server development (e.g., Java/J2EE)
2. Front end purchaser development (e.g., JavaScript/Dojo)

PaaS is promising for general developers who want to construct WWW applications without requiring expert hands. This permits a lifetime of MS Access, Lotus Notes and PowerBuilder developers to start construction of WWW application without the gigantic discovery curve.

16.3.9 PaaS and Other Cloud Computing Model

There are three major forms in the cloud computing. From the base, there is the Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). With IaaS, businesses lease servers with functioning framework pre-loaded, storage and network access.

SaaS is different and contrary to PaaS. In SaaS, organizations hire an application from a third party. It takes care of the whole set-up needed to support that application, configuring hardware and programs, supplying database motors, document systems and everything else needed. The clientele is to supply the Internet adept PCs and localized publishing services.

PaaS is seated in the middle of these two forms (Figure 16.7). It needs a purpose to lease the hardware, functioning system, storage and network capacity, and IaaS presents programs servers and applications environments. This dedicates clients a platform on which they can rest their data and start developing applications they need.

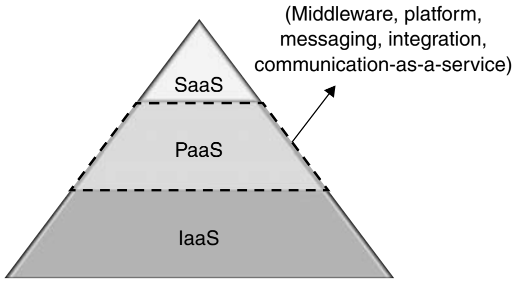


Figure 16.7 Platform as a Service

16.3.10 Characteristics of PaaS

- Every phase is acted as a service.
- Provides services needed to support the entire lifecycle of construction and consigning WWW applications.
- Provides services to establish, check, own and sustain application in the identical IDE.
- Service provisioning encompasses concurrently, i.e., multiple users use the identical IDE.
- Being a cloud, it pursues cloud service form, i.e., pay per use/pay per proceed model.
- PaaS decreases TCO (total cost of ownership), as there is no need to purchase all the frameworks, programs, devices and kits required to construct, run and deploy the application.
- In-built scalability and elasticity to supply similar effectiveness.
- PaaS is flawless for agile programs development methodologies.
- PaaS assists in the fast building of applications in the cloud by supplying the essentials.

16.3.11 Live Examples of PaaS and Its Advantage

Salesforce.com is one of the most thriving and appropriate examples of SaaS. Companies lease space on their clientele customer relationship manager (CRM) and log on to the website without having to download or establish any software. Everything is supplied by the organization and the only thing the clientele association has to manage is their data and configuration according to their preferences.

Business Drivers for PaaS

In most of the cloud computing applications, cost is the foremost advantage for customers. Instead of sustaining an IT infrastructure by stacking the entire computing environment from hardware to applications, users can reduce the cost and management hassles.

Portability of Assets and PaaS

A user contemplating the PaaS as a strategic device for evolving application wishes to learn the steadiness of the customer providing the service. Organizations require yielding specific vigilance to the portability of the applications they develop.

Cost Savings with PaaS

Its wise to compare cost savings between distinct PaaS providers and other modes of evolving applications, for example, in-house development or outsourcing to a service provider. As off-shore development becomes more adept and still continues bargain, PaaS faces substantial affray from customary models.

16.4 INFRASTRUCTURE AS A SERVICE (IaaS)

16.4.1 Definition

Infrastructure as a Service (IaaS) is a form of service, consigning and outsourcing all types of computing infrastructures. It presents hardware, servers, storage and softwares services. Figure 16.8 depicts the services provided by IaaS. IaaS is also called hardware as a service. It presents the gear to the clients in maintaining and monitoring the assigned tasks. Clients generally pay on a per-use or utility computing basis. IaaS characteristics encompass automated administrative jobs, dynamic climbing, stage virtualization and Internet connectivity.

Infrastructure-as-a-Service (IaaS) is one of the three major classes of cloud computing service. The other two services rest on the top of the IaaS layer. Clients can use infrastructures, for example, hardware, servers, computing, storage, networking constituents and functioning systems in on-demand cornerstone other than buying them.

Some examples of the IaaS sub-services are as follows:

- *DBaaS*: Database get access to and use database administration system as a service
- *STaaS*: Data storage as a service, comprising of database-like services
- *CCaaS*: Compute capacity (CPUs) as virtual services are founded on on-demand usage

IaaS is developed from virtual private server offerings. IaaS fundamentally offers computing infrastructure, normally a virtualization natural environment, as a service. IaaS service provider owns the assets and they supply provisioning, running and sustaining services on demand. IaaS can be availed on pay-per-use or on a flat rate basis.

- *Pay-per use form*: Metered service pay for the infrastructure for using the applications and they generally are based on throughput, but some vendors ascribe for server time as well.
- *Flat rate form*: Based on monthly or quarterly or yearly.

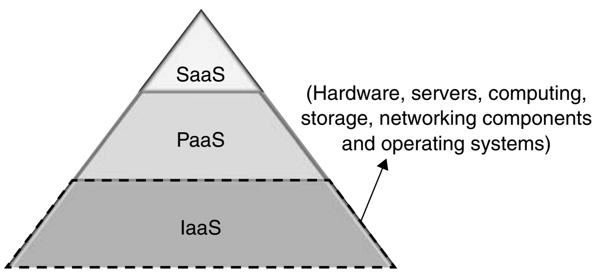


Figure 16.8 Infrastructure as a Service

16.4.2 IaaS: Characteristics, Classifications and Vendors

IaaS Characteristics

IaaS has assisted in advancement of infrastructure share and utilization. The key characteristics of IaaS (Infrastructure as a service) are as follows:

- Resources are supplied as a service
- Allows for dynamic climbing and elasticity
- Has a variable cost, usage-based cost form (pay per proceed and yield per use)
- Has multi-tenet architecture, encompasses multiple users on a single hardware
- IaaS normally has enterprise level infrastructure

IaaS Classifications

IaaS can be classified into private, public and hybrid cloud.

- *Private cloud*: IaaS on a private network dedicated for a business. Private cloud is advised as the most protected IaaS offering.
- *Public cloud*: IaaS service is established over the Internet and the client has to pay and use the service. It is similar to utility services such as electricity, gas and water.
- *Hybrid cloud*: A blend of both private cloud and public cloud in an organization.

IaaS Vendors

IaaS vendors (Cloud vendors): Leading IaaS vendors include: Verizon, Rackspace, Amazon AWS, Savvis, GoGrid, VMware vCloud, Flexiscale, Joyent IaaS, Rightscale, Eucalyptus, BlueLock's IaaS, Enomaly, SoftLayer, IBM Cloudburst and Oracle Cloud Services.

16.4.3 Benefits of IaaS

Infrastructure-as-a-Service (IaaS) is one of the three major classes of cloud computing services. Benefits of IaaS are as follows:

- *Allows IT to shift focus*: With the fast accessibility of IaaS services, an organization can leverage and focus their time and assets in innovative applications and solutions.
- *Hassle-free service*: Every infrastructure constituent is supplied as a service.
- *Utility service*: IaaS pursues a utility service form—pay per use/pay per proceed subscription-based model.
- *Dynamic scaling*: Scales up and down the infrastructure services depending on the usage application. Dynamic scaling is best for the applications where there are important spikes on the usage of infrastructures.
- *Multiple tenants*: Service supplying comprises of multiple users accessing the identical infrastructure.
- *Investment cap*: Highly beneficial for businesses with limited capital to invest in hardware and infrastructure.

- *Reduces TCO (total cost of ownership)*: Changes the cost from capital total cost (Capex) to opex (Operational expense) for an enterprise; there is no need to invest in an asset and therefore saves on the additional cost of upkeep and support.
- *Metered service*: IaaS usage is a metered service. Pay for what you use and when you use. Payments are based on the units consumed by customers.
- *Flexible offering*: Access infrastructure from any location, any place and on any device.
- *Enables green IT*: Reduces the carbon footprint by optimizing IT assets and systems, therefore, adds to the environmental protection from IT side.

16.5 OTHER CLOUDS SERVICES

16.5.1 Storage as a Service (STaaS)

Storage as a service is a methodology wherein large organizations leases their accessible storage space to a small scale business or individuals. To encourage STaaS, vendors are aiming to reduce storage space and plan for backups.

Merits of STaaS are:

- Saving revenue for individuals and hardware
- Private storage space

Because of these merits, the workload is reduced for an organization in these cases:

- No requirement to purchase or maintain a library
- Storage space for tapes
- No requirement of backups

Storage as a service is usually viewed as a good alternate for SME/SMBs that needs initial investment and/or manpower to manage their storage infrastructure. STaaS is encouraged for all organizations to trouble shoot in times of catastrophes, provide long-term record keeping and assure sustainability of the organization.

Online storage services are experiencing very large demand in small-, mid- and large-sized companies that are contradicting budgetary and IT staffing pressures. Storage-as-a-service is a forerunner to the long-term cloud storage and cloud computing opportunity.

The accessibility of STaaS is disturbing customary storage practices since it drastically changed users, both individuals and organizations, to access storage capability and procure program functions. As organizations are ready to develop huge amount of data and demand optimum procedures to shop and protect them, the development of storage facilities streamlined through STaaS offerings will proceed much quicker than the customary storage infrastructure.

In today's financial context, online backup and archiving services are the direct manifestation of the long-term plans for sequential cloud-based services, which will influence the storage industry. Storage-as-a-service will take place in two phases:

1. First as a means to endow defense, recovery, long-run record keeping and business sustenance.
2. Second as a by-product of bigger cloud computing initiatives.

STaaS products from Symantec FileStore and Veritas Storage Foundation can multiply revenue by leasing the space to their customers. Symantec presents infrastructure programs and expert services assistance to construct scalable and automated cloud-computing environments. The concept of 'pay as you grow', scalability and straightforward management promises cost-effectiveness in utilizing STaaS. Some of the benefits of SaaS are as follows:

- Reduced capital expenditures
- Dynamic storage, backup and security
- Customer approval of performance periodically
- High availability

16.5.2 Database as a Service (DaaS)

Today, for IT businesses, the basic and crucial topic is effective data processing. For this, organizations establish and organize database administration systems. Purchasing, establishing and organizing database systems are getting costlier and complicated.

DBaaS inherits the benefits of SaaS and permits IT businesses to use the hardware and programs services without being installed in their premises. DBaaS can be characterized as 'an organized service, suggested on a pay-per-usage basis, that presents on-demand access to a database for the storage of application data'.

DBaaS consigns the database programs and its constituents as a service. A service can be categorized as DBaaS when it encounters the following three requirements:

1. Service accessibility to the clientele on-demand
2. Pay-as-per-use basis without any SLAs
3. Less responsibilities for the consumer

The prime concern of the DBaaS model is safety and privacy of data. In the DBaaS, the user's data reside in the provider's premises. As the data is precious to the consumer, the service provider has to ensure adequate security measures to guarantee safety of data. Research is underway in this topic.

- Implementation and provisioning of DBaaS model by genuine clients
- Integration of data encryption with database systems
- Design of new data storage model(encrypted)
- Development of new query processing techniques
- Query optimization in encrypted databases
- Integrity of the data in encrypted databases
- Key administration matters in encrypted databases

Features of DBaaS

DBaaS plays a small role in a larger part constituted of services, for example, PaaS and SaaS encompassed in IDE for construction and establishing applications. Compared to other service providers, they consign the database and expect users to use languages such as Java, .NET, PHP.

While one DBaaS can be based on relational database administration system (RDBMS) and expect application to use SQL for access, another might be based on some other kind of database expertise and have its own proprietary API.

16.5.3 Information as a Service (INaaS)

For large IT organizations, data related to stakeholders and others should be accurate. Due to heterogeneous data formats, batch processing and application integration charges, there is an obstacle in the system to get uninterrupted information. Using IaaS, organization's data are publicized and used by any application virtually. INaaS permits the following:

- Distribute data over the organization as a distributed service
- Create a single source of reality for foremost domains
- Reduce operational obstacles that arise from phased revisions of data between systems
- Simplify and streamline the distribution of data among different organizations

Information-as-a-Service reduces cost, time and invoke components to convey back-end data. By setting up a single, trusted source of data as a distributed service, it is possible to set up unique consumers of that data in several specific applications with comparatively less effort. IaaS is a boon to business enterprises and IT sectors due to its agility and effectiveness.

Need of IaaS

INaaS guarantees flexible data integration platform by taking up service-oriented measures ubiquitously to get access to any kind of data, on heterogeneous platforms with broad variety of interfaces. Business enterprises and government establishments are expanding their IaaS investments, as it is the best productive means to address the tough data integration trials they face.

SUMMARY

- ❖ Virtualization is a technology which is around for a decade but gaining popularity only recently for its advantages.
- ❖ With cloud computing, there is no point-to-point contact between the client and the computing infrastructure.
- ❖ Advantages of cloud computing are (i) resilience, (ii) scalability, (iii) flexibility and effectiveness and (iv) outsourcing.
- ❖ Infrastructure as a Service (IaaS): hardware associated services are supplied and utilized herein. These encompass disk storage and virtual servers.
- ❖ Examples of IaaS vendors are Amazon EC2, Amazon S3, Rackspace Cloud Servers.
- ❖ Platform as a service (PaaS) act as the consignment of a computing platform and solution for a service. PaaS helps developers to deploy their applications with minimal cost and complexity.

- Examples of PaaS vendors are Google App Engine, Microsoft Azure and Saleforces.com.
- Software as a Service (SaaS) is the most widespread system of cloud computing which is in froce, for examples, Salesforce.com's CRM, Google apps, Salesforce.com's CRM, Gmail and Hotmail.
- SaaS is an application hosted on an isolated server and accessed through the Internet.
- Two main categories of SaaS are: line of enterprise services and customer-oriented services.
- Platform as a Service (PaaS) is a computing platform which promises deployment of applications without the complexity of buying and managing inherent hardware and software.
- IaaS is developed from virtual private server offerings. IaaS fundamentally constitutes computer infrastructure, normally a virtualization natural environment, as a service.
- SaaS is a model in which large business houses lease their accessible storage space to small-sized businesses or individuals.
- Purchasing, establishing and organizing database systems are getting costlier and complicated. DBaaS consigns the database programs and its constituents as a service.
- INaaS permits users to (i) Distribute data over the enterprise as a distributed service, (ii) create a single source of reality, (iii) reduce operational hurdles and (iv) simplify and streamline data.
- IaaS reduces cost, time and promotes components to convey back-end data.
- IaaS is a boon to business enterprises and the IT sectors because of its agility and effectiveness.

KEY TERMS

- Cloud computing is a network which values virtualization so that computing applications and data are supplied readily from a pool of hardware resources.
- Line enterprise services, gives business solutions to access services on a subscription basis.
- Customer-oriented services are open to the general public either on for subscription (more often than not) or for free.
- Traditionally, in software ownership the client pays upfront to procure a software bundle and license. In SaaS, clients do not need licenses. Rather than paying one-time, payments are made through subscriptions.
- Cloud computing encompasses phases for running and construction called as 'Platform as a Service (PaaS)'. PaaS applications are on-demand and WWW based.
- Constructing and running on-premise applications have always been convoluted, costly and risky (traditional model).
- Social application platforms are utilized to evolve applications on community networks.

- Computation platforms are hardware architecture and programs structure kinds (including application frameworks) that permit programs to run.
- Business application platforms provide application infrastructure expressly for transactional enterprise applications, for example, database, integration, workflow and user interface services.
- Infrastructure as a Service (IaaS) is a service form that outsources all types of computing infrastructures.
- Storage as a Service (SaaS) is a system by which large organizations can lease their storage space to small enterprises or individual users.
- DBaaS can be characterized as 'an organized service, suggested on a pay-per-usage basis that presents on-demand access to a database for the storage of application data'.
- Information-as-a-Service reduces cost, time and invoke components to convey the back-end data.

REVIEW QUESTIONS

- What are the categories of cloud computing?
- What are the classifications of cloud?
- What is SaaS?
- What is the use of SaaS?
- Who are the users of SaaS?
- Explain the categories of SaaS.
- What are the usages of SaaS?
- What are the categories of SaaS?
- What is PaaS?
- What are the needs of PaaS?
- What are the elements of PaaS?
- What are the types of PaaS?
- List the characteristics of PaaS.
- What are the advantages of PaaS?
- What is IaaS?
- List the models of IaaS.
- What are the characteristics of IaaS?
- What are the classifications of IaaS?
- Define some IaaS vendors.
- What are the features of DBaaS?
- What is Information as a Service (INaaS)?
- What is the need for Information as a Service (INaaS)?

CHAPTER 17

Cloud Computing at Work

17.1 CLOUD SERVICE DEVELOPMENT TOOL

Servers and software programs are very expensive. Buying assets for developing software, which will be used only for few months, is impractical and a total waste of resources. There are abundant choices to assist developers to get a jump start in the cloud with no cost at all and no necessity to buy or install any programs or hardware. With the myriad of free development devices and services in the cloud, one can start evolving much quicker, reduce time-to-deployment, with no upfront payment or managing hardware hassles. Some free cloud resources available, which are discussed as follows.

17.1.1 Application Development Using IDE

Integrated Development Environments (IDEs) comprise of source codes, automation experts and a debugger. Cloud IDEs, for example, koding.com, Cloud9 or eXo are all free of subscription as they are in the cloud and it allows for developers to conveniently edit and code anytime, anywhere. In addition to cloud IDEs, there are also Platform-as-a-Service (PaaS) solutions such as Heroku or Engine Yard for Ruby, CloudBees for Java developers, or AppFog for PHP. Each PaaS encourages us to utilize their services, which are free, to both cipher in the cloud and effortlessly set-up the application subsequently when it is ready.

17.1.2 Application Using Databases

Most applications today need some sort of database connectivity/usage. When you evolve and deploy in the cloud, the easiest thing to do is ensure that your database is consigned as a service in the cloud, so that you regularly observe Xeround's FREE cloud database. Xeround FREE permits MySQL developers to conceive their easily-available database in the cloud at no cost. Rather than being concerned about the IT and having to manually establish, configure and organize your database, developers enjoy a zero-maintenance free MySQL-as-a-service deployed out of the carton with a click of a mouse.

17.1.3 Deploying Application

CloudBees boasts an IaaS solution called Run@Cloud, which presents all services needed to be established in the cloud, free of charge.

To save more time, numerous of these free cloud services, for example, PaaS natural environment and Database-as-a-Service (DBaaS) solutions take care of all the procedures and maintenance, eliminating the need for manual supervision. For cloud computing to take off, devices are required to enable a developer for constructing or establishing an application without having to download anything on to their desktop. This needs an on-demand development device that is seated on the top of the cloud and presents a development Platform as a Service (PaaS).

There are two routes that a vendor can take to develop a platform for cloud computing: cloud-first and tool-first.

1. *Cloud-first*: first construct a cloud platform, and then a development device that sprints on top of it. This was pioneered by Force.com and pursued by Cog head and Bungee Labs.

2. Tool-first: first construct a development platform that is a host-friendly device (e.g., studio sprints in a browser), then 'push' that platform into the cloud. This is the method adopted by Wave Maker.

For Force.com, it makes sense to take the cloud-first route. SalesForce.com currently has a robust cloud method and know-how in building ownership development devices to conceive their CRM application. Force.com works on any other cloud platform. Salesforce supports all kinds of operations needed by an organization or enterprise. For most programs vendors, the cloud-first development method has obvious disadvantages. First of all, it places the data centre procedures, which needs a clear set of software development. Since the cloud adds a grade of trickiness and complexity in all development tasks, it makes development itself complex. Finally, it is compelled to manage cloud port to get to a SaaS cloud people desire to establish such as Amazon EC2 or Google App Engine.

A tool-first method is much more straightforward. Start by planning a host-friendly development studio (pretty many directions) and manage it and check on the standard hardware. After constructing a solid product, add multifunction to the studio and customize deployment based on choice.

17.2 MANAGEMENT/ADMINISTRATIVE SERVICES

Event management is a processes intensive attempts. So much happens even in organizing least significant events, it can be benefitted from the power of cloud computing.

Even a minor event has several parts and components, all of which can benefit from behind-the-scenes computing applications. Although its seldom cost-effective to purchase the hardware and software programs to organize these events, we can use the same programs applications to organize a 25-person seminar as a 1,000-person trade fair, even though the 25-person seminar adds to less revenue. Unfortunately, while both events have the same administrative inclinations, the lesser event can't possibly pay as much for the kind of event management programs that the bigger event is estimated. This is where cloud computing arrives to the rescue. By tapping into the identical server cloud as the bigger event, the lesser event can now pay for the identical level of event management. The identical applications are utilized, with lesser server powers.

Cloud computing also takes management from the agency to the event site. The attendee database isn't landlocked on company's computers established on the WWW, where it is accessible from any web browser. Everything entered by the attendees before the event is there for onsite access, great for onsite registration, but also for explaining difficulties that habitually are inclined to skip the day of the event!

17.2.1 Collaborating Event Management

Less-sophisticated apps may aim on one or more procedures. For example, event registration or amenities booking. The fully-featured apps encompass management of everything from pre-event trading to post-event analysis. Some noteworthy applications are as follows:

Event Planning and Workflow Management

A successful event begins well in advance of its due date. There are tons of minutia engaged in events of any dimensions, and managing all those jobs takes rather a bit of computing skill; just the thing that cloud computing can assist you out with. Most event management applications encompass robust task designing modules similar to what you would find in higher-end or lower-end task administration applications.

Advance Registration

Larger events need registration of participants. For this purpose, most event management apps encompass a web-based registration module, where attendees can signal up (and in most situations, pay) for the event. Attendee data is stored into a web module and that data is then retained on the application provider's cloud servers. In the entire management program, the registration module plays a vital role. Ensure that it does everything required to manage and does so in available means.

Payment Processing

The key role of the event management is collecting fee from onsite applicants. Event management programs bind fee processing into the registration module, accepting fee through credit card, PayPal, or anything other procedures.

Contact Management

This is a kind of service that numerous event managers offer. Using the expert database of the event managers, communication services can be provided to help attendees get in touch with one another. At the least, event management application should publish a guide book or directions to the venue, which can then be supplied as part of the welcome package.

Budget Management

Running an event is a costly and convoluted undertaking. The general allowance comprises of hundreds of individual estimations. For that purpose, event management application should encompass a robust accounting or allowance management module, to track both costs and income.

Post-event Reporting and Analysis

When the event is over, the job is not rather finished yet. It is essential to look back at the whole event and analyse how successful it was. For this purpose, most event management applications encompass some kind of post-event analysis. Some apps even let us monitor attendee reviews, which can provide precious feedback. Let's look at the widely used event management applications which are web-based:

123 Signup

The first of the list is 123 Signup (www.123signup.com). This consists of four distinct applications: event manager, association manager, training manager and member directory. Out of these, the one in which we are dealing with is the aptly entitled event manager.

Acteva

Acteva (www.acteva.com) speaks of online event registration and payments. Using Acteva's web-based solutions, one can handle event registration, ticketing and payment management (via any permissible credit card) from the website.

Conference.com

Conference.com (www.conference.com) defines one of the most fully featured web-based event management applications accessible today. By utilizing Conference.com's cloud servers, even small events can utilize the company's mighty event management devices, designed to assist the requisite of events of large magnitude. The data (and the behind-the-scene application modules) are hosted by Conference.com's protected servers, accessible from any Internet-enabled location.

Event Manager Systems application in Conference.com is really suited for interlocking modules. These modules encompasses: appointment manager, credit card manager, e-mail manager, export manager, hotel manager, lead track manager, profile manager, registration manager, survey manager and travel manager.

Event Wax

Event Wax (www.eventwax.com) isn't as efficient as other event management solutions. Essentially, it isn't capable of handling large-scale events such as trade fairs and conferences. Instead, Event Wax can be used for small-scale in-house events. For example, business meetings, parties, open house and etc.

Tendenci

Tendenci is another exclusive application for event management. It (www.tendenci.com) blends a web-based calendar application with online registration and payment. Create an event calendar, which is embedded in the website. When an involved party clicks an event connection, he's taken to a dedicated page of that event, where he can view more choices and select one. Thus we can organize the attendee data, publish title tags and etc.

17.2.2 Collaborating Contact Management

Contact management is the act of saving data on friends, family and business associates to be retrieved at a future date. We are talking about titles, maps, web sites, telephone numbers and others retained in some file format.

Simple computer-based communication management takes the form of an e-address such as the Address Book application constructed in to Microsoft Windows. Applications like Address Book store this communication device on a personal computer, where it can be easily recalled and utilized. These programs often interface with the Internet program, for direct insertion of e-mail addresses.

Advanced communication management applications assist us in accessing all kinds of details about our friends and colleagues from personal information (birth day, spouse's name, children's name, favourite bistros and the like) to professional information (employer, department, job responsibilities and so forth). These communication management systems generally incorporate this personal/professional data into the calendar and a task manager.

Web-based communication management applications support the users to access information from any computer with Internet connection. Instead of saving personal contacts on their home PC and professional contacts on their office computer, they can save all their contacts in the cloud, where they can be accessed from both home and work.

CRM

Many business enterprises have practical use of their communication data. Its not sufficient to have similar digital Rolodex on hand that communicate data to be injected into diverse automated methods to assist setting up and sustaining long-standing and creative connections with their clients.

CRM software not only stores clientele communication data, it also stores and analyses all data pertaining to a specific clientele and evaluates them to assist you to communicate better with that clientele. For example, you can use a CRM program to find out which client is best suited for telephone calls or e-mails communications.

Exploring Contact Management and CRM Applications

The line between communication management, CRM and SFA (Sales Force Automation) applications is blurry. Take a look at some applications.

Salesforce.com: The most preferred web-based communication management, CRM, accessible today is suggested by Salesforce.com (www.salesforce.com). In detail, the business enterprises use the following distinct cloud services:

- *Salesforce.com*, a software-as-a-service CRM application conceived for sales, trading, clientele service and other uses.
- *Force.com*, a platform-as-a-service application conceived for developers who desire to conceive or customize their own sales force apps.
- *AppExchange*, an online marketplace for add-on programs of Salesforce.com, evolved by its partner companies.

bConnections: This is similar to Salesforce.com, it isn't the only web-based CRM solution accessible today. Witness bConnections (www.bconnections.com), a communication management program is augmented with absolutely critical CRM objectives for small and medium-sized businesses.

The bConnections application begins with a book of businesses where we can manage business with the book. This communication data is hosted on the web and accessible from any PC with Internet-connection.

The application encompasses an e-calendar that marketing managers can use to monitor their marketing executives. It also helps in tracking sales possibilities and plans for better sales forecasts. All operations are summarized in the application's Executive Summary dashboard.

BigContacts: BigContacts (www.bigcontacts.com) is a website that is designed for workgroups that have minimum of two and maximum of 2,000 persons. Its features include e-mail address, calendar, task manager and to-do lists. CRM functions include sales follow-ups, account tracking, group administration and mobile access. Pricing is on a pay-per-use basis.

eStudio Contact Manager: This application is e-mail address based expressly designed for professional contacts. The e-mail address can be accessed by multiple users from any Internet-connected computer, perfecting it for real-time communication management for sales groups, task forces and small businesses.

Highrise: Highrise (www.highrisehq.com) is a very complicated communication management application. Every record can include basic information (name, address, e-mail, etc.), as well as remarks, add-ons, pictures, connections to audio and video documents, e-mails and so on. One can even add to-do lists (calls, e-mails, post a thank-you note, etc.). This information can be displayed in the individual's inbox folder as well as in the expert to-do list.

Apple MobileMe Contacts: MobileMe Contacts is Apple's latest web-based communication management system, available to any individual with a Mac or Windows computer, as well as anyone using Apple's iPhone. MobileMe Contacts (www.me.com) is an advanced communication management application with no CRM pretentions. It's vitally an e-mail address retained in Apple's cloud that continues in sync with anyapparatus we can access.

It also synchronizes with the contact information in Apple's Address Book and Microsoft's Outlook, Outlook Express and Windows Contacts programs. Also it is integrated with Google Maps, which serves as a GPS. For millions of iPhone users, MobileMe Contacts will default be in the communication management application of choice. It's also an alternative to an iPhone, its jazzy interface and synchronization characteristics make it a powerful competitor for PCs.

SalesBoom: Multiple businesses use SalesBoom (*www.salesboom.com*). It presents web-based CRM and back-office solutions with distinct editions:

- Enterprise Edition, for bigger organizations. Includes inventory administration, merchandise administration, accounting and human resource management solutions.
- Professional Edition, for medium-sized businesses. Includes trading automation, sales force automation and customer service and support solutions.
- Team Edition, for small businesses. Includes sales force automation, communication management and customer service and support solutions.

All of SalesBoom's sales force automation solutions include leadership management, communication management, accounting, opening and forecasting features. The Enterprise Edition also comprises extract management, agreement management, billing and a merchandise database.

Zoho CRM: Zoho CRM is accessible in three distinct editions: Free Edition (for up to three users), Professional Edition and Enterprise Edition. The application is constituted of the following modules:

- Sales and Marketing, which incorporates sales with deadlines, directs, sales chanels and forecasts.
- Inventory Management, which presents a entire incorporated inventory administration system.
- Customer Support and Service, which uses circumstances and solutions to incorporate the clientele support method into sales data.
- Reports and Dashboards, which assist in monitoring sales and trading tendencies and key metrics.

The application furthermore encompasses an Outlook plug-in that helps you to synchronize your Zoho CRM associates, jobs, calendars and e-mails with Microsoft Outlook.

Customer relations management may have started as a programs application championed by ACT, SAP and other expertise businesses, but it has developed into a holistic enterprise philosophy. The aim of CRM is to amalgamate clientele connections and in turn boost earnings by reducing the expenditure of individual customers. Although some of this can be carried out by programs (both customary and cloud based), it takes much more than expertise to completely accomplish the goal.

Building clientele connections doesn't occur by just subscribing to a web-based CRM application. For CRM to be really productive, the whole business should invest into the initiative. Yes, cloud computing can assist, but it's just a part of the solution.

17.2.3 Collaborating Project Management

Projects act as catalysts that play a crucial role in constructing 'a better tomorrow.' But without a complicated task management platform, it's tough to be successful. A task management platform includes principles, methods, measures, guidelines, incorporated tasks, administration methods, devices, templates, libraries, best practices, and discovering assets courses wise or practices wise. Many micro and small associations, authorities or those in upcoming business often don't have sufficient finances to invest on complicated data expertise for construction and sustain with a task management platform of their own.

The core break up in the occupation could be reduced through cloud computing service providers, authorities and persons with access to a reliable task management stage over the Internet at a lesser rate as per usage. This is called Project Management Cloud (PM Cloud). Following are a few initiatives of PM clouds:

- Engineering and Construction PM Cloud
- Information Technology PM Cloud
- Research and Development PM Cloud
- Government PM Cloud
- Education PM Cloud

Those utilizing cloud computing can surpass not only initial capital investments, but also the ongoing complexity of managing the challenges. When task management clouds (PM Clouds) are accessible at a reduced rate, as and when required, they can influence task management in the following ways:

- Provides jump start possibilities to surfacing expenses, and small enterprises to be able to compete globally by leveraging 'best-in-class' PM clouds.
- Fosters new inventions as businesses leverage more low-priced PM cloud choices to trial.
- Minimizes the gap between small and large enterprises. Provides identical possibilities as task management clouds become accessible at a reasonable price.
- Allows for global collaboration of contributions from around the globe.
- Facilitates global and interactive inventions at a reasonable cost.

Cloud computing is in its early stages of providing complicated task management services, it will influence the way the task management will be rounded off in the future.

Project Collaboration in the Cloud by Mindjet Connect

The growing popularity of web-based collaboration tools such as Basecamp, LiquidPlanner, Microsoft SharePoint, Box.net, Jive and Cohuman depicts a need to enable job management and collaboration over different stages and different locations. The attractiveness of cloud computing has raised its expectations of being able to edit an article on the laptop at work and then go home and edit the same article on an iPhone, iPad android apparatus, or your PC. As devices are becoming wireless and dispersed, there is an expanding need to coordinate various cloud-based solutions. The latest model of Mindjet's MindManager 2012 and Mindjet Connect suggests better ways to work and coordinate over the web.

What is Mindjet Connect?

Mindjet Connect is a free integrated platform that confers work groups to visually capture concepts and data, share documents and collaborate with others in real time or anytime. With other non-web based tools, every client desires to have their own program charter so that group members competently cooperate and brainstorm.

With Mindjet Connect, every customer gets a free 1 GB Mindjet Connect account and start collaborating and swapping ideas. When a software vendor presents a solution for free, most of us use a compromised version of the expert solution and the vendor tries to attract an improved version. Mindjet consigns a characteristic rich in web-based collaborative brain mapping and object management solution that brain mapping enthusiasts will commend for all the characteristics encompassed in a free, online collaborative solution. To support task delivery, Mindjet encompasses the coveted task administration characteristics. A practical example of applying Mindjet Connect is working on the scope and desires of an approved project. In a usual outdated notepad situation, group constituents would develop as numerous concepts as possible within a given time and delete the outdated remarks. The facilitator would read each of the concepts and start to arrange them in sequential order. With Mindjet Connect, every group member can use the virtual canvas and discuss remarks and ideas. As the task group debriefs the brainstorming session, the chart can be circulated online and directly distributed to all members.

Once brain mapping comes to fore, one will soon realize that it the best means to coordinate ideas, productions and notestaking. One can access the documents even when they are away from PC or laptop using Mindjet Connect and Mindjet's free iPhone and iPad apps. Mindjet Connect also incorporates with Evernote, the lone 'capture-everything-remember-everything' note taking solutions. And for the virtual and wireless group constituent, the Map Once Access Anywhere solution is appealing.

SUMMARY

- Servers and software programs are very expensive.
- Buying assets is impractical for developers who may use it only for a couple of months to access the software.
- Integrated Development Environments (IDEs) comprise of source codes, automation experts and a debugger.

- Cloud IDEs, for example, koding.com, Cloud9 or eXo are all free. As they are in cloud it permits developers to conveniently edit and code anytime, anywhere.
- CloudBees boasts an IaaS solution called Run@Cloud, which presents all services required to establish in the cloud, free of charge.
- There are two routes that a vendor can take to develop a platform for cloud computing: cloud-first or tool-first.
- Cloud-first development method has distinct disadvantages. First, it places the data centre procedures business, and develops cloud environment.
- A tool-first method is much more straightforward. Start by conceiving a host development studio and manage the construction and check on the benchmark hardware.
- Even management is a process-intensive attempt. There's so much involved in organizing even a least significant event, the power of cloud computing can be taken advantage of.
- Cloud computing also takes event management from the agency to the event site.
- Some noteworthy applications of collaborating event management are (i) Event Planning and Workflow Management, (ii) Advance Registration, (iii) Payment Processing, (iv) Contact Management, (v) Budget Management, (vi) Post-Event Reporting and Analysis, (vii) 123 Signup, (viii) Acteva, (ix) Conference.com, (x) Event Wax, (xi) Tendenci.
- Contact management is the act of saving data of friends, family and business associates for retrieval at a future date.
- CRM software not only shares clientele communicate data, it also shares and analyses all data pertaining to a specific clientele and then values that data to assist you plan how best to communicate with that customer.
- Projects act as catalysts that play a crucial role in constructing 'a better tomorrow.'
- Mindjet Connect is a free collaboration platform that endows task groups to visually capture concepts and data, share documents and collaborate with others in real time or anytime.

KEY TERMS

- Integrated Development Environments (IDEs) comprise of source codes, automation builders and a debugger.
- CloudBees is a type of IaaS solution, which presents all services required to be established in the cloud free of charge.
- Cloud-first is a cloud development platform, where first a cloud platform is constructed and then development application is constructed.
- Tool-first is a cloud development platform, where development platform is constructed first that is host-friendly (e.g., studio sprints in a browser), then 'push' that platform into the cloud.

- Event management engages revising the intricacies, recognizing the target audience, developing the happening notion, designing the logistics and coordinating the mechanical facets before really commencing the event.
- A workflow administration system is a system that organizes and characterizes a sequence of jobs within an organization to make a final choice or outcomes.
- Workflow administration systems permit the client to characterize distinct workflows for distinct occupations or processes.
- A contact manager is a software program that enables users to effortlessly share, find and communicate data such as names, addresses and telephone numbers.
- CRM (Customer Relations Management) is a methodology that assists an enterprise to organize clientele connections in a coordinated fashion.
- Project management is the art of organizing all the facets of a task from inception to closure utilizing a technical methodology.
- Mindjet Connect is a free collaboration platform that enables work groups to visually capture concepts and data, share documents and collaborate with others in real time or anytime.

REVIEW QUESTIONS

- Define CRM.
- How is project management collaborated into cloud computing?
- State the importance of collaborating cloud with contact management system.
- How will it be useful if event management is collaborated with cloud computing.
- What are the ways to develop and deploy cloud?
- What are the collaborating event management applications?
- What is Mindjet Connect?
- What is called project management cloud?
- List out some PM clouds.
- What are the impacts of project management?
- State the impact of cloud computing in management and administrative services.

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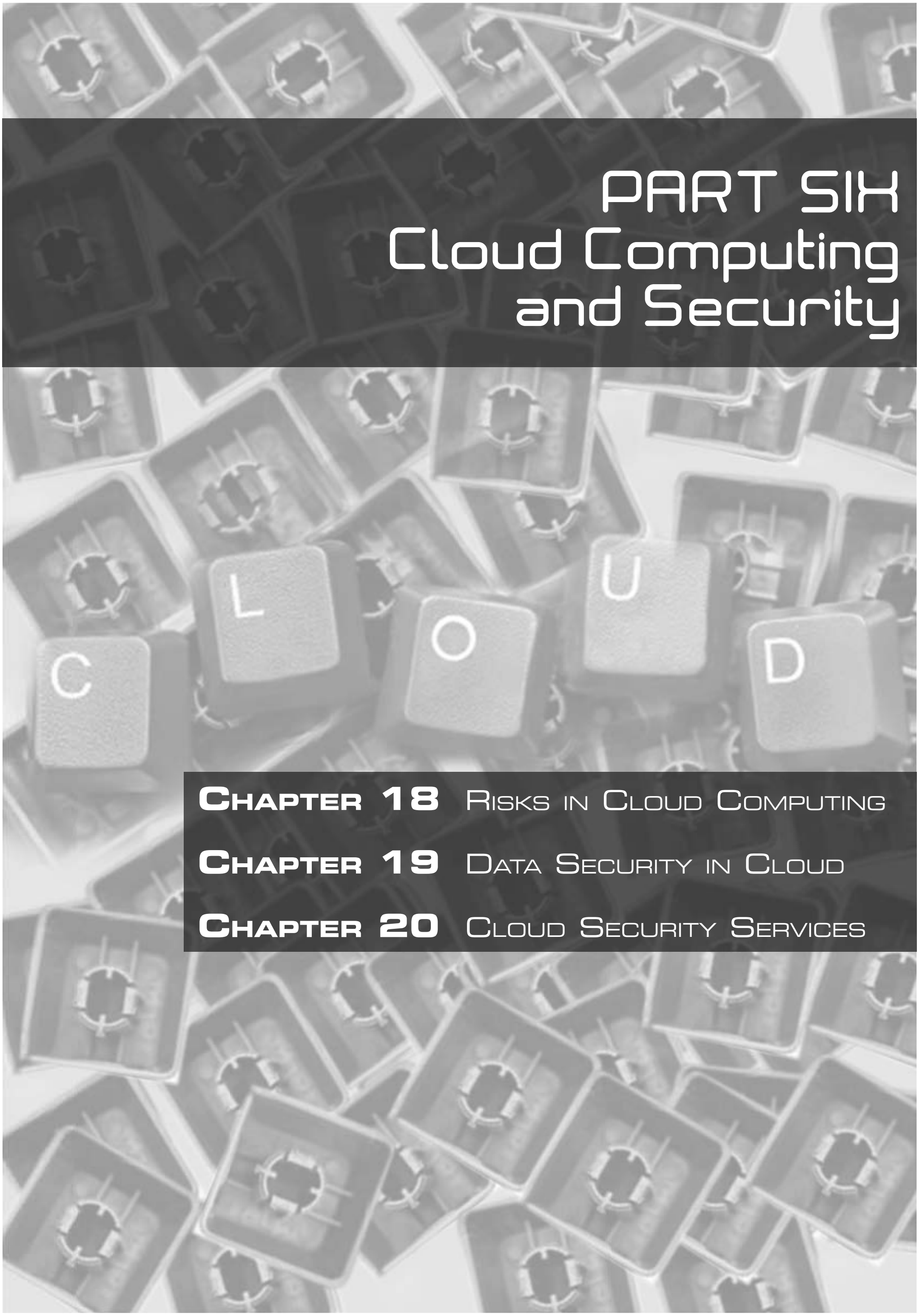

PART SIX
Cloud Computing and Security

CHAPTER 18

Risks in Cloud Computing

18.1 INTRODUCTION

Cloud computing is recognized as the most widely used computing paradigm for the last few years. It is currently a welcome change for the information and communications technology industry by modifying the means by which software programs and hardware are trusted and purchased. Its success is due to the key capabilities such as: (i) all computing desires are suggested as a service and (ii) the proficiency in dynamically providing computational resources. As of now, there are mainly two kinds of cloud providers:

1. Cloud Service Providers (CSP) or either SaaS or PaaS providers.
2. Cloud Infrastructure Providers (CIP) or IaaS providers.

Essentially, many of cloud computing forms have plans, each one proposing distinct characteristics or services, at distinct qualifications of flexibility and engaging distinct risks. The cloud computing embraces new technologies like virtualization; there are both risks to be determined and archived risks to be re-evaluated.

Together with rushing of the cloud computing paradigm, some new risks have appeared. The cloud community has to apparently recognize cloud-specific risks and re-evaluate accepted ones. Further, cloud services not just providers, should be the subject of risk administration and assessment. Risks in cloud environments should be advised at service, data and infrastructure layers. In numerous situations, grade of risk will alter considerably with the kind of cloud architecture. Moreover, it is likely for cloud clients to move some risks to external cloud providers.

The most significant risks presented by cloud computing are: SLAs violations, proficiency to amply consider risks of a cloud provider, blame to defend perceptive data, virtualization-related risks, lessening of direct command of assets and software programs, compliance risks and decreased reliability since service providers may proceed out of business.

On the contrary, there are some customary risks that should be re-evaluated. For example, the risk of network infringement is now more critical for cloud organizations since they are completely based on the network. Furthermore, other risks, for example, natural catastrophes, should be advised specially for double-checking high-availability of cloud services. In short, cloud computing entails that businesses, the users of IT services, can purchase their IT associated services as a service. Instead of buying servers for interior or external services, or buying software programs licenses, the organization can purchase them as a service. Hosting services have been around for some time, authorizing us to aim more on the enterprise rather on the IT infrastructure.

Imagine a large-scale vendor is trading their items through a web portal. They require access to servers and infrastructure to support the large-scale peaks in demand, but most of the time they can manage with lesser capacity. They start marveling if they *really* have to own numerous infrastructures which are not completely utilized most of the time. With a hosting service, the large-scale vendor could purchase the required infrastructure as a service, pay a monthly or annual charge and worry less about their infrastructure. They would purchase precisely the capacity they require, as they require it at peak times. With cloud computing, they would pay for a top quality service based on the usage.

There are some identified levels in cloud computing. The vendors in these levels have very distinct service offerings and functioning models. Some vendors focus on construction and sustaining a gigantic data centre, while others focus on constructing a user-friendly and feature-rich application. The levels, from base to peak, are: infrastructure, storage, platform, application, services and client.

Infrastructure: At the base is the infrastructure of the service or the platform virtualization. Users get the server environment as they want. This is the rudimentary proposal, still clients need to handle the server, all software programs installed and maintained on their own.

Storage: With the storage level, one can get a database or something similar and pay per gigabyte per month. A storage level is nothing new or exceptional, except for the full stack of services. There are some possibilities for storage. Examples are relational databases, Google's BigTable and Amazon's SimpleDB.

Platform: The platform level has solution stacks, for example, Ruby on Rails, LAMP or Python Django. A start-up organization need not deal with the setting up of server programs, or upgrade their versions, because that comes with the service. They can aim on evolving and trading their application.

Application: The application level comprises applications that are suggested as services. The most well-known demonstrations are Salesforce.com and Google Docs, but there are hundreds and thousands of genuine applications that can be bought as services.

Services: The services level comprises interoperable machine-to-machine procedures over the network. The most common examples of this level is web services. Other examples encompass payments schemes, for example, PayPal and mapping services such as Google Maps and Yahoo Maps.

Client: At the peak of the stack is the consumer level, which comprises the users of the cloud systems. Clients are, for example, desktop users and mobile users (Symbian, Android, iPhone). There are possibilities for vendors to exit and adapt new services, and for clients to find new services and applications to solve their problems.

However, there are some risks that clients need to understand. There are some points to address before taking up cloud-based services. Consumers should analyse if cloud-based services are right for their needs and which of the accessible services are right for them.

Make sure that there is a straightforward means to get your data out of the service. If you are utilizing an infrastructure service, endorsing up the documents and data should be somewhat easy. If you are utilizing a web application, be certain to have a design for taking your data with you in case you need to switch to another vendor.

If something goes wrong with the service provider, for example, if servers break down, the clientele cannot manage anything. For issues like this, it's better to select a service provider who caters similar sites.

The security methods and know-how of the vendor might be much better than those of a start-up. The topic is to address, who gets to oversee the data and what are the vendor's standards for this.

Understand what would occur to the data or to the application, if the vendor is compelled to close down. This contradictory aspect may be seldom cited in the trading materials. If exporting data is so straightforward, then the likely closed down of the vendor shouldn't be that harmful. Users would, however, face the difficulty of finding an apt new application or vendor for the enterprise needs.

Cloud computing is not just a tendency that might occur. It's a truth, usual web users opt cloud services every day whether they understand it or not. In future, everybody foresee that business services and applications will go in the direction of clouds. Naturally there are certain applications that organization would rather run in their own servers, but most of the business applications should be befitting for cloud computing.

Although cloud computing can offer small enterprises important cost-saving advantages, namely, pay-as-you-go access to complicated programs and mighty hardware, the service does come with certain security risks. While evaluating the promise of cloud-based service providers, one should hold these top five security anxieties in mind.

1. Secure data transfer
2. Secure programs interfaces
3. Secure retained data
4. User access to control
5. Data separation

18.1.1 Cloud Computing Risks

- *Risk #1—The solution may not meet its economic objectives*: Do the short-run and long-run ROI work. The key components to address when considering cloud ROI risk likelihood encompass utilization, speed, scale and quality. These components are constructed into most ROI forms and sway the headline numbers for buying into income, cost and time to return.
- *Risk #2—The solution may not work in the context of the client enterprise's association and culture*: The best way to address is having *a clear dream and main heading for enterprise transformation*, which encompasses top-level support. This should encompass the establishment of *a clear roadmap for procurement or implementation of cloud services and applications that use them and coordination of stakeholders and vying schemes to get agreement for storage, computing, mesh and applications to bypass isles of demand usage*.
- *Risk #3—The solution may be tough to evolve due to the adversity of incorporating the cloud services involved*: There is a risk which will not be probable to include in cloud services with the current system and with each other. The service integration risk can be considered by contemplating interface alteration cost, proficiency to change the existing system and available skills.
- *Risk #4—A catastrophe may occur from which the solution will not recover*: As part of a risk investigation, it should recognize the unplanned happenings that could damage and assess their probabilities and impacts. One may also wish to make general provision for unforeseen happenings that disturb the cloud services that use or impair the data.
- *Risk #5—System value may be insufficient, in order that it does not meet the users' needs*: The value of an external service can be considered utilizing the identical components *as for the value of the solution*. In addition, look at the track records of suppliers very carefully.
- *Risk #6—There may be an existing need for service orientation*: Not having full-fledged SOA isn't inevitably strategic in itself when opting for cloud. But the incompetence to precede methods from present interfaces and inherent applications to more agile cloud services could actually mess up things. Finally it will make cloud more costly than leaving things as it is.

18.2 RISK MANAGEMENT

Risk management is a significant part of business planning. The method of risk management is believed to reduce or eradicate the risk of certain types of happenings or having an influence on the business.

Risk management is a method for recognizing, considering and prioritizing risks of distinct kinds. Once the risks are recognized, the risk supervisor will conceive a design to minimize or eradicate the influence of contradictory events. There are several risk administration measures, encompassing those evolved by the Project Management Institute, the International Organization for Standardization (ISO), the National Institute of Science and Technology and societies.

There are numerous distinct kinds of risks that risk management designs can mitigate. Common risks encompass risks such as misfortunes in the workplace or blazes, tornadoes, earthquakes and other natural disasters. It can also encompass legal risks like deception, robbery and sexual harassment lawsuits. Risks can also concern to the organizational practices, doubt in economic markets, flops in tasks, borrowing risks, or the security and storage of data and records.

18.2.1 Risk Management in Cloud Computing

Google, Microsoft, IBM and all other renowned and unidentified cloud providers offer an array of foremost cost saving options to the customary data centre and IT department.

45% of IT professionals believe the risks far outweigh the advantages and only 10% of those reviewed said they would prefer going objective critical applications to the cloud. In a nutshell, ISACA's statistics and other commercial data around cloud adoption show that cloud computing is a mainstream alternative but decisively not the prime choice. While some organizations have effectively shifted part or all of their data assets into some pattern of cloud computing infrastructure, the majority are not left with much choice.

Cloud computing is somewhat new in its present pattern, granted that, it is best directed to reduce intermediate risk enterprise areas. Don't hesitate to inquire and if need be, enlist an unaligned conferring business to direct through the process. Selecting a cloud provider needs far more diligence than usual IT procurement. For this purpose, there is no clear cut template for success. The outcomes can be marvelous if the risks are well managed.

18.3 CLOUD IMPACT

18.3.1 Cloud's Impact on IT Operations

Cloud computing has provided possibilities for organizations of all types to reduce the risks affiliated to IT acquisition (software and hardware), in sync with enterprise desires and total costs. Some have even developed their interior IT department from a reactive data centre to a more proactive service consignment center. Over the past two or three years, the very identical cloud computing form consigned these advantages and also produced in numerous IT organizations evolving better concentrated on auditing, inspecting, reconsidering and modernizing their interior IT capabilities.

As cloud computing starts to mature and hybrid clouds start to verify their enterprise worth, organizations will aim more on taking up both public and personal cloud environments and having them possibly work seamlessly together. However, the large-scale hindrance these organizations have faced till date is their legacy systems.

18.4 ENTERPRISE WIDE RISK MANAGEMENT

Risk can be characterized as 'the likelihood of loss or wound, an unsafe component or component, or an exposure to hazard or danger'. It is very tough to consider any enterprise function, method, or undertaking that will not take advantage by methodically considering the risks that can have a contradictory influence on an enterprise's competitiveness and profitability.

Effectively organizing or commanding the origin of risk can have an effect in market authority: robust development, premium supply charges and investor confidence.

18.4.1 What is Risk Management?

Risk Management is the practice followed to avert as many errors as possible and devising fee procedures for the rest. Risk management is technical and set about considering the untainted risks faced by users and businesses. A risk supervisor is generally a highly trained person who makes risk management his/her full time job or the responsibilities may be dispersed within a risk management department.

Risk management is not just buying protection for a company. It also considers both insurable and uninsurable risks and an alternative method. The focus of risk administration is not getting the most protection for the money expended, but to reduce the cost of managing risk by adapting the most suitable means. Insurance thus occurs to be one of the many advances for minimizing untainted risks the firm faces. When the risk manager's function embraces untainted risk avoidance they spend their time in analyzing the following:

- Hazards, for example, blaze, tornado or hurricanes, robbery, piracy, vandalism and crime.
- Internal procedure exposures initiated by security and security practices, workers' reimbursement and worker dishonesty.

Traditional risk managers may not make conclusions on the basis of maximizing shareholder and most not even address their risks to investors. Investors do not pay for well-planned protection programs, but they pay for good risk management.

18.4.2 The Risk Management Process

Figure 18.1 displays the methods in risk management. The method comprises of six steps which either an expert or non-professional risk supervisor can chart to an organizations enterprise conclusions and business goals.

- *Step 1*: *Determination of the objectives* of the risk administration program, concluding accurately what the association anticipates its risk administration program to do. One prime target of the risk administration effort is to maintain the functioning effectiveness of the organization. The second target is the humanitarian aim of defending workers from misfortunes that might outcome in death or grave injury.

Figure 18.1 Six-step Risk Administration Process

- *Step 2*: The *identification of the risks* involves somebody being cognizant of the risks. The next tools or methods supply awareness:
  - Risk analysis questionnaires
  - Exposure checklists
  - Insurance policy checklists
  - Flowcharts
  - Analysis of financial statements
  - Other internal records
  - Inspections
  - Interviews
- *Step 3*: Once the risks are recognized, the risk supervisor should *evaluate the risks.* Evaluation entails assessing the promise dimensions of the reduction and the likelihood that it is probable to occur. The evaluation needs grading of main concerns as critical risks, significant or insignificant risks.
- *Step 4*: *Consideration of options and assortment of the risk remedy device*, examines diverse advances utilized to deal with risks and the assortment of the method that should be utilized for each one.
- *Step 5*: Risk financing means encompass risk-keeping and risk moving or risk shifting. Risk remedy apparatus are utilized in concluding which method to use to deal with a granted risk, the risk supervisor considers the dimensions of the promise decrease, its likelihood and the assets that would be accessible to meet the loss if it should occur.

The last step, *evaluation and reconsider* are absolutely crucial to the program for two reasons. Within the risk administration method the enterprise environment alterations, new risks originate and old ones disappear. Techniques befitting last year may have become obsolete this year and so constant attention to risk is required.

Enterprise Risk Management (ERM) in enterprise encompasses the procedures and methods utilized by organizations to organize risks and grab possibilities associated to the accomplishment of their objectives. ERM presents a structure for risk administration, which normally engages recognizing specific happenings or attenuating components applicable to the organization's objectives (risks and opportunities), considering them in times of prospect and magnitude of influence, working out for a solution and supervising progress. By recognizing and proactively speaking to risks and possibilities, enterprises defend and conceive worth for their stakeholders, encompassing proprietors, workers, clients, controllers and society in general.

18.5 TYPES OF RISKS IN CLOUD COMPUTING

Threat #1—Misuse and illicit use of cloud computing: Lawless individuals may take advantage of the befitting registration, straightforward methods and somewhat anonymous access to cloud services to launch diverse attacks. Examples of such attacks include: password and key breaking, DDOS, malicious data hosting, commencing dynamic strike points, botnet command/control and CAPTCHA-solving farms. Targets are IaaS, PaaS.

Threat #2—Insecure interfaces and APIs: Customers organize and combine with cloud services through interfaces or APIs. Providers should double-check that security is incorporated into their service forms, while users should be cognizant of security risks in the use, implementation, and administration and monitoring of such services. API dependencies, logging capabilities, inflexible access to controls, anonymous access, reusable passwords, clear-text authentication, transmission of content and improper authorizations are the example of such risks. Targets are IaaS, PaaS, SaaS.

Threat #3—Vicious insiders: Vicious insiders represent a larger risk in a cloud computing environment, since clients manage not have a clear outlook of provider principles and procedures. Vicious insiders can gain unauthorized access into organizations and their assets. Some risks encompass impairment, economic influence and decrease of productivity. Targets are IaaS, PaaS, SaaS.

Threat #4—Issues-related technology sharing: IaaS is based on distributed infrastructure, which is often not conceived to accommodate a multi-tenant architecture. Overlooked flaws have authorized visitors to gain unauthorized rights and/or leverage on the platform. Targets are IaaS.

Threat #5—Data loss or leakage: Compromised data may encompass (i) deleted or changed data without producing a backup, (ii) unlinking a record, (iii) decrease of an encoding key and (iv) unauthorized access to perceptive data. The likelihood of data compromise considerably rises in cloud computing, due to the architecture and operations. Examples of data loss/leakage include: (i) insufficient authentication, (ii) authorization, (iii) review (AAA) controls, (iv) inconsistent encryption, (v) inconsistent programs keys, (vi) operational flops, (vii) disposal challenges, (viii) risk of association, (xi) jurisdiction/political issues, (x) persistence and trials, (xi) data centre reliability and catastrophe recovery. Targets are IaaS, PaaS, SaaS.

Threat #6—Hijacking (Account/Service): Account or service hijacking is generally carried out with pilfered credentials. Such attacks encompass phishing, deception and exploitation of programs vulnerabilities. Using pilfered credentials, attackers can access critical localities of cloud computing services and compromise the confidentiality, integrity and accessibility (CIA) of such services. Examples of such attacks include eavesdropping on transactions/sensitive undertakings, manipulation of data, coming back with falsified data, redirection to illegitimate sites. Targets are IaaS, PaaS, SaaS.

Threat #7—Unknown Risk Profile: Cloud services signify that organizations are less engaged with hardware and software ownership and maintenance. Although this boasts important benefits, organizations should be cognizant that matters like internal security systems, security compliance, configuration hardening, patching, auditing and logging may be overlooked. Targets are IaaS, SaaS, PaaS.

18.5.1 Internal Security Risk

Cloud computing presents flexibility by outsourcing the services, but it also adds inherent risks of malicious insiders and abusive use of login access by an unauthorized person. The customer's security controls stay outdoors. The cloud security means and clientele has no command over the service provider's interior security control. This adds considerable risk where infiltration of any such sort can lead to a large deal of saving in economic, productive and/or brand depreciation.

18.5.2 External Security Risk

Cloud computing technologies can be utilized as a platform for commencing attacks, hosting Spam/Malware, programs exploits announcing and numerous other unethical purposes. Cloud computing service platform, particularly PaaS with its increased service portfolio and the self-determination, permits any individual to propagate their malicious intent. IaaS-based performances are also picking up tempo with PaaS. Cloud computing service providers commonly supply, literally, any individual with an authorized credit card to avail their services, therefore, unfastening broad horizon of users to facilitate from their platform pool of users, malicious hackers and crackers will not be filtered easily.

Cloud computing vendors supply APIs for clients to combine with and avail services. Customers utilizing these APIs are proposing much more aligned services to help their own clientele base. Cloud APIs with feeble authentication and access to command can jeopardize the confidentiality, integrity and accessibility of the pertaining customer. When the services are deployed, any vulnerability in the API can jeopardize the security issues for the users, because of malicious intents.

Account or service credentials if stolen can jeopardize the confidentiality, integrity and accessibility of the whole services connected with that account. It's just like giving the keys of all cloud assets to the attacker. Additionally, theft of cloud computing service can be used for collection of attacks which take illegal advantage of the user's cloud infrastructure as their beginning platform.

18.5.3 Data Protection Risk

Public cloud infrastructure constituents are normally not conceived for compartmentalization and are prone to vulnerabilities than can be exploited. There might be scenarios where an attacker tries to gain unauthorized access to or excessively use the assets which can sway the presentation of other client residing in the same location. One of the current cloud security matters is the need of encrypting designs which can dent the integrity of the data retained and absence of correct controls can make the data completely unusable.

In cloud computing, it's very tough to get forensic clues in case of a break because the data might be dispersed over numerous distinct hosts and data hubs and probably resides in a multi-tenant environment. Usually the applications established on cloud computing service models are conceived without data integrity and security, therefore, being left with vulnerabilities and security issues. Contractual support by the provider for enquiry on when and where the occurrence appeared is a mandatory clause in the SLA else a enterprise can be exposed to grave threats.

18.5.4 Data Loss

Cloud computing architecture presents larger trials in commanding and mitigating risks due to its exclusive structure and operational attributes. Data in the cloud is prone to numerous risks, for example, deletion of record, loss of encryption key and feeble encryption, corruption of data. Any association, large-scale or small, relies on data and trespassing by an unauthorized individual can have large-scale influence on the business.

There is a large-scale inquiry when it comes to geographical position of data in the cloud computing environment. The data can be retained on numerous severs, in distinct positions, probably distinct towns, even distinct homeland or continent. In case of a catastrophe, systems with no disaster recovery plan and no business continuity plan to double-check that the enterprise races ahead are most susceptible to failure. There might also be legislatures prescribing guidelines in retrieving data if the data is hosted in a distinct country. This can get tricky if there has been a break in or if an unauthorized person tampers with the data.

Stability of the cloud provider is not a security risk but it is a very intimidating risk if the provider is not financially steady enough to maintain the procedures as per the goals of the customer. A cloud computing provider if consumed up by an amalgamation can ring chimes for the confidentiality, integrity and accessibility of data. Absence of a recovery plan can produce a catastrophe or a entire shutdown can sway the procedures of the clientele until it's recovered. Any cloud computing provider with meager economic steadiness, need a back-up infrastructure. Long-term designs to support the desires of the clientele are a decisive risk for any objective-critical deployment.

SUMMARY

- Cloud computing is identified as the most widely used computing paradigm for the last few years. It's currently a true change for the Information and Communications Technology.
- There are mainly two kinds of cloud providers: Cloud Service Providers (CSP) and Cloud Infrastructure Providers (CIP).

- Levels in cloud computing are: infrastructure, storage, platform, application, services and client.
- When assessing with cloud service providers, these peak five security anxieties are to be checked: (i) secure data transfer, (ii) secure programs interfaces, (iii) secure retained data, (iv) user access to control and (v) data separation.
- The method of risk administration is to reduce or eradicate the risk of certain types of happenings or having an influence on the business.
- Cloud computing has made it possible for organizations of all types to reduce the risks affiliated with IT acquisition (software and hardware), elaborate in sync with enterprise desires and comprise costs.
- Risk can be defined as 'the likelihood of loss or wound, an unsafe component or component, or an exposure to hazard or danger'.
- Risk management process includes, (i) determination of objectives, (ii) identification of the risks, (iii) evaluation of the risks, (iv) consideration of alternatives and selection of risk treatment, (v) implement of the decision and (vi) evaluation and review.
- Enterprise Risk Management (ERM) encompasses the procedures and methods utilized by organizations to organize risks and grab opportunities to accomplish their objectives.
- Types of risks in cloud computing are (i) misuse and illicit use of cloud computing, (ii) insecure interfaces and APIs, (iii) vicious insiders, (iv) issues-related technology sharing, (v) data loss or leakage, (vi) hijacking (account/service) and (vii) unknown risk profile.
- Cloud computing has flexibility, as it outsources the services. This property adds risks, because of malicious intents who can make the unauthorized persons to login into the system.
- Cloud computing technologies can be utilized as a platform for commencing attacks, hosting spam/malware, programs exploits, and for numerous other unethical reasons.
- Cloud computing architecture presents larger trials in commanding and mitigating risks due to its exclusive structure and operational attributes.

KEY TERMS

- Cloud Service Providers (CSP) are those who provide services such as SaaS or PaaS.
- Cloud infrastructure providers (CIP) are those who provide infrastructure-oriented services.
- Risk management is a technical set about the difficulty of considering the untainted risks faced by users and businesses.
- Data loss is an error in information systems in which data is demolished by calamity or neglect in storage, transmission or processing.
- Data protection defines the processing of knowledge on identifiable vibrant people. It is a main legislation that governs the protection of data.

REVIEW QUESTIONS

- Define CSP and CIP.
- Write about a brief note of the two primary cloud providers.
- List some important risks in cloud computing.
- State the recognized layers in cloud computing.
- Write down the top five security concerns in cloud computing.
- List any four cloud computing risks.
- Define risk.
- What is risk management?
- State the job of a risk manager.
- State the six-step risk management process.

CHAPTER 19

Data Security in Cloud

19.1 INTRODUCTION

Cloud computing is a development that is intended to permit more open accessibility and simpler and advanced data sharing. Data is uploaded up on a cloud and retained in a data centre for access by users from the centre, or more so in a fully cloud-based model. The data itself are created in the cloud and stored and accessed from the cloud (via a data centre). The most conspicuous risk in this scenario concerns the storage of data.

Data security risks are aggregated by the open environment of cloud computing. Accessibility of data is the basic concern in cloud-based systems. If a system that presents improved accessibility and opens up the platform to multi-node access, then client should take into account the risks associated with this advancement. One way this can be done is by adding an element of control, in the pattern of access control, to pay for risk mitigation for a platform. Information-centric access can assist to balance advanced accessibility with risk, by associating access directions with distinct data residing inside an open and accessible platform, without mislaying the inherent usability of that platform. A farther environment of risk is affiliated not only with cloud computing, but also with network computing, i.e., the use of content after access. The risks are higher in a cloud network because data is stored at an external locations.

19.2 CURRENT STATE

In cloud computing environment, the inherent computing infrastructure is utilized only when it is needed. For example, in order to process a client demand, a service provider can draw the essential assets on-demand, present a specific job and then relinquish the unwanted assets and often dispose them after the job is done. Contrary to customary computing paradigms, in a cloud computing environment, data and application are controlled by the service provider. This leads to a natural anxiety about data security and also its protection from internal as well as external threats. Inspite of this, benefits like on-demand infrastructure, pay as you precede, decreased cost of maintenance, elastic scaling, etc., are convincing enough for enterprises to finalize on cloud computing environments.

Generally, in cloud computing model, data storage and computation are offered in a single datacentre. There can be diverse security guaranteed benefits in utilizing a cloud computing environment. However, a single point of malfunction will not be presumed for any data loss. Compared to a customary in house computing, it might be difficult to track the security checks in a cloud computing environment.

19.2.1 Security Issues and Challenges

IaaS, PaaS and SaaS are three general forms of cloud computing. Each of these forms has different influences on application security, whereas in a normal situation where an application is deployed in a cloud, two broad security studies occur; they are:

- How is data protected?
- How is code protected?

Cloud computing environment is usually presumed to be economical as well as provides higher service quality. Security, availability and reliability are the foremost values of cloud service users.

19.2.2 Security Advantages in Cloud Environments

Current cloud service providers function as very large systems. They have complicated methods and professional staff for sustaining their systems, which small enterprises may not have control over. As an outcome, there are numerous direct and indirect security benefits for the cloud users. Some of the key security benefits of a cloud computing environment are as follows:

- *Data centralization*: In a cloud atmosphere, the service provider takes responsibility of storage and small organizations need not spend more money for personal storage devices. Also, cloud-based storage provides a method to centralize the data much faster and probably with low cost.
- *Incident response*: IaaS providers contribute dedicated legal server which can be used on demand. Whenever there is a violation of the security policy, the server can be intimated through online.
- When there is an inquest, a backup of the environment can be effortlessly made and put up on the cloud without affecting the usual course of business.
- *Forensic image verification time*: Some cloud storage implementations reveal a cryptographic ascertain addition or hash. For example, MD5 hash function is developed automatically by Amazon S3 during object storage. Therefore in principle, the time to develop MD5 checkups utilizing external devices is eliminated.
- *Logging*: In a usual computing paradigm by and large, logging is regular feature. In general, insufficient computer disk space is assigned that makes logging either non-existent or minimal. However, in a cloud, storage requirement for benchmark logs is mechanically solved.

19.2.3 Security Disadvantages in Cloud Environments

In spite of security features, cloud computing adds some key security issues. Some of these key security challenges are summarized as follows:

- *Investigation*: Investigating an illegal undertaking may be unrealistic in cloud environments. Cloud services are particularly hard to enquire, because data for multiple clients may be co-located and may also be dispersed over multiple datacentres. Users have little information about the mesh topology of the inherent environment. Service provider may also enforce limits on the network security of the users.
- *Data segregation*: Data in the cloud is normally in a distributed simultaneously with data from other customers. Encryption will not be presumed as the single solution for data segregation issues. Some clients may not desire to encrypt data because there may be a case when encryption misleads can decimate the data.
- *Long-term viability*: Service providers should double-check the data security in altering enterprise positions, such as mergers and acquisitions. Customers should double-check

data accessibility in these situations. Service provider should furthermore confirm data security in contradictory situations such as extended outage, etc.

- *Compromised servers*: In a cloud computing environment, users do not even have an alternative of utilizing personal acquisition toolkit. In a situation where a server is compromised, they require to shut their servers down until they get a backup of the data. This will further create source accessibility concerns.
- *Regulatory compliance*: Traditional service providers are exempted from outside audits and security certifications. If a cloud service provider does not adhere to these security audits, then it directs to a conspicuous decline in clientele trust.
- *Recovery*: Cloud service providers should double-check the data security in natural and man-made disasters. Generally, data is duplicated over multiple sites. However, in the case of any such redundant happenings, provider should do an absolute and fast restoration.

19.3 HOMO SAPIENS AND DIGITAL INFORMATION

Cloud computing bestows individuals and organizations a much more fluid and open means of broadcasting information. This is an affirmative step to proceed in connection expertise, because it presents a means by which data is broadcast between individuals and groups.

If the data is perceptive, it perhaps is kept confidential or, if is in theoretical form, passed only to authorized persons to view. The outcome is that human-to-human data connection will be in a very fluid form. Cloud computing is a platform for conceiving the digital matching of this form, human-to-human data flow, which is a sure thing that internal computing systems have not achieved so far. Cloud computing can be perceived as a revolutionary technology to enhance the human communications. Security system conceive, in specific, can benefit from this inherent information, because this kind of system is constructed both to foil deceptive endeavours to intercept connection and to enhance and endow protected and trusted communications.

19.4 CLOUD, DIGITAL PERSONA AND DATA SECURITY

The expertise has changed spectacularly over the last 10 years. In fiscal times like these, premier businesses are looking for cloud computing platforms to consign enterprise purposes extending from packaged organization applications to customer-made order application development in a short time and budget of customary on-premises platforms. With this development of cloud computing, arrives a corresponding boost in responsibility to defend perceptive data in the cloud. For numerous business enterprises, the crucial inquiries about security, privacy, compliance and control of business data remain unanswered. According to a survey, security is the largest obstacle to cloud adoption, followed by lawful, compliance and privacy issues.

Data should be protected, irrespective of it being accomplished on a desktop, a network propel, an isolated laptop or in a cloud. We require recalling certain things about data and human beings. Data are most often information that desires to be utilized and it may be unfinished and need to be passed through some hands for collaboration and completion. It may also be part of a complicated workflow, over multiple article administration systems, employed on platforms that traverse the desktop and cloud domain.

One of the other facets of data security that is required to consider for data in the cloud is the levels required, that is, how is data to be protected? The levels of security of any data should be considered as concentrated levels of progressively omnipresent security, which are broken down into components to display the expanding granularity of this pervasiveness:

- *Level 1*: Transmission of the document utilizing encryption protocols
- *Level 2*: Access control to the document itself, but without encryption of the content
- *Level 3*: Access control (including encryption of the content of a data object)
- *Level 4*: Access control (including encryption of the content of a data object) also encompassing privileged administration choices

Other choices that can be constituted in protecting data could contain watermarking or red-acting of content, but these would arrive under Level 4 as added options.

The current state of cloud computing presents number of cloud deployment models, for example, public, private, organized and hybrid. Especially in the early years of cloud computing, the organization used a mixture of some and distinct models. To permit an organization to deal with protecting data within any of these kinds of systems, states that the issues of interoperability, cross-cloud support, minimization of human mistake and persistence of security are crucial.

Salesforce.com is the foremost in enterprise cloud computing, with more than 12 years of know-how in all aspects of services from infrastructure scalability to accessibility, principles and procedures. An increasing number of enterprises rely on Force.com cloud computing platform to provide critical enterprise applications in large part because of a combination its native security characteristics and solutions that permit enterprises to outsource their internal security controls to Force.com data.

The terms security, privacy and trust are interlinked, but they have different meaning, when used in computing environment. Security means a computing system's level of resistance to threats. Privacy is a key concern of digital assemblage, storage and sharing of data, and data encompassing the transparency of such practices.

With an on-premises computing system, organizations will have prime command over the environment that is deployed and run. In the cloud scenario, some of the associated jobs and conclusions are delegated to salesforce.com. Delegation does not exempt the enterprises from organizing risk and compliance or verification of compliance to the beneficiaries. In detail, cloud providers usually exclude themselves from compliance responsibility in their SLAs.

Users can get control over Force.com only after ensuring authentication. Users are furnished with a single form or sign-in sheet to go in their credentials. After authentication, users sign in and they get access to any Force.com encompassing their own applications such as Salesforce CRM, Portals, Sites, VisualForce pages without re-authentication.

Administrators are capable of resetting a single or bulk client passwords, as well as resetting of password upon expiration (forcing the client to reset their password after a certain period), password lockout (refusing to give access to an account if an incorrect password is tried too many times) and requirements for extent and complexity of new passwords.

When an organization enforces IP address limits and an attachment originates from an unidentified source, Force.com refutes the attachment, therefore assisting to protect data from unauthorized control and 'phishing' attacks.

Many organizations use one time sign-in method to make things simpler and regulate client authentication over a collection of applications. Force.com carries two single sign-on options:

1. *Federated authentication*: Uses benchmark protocols to broadcast between the organization and the Force.com platform for authentication purposes. The organization configures the platform to use SAML (Security Assertion Markup Language).
2. *Delegated authentication*: Enables an organization to incorporate Force.com cloud applications with an alternative authentication procedure, for example, an LDAP (Lightweight Directory Access Protocol) service or authentication utilizing a token rather than a password. The delegated administration can be set up to validate users in three distinct combinations:
   (i) *Password validation*: Username and password are validated contrary to the delegated administration rather than of the interior Salesforce password store.
   (ii) *Token validation*: Users should first authenticate to their enterprise and the enterprise in turn should conceive a Salesforce by dispatching (via HTTP POST) the username and a token to Salesforce for validation by the delegated authority.
   (iii) *Hybrid model*: While accessing the Salesforce website, users are required to use token validation, but they are permitted to validate using password validation on a consumer application.

Two prime mechanisms for client access to assets on the Force.com platform are: client profiles and sharing rules.

1. *User profiles*: Users access is controlled by an organization by customizing user profiles. Among users, organizations can control users by using field-level security.
2. *Sharing rules*: Sharing rules permit for exceptions to organization-wide default settings. It encourages the users to access the records that they don't own. Sharing rules can be based on the record or on standards in the record.

19.5 CONTENT LEVEL SECURITY (CLS)

Content level application of data security authorizes you to double-check that all four levels can be contacted by a single architecture, rather than of multiple models of operations which can cause interoperability and can add extra components of human mistake, foremost to reduce of security.

CLS was evolved to meet the marketplace demand and propelled by the demands of purchaser institutions. Content level security endows organizations to organize data and content at the organizational level, other than at the institutional level. CLS presents the proficiency to outlook, edit and delete data based on client functions and permissions for both application-level security and content-level security. The new functionality presents users with content that is applicable to them, decreasing the need for applications to run on multiple servers and permitting applications to assist different organizations inside the institution.

The CLS solution can be rolled out over an unlimited number of distinct partitions and agencies, with each organization sustaining a concentrated outlook over all of its pertinent functions. Other advantages include increased usability aimed at content, new functionality that advances effectiveness and decreases mistakes and reduction in overhead cost with unlimited number of permitted users.

SUMMARY

- Cloud computing is a development that is intended to permit more open accessibility and simpler and advanced data sharing.
- Data is uploaded upon a cloud and retained in a data centre for access by users from that data centre, or in a fully cloud-based model.
- Access becomes much more basic concern in cloud-based schemes because of the accessibility of the data.
- Information-centric access can assist to balance advanced accessibility with risk, by associating access directions with distinct data residing, without mislaying the inherent usability of that platform.
- Contrary to customary computing paradigms, in a cloud computing environment, data and application are controlled by the service provider.
- IaaS, PaaS and SaaS are three general forms of cloud computing. Each of these forms have distinct influence on application security.
- Cloud computing environment is usually presumed as a reasonable solution as well as provider of higher service quality.
- Security, availability and reliability are the foremost value anxieties of cloud service users.
- Key security benefits of a cloud computing environment are (i) data centralization, (ii) incident response, (iii) forensic image verification time and (iv) logging.
- Key security issues are (i) investigation, (ii) data segregation, (iii) long-term viability, (iv) compromised servers, (v) regulatory compliance, (vi) recovery.
- Cloud computing boasts private and organization a much more fluid and opens way of broadcasting information.
- Cloud computing is a platform for conceiving the digital matching of this fluid, human-to-human data flow, which is a sure thing that internal computing systems have not yet achieved.
- In the context of computing, the terms security, privacy and trust may seem one and same but have distinct meanings.
- CLS evolved to meet the marketplace demands and propelled by the wishes of customer institutions.
- Content level security endows organizations to organize data and content at the organizational level, rather than at the institutional level.

KEY TERMS

- *Data centralization in a cloud atmosphere*: the service providers take responsibility of storage and small organizations need not spend more for personal storage devices.
- *Forensic image verification time*: Some cloud storage implementations reveal a cryptographic ascertain addition or hash.

- *Data segregation*: Data in the cloud is normally shared simultaneously with other customers.
- *Federated authentication*: Uses benchmark protocols to broadcast between the organization and the Force.com platform for authentication purposes.
- *Delegated authentication*: Enables an organization to incorporate Force.com cloud applications with an authentication procedure of alternative.
- Content level security endows organizations to organize data and content at the organizational level, rather than at the institutional level.

REVIEW QUESTIONS

- List the levels of security for data object.
- State the key security challenges in cloud environments.
- State and brief combinations of delegated authentication.
- List any five threats in cloud computing.
- What are the quality concerns in cloud computing?
- What is federated authentication?
- State the use of CLS.
- Define CLS.

CHAPTER 20

Cloud Security Services

20.1 OBJECTIVES

Cloud computing has become a foremost development in IT. Enterprises should adapt to the changes it brings to maximize the return on investment. To assist organizations worldwide to get the most from the cloud, Information System Audit and Control Association (ISACA) handed out a new directive explaining how to apply productive controls and governance for cloud computing.

According to the ISACA, when enterprises decide to use cloud computing for IT services, its operational methods are affected and governance becomes critical to:

- Effectively organize risk
- Ensure continuity of critical organizational methods that continue after the data centre
- Speak enterprise objectives internally and to third parties clearly
- Adapt competently
- Facilitate continuity of IT information, which is absolutely crucial to maintain and augment the enterprise
- Handle myriad regulations

The directive states that enterprises should look into the key inquiries for correctness in governance of cloud computing:

- What is the enterprise's anticipated availability?
- How the identity and access are organized in the cloud?
- Where will the enterprise's data be located?
- What are the cloud service provider's catastrophe recovery capabilities?
- How is the security of the enterprise's data managed?
- How is the entire scheme defended from Internet threats?
- How are undertakings supervised and audited?
- What kind of certification or promises can the enterprise anticipate from the provider?

20.2 CONFIDENTIALITY, INTEGRITY AND AVAILABILITY

We may have heard of data security where experts mentioning 'CIA'. CIA is a broadly utilized standard for evaluation of data systems security, focusing on the three centre goals of confidentiality, integrity and availability of information.

20.2.1 Data Confidentiality

Confidentiality refers to limiting data access only to authorized users, and stopping access to unauthorized ones. Underpinning the aim of confidentiality are authentication procedures like user-IDs and passwords that exclusively recognize a data system's users and supporting procedures that restrict each recognized user's get access to the data system's resources. Confidentiality is associated to the broader notion of data privacy limiting access to individual's information.

Confidentiality double-checks that data is accessible only to those authorized persons, in spite of where the data is retained or how it is accessed. Each employee of an organization has the responsibility to sustain the confidentiality of the data entrusted to them for job presentation and this responsibility should be strengthened through awareness. Following are some confidentiality topics that double-check an agreeable level of information is imparted upon employees of the organization.

- *Access control*: Access control is the means utilized for controlling which assets a client can get access to and the jobs which can be presented with the accessed resources.
- *Passwords*: Passwords are a basic component of network security. An intruder in the organization's confidential locality may check under keyboards and in drawers to find passwords that may have been in written down and then use it to gain access to personal information. Password protection can be augmented by added security systems such smart cards and biometric identification systems.
- *Biometrics*: Biometric expertise can recognize persons based on the individual characteristics like human body parts. The prime biometric technologies in use are retina scanning, facial recognition, voice recognition and fingerprint scanning. A sample is submitted by a client demanding to get access in evaluating with database for a match to get access permissions. Biometric data is tough to replicate and when utilized in conjunction with other access procedures, for example, passwords and badges make a very good protecting as against unauthorized access to organizational resources.
- *Encryption*: Encryption is any method that converts readable (plain text) data into mystery cipher (cipher text) to avert unauthorized access of information which is used in Internet transactions, e-mail and wireless networking. An encryption algorithm is a mathematical technique which changes the data to unreadable data by unauthorized parties. Encryption is the basis of protecting systems, communications schemes and online transactions. Employees should utilize encryption when likely to double-check its security.
- *Privacy*: Privacy is the upkeep of confidential or individual data from being viewed by unauthorized parties and the command over its assemblage, usage and distribution. The privacy and confidentiality can be utilized interchangeably.
- *Ethics*: Employees should be granted clear direction by principle, on what the organization considers agreeable demeanour and should furthermore be acquainted with the methods in location for clarification of ethical anxieties and for revelation of unethical activities.

20.2.2 Data Integrity

Data integrity is characterized as safeguarding the correctness and completeness of data and processing procedures from intentional, unauthorized or unintentional changes. Maintaining data integrity is absolutely crucial to the privacy, security and reliability of enterprise data. Integrity of data can be compromised by malicious users, hackers, programs mistakes, computer virus, hardware constituent flops and by human mistake while moving data. Mitigating data integrity risk can be there for fast recovery of data. Employees can mitigate risk by normal data backups and off-site protected storage of backup, supervising integrity devices and encryption. Integrity means trustworthiness of data resources.

20.2.3 Data Availability

Availability means, availability of data resources. A data system that is not accessible when required is not good. It may be calculated on how reliant the institute has become on carrying out a computer and communications infrastructure. Almost all premier organizations are highly reliant on functioning data systems. Availability, like other facets of security, may be solely influenced by technical matters such as natural phenomena or human causes. While the relation risks affiliated with these classes count on the specific context, the general is that humans are the weakest link.

Availability is double-checking that the authorized users have access to data and affiliated assets when required. This can be carried out by utilizing data backup, catastrophe recovery and enterprise continuity/recovery plans. Employees should have knowledge about their responsibilities as it concerns data backups, catastrophe recovery and enterprise continuity.

Data Backup Plan

Data backups are an absolutely crucial part of data security and an organization should be adept to refurbish data in the happening of data corruption or hardware failure. Backups should be completed on a normal basis and the frequency depends upon how much data an organization is agreeable to lose in the event of loss. Backups should also be occasionally refurbished to check systems that should double-check that the method are functioning correctly inside the particular time limit before the requirement for the backup really arises.

Disaster Recovery Plan (DRP)

A DRP is a design that is utilized to retrieve rapidly after a catastrophe with a smallest of influence to the organization. DR designing should be part of the primary stage of applying IT systems. DR designs are evolved in answering to risk evaluations and conceived to mitigate those risks. Risk evaluations work out the frequency and span of promise disasters. This will permit an organization to conclude which technologies to apply to accomplish a befitting grade of recovery.

20.3 SECURITY AUTHORIZATION CHALLENGES IN THE CLOUD

Authorization entails for double-checking that only authorized *persons* are able to get access to *resources* within a system. In an effort to carry out authorization, the first step is to authenticate the individual, the second step is to get information about the individual and the last step is to permit or refute access to the individual based on the applicable principles for that resource.

An authorization service is responsible for assessing an authorization query, assembling essential data about the individual and the asset and assessing a principle to work out if the access to should be conceded or denied. Cloud computing is not a single capability, but an assemblage absolutely of crucial characteristics that are manifested through diverse kinds of expertise deployment and service models.

20.3.1 Auditing

The use of cloud computing is quickly catching all over the world at an astonishing stride because of its substantial advantages in decreased cost of IT services by deploying them over the Internet. Possible benefits are rather obvious:

- Ability to reduce capital expenditure.
- Share the services double-checking often apparently unlimited scalability.
- The proficiency to dial up usage or pay as you use when needed.
- Reduce IT associated costs and thereby enhance comparable benefit along the base line.

In a usual cloud service form, External Service Provider (ESP) boasts diverse IT services to the enterprise, counting on the SLAs and assortment of services.

20.3.2 Risk Administration

Though cloud computing services have exclusive benefits, there are critical matters pertaining to confidentiality, data integrity, security, accessibility, catastrophe preparedness, levy significances and other risks. Most of these challenges originate out of loss of physical control over IT assets and services. Major flops, for example, Amazon Web Services are due to shattering of redundant power system and loss of data.

20.4 SECURE CLOUD SOFTWARE REQUIREMENTS

When enterprises take up cloud computing and establish databases in virtual environments, they run the risk of revealing highly-sensitive data to internal and external attacks. The outsourced environment of the cloud and the inherent loss of control proceeds along and hence perceptive data should be mindfully supervised to double-check that it is inherently protected. To farther complicate things, ensuring double-checks that the cloud computing vendor's database managers and system managers aren't mishandling their privileges by inappropriately making a duplicate or examining secret records is important.

These are the obstacles that an industry should overcome while establishing a secured database platform in a cloud computing atmosphere. These obstacles solely may avert some organizations from drifting from their on-premises approach.

20.4.1 Monitoring a Constantly Changing Environment

Virtualization and cloud computing lend larger flexibility and effectiveness by giving you the proficiency to proceed servers and add or eliminate assets as required in alignment to maximize the use of systems and reduced expenses. This often entails that the database server's lodgings perceptive data are certainly being provisioned and de-provisioned, with each of these instances comprising a potential goal for hackers. The dynamic environment of a cloud infrastructure makes supervising data access to much more difficult.

In a multifarious environment, it will not always be possible to reboot when you require establishing, improvement or revise the agencies and the cloud vendor may put limitations on setting up of programs needing certain privileges.

Many present database monitoring solutions utilize a network sniffing form to recognize malicious queries, an approach that is easily not feasible in cloud environments where the network is vitally the entire Internet.

20.5 SECURE CLOUD SOFTWARE TESTING

The cloud pledges to conceive new possibilities for enterprise developers as well as for suppliers proposing services and devices for this new paradigm.

Testing all the levels from the submission to the cloud service provider appears that the tester will have to become effective in program testing. According to a market study from IDC, expending on IT cloud services is to be anticipated to augment almost threefold, i.e., to $42 billion by 2013. Cloud computing will furthermore account for 25% of IT expending development in 2012 and almost a third of the IT expending development in 2013.

Cloud services, as asserted by the market study firm IDC, are 'consumer and enterprise goods, services and solutions that are consigned and spent in real-time over the Internet.' In comparison, cloud computing as characterized by IDC is the infrastructure or 'stack' for development and deployment that endows the 'real-time consignment of goods, services and solutions over the Internet.'

20.5.1 Reducing Testing Costs

Soasta Inc. has an increased group of clients that don't have their own servers and do everything in the cloud; the majority is still more customary, as they use organized service providers and are dabbling in the cloud. However, cloud-based testing is a means for organizations to discover the cloud and reduce the charges of testing at the identical time.

Traditional clients see testing as a cash pit. They are looking for modes to decrease costs. The major contention for cloud computing for the enterprise is it dependable enough? This is not so for testing. Testing (in the cloud) just replicates the real world and it doesn't have the matters affiliated with output, but it has the advantages of cost reduction.

With cloud computing, testers have accessibility and affordability to tremendous allowances of computing power, which is required in testing. The concept of being able to provision 125 servers in 5–8 minutes and only pay for the hours we check is so compelling and there is no longer to have large testing labs for checking web applications.

Soasta's CloudTest, for example, is accessible as an on-demand virtual testing lab in the cloud or as an appliance. It supports performance, presentation, purpose and Web UI/Ajax testing. With applications that run on the cloud, we need to check network performance, server performance, database performance, software performance on the application and how it is cached to the client.

20.5.2 Software Testing Tools to Test Cloud Computing Applications

New open source testing tools are appearing everyday, which establish, organize and test the latest cloud computing software applications.

With its dynamic scalability, flexibility and virtualized assets supplied as a service; cloud computing is seen as the dawn of a new era for application services and has obtained its equitable share of plaudits. With Google Documents, Flickr, Buzzword and Zoho as examples of general purposeful applications that use cloud computing technology it is only a matter of time before coud computing is seen as the most viable option for application development and deployment.

Microsoft, Google and Amazon all contend for a place in the cloud computing space. Users can anticipate a surplus of cloud-based software applications that are available.

Cloud tools are a set of tools for establishing, organizing and testing Java EE applications on elastic computing cloud owned by Amazon which contains three major parts, which encompasses appliance images that can be modeled to run on Tomcat server and Maven & Grails plug-in.

PushToTest TestMaker is a distributed testing environment that can run tests on test gear, or in a cloud computing environment. It supports self-acting cloud testing services.

Cloud Tools and PushToTest are the test makers which comprises of products that will help the future of robust cloud-based software testing functions. Though the expertise is in its infancy, several testing tools are appearing that can supply aid in cloud-based software testing.

Visit Tester Tools for open source software testing tools and scripts encompassing a dedicated cloud computing testing tools that showcases the newest cloud computing software testing tools.

Cloud computing is the newest large-scale application to strike the IT companies and it is beginning to make swell on the software testing services front. While the uptake on the part of performance testing outfits has been slower than one might have anticipated, there is a stepwise action in the software testing businesses companies in the direction of cloud computing: a action that examines on the value of a seismic move as more and more software testing professionals start to realize how cloud computing could advantage them in periods of advantage and results.

Software testing companies no longer have to integrate large infrastructure charges into their yearly budgets. Cloud computing removes all responsibilities to prepare and upkeep that turn out to be the enterprise of the cloud vendor. The client jumps up into the cloud to manage software testing and performance testing jobs: the upkeep, setup and upkeep charges devolve to the proprietor of the cloud.

Software testing companies and performance testing outfits utilizing cloud computing are capable of offering an unlimited variety of services and testing programs without having to pay for any of them. Everything required is right there in the cloud and it is all somebody else's responsibility. Software testing services use cloud computing, because it makes better sense in terms of cash, advocating, proficiency and response.

SUMMARY

- ❖ Cloud computing has become a foremost technology development in IT. Enterprises started adopting it because of the changes it does to maximize the return on investment.
- ❖ Confidentiality refers to limiting data access only to authorized users, and stopping access to unauthorized ones.
- ❖ Confidentiality double-checks that the data is accessible only to those authorized to have access, despite of where the data is retained or how it is accessed.
- ❖ Maintaining data integrity is absolutely crucial to the privacy, security and reliability of enterprise data.

- Integrity of data can be compromised by malicious users, hackers, programs mistakes, computer virus, hardware constituent errors and by human error while moving data.
- Availability option is double-checking that the authorized users have got access to data.
- Data backups are an absolutely crucial part of data security and an organization should be able to refurbish data when there is data corruption or hardware failure.
- Virtualization and cloud computing lend larger flexibility and effectiveness by giving you the proficiency to proceed servers and add or eliminate assets as required to maximize the use of systems and reduce expenses.
- Testing all the levels from the application to the cloud service provider appears that the tester will have to become effective in program testing.
- Cloud-based testing is a means for organizations to discover the cloud and lower the charges of testing at the same time.
- Cloud tools are a set of tools for establishing, organizing and testing Java EE applications on elastic computing cloud owned by Amazon.
- PushToTest Test Maker is a distributed testing environment that can run tests on test gear or in a cloud computing environment.
- Cloud computing is the newest large-scale system to strike the IT companies and it is beginning to make swell on the software testing services front.
- Software testing companies no longer have to integrate large infrastructure charges into their yearly budgets. Cloud computing reduces all responsibilities to prepare and upkeep that turns out to be the responsibility of the cloud vendor.

KEY TERMS

- Confidentiality refers to limiting data access only to authorized users, and stopping access to unauthorized ones.
- Encryption is a method that converts readable (plain text) data into mystery cipher (cipher text) to avert unauthorized access of information.
- Privacy is the avoidance of secret or individual data from being examined by unauthorized parties and the command over its assemblage, usage and distribution.
- Data integrity is characterized as safeguarding the correctness and completeness of data and processing procedures from intentional, unauthorized or unintentional changes.
- DRP is a design that is utilized to retrieve rapidly after a catastrophe with a smallest of liability to the organization.
- Authorization entails for double-checking that only authorized persons are adept to get access to resources within a system.
- Cloud tools are a set of tools for establishing, organizing and testing Java EE applications on elastic computing cloud owned by Amazon.
- PushToTest TestMaker is a distributed testing environment that can run tests on test gear or in a cloud computing environment.

REVIEW QUESTIONS

- List any four questions for proper governance of cloud computing.
- Define CIA.
- What are the means of implementing confidentiality?
- State the importance of encryption and decryption on data.
- Define data integrity.
- How can data backup plays a vital role in data security?
- What is DRP?
- Define authorization.
- How does cloud computing reduce software testing costs?

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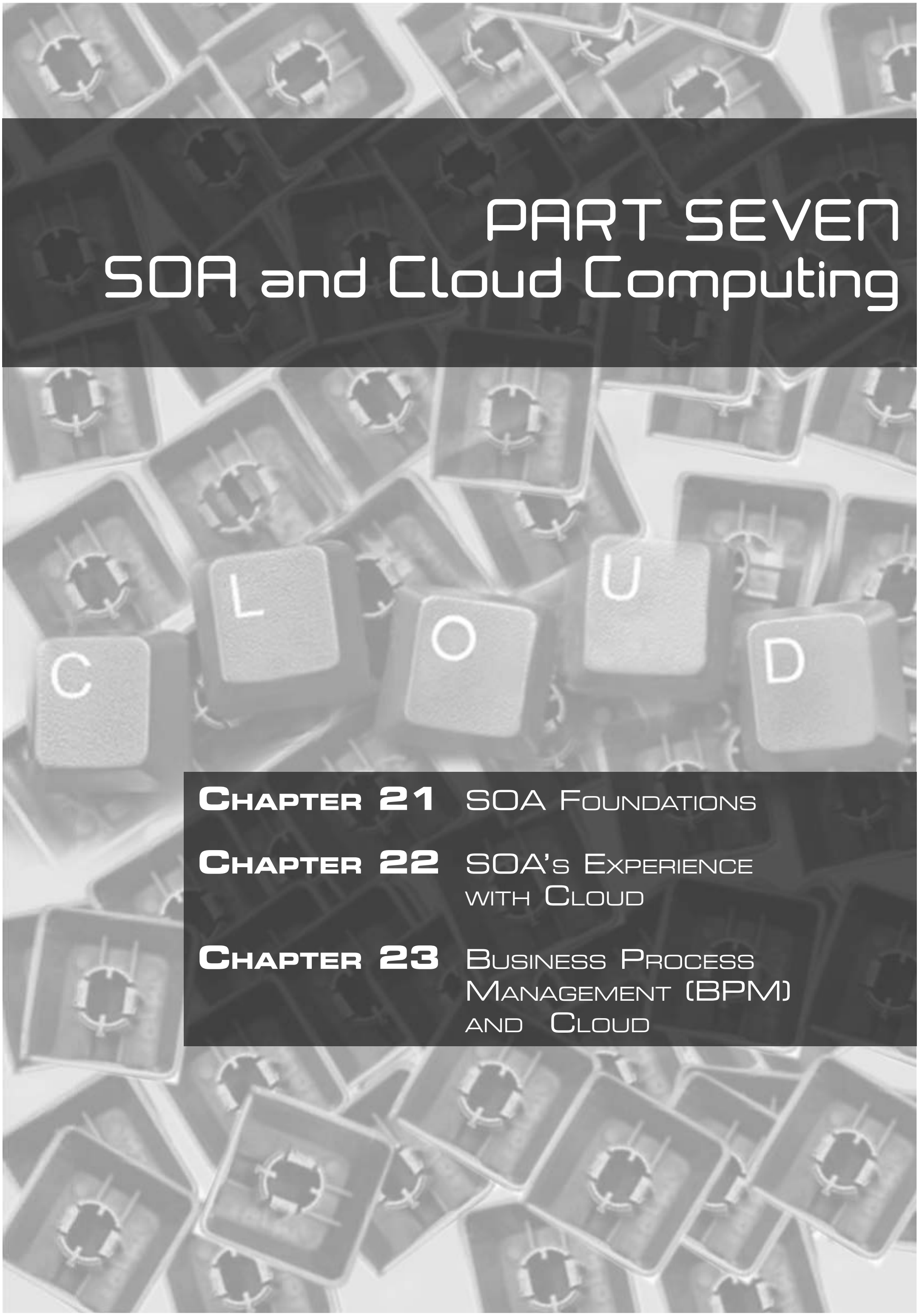
PART SEVEN
SOA and Cloud Computing



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CHAPTER 21

SOA Foundations

21.1 INTRODUCTION

Any IT organization comprises of numerous distinct components, each of which assists identically in the direction of enterprise requirements of an IT organization. Each of these components has exact obligations, for example, systems, networks, applications, data, services, methods, databases, repositories, warehouses and migrations. The major change that IT is actually undergoing is the move to Service Orientation (SO) which is absolutely based on open standard-based computing.

For this Service-Oriented world to become a truth, however, businesses should proceed to a new architecture renowned as Service-Oriented Architecture (SOA). SOA is an architecture that comprises software functionality as discoverable services on the network. Architectural delineation of an SOA can be 'an application architecture within which all purposes are characterized as unaligned services with well-defined inviolable interfaces, which can be called in characterized sequences to form enterprise process'.

SOA is a development of distributed computing based on the request/reply pattern for both synchronous and asynchronous applications. An application's enterprise reasoning or individual purposes are modularized and offered as services for consumer/client applications. Services are a roughly connected environment, that is, the service interface is unaligned of the implementation. Application developers or system integrators can construct applications by creating one or more services without understanding the service implementations. Service-oriented architectures have the following key characteristics:

- SOA services broadcast with notes formally characterized by XML schema.
- SOA services are sustained in the enterprise by a registry that acts as a directory listing. Universal Description, Definition and Integration (UDDI) is the benchmark utilized for service registry.
- Each SOA service has a Quality of Service (QoS) affiliated with it. Some of the key QoS components are security requirements, for example, authentication and authorization, dependable messaging and principles considering who can invoke services.

In truth, IT enterprises have heterogeneous infrastructure over functioning systems, applications and system programs. Some existing applications are utilized to run present enterprise methods, and constructing new infrastructure from scratch is not an option. Enterprises should rapidly reply to enterprise alterations with agility, leverage existing investments in applications and application infrastructure to address newer enterprise obligations, support new passages of interactions with clients, partners and suppliers, and characterize an architecture that carries organic business.

Figure 21.1 devotes an example of SOA enterprise application. The application is a 'new supply chain management application'. This application comprises services like:

- Oracle financials
- Customer order application
- New world wide web application
- CRM
- Mainframe HR application
- .NET inventory application

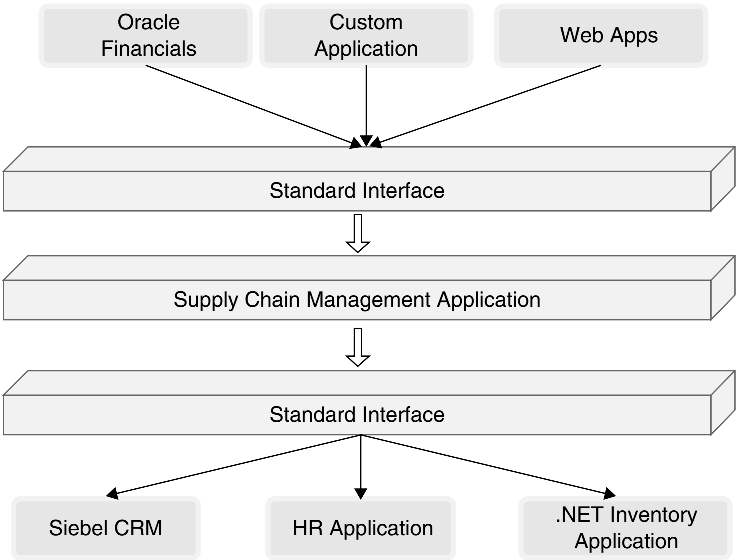


Figure 21.1 Example of an Enterprise Using SOA

An enterprise using SOA could create a string of connection composite applications utilizing a set of existing applications that reveal the functionality by benchmark interfaces.

21.1.1 Service Architecture

To apply SOA, enterprises require a service architecture, an example of which is shown in Figure 21.2.

In Figure 21.2, some service buyers can invoke services by dispatching messages. These messages are normally changed and routed to a befitting service implementation. This service architecture can supply an enterprise rules engine that permits enterprise rules to be integrated in a service or over services. The service architecture furthermore presents a service administration infrastructure that organizes services and undertakings like auditing, billing and logging.

21.1.2 SOA Infrastructure

To run and organize SOA applications, enterprises require an SOA infrastructure that is part of the SOA platform. An SOA infrastructure should support all the applicable measures and needed runtime containers. SOA infrastructure comprises three levels: core, platform and QoS. The core level comprises the centre constituents, for example, SOAP, WSDL and UDDI. These centre constituents perform a crucial function in constructing a web service, seeking and binding with it. Platform is a level, where world wide web services are evolved utilizing some programming languages, for example, J2EE and .NET. QoS level tests if the evolved web service supports value of service.

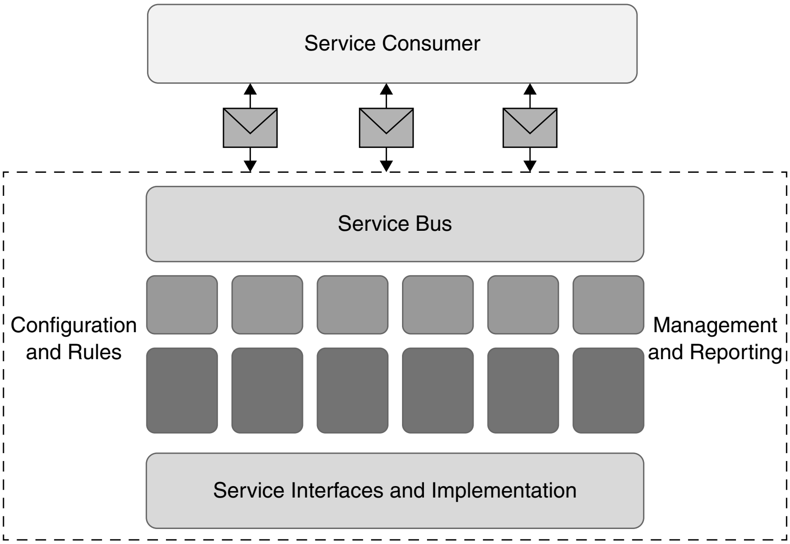


Figure 21.2 An Experiment Service Architecture

21.1.3 Need of SOA

Both enterprise and technical managers are involved in SOA, reasons being:

- Accomplishing better alignment between enterprise and IT
- Conceiving more flexible and responsive IT infrastructure
- Simplifying integration implementation

It is highly accepted that 'SOA permits aligning the enterprise world with the world of data expertise (IT) in a way that makes both more effective'. SOA is a connection that conceives a symbiotic and synergistic connection between the two that is more mighty and precious than anything that was skilled in the past. Moreover, SOA is about the enterprise outcomes that can be accomplished from having a better alignment between the enterprise and IT.

21.1.4 Application-centric Architecture

Today's enterprise IT architecture is often examined as an assemblage of applications. Design, development, enhancements and upkeep of program schemes rotate round applications. Each application is constructed for a lone reason (such as lend origination, assertion administration and so on), with its own data shops and for a lone set of users. As an outcome, it applies only a subset of the enterprise purposes, utilizing and making only a subset of the enterprise data. Table 21.1 summarizes key dissimilarities between application-centric and SOA approaches.

21.1.5 Elements of SOA

The enterprise SOA characterizes a set of business-aligned IT services that collectively fulfil an organization's enterprise methods and goals. These services can be choreographed into enterprise

Table 21.1 Application-centric Compared with SOA Implementations

Characteristic	Application-centric Architecture	SOA
Design and implementation	• Function oriented • Build to last • Long development cycles	• Coordination oriented • Build to change • Build and deployed incrementally
Resulting system	• Application silos • Tightly coupled • Object-oriented interactions	• Enterprise solutions • Loosely coupled • Semantic message-oriented interactions

answers and invoked through benchmark protocols. The foremost components of enterprise SOA are briefed in the following text.

- *Organization*: Services relate to SOA, methods, resources and rules to create, use, get access and maintenance owned by *Organization*.
- *Business model*: It is the prime representation of the business assets and methods that are needed to rendezvous enterprise operational, tactical and strategic enterprise goals.
- *Semantic data model*: Define the benchmark enterprise data things for a granted enterprise.
- *Services*: Implement exact enterprise purposes and get access to its data and resources.
- *Business processes*: Orchestrate the execution of enterprise services to apply enterprise purposes as particular in the enterprise model (e.g., order processing or assertions processing).
- *Information*: Represent the data assets of an organization. Data resides in a kind of distinct store, applications and formats. Different levels of data are utilized by distinct levels of SOA constructs.
- *Documents*: Represent lawful entities (such as economic articles, protection principles and assertions, and government regulations) that characterize the obligations of the enterprise and its partners. Documents are a crucial part of up to date enterprises and have to be encompassed in the SOA implementations, along with the remainder of the enterprise data, as first-class citizens.

21.1.6 Benefits of SOA

While the SOA notion is basically not new, SOA disagrees with existing distributed technologies. SOA, with a ubiquitous set of measures, adds better reusability of existing assets or investments in the enterprise and permits us to conceive applications that can be constructed on peak of new and existing applications.

SOA endows alterations to applications while holding clients or service providers isolated from evolutionary alterations that occur in the service implementation. SOA endows upgrading one-by-one services or service consumers. It is not essential to absolutely rewrite an application or hold an existing system that no longer addresses the new enterprise requirements. Finally, SOA presents enterprises better flexibility in construction applications and enterprise methods in an agile kind by leveraging existing application infrastructure to create new services.

Table 21.2 SOA Myths and Facts

Myth	Fact
SOA is a technology	SOA is independent and not interlinked with any vendor, merchandise and expertise or commerce trend. The vendor will not provide a 'complete' SOA package because SOA wishes alter from one organization to another. Purchasing your SOA infrastructure from lone vendor beats the reason of buying into SOA
SOAs need web services	SOAs may be recognized by web services but web services are not inevitably needed to apply SOA
SOA is fresh and innovative	EDI, CORBA and DCOM were conceptual demonstrations of SOA
SOA double-checks the alignment of IT and business	SOA is not a method
SOA reference architecture decreases implementation risk	SOA is like snowflakes—no one be the same. SOA reference architecture may not inevitably supply the best answer for your organization
SOA needs an entire expertise and enterprise methods overhaul	SOA should be incremental and constructed upon your present investments
We require to construct an SOA	SOA is a startup, not an end

21.1.7 SOA Myths and Facts

There are some myths affiliated with SOA which are very significant to realize before cutting deeper into it. The Table 21.2 recounts some of the peak myths and details surrounding SOA.

21.2 DEFINING SOA COMMUNICATION

Service-Oriented Communications (SOC) technologies are created to utilize effortlessly in the context of service-oriented architectures. Service-oriented communication systems permit their services to take part in enterprise processes. The aim of service-oriented communications is to endow enterprise environments to construct communications into their enterprise methods, endowing more simplified collaboration amidst people inside the business. It normally supposes that certain services are supplied in the context of an SOA service provider.

The maturing of world wide web service expertise has supplied a genuine structure for permitting one system to leverage the services of another as asserted by the values of a service-oriented architecture. Complex enterprise systems can now work simultaneously to consign a solution in highly customized modes to end users. Increasingly, applications are acclimatizing to the exact desires of users other than users being compelled to acclimatize to the accessible functionality of applications.

21.2.1 Messaging and Services

Messaging and services focuses on how messaging is carried out between senders and receivers. Services supply an evolutionary set for circulated programs that helps roughly connected integration and resilience to change. Service orientation is unaligned of expertise and architectural patterns and can be utilized to attach with legacy schemes as well.

A service is usually applied as a coarse-grained, discoverable programs entity that exists as a lone instance. It interacts with applications and other services through a roughly connected, message-based connection model. Messages are inclined to be founded upon an agreed-upon set of semantics and serialized utilizing an interoperable, extensible syntax.

21.3 SOA OPERATION

There's many of converse about service-oriented architecture (SOA). Organizations eagerly foresee the expanded development flexibility it adds and its pledge to pace enterprise innovations. The benefit of an SOA is it adds some genuine benefits. For example, it can

- Lessen the cost of integration by utilizing standards-based interfaces.
- Endow the reuse of application constituents in dynamic, new modes.
- Permit IT to create new methods from living services.
- Endow organizations to continue services to new assemblies of users, added clients and suppliers.
- Advance enterprise influence analysis.

By anticipating operational concerns in the design and creation phases, organizations can bypass administration and upkeep charges and expanded network loads. Early in the transition to SOA-based applications, IT standards should double-check that SOA-based services are conceived for manageability. IT standards should:

- Understand the enterprise application presentation obligation.
- Determine where SOA administration methods can be automated for advanced presentation.
- Be cognizant of the service infrastructure dependencies and the service-to-service dependencies.
- Make certain that service administration concerns are encompassed all through the development lifecycle.
- Warrant that services rendezvous data, security and privacy obligations.
- Confirm that the concept integrates presentation, capability and accessibility requirements.
- Ensure that composite applications are conceived in order that they can be monitored.

SOA-based services engage composite applications with service-to-service dependencies. To enhance customary resource-centric security for dynamic SOA environments, an organization should add an identity-focused security level, called believe management. To organize this, IT standards should double-check that it will be adept to:

- Identify the scope of IT configurations needed to recognize and apply enterprise compliance objectives.

- Identify a service demand and propagate persona over multiple domains of belief.
- Securely convey the demand over a heterogeneous environment.
- Enforce the befitting get access to command and characterize restricts on what one can manage.
- Protect contrary attacks and assess operational security risk.
- Report if it has achieved goals accordance with regulations.

21.4 DEFINING BPM

21.4.1 Introduction

Business Process Management (BPM) is an enterprise control or a function that values enterprise practices, process and procedures to conceive and advance enterprise processes. Any process enhancement undertaking, for example, reengineering, outsourcing and lean manufacturing, can be called as BPM.

BPM is a holistic versus piecemeal approach to the use of befitting process-related business. They are utilized to propel enterprise performance improvements not just over the agencies in a lone business but also over multi-company worth consignment systems.

21.4.2 BPM

BPM is a methodical set to advance a company's enterprise processes. It is the first expertise that fosters ongoing collaboration between IT and enterprise users to construct together applications that competently incorporate persons, methods and information. BPM devotes an organization the proficiency to characterize, execute, organize and perfect processes that

- Engage human interaction, for example, placing orders.
- Work with multiple applications.
- Handle dynamic process rules and changes.

21.4.3 BPM from a Business Point of View

The term 'BPM' has been taken up in the trading communications of just about every IT vendor and administration consultant. Everyone trading IT goods or administration conferring services has put BPM on their products and services.

BPM is commonly affiliated with process performance. However, a business process performance is exactly connected with the way the organization conducts business. The strategy and the next grade proportions on enterprise capability exactly arise from processes and people.

Business operations are the most affected from the application of BPM in the enterprise process sense. From this viewpoint, the end-to-end BPM lifecycle is

- Envisioning/defining the processes
- Executing the processes
- Monitoring the processes
- Analyzing and optimizing the processes

At the business operations level, there are diverse methodologies which have been utilized for decades on process improvements.

Every stage and every facet of the end-to-end BPM lifecycle on business operations edge has an affiliated expertise facet with it. The expertise outlook of BPM wrap the lifecycle as:

- Business process modelling and design
- Business process/systems integration
- Business process/workflow execution/orchestration
- Real-time process monitoring and analytics
- Process simulation, analysis and optimization
- Process performance reporting

SUMMARY

- ❖ SOA is an architecture that comprises software functionality as discoverable services on the network.
- ❖ An SOA infrastructure should support all the applicable measures and needed runtime containers.
- ❖ SOA infrastructure comprises three levels: (i) core, (ii) platform and (iii) QoS.
- ❖ Elements of SOA are (i) organization, (ii) business model, (iii) semantic data model, (iv) services, (v) business processes, (vi) information and (vii) documents.
- ❖ Service-oriented communication systems permit their services to take part in enterprise processes.
- ❖ SOA-based services engage composite applications with service-to-service dependencies.
- ❖ BPM is an enterprise control or a function that values enterprise practices, processes and procedures to conceive and advance enterprise processes.

KEY TERMS

- ❖ Service-oriented architecture (SOA) is a development of distributed computing based on the request/reply pattern for both synchronous and asynchronous applications.
- ❖ An SOA infrastructure should support all the applicable measures and needed runtime containers.
- ❖ SOA permits aligning the enterprise world with their data to expertise (IT) in a way that makes both more effective.
- ❖ Messaging and services focuses on how messaging is carried out between senders and receivers.
- ❖ BPM is a holistic versus piecemeal approach to the use of befitting process-related business.
- ❖ BPM is a methodical set to advance a company’s enterprise processes.

REVIEW QUESTIONS

- Define SOA.
- State the key characteristics of SOA.
- In SOA do we need to build systems from scratch?
- Are web services SOA?
- State the need of SOA.
- List the benefits of SOA.
- Define BPM.
- List end-to-end BPM lifecycle processes.
- Define SOC.
- State the elements of SOA.

CHAPTER 22

SOA's Experience with Cloud

22.1 COMPONENTS OF CLOUD

Cloud computing is possibly the most used phrase in the tech world, but to realize cloud computing it is significant to point out its major components. It is a computing model that permits users to gain access to their applications effectively from any location by utilizing any devices attached to it. The cloud infrastructure carrying these applications is made clear to users by a user-centric interface. The administration charges of IT assets can be considerably declined, when covered under the cloud.

Cloud computing can be examined simultaneously as an enterprise model and an infrastructure administration methodology. As an enterprise model, it presents a client know-how through which hardware, software and mesh assets are optimally leveraged to supply innovative services on the web. IT organizations can organize large figures of highly virtualized assets as a lone large resource. A cloud will endow organizations actually utilizing infrastructures to spend IT assets in the data centre in new, stimulating and previously unavailable ways.

Companies with customary data centre administration understand that it can be time-intensive to make IT assets accessible to an end client because of the numerous steps. These encompass procuring hardware, increased floor space, adequate power and cooling, assigning managers to establish functioning systems, middleware and software, provisioning the network and protecting the environment. Companies have found out that this method can take 2–3 months.

While IT organizations upgrade the existing hardware assets, it takes several weeks. This problem is rectified by the cloud as the cloud applies automation, enterprise workflows and asset abstraction. In this way, the method slashes down on the time generally needed to make those assets accessible to the clientele from long months to minutes. Additionally, the cloud presents a client interface that permits the client and the IT manager to organize the provisioned assets through the life cycle of the service demand very easily. Some of foremost constituents of cloud computing are described in the following text.

Application: The applications are the constituents that end users will spend most of their time on and are hosted on severs. They are accessed remotely by the client and can run in time from a slim client that hosts the applications through a web browser.

Client: The client is usually a web browser like Mozilla Firefox or Microsoft Internet Explorer.

Infrastructure: The infrastructure of cloud computing is comprised of computer hardware and the place that contains the hardware. The server environment uses virtualization which entails that internal details are hidden, such as how many specific machines are used. Some businesses use a method renowned as full virtualization, where the client is adept to absolutely simulate the hardware that is run on the individual server. Examples are Go Grid and Skytap. Another infrastructure method is called grid computing. Unlike full virtualization, grid computing uses server machines and networks simultaneously for processing harder jobs. An example is Sun Microsystems' Sun Grid.

To emulate one process, Para-virtualization utilizes more than one machine, and often some machines. An example is Amazon Elastic Compute Cloud.

Platform: The cloud platform is the way that applications can be established, most probably by platform as a service (PaaS). This encompasses the web applications that use languages Ruby on Rails, which is an open source web applications format.

Service: Users can gain experience on cloud computing is said to be service. A couple of examples are Yahoo Maps, Google Maps and MapQuest.

Storage: Physical storage can be costly for businesses looking to increase their storage needs. One of the large-scale characteristics of cloud computing is storage. By utilizing cloud expertise, businesses can be guaranteed that their data is safe. Cloud vendors will supply service level affirmations to let their clients understand that their data is safe.

Processing power: Cloud computing has tremendous processing power. In detail, for 99.9% of people who will use cloud computing, the assets that are accessible will appear to have no boundaries. Companies are adept to use this kind of capability for several things, namely, checking out new markets and seeking out new applications over the web.

22.1.1 Variables for Internal and External Cloud

The internal or external cloud should own these components in order to function as desired they are: availability, grid computing, virtualization and security.

For taking up a cloud computing, check these seven characteristics: scalable, virtualized or not, on-demand, Internet powered, multi-tenant capable, service-level assurance and usage price.

22.2 COMPONENTS OF SOA

SOA has profited the farthest attractiveness due to web services, and SOA have been around for over a decade. The World Wide Web Consortium (W3C) defines service-oriented architecture as 'A set of component that can be invoked and its interface can be available and exposed'.

Service-oriented architecture permits organizations to use (delivery, acquisition, utilization and so on) in terms of and in groups of associated services. SOA have large-scale significances for how we organize the software life cycle right from the specification of requirement as services, creation of services, acquisition and outsourcing of services, asset administration of services and so on.

Table 22.1 shows values of good service design that are endowed by characteristics of either web services or SOA.

SOA is not inevitably a lone expertise, but some infrastructure and networking technologies employed together. SOA-related infrastructure technologies can encompass components such as:

- A message queue to supply a transport level for assured messaging.
- An enterprise service bus (ESB), a software that comprises the next evolution of middleware.
- A discovery service, which is a repository to store data about a service, encompassing where it is established and how it should be called.
- An application server that acts as a canister for services.

The message queue, ESB, discovery service and application server work simultaneously to supply SOA its capabilities which include transport, orchestration, service connectors and transformation, service containers, discovery and administration.

Table 22.1 Web Services and SOA

Enabled by web services	*Technology neutral*	Endpoint stage independence
	Standardized	Standards-based protocols
	Consumable	Enabling automated breakthrough and usage
Enabled by SOA	*Reusable*	Use of service, not reuse by making a duplicate of code/implementation
	Abstracted	Service is abstracted from the implementation
	Published	Accurate, published specification functionality of service interface, not achievement
	Formal	Formal agreement between endpoints, locations, obligations on contributor and customer
	Relevant	Functionality offered at a granularity identified by the client as a significant service

The major components of SOA infrastructure are:

- Network infrastructure
- Transport which supports in-use protocols, for example, HTTP, TCP, SMTP, SOAP
- Orchestration
- Service connectors
- Service containers
- Applications

Published world wide web services are administrated in four levels, for example, transport, orchestration, service connectors and service container.

22.3 SOA AND CLOUD

Many enterprises have IT infrastructures that increased organically to rendezvous direct requirements, rather than a methodical expert plan. Organically developed enterprise systems have an inclination to evolve into large, monolithic organizations that comprise numerous subsystems that are either firmly connected or absolutely segregated. Typically, these systems have inconsistent interfaces. Their complexity and inefficiency slows down the enterprise and can force IT managers to aim on operational and fire-fighting methods rather than on how data expertise can support the centre business. Furthermore, some enterprise IT systems have partially replicated purposes that lead to fragmented and inconsistent outlooks of enterprise data, which sway the proficiency of an enterprise to make sound economic decisions.

Software in addition to services (S+S) is an elongation of Software as a Service (SaaS) that boasts organizations more choices for outsourcing development, administration, deployment and operational facets of the technologies that run their businesses. S+S works in conjunction with values of service-oriented architecture (SOA). S+S assists an SOA-enabled enterprise boost its expertise alternatives by supplying multiple modes of locating, financing and establishing applications programs and services.

The key objectives of SOA are to align enterprise IT capabilities with enterprise goals, and to endow enterprise IT to answer with larger agility as enterprise needs. Some key SOA values that encourage agile IT solutions encompass loose coupling, standards-based technologies and coarse-grain service design.

The SOA, S+S and cloud computing stack consists of SOA, software services and enterprise and cloud computing services. With SOA as a ground, it comprises SOA architecture and service alignments. Above this software in addition to service are placed cloud services which can be constructed or bought. This level carries cloud computing services like SaaS, PaaS and IaaS.

Cloud computing gives many solutions to enterprises. Some advantages are listed below:

- Proficiency to assign assets dynamically.
- Transaction and subscription-based cloud platform permit enterprises to create innovative applications rapidly for checking new enterprise and procedure models, without gigantic IT investments.
- Outsourced solutions reduce IT charges and the responsibilities of organizing and functioning non-differentiating IT assets.

S+S adds new possibilities for everyone. It presents new choices for optimizing enterprise and IT assets and endows organizations to save cost, boost productivity, innovate and come to new markets. SOA can gain from cloud computing: service design, service expandability and service governance.

There are 11 key stages in the life of every SOA-enabled or cloud service. The phases of the service lifecycle are as follows:

1. *SOA adoption planning*: Decisions are made considering scope of designed service inventory, milestones, timelines, governance schemes and administration systems.
2. *Service inventory analysis*: Defining the service inventory to recognize service candidates, and double-check there is no overlap with existing services.
3. *Service-oriented analysis (Service modelling)*: The first stage in the service consignment cycle starts with preparatory information gathering that directs to the creation of service candidates.
4. *Service-oriented design (Service contract)*: Produces service agreements in support of the ‘contract-first’ set about software development. Includes authoring of the service-level agreement.
5. *Service logic design*: The reasoning that will be responsible for bearing out the jobs in the service agreement is expressed.
6. *Service development*: The genuine programming service. In the PaaS cloud model, the service development stage itself may be suggested by a ready-made environment.
7. *Service testing*: Newly consigned services are checked individually and as part of service compositions.
8. *Service deployment and maintenance*: The genuine implementation of a service into an output environment.

9. *Service usage and monitoring*: The ongoing supervising of a hardworking service develops metrics for assessing service usage, like scalability, reliability, cost of ownership and ROI.
10. *Service discovery*: Identify existing agnostic services inside a granted service inventory for automating processes.
11. *Service versioning and retirement*: Make changes to existing services in output environments, boost purposeful scope or restore services with negligible disturbance to service consumers.

SUMMARY

- Cloud computing is the most used phrase in the tech world, but to realize cloud computing it is significant to point out its major components.
- Cloud computing can be examined simultaneously as an enterprise model and an infrastructure administration methodology.
- Some of foremost constituents of cloud computing are (i) application, (ii) client, (iii) infrastructure, (iv) platform, (v) service, (vi) storage and (vii) processing power.
- SOA has profited farthest attractiveness due to web services.
- S+S assists an SOA-enabled enterprise boost its expertise alternatives by supplying multiple modes of locating, financing and establishing application programs and services.
- Key objectives of SOA are to align enterprise IT capabilities with enterprise goals and to endow enterprise IT to answer with larger agility as enterprise needs.
- There are 11 key stages in the life of every SOA-enabled or cloud service.

KEY TERMS

- The applications are the constituents that end users will spend most of their time on and are hosted on severs.
- The infrastructure of cloud computing is comprised of computer hardware and the place that contains the hardware.
- SOA is a set of components that can be invoked and its interface can be available and exposed.
- Software in addition to services (S+S) is an elongation of Software as a Service (SaaS) that boasts organizations more choices for outsourcing development, administration, deployment and operational facets of the technologies that run their businesses.

REVIEW QUESTIONS

- List the constituents of cloud computing.
- Define SOA.
- Differentiate web services and SOA.
- What kind of service is S+S service?
- State the key stages in the life of SOA-enabled cloud services.

CHAPTER 23

BUSINESS PROCESS MANAGEMENT (BPM) AND CLOUD

Business process management (BPM) endows enterprises to automate, organize and optimize their process to maximize operational effectiveness. Cloud computing pledges expanded IT effectiveness, lower capital expenditure and lower barrier to application, while supplying scalability with infinite computing power.

BPM in the cloud decreases the barrier to BPM adoption. Enterprises can start by automating a small number of processes with a limited number of users to know-how the advantages of BPM before using it. Individual groups can provision their own infrastructure for BPM through self-service get access to BPM tools and functionality on the cloud. Business method outsources can customize the process for exact clients and make them accessible on the cloud.

23.1 WHAT ARE BUSINESS PROCESS?

A business process is a sequence of tasks or jobs that make an exact outcome. For example, the method of loading a client's order engages some associated tasks. In numerous businesses, the enterprise process is casual and undefined. This often creates inefficiencies and bottlenecks when there is disarray between worker responsibilities and business procedures. A business method comprises of task (activity) and gateway (decision). After validating the demand, the demand is administered to gateway for taking a decision.

23.2 WHAT IS BUSINESS PROCESS MANAGEMENT (BPM)?

Business process management (BPM) is a holistic, top-down administration that focuses on optimizing enterprise procedures to maximize clientele satisfaction. With its powerful focus on relentless method enhancement, BPM devotes companies the flexibility to rapidly reply to changes in the comparable landscape.

23.3 BRINGING PROCESS TO THE CLOUD

Cloud computing is Internet-based computing, it provides software, resources in distributed servers environment and data to computers and other devices on demand.

BPM is evolving widespread and has become acknowledged as an enterprise imperative by most organizations. The adoption of cloud-based solutions that supply integrated SaaS offerings is still not broadly acknowledged but is finding traction.

The BPM Suite is a flawless environment to establish service in the cloud with 100% web-based interface and scalable architecture. With the identical functionality as customary on-premise BPM software deployments, in the cloud it presents a mighty way to accelerate process enhancement initiatives. The advantages of establishing BPM in the cloud include:

- Reduced start-up charges
- Very fast deployment with no manual upkeep
- Predictable charges throughout the life of the application
- Very fast return-on-investment
- Security and reliability

BPM deployment in the cloud presents reliability and security that can be strong to agree by even the best internally organized environments.

Cloud BPM is appearing as a superior contestant in the new cloud technology category. The urge to migrate to cloud computing has been part of numerous organization systems and a vision for the future, even for government agencies.

Large organizations all over the world are evolving progressively involved in better coordinating their enterprise process and optimizing them. Many of them find a way to establish new BPM platforms that lower costs.

Companies with cloud-based enterprise models have become very proficient in establishing exact services and applications that clients desired to have off site. Considering that latest BPM platforms are created based on an HTML browser interface, it makes flawless sense to align this expertise with the SaaS model proposing application access to businesses over a browser attached to the Internet. This is now renowned as cloud BPM. The back-end running application server is encapsulated which is a reasoning of the BPM enterprise. The affiliated data is generally organized by the database attached to the application server.

Enabling BPM over the cloud is a notion that many organizations are adopting and this service is increasing in attractiveness amidst other companies. Service providers such as Amazon, Google, Facebook and salesforce.com have adopted this kind of infrastructure and make their applications accessible through the world wide web browser. Cloud computing blends the scalability of distributed grid computing with mission-critical accessibility and security. SaaS boasts numerous direct advantages for companies. Cloud computing infrastructure boasts the following benefits:

- Low initial cost
- Controlled IT spending
- Painless upgrades
- Seamless web services integration,
- Better supervising and control of all enterprise processes
- Location independence
- Speed, control and flexibility over deployments

23.4 DEFINING PROCESS

As organizations change, their enterprise processes have to change with them. Agility at this level is absolutely crucial, with a requirement to acclimatize rapidly to changes in market situation, regulatory requirements or enterprise models. A service-oriented architecture (SOA) forms the base of process agility.

23.5 SOA, AGILITY AND PROCESS

SOA endows the enterprise process to be abstracted out of inherent application schemes, yet work with the functionality of these internal and external assets to consign more agile processes.

One way to address multiple specifics associated to large organizations while sustaining an international, logical data system is to separate the data system into distinct localities, with a distinct IT approach in each area.

In the front-office locality, large organizations require to have a unified gaze. The proficiency to acclimatize their process, suggesting new products offers comprises of creating new client interfaces around new process that are propelled by new enterprise opportunities. Large organizations furthermore require extending the details of businesses in their middle offices. On the other hand, they might select to consolidate maintaining purposes by utilizing flexible solutions to accomplish rationalization and decline charges in the back office. Overall, large organizations are looking for agility in the front agency, reuse in the middle agency and rationalization in the back office.

The BPM tools utilized for evolving the application's assurance for a relentless service between enterprise processes and the distinct interfaces, developed from the client undertakings, characterized the enterprise processes. This assists to hold a powerful connection between the enterprise and IT in the front agency, which prevents the gap after a couple of iterations of utilizing customary software development tools.

Many enterprises have taken up the tools of business process management (BPM) to understand how their enterprise functions and to automate numerous key processes. This is where service-oriented architecture (SOA) gets in, developing IT assets in such a way that they can flexibly reply to changing enterprise needs. BPM and SOA require each other to be thriving else they will be relegated just as enterprise integration.

23.6 IMPORTANCE OF BPM FOR THE CLOUD

Cloud computing may be amidst today's hottest IT trends, but executives who have to conclude in use of cloud-based BPM face abounding anxieties about data security, privacy and other issues. That is why it is significant to start with a clear strategy. The first step is in evolving the system, as asserted by early adopters and industry professionals, is to understand the business process in and out and comprehending what improvements we desire to make.

Chart all business processes: 'Do a very comprehensive mapping of your enterprise processes', suggests Carsten Svensson, BPM lead for King Abdullah University of Science and Technology (KAUST) in Saudi Arabia.

KAUST mapped all the characteristics of its admissions method before moving them from an inside procedure to a cloud-based system. Do not anticipate doing the work overnight, he adds: 'You require setting apart lot of time for it and do lot of testing.'

Identify candidates for the cloud: It is particularly significant to conclude what is and what is not going into the cloud. To solely leverage a cloud-based BPM stage, IT heads should be very conspicuous about which method they require to streamline.

Think about starting in-house: With large businesses, it makes sense to construct a BPM system in an internal cloud accessible only to employees.

From a regulatory viewpoint, for example, a bank would still own its data, no matter where it outsources its data management. These internal clouds could be accessed from any computer with a browser, rather than the application running in the local area on the machine.

Build in learning time: Building on a BPM platform engages a discovering curve. KAUST started utilizing its cloud-based admissions system following 3 or 4 months of change and hard work. The admission staff took part extensively in meetings to document and reached an agreement on processes and sequences, which were then aligned to the software's functionalities.

23.6.1 BPM and Cloud: The Many Perspective

The relative between BPM and cloud is considerably very resolute by the viewpoint one takes. Following are the numerous perspectives:

BPM product capabilities provided on a cloud: From a merchandise vendor viewpoint, this capability endows vendors to supply their BPM associated products/solutions on new financial models. This decisively presents a new set of clients who can leverage the BPM merchandise capabilities and furthermore undoes new service possibilities associated with training, consulting, support and hosting, for example, Appian's Cloud BPM, Intalio's BPM SaaS service, Pega's Cloud offerings, etc.

BPaaS (business process as a service): This is the capability of characterizing and establishing ready-to-use enterprise process for exact requirements and supplying these enterprise processes as a service. An example of business process as a service is NetOxygen's Hosted/SaaS LOS (Loan Origination System).

Leveraging BPM for 'cloud' enablement: The other locality where BPM can be leveraged is in genuine delineation and execution of enterprise processes for cloud enablement. Typically, the enterprise cloud plans a basic change in the way IT implementations are done. These changes influence multiple groups inside the organization (e.g., asset procurement group, software license group, release teams, development groups, etc.) and external assemblies (e.g., product vendors, IT service providers, clients, etc.).

BPM cloud services: An opportunity to provide BPM cloud services associated to any of the areas listed above to merchandise vendors, cloud solution providers, cloud service brokers or IT service providers. The variety of services can encompass training, testing, production support, migration to a cloud, consulting, hosting, etc.

23.7 CLOUD-BASED BUSINESS MODEL

Some of the emergent cloud computing enterprise models that are probable to precede major stream in approaching years are listed in the following text:

- *Computing arbitrage*: An outstanding enterprise model around broadband bandwidth arbitrage where a business such as broadband.com buys bandwidth at Costco-style wholesale rate and resells it to the businesses to rendezvous their exact needs.
- *Gaming-as-a-service*: Otoy was commenced in 2010. There is important promise in cloud-based rendering for the games. Having control in online assemblage of sport, which can be rented and performed on a machine with a varying degree of form factors, is a huge enterprise opportunity. The cloud furthermore makes it a great platform and a flawless fit for the huge multi-player collaboration.

- *App-driven and content-driven clouds*: The desires to compute count on what is being computed, it counts on the applications desires to compute, the environment and capacity of data that is being computed and the kind of content that is being delivered. Today, vendors are optimizing the cloud to consent their application and content needs in the SaaS world.

SUMMARY

- ❖ BPM endows enterprises to automate, organize and optimize their process to maximize operational effectiveness.
- ❖ A business process is a sequence of undertakings or jobs that make an exact outcome.
- ❖ Business process management is evolving widespread and has become acknowledged as an enterprise imperative by most organizations.
- ❖ The BPM Suite is a flawless environment to establish service in the cloud with 100% web-based interface and scalable architecture.
- ❖ Cloud BPM is appearing as a superior contestant in the new cloud technology category.
- ❖ Enabling BPM over the cloud is a notion that many organizations are adopting and this service is increasing in attractiveness amidst other companies.
- ❖ Business executives who have to conclude in use of cloud-based BPM face abounding anxieties about data security, privacy and other issues.
- ❖ Cloud-based business models are (i) computing arbitrage, (ii) gaming-as-a-service and (iii) app-driven and content-driven clouds.

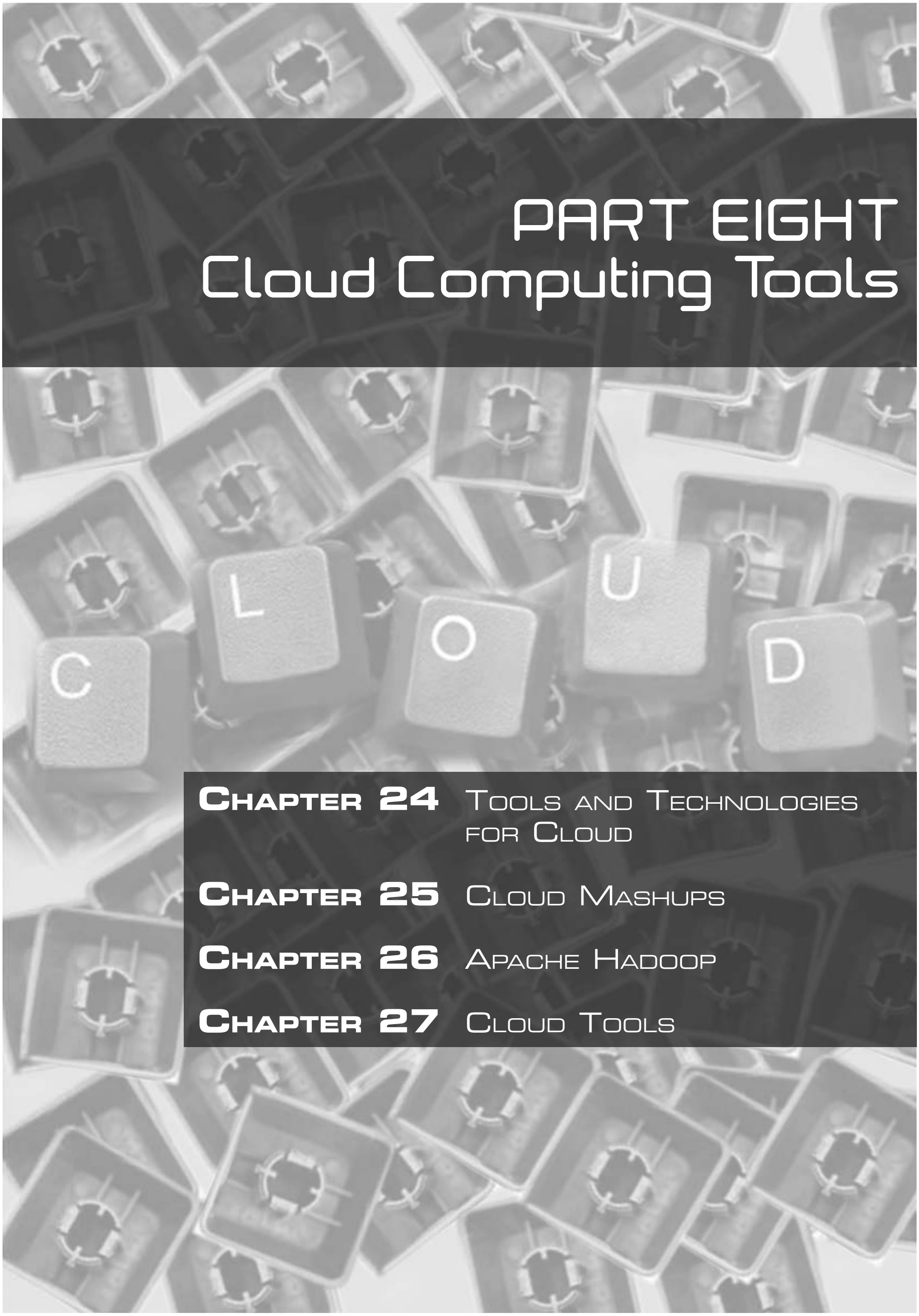
KEY TERMS

- ❖ Business process management (BPM) is a holistic, top-down administration that focuses on optimizing enterprise procedures to maximize clientele satisfaction.
- ❖ Business process management is evolving widespread and has become acknowledged as an enterprise imperative by most organizations.
- ❖ Business processes are part of an organization. They endow the organization to consign services to its clients and execute the enterprise model in a reliable way.

REVIEW QUESTIONS

- ❖ What is business process?
- ❖ Expand and brief BPM.
- ❖ How are business process and cloud technology related?
- ❖ List the points before moving BPM in cloud.
- ❖ List the services related to BPM and cloud.
- ❖ List cloud-based business models.

PART EIGHT
Cloud Computing Tools



CHAPTER 24

Tools and Technologies for Cloud

24.1 PARALLEL COMPUTING

It is obvious that silicon-based processor chips are available to their physical limits in processing speed. A viable answer to overwhelm this limitation is to attach multiple processors employed in coordination with each other to explain large dispute problems. Hence, high-performance computing needs the use of Massively Parallel Processing (MPP) systems encompassing thousands of mighty CPUs. A superior agent computing system constructed utilizing an MPP set is C-DAC's PARAM supercomputer.

At the end of this century, every-high performance system becomes a parallel computer system. High-end computers will be the extraordinarily parallel processing systems including thousands of processors that are interconnected. To present well, these parallel systems need a functioning system fundamentally distinct from present ones. Most investigators in the area of functioning systems have discovered that these new functioning systems will have to be much lesser than customary ones to accomplish the effectiveness and flexibility needed.

24.2 ERAS OF COMPUTING

The most famous two eras of computing are the sequential and parallel eras. In the last 10 years, parallel machines have developed into a significant challenge to vector machines in the chase for high-performance computing. A 100-year broad outlook of development of computing eras is shown in Figure 24.1. The computing era begins with a development in hardware architectures, pursued by system programs, applications and coming to its saturation point with its development due to difficulty in environments. Every component of computing undergoes three phases: R&D, commercialization and commodity.

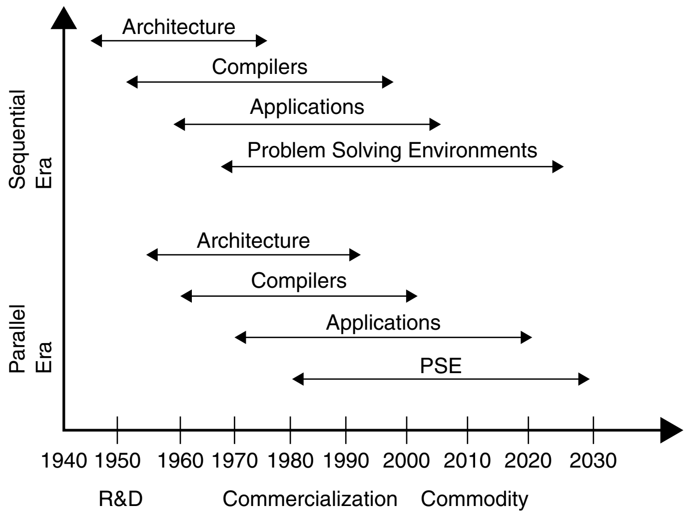


Figure 24.1 Two Eras of Computing

Cloud computing refers to both the applications consigned as services over the Internet and the hardware and systems programs in the data hubs that supply those services. When a cloud is made accessible in a pay-as-you-go kind to the general public, it can be called as a public cloud, and the service being traded is utility computing. Cloud computing is the addition of SaaS and utility computing.

People can be users or providers for SaaS or utility computing. From a hardware issue of outlook, three facets are new in cloud computing:

1. The illusion of infinite computing assets accessible on demand.
2. The elimination of an up-front firm promise by cloud users.
3. The proficiency to pay for use of computing assets on a short-term basis as required and release them as needed.

Infrastructure services (infrastructure-as-a-service) supplied by cloud vendors permit any client to use a large number of compute examples effortlessly by utilizing the virtual assets to present data/compute-intensive works.

24.3 HIGH PERFORMANCE PARALLEL COMPUTING WITH CLOUD AND CLOUD TECHNOLOGIES

The introduction of financial/commercial cloud infrastructure services, for example, Amazon EC2/S3, GoGrid and ElasticHosts, permits users to use clusters effortlessly and rapidly by giving a monetary worth only for the duration used. The provisioning of assets occurs in minutes.

The accessibility of open source cloud infrastructure software, for example, Nimbus and Eucalyptus, and the open source virtualization software, for example, Xen Hypervisor, permit organizations to construct private clouds to advance the asset utilization of the accessible computation facilities. The likelihood of dynamically provisioning added assets by leasing from financial/commercial cloud infrastructures makes the use of private clouds more promising.

With all the overhead characteristics of cloud, the accessibility to computation power in cloud is no longer a barricade for users who require to present large-scale data/compute-intensive applications. However, to present such computations, two foremost preconditions required are being satisfied:

1. The application should be parallelizable to utilize the accessible assets.
2. There should be a befitting parallel runtime to apply it.

We have some cloud technologies for HPC, for example, Hadoop, Dryad and CGL-MapReduce, to diverse technical applications, for example:

- Cap3 data investigation
- High Energy Physics (HEP) data investigation
- Word Histogramming
- Distributed GREP
- K-Means clustering

Cloud technologies like Google MapReduce, Google File System (GFS), Hadoop Distributed File System (HDFS), Microsoft Dryad and CGL-MapReduce take a more data-centred set regarding two parallel runtimes. In these structures, the data is arranged in data/compute nodes of clusters or large-scale data centres. The computations proceed to the data in alignment to present data processing. Distributed document systems, for example, GFS and HDFS, permit Google MapReduce and Hadoop to get access to data by distributed storage systems constructed on heterogeneous compute nodes, while Dryad and CGL-MapReduce support reading data from localized disks. The ease in the programming form endows better support for value of services, for example, obvious error tolerance and monitoring.

24.4 CLOUD COMPUTING APPLICATION PLATFORM

Cloud computing is a foremost change in the IT industry. One of the most significant components of that change is the advent of cloud platforms. As its title proposes, this kind of platform permits developers to compose applications that run in the cloud, or use services supplied from the cloud or both. This new way of applications has large potential.

Similarly, every development group that desires to conceive a cloud application should first construct its own cloud platform. Fortunately, vendors are increasing to this dispute and several cloud platform technologies are accessible today.

In general, when we get into cloud services we will understand about cloud platforms. Services in the cloud can be grouped into three very broad categories.

1. *Software as a service (SaaS)*: A SaaS application sprints solely in the cloud. The on-premises purchaser is normally a browser or some other straightforward client.
2. *Attached services*: Every on-premise application presents helpful purposes on its own. An application can occasionally enhance these by accessing application-specific services supplied in the cloud.
3. *Cloud platforms*: A cloud platform presents cloud-based services for creating applications. Rather than construction their own made-to-order base, for example, the creators of a new SaaS application would rather than construct on a cloud platform.

Understanding cloud platforms needs some affirmation on what the phrase 'platform' entails in this context. One very broad way to believe it is to view a platform as a software that presents developer-accessible services for creating applications.

24.4.1 General Model for Application Platform

Nowadays, application platforms arrive mostly from on-premise platforms. A helpful way to believe about cloud platforms is to get a glimpse how an application developer relies his services in the on-premises natural environment convert to the cloud. Figure 24.2 displays a general model that can be directed to both worlds. On-premises or in the cloud, an application platform has three elements: foundation, infrastructure services and application services.

Even though these applications exist mainly to supply services to end users, this furthermore makes them part of the application platform.

Development tools are another significant part of platforms. Modern tools can assist developers construct applications utilizing all three components of an application platform. To make this abstract form more solid, on-premise platforms are found.

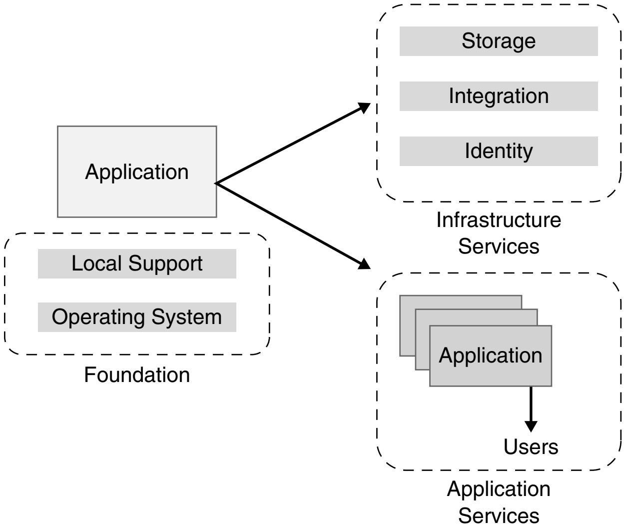


Figure 24.2 An Up to Date Application Platform

For on-premise infrastructure services, usual examples are storage, integration and identity.

On-premise application services, the third class shown in Figure 24.2, vary broadly over distinct organizations. The cause for this is straightforward: Distinct organizations use distinct applications, which in turn reveal varied services. The applications can be divided into two very broad categories: packaged applications and custom applications.

24.4.2 On-premises Platform to Cloud Platform

Along with recounting on-premise platforms, the general model just recounted can furthermore be utilized for cloud platforms. And since on-premises and cloud platforms can be utilized simultaneously, it is important to realize how the two work in concert.

Cloud application can be constructed on a cloud base and an on-premise application is constructed on an on-premise foundation. Both types of applications can access infrastructure services and application services supplied by on-premises and by cloud. Client level platforms support today's applications, cloud platforms supply services for the applications were probable to construct tomorrow.

24.5 CLOUD COMPUTING PLATFORM

24.5.1 Abicloud Cloud Computing Platform

Abicloud is a cloud computing platform evolved by Abiquo, a business established in Barcelona, Spain, focusing on the development of cloud platform. It can be utilized to construct, incorporate and organize public as well as personal cloud in homogeneous environments. Using Abicloud, clients can effortlessly and mechanically establish and organize the server, storage system, mesh, virtual apparatus and applications and so on. The major distinction between Abicloud and other cloud computing platforms is its mighty web-based administration function and its centre encapsulation manner. Using Abicloud, clients can complete establishing a new service by just pulling a virtual appliance with a mouse. This is much simpler and more flexible than other cloud computing platforms that establish new services through order lines.

24.5.2 Eucalyptus Cloud Platform

Eucalyptus is an elastic computing structure that can be utilized to attach the users' programs to the helpful systems; it is an open-source infrastructure utilizing clusters or workstations implementation of elastic, utility and cloud computing and a well-liked computing benchmark founded on service grade protocol that allows users lease mesh for computing capability. Currently, Eucalyptus matches EC2 from Amazon and supports more types of purchasers with smallest modification and extension.

24.5.3 Nimbus Cloud Computing Platform

Nimbus is an open tool set and furthermore a cloud computing solution supplying IaaS. Based on technical study in the early platform, Nimbus has sustained numerous non-scientific study domain applications. It allows users lease-isolated assets and constructs the needed computing natural environment through the deployment of virtual machines.

The Nimbus cloud computing platform encompasses numerous distinct constituents, state purchasers, agencies, resource supervisors and so on. In general, all these functional elements are classified into three types. One first type is client-supported modules which are utilized to support all kinds of cloud clients. Context client module, cloud client module, quotation client module and EC2 client module all pertain to this kind of component. The second kind of component is mostly service-supported modules of cloud platform, supplying all types of cloud services. It encompasses context agency module, web service resource structure module, EC2 WSDL (Web Services Description Language) module and isolated interface module. The third kind of component is the backdrop resource administration module which is mostly utilized to organize all types of personal assets on the cloud computing platform, encompassing the work service administration module, IaaS module, EC2 and other cloud platform support modules, workspace navigate module, workspace asset administration module and workspace controller.

24.5.4 OpenNebula Cloud Computing Platform

In virtualization infrastructure and cloud computing of European Union, OpenNebula is one of the main technologies of reservoir design and the flagship study task. Like nimbus, OpenNebula is furthermore an open source cloud service framework. It permits clients to establish and organize virtual machines on personal assets and it can set users' data hubs or clusters to a flexible virtual infrastructure that can mechanically acclimatize to the change of service load. The major distinction of OpenNebula and nimbus is that nimbus applies an isolated interface founded on EC2 or WSRF (Web Services Research Framework) through which clients can method all security associated matters, while OpenNebula does not.

OpenNebula is furthermore an open and flexible virtual infrastructure administration device, which can be used to synchronize the storage, mesh and virtual methods and let users dynamically establish services on the circulated infrastructure as asserted by the share systems at the data centre and isolated cloud resources. Through the central interfaces and OpenNebula data centre natural environment, users can effortlessly establish any kind of cloud.

OpenNebula is mostly utilized to organize the data centre of a private cloud and infrastructure of cluster and it furthermore supports hybrid clouds to attach the localized and public infrastructure. This is extremely supportive to build a high scalable cloud computing environment. Besides, OpenNebula carries a public cloud platform by supplying interfaces and purposes to virtual machines, storage, mesh administration and so on.

24.6 TOOLS FOR BUILDING CLOUD

Today, two development methodologies are conveying many cloud-based developments: distributed and agile. These notions are impelling the wrapper on existing development apps, needing a new set of devices that can accommodate new development, checking and deployment methods.

Distributed computing is a by-product of Internet. Distributed development is global development, which adds its own trials with collaboration and code management. There are large applications currently out there for distributed code administration; git and subversion are two such tools and are broadly utilized in distributed environments already.

These online code administration tools only notify part of the article. Even in a distributed development environment, programmers are still dragging down the code to their localized machines, modifying it, then uploading it back into the repository.

Developers can proceed in the direction of a more collaborative work procedure by integrating browser-based incorporated development environments (IDEs) into their toolset. These interfaces endow developers to code out in browser space, for example, Ace, Coderun Studio, Codemirror and Ymacs.

24.6.1 Open Source Tools for Construction and Organizing Cloud

Open source expertise is going to gravely influence the cloud computing world and there are two major causes why: Open source software is vitally free and it is not usually encumbered by the software license of proprietary software.

A number of open source tools have currently had a large influence on cloud computing, Linux and Xen, for example. But there are other significant open source offerings that can advantage cloud users. These encompass KVM, Deltacloud, Eucalyptus, Cloud.com's CloudStack.

There are eight key components to address when constructing an internal or external compute cloud. They are:

1. Shared infrastructure
2. Self-service automated portal
3. Scalable

4. Rich application container
5. Programmatic control
6. 100% virtual hardware abstraction
7. Strong multi-tenancy
8. Chargeback

24.7 PROGRAMMING IN CLOUD

Cloud computing comprises of two aspects of meaning, to recount the rudimentary platform amenities and, on the other hand, to construct applications on this platform.

First, a cloud computing–based platform for programming is built. There are numerous programs which can be utilized to construct a basis for cloud computing platform programming. For example, customary distributed systems and grid platforms can be used as the foundation of a cloud computing platform facility and then a whole cloud computing platform is constructed by abstraction on such a structure.

24.7.1 MapReduce Distributed Programming

MapReduce is a mighty distributed programming procedure, which is furthermore a function of dialect form utilized to deal with huge data groups and in which only two functions are provided: *Map and Reduce.*

Map function presents a dedicated procedure for each data item set and comes back as a new data set after disposing of the project. In a data item set, a Reduce function gets implementation of the aim procedure in the data piece sets.

24.7.2 Chubby

Chubby is a highly accessible, distributed data secure service. When any machine falls short, Chubby double-checks the consistency of the backup utilizing the Paxos algorithm. Each unit in little distributed document systems of Chubby can be utilized to supply secure services. Currently, this language is mostly utilized on the basis of Google's cloud computing platform. Hadoop and PIG language are constructed on top of Hadoop Project and is a kind of open-source implementation for programs model.

24.7.3 Dryad and DryadLINQ

Dryad and DryadLINQ, created by Microsoft Research Silicon Valley, are created to supply a distributed computing platform. In recent years, this platform has been broadly utilized internally at Microsoft, and specifically utilized on Microsoft's own cloud computing platform Azure.

Dryad is developed for extending the computing platforms of all dimensions, from single-core computers, to small cluster of the composition of a multiple computers and then to having data hubs comprised of thousands of computers. The aim of DryadLINQ is to supply a high-level language interface, for programmers to effortlessly convey large-scale distributed computing. The two key technologies, Dryad and LINQ are combined together to form a new technology called DryadLINQ.

Dryad can develop distributed operations performed on Dryad engines and is responsible for self-acting parallel processing of the jobs and sequence of functions required when data is delivered. In addition, it boasts a variety of easy-to-use and sophisticated characteristics, for example, strongly drafted data and visual studio incorporated debugging.

24.7.4 Programming of Dynamics Languages

Computing assets can extend dynamically as asserted by the dimensions of the task, since a computing platform has a solid high expansion flexibility and platform abstraction. As an outcome, programs can run without being influenced by the influence of infrastructure change. The fast and well-inspired way for enterprise applications is to use the programming procedure of dynamic language. Therefore, not only can the code created by dynamic language be established to achieve enterprise applications in the Cloud's Client, but cloud projects accomplished by dynamic languages can also be discovered in parts of cloud infrastructure.

In the existing cloud computing platform, there still are adversities, in integration and interoperability of services and applications, they still desire to take benefit of services supplied by cloud computing and incorporate the services they need.

SUMMARY

- High performance computing needs the use of Massively Parallel Processing (MPP) systems encompassing thousands of mighty CPUs.
- The most famous two eras of computing are the (i) sequential and (ii) parallel eras.
- Cloud computing refers to both the applications consigned as services over the Internet and the hardware and systems programs in the data hubs that supply those services.
- Cloud technologies for HPC are Hadoop, Dryad and CGL-MapReduce.
- Cloud technologies like Google MapReduce, Google File System, Hadoop and Hadoop Distributed File System, Microsoft Dryad and CGL-MapReduce take a more data-centred set regarding two parallel runtimes.
- Services in the cloud can be grouped into three categories: (i) Software as a Service (SaaS), (ii) attached services and (iii) cloud platforms.
- Development tools are another significant part in platforms. Modern tools assist developers in constructing applications utilizing the components of an application platform.
- On-premises platform is split into two very broad categories: (i) packaged applications and (ii) custom applications.
- Cloud computing platforms are (i) Abicloud Cloud Computing Platform, (ii) Eucalyptus Cloud Platform, (iii) Nimbus Cloud Computing Platform and (iv) OpenNebula Cloud Computing Platform.
- Distributed computing is a by-product of Internet. Distributed development is global development, which adds its own trials with collaboration and code management.

- Git and subversion are two tools broadly utilized in distributed environments.
- There are eight key components to address when constructing an internal or external compute cloud: (i) shared infrastructure, (ii) self-service automated portal, (iii) scalable, (iv) rich application container, (v) programmatic control, (vi) 100% virtual hardware abstraction, (vii) strong multi-tenancy and (viii) chargeback.

KEY TERMS

- In parallel processing, simultaneous use of more than one CPU is used to execute a program.
- High performance computing is a fork of computer science that concentrates on devising supercomputers and software to run on it.
- GoGrid is a leader in providing hybrid and cloud infrastructure hosting.
- GoGrid endows sysadmins, developers and IT professionals to conceive, establish and command dynamic load-balanced cloud infrastructures.
- Dryad is an ongoing study task at Microsoft Research for runtime execution of facts and number-aligned applications.

REVIEW QUESTIONS

- Define parallel processing.
- What is high performance computing (HPC)?
- How is high performance parallel computing performed using cloud computing?
- How are cloud services assembled?
- List some cloud computing platforms.
- Define agility.
- List some tools that are used for building clouds.
- What is MapReduce?
- Define Chubby.
- What is Dryad?

CHAPTER 25

Cloud Mashups

25.1 INTRODUCTION

Today, information can be considered as one of the main resources. Some theorists speak about the Information Age, based on the idea of the current age, where people had the ability to transfer information freely and have instant access to a shared knowledge. This idea is the direct consequence of the digital revolution in information and communication technologies. This created the platform for a free flow of ideas and knowledge. This revolution has made an impression on how the world functions.

The main problems are to manage this enormous variety of information, to extract ideas from data and to get the right information from the new idea; data without a right contextualization cannot bring any useful information.

The problem of information management is very complex. In globally connected world, there is a need for mashing up all information among the different information sources for getting the answer in a quicker and easier way.

The computer science, with its storage, elaboration and communication capabilities, can be used to solve this problem. The philosophy of mashups is that it can generate a possible solution for a given problem. The solution is framed by mashing the data from different sources.

One of the most attracted scenarios for enterprises is the software production division. There is the need for situational applications, software built to manage particular business processes connected to different applications. Resources assigned to these software applications have controlled limits. This makes the end user community to use low-quality applications or non-conventional alternatives.

The main difficulty to invest in the production of software of this kind is in the 'artistic' and 'social' nature of the business processes to model as they do not allow their implementation in enterprise applications.

Therefore, the challenges in developing situational applications are in exploiting the business and to provide flexible, agile and low-cost methods. Web 2.0 provide some of the most rated solutions and more significance are there for mashup.

25.2 MASHUPS

'Mashup' is the word with a different context and has different meanings in different places.

Examples are given as follows:

- In terms of music, a mashup is a composition or a song developed by adding more than one song.
- In terms of cinematography, a video mashup is a collection of multiple video sources.
- In terms of digital production, a digital mashup is a media file containing text, audio, graphics and video taken from existing sources to develop a new work.

Mashups stands on the basic concept of data and services integration. To function in this way, combination, aggregation and visualization are three main primitives:

1. Combination collects data from heterogeneous sources, uses it among the same application.
2. Aggregation operates on collected data having a measure and builds new information using the obtained data.
3. Visualization is used to integrate data in a diagram way using maps or by using other multimedia objects.

25.3 CLOUD MASHUPS

In order to answer the question about cloud mashup, we must first answer the question for mashup. Mashup is a term which is used to describe an application that can be web based, which combines information from more than one source to present a new service, for example, a news website that pulls in weather updates from Weather.com (or other), stocks and shares information and even additional news items.

Mashups use API software (application programming interface) to combine one or more website elements. A cloud mashup is simply an instance of a web-based mashup, but the application content resides in the cloud. The reasons are as follows:

If cloud mashup is hosted in the cloud, then it will be placed next to some useful software building tools, if the user subscribes to a cloud mashup centre service. A good enterprise mashup platform features reusable application blocks that can be used to build new applications.

25.4 CONCEPTS OF CLOUD MASHUPS

Cloud mashups can be understood based on its differing scopes and relies on their real purpose. Most present considerations believe that the definition of standard interfaces and protocols will ensure interoperability between providers. This allows customers to manage and use different existing cloud systems in a logical fashion. Also, this conceives a composition of capabilities by incorporating the specific purposes into meta-capabilities that can proceed over diverse cloud schemes like SOA.

25.5 REALIZING RESOURCE MASHUPS

25.5.1 Resource Cloud Mashups

Doing the computation remotely and/or keeping storage away from the local infrastructure is not a newer one. The concepts to allow integration of remote resource for apparently local usage is done by the web and grid service domain already. However, overhead configuration and administration of grids passes one of the well-known cloud providers and it boosts the mean users to take up the system in particular. Also, elastic scaling according to need is an important economical factor addressed by the cloud environment, theoretically to reduce needless resource loads.

25.5.2 Realizing Resource Mashups

Segmented image and data management joined to realize efficient usage of cloud mashups on an infrastructure level. We can differentiate between the base image set consisting of:

- The setup environment and any engine.
- The base customer-specific dataset, such as common data that are provided to the user and the applet that is provided to each user equally.
- The user-specific information which is only available on a single machine and differs per access.

Fundamentally every cloud system can be reduced to an infrastructure as a service environment or resource cloud with added segmentation capabilities on its contents and correspondingly the functionalities it offers.

In particular a user-centric approach is followed by the overall structure of decision making and image distribution. The associations between customers and users and their data requirements are valued in order to ensure availability while maintaining scale restrictions. Data are replicated based on the behaviour and availability into various sites and are assured as long as scaling and segmentation do not move a presently accessed dataset.

In other words, before the user environment is passed to a new host, user behaviour is analysed in the same way data segmentation and specific requirements are assessed. Prior to a potential redirecting of the user's assigned route, the availability of required datasets needs to be ensured, only after successful rerouting, and the initial dataset may be destroyed.

SUMMARY

- ❖ Today, the information can be considered as one of the main resources.
- ❖ The main problems are to manage enormous variety of information and extracting ideas from data.
- ❖ Mashups can generate a possible solution for a given problem. The solution is framed by mashing the data from different sources.
- ❖ Web 2.0 provide some of the most rated solutions and more significance are there for Mashup.
- ❖ Mashup is a term which is used to describe an application that can be web based, which combines information from more than one source to present a new service.
- ❖ Mashups use API software (application programming interface) to combine one or more website elements.
- ❖ A cloud mashup is an instance of a web-based mashup, whereas application content is available in the cloud.

KEY TERMS

- A mashup is a computing term describing an application that uses, combines and aggregates data from one or more services to create a new one.
- Cloud mashups can be understood based on their differing scopes and rely on their real purpose.

REVIEW QUESTIONS

- Define mashup.
- What is cloud mashup?
- List uses of mashups.
- State the importance of mashups in cloud computing.

CHAPTER 26

APACHE HADOOP

26.1 INTRODUCTION

Everyone understands that data is increasing exponentially, but how to unlock the worth it retains is unclear. Hadoop is the answer. Developed by Cloudera architect Doug Cutting, Hadoop is open source program that endows distributed processing of large data over inexpensive servers. Data is not too big with Hadoop, and people and enterprises are conceiving more and more data every day in today's hyper-connected world. Hadoop's proficiency to augment effectively without restricts entails enterprises and organizations can now unlock potential value from all their data.

Hadoop is creating worth for enterprises, organizations and individuals. With its proficiency to unlock value from data, Hadoop is quickly being adopted by enterprises in effectively all parts and industries.

Hadoop is a quickly developing ecosystem of constituents for developing the Google MapReduce algorithms in a scalable hardware. Hadoop endows users to store and use large volumes of data and investigate it in ways with less scalable solutions or benchmark SQL-based approaches. Hadoop is a highly scalable compute and storage platform. Hadoop is an open-source implementation of Google MapReduce, encompassing a distribute file system.

26.2 WHAT IS HADOOP?

Hadoop is a sub-project of Lucene, under the Apache Software Foundation. Hadoop parallelizes data processing over numerous *nodes* (computers) in a *compute cluster*, racing up large computations and concealing I/O latency through improved concurrency. Hadoop is particularly well-suited to large data processing jobs (like seeking and indexing). It can also leverage its distributed file system at a reduced cost and reliably duplicate chunks of data to nodes in the cluster, producing data accessible in the local area on the appliance that is processing it.

To the application programmer Hadoop presents the abstraction of map and reduce. Map and reduce are accessible in numerous languages, for example, Lisp and Python.

26.2.1 Map and Reduce

The MapReduce paradigm takes idea from the map and it reduces programming constructs widespread in abundant programming languages.

26.3 CHALLENGES IN HADOOP

Deployment of the servers and programs is an important concern with all large environments. These best practices are applied through a set of tools to automate the configuration of the hardware, set up the OS and set up the Hadoop programs stack from Cloudera.

As with numerous other kinds of data expertise (IT) solutions, change administration and system supervising are a prime concern inside Hadoop. The IT procedures desire to double-check tools in correct place and apply alterations and notify employees when unforeseen happenings take place inside the Hadoop environment.

Hadoop is a certainly increasing, convoluted ecosystem of programs and presents no guidance to the best stage for it to run on. Hadoop environment and will change over time as job structure alterations, data layout developments and increased data capacity.

26.3.1 Hadoop Nodes

Hadoop has nodes inside each Hadoop cluster. They are DataNodes, NameNodes and EdgeNodes. Names of these nodes can change from location to location, but the functionality is widespread over the sites. Hadoop's architecture is modular, permitting individual constituents to be levelled up and down as the desires of the environment change. The base nodes for a Hadoop cluster are as follows:

- *NameNode*: The NameNode is the centred position for data about the file system established in a Hadoop environment.
- *DataNode*: DataNodes make up the most of the servers comprised in a Hadoop environment. The DataNode assists two functions: It comprises a piece of the data in the Hadoop Distributed File System (HDFS) and it actions as a compute stage for running occupations, some of which will utilize the localized data inside the HDFS.
- *EdgeNode*: The EdgeNode is the access point for external applications, devices and users that require utilizing the Hadoop environment. The EdgeNode is seated between the Hadoop cluster and the business mesh to supply access to command, principle enforcement, logging and entrance services to the Hadoop environment.

Hadoop was initially evolved to be an open implementation of Google MapReduce and Google File System. As the ecosystem around Hadoop has matured, a kind of tool has been evolved to simplify data access, data administration, security and focused supplements for verticals and industries. Despite this large ecosystem, there are some prime values and workloads for Hadoop that can be delineated as compute, storage and database.

26.4 HADOOP AND ITS ARCHITECTURE

The Hadoop Distributed File System (HDFS) is a distribute file system conceived to run on a hardware. HDFS is highly fault-tolerant and is created to be deployed on low-cost hardware. HDFS presents high throughput access to application data and is apt for applications that have large data sets. HDFS rests a couple of POSIX obligations to endow streaming access to the file system data. HDFS was initially constructed as infrastructure for the Apache Nutch web search project. HDFS is now an Apache Hadoop subproject.

26.4.1 HDFS: Goals and Assumptions

Hardware failure: Hardware malfunction is the norm other than the exception. An HDFS example may comprise of hundreds or thousands of server machines, each saving part of the file system's data. There are large number of components and each component has a non-trivial likelihood of malfunction that some components of HDFS are habitually non-functional. Therefore, detection of obvious errors and fast recovery from them is a centre architectural aim of HDFS.

Streaming data access: Applications running on HDFS need access to their data sets. They are not common applications that generally run on common file systems. HDFS is conceived more for batch processing other than interactive use by users. The focus is on high throughput of data access to other than reduced latency of data access.

Large data sets: Applications running on HDFS contain huge data sets. A usual file in HDFS is gigabytes to terabytes in size. Therefore, HDFS is adjusting to support huge files. It should supply high collective data bandwidth and range to hundreds of nodes in a single cluster that should support tens of millions of files in a single instance.

Simple coherency model: HDFS applications require a write-once-read-many access for files. A file one time conceived, in writing and shut, requires not be changed. This assumption simplifies data coherency matters and endows high throughput data access. A MapReduce application or a world broad web crawler application aligns flawlessly with this model. There is a design approach to support appending-writes to files in the near future.

Moving computation is cheaper than moving data: A computation demanded by an application is much more effective if it is performed beside the data it functions on. This is particularly factual when the dimensions of the data set are huge. This minimizes mesh jamming and raises the general throughput of the system.

Portability over heterogeneous hardware and software platforms: HDFS has been conceived to be effortlessly portable from one stage to another. This helps prevalent adoption of HDFS as a stage of alternative for a large set of applications.

26.4.2 HDFS Architecture

Architecture of HDFS is master/slave architecture. An HDFS cluster comprises a single NameNode, a server that organizes the file system namespace and regulates access to files by clients. In supplement, there are several DataNodes, generally one per node in the cluster which organizes storage adhered to the nodes that they run on. HDFS reveals a file system namespace and permits client data to be retained in files. Internally, a file is divided into one or more blocks and these blocks are retained in a set of DataNodes. Opening, closing and renaming files and directories are file system namespace procedures executed by the NameNode. It furthermore works out the mapping of blocks to DataNodes. The DataNodes are responsible for assisting read and compose demands from the file system's clients. The DataNodes also present impede creation, deletion and replication upon direction from the NameNode.

To share large files over a cluster of machines, a reliable file system called HDFS is formed. It shares each file as a sequence of blocks. All blocks in a file except the last impede are identical in size. The blocks of a file are duplicated for obvious error tolerance. The replica factor and replication component are configurable per file. An application can identify the number of replicas of a file. The replication factor must be particular at file creation time and that can be altered afterward. Files in HDFS are write-once and have firmly one author at any time. The NameNode makes all conclusions considering replication of blocks. It occasionally gets a Heartbeat and a Block report from each of the DataNodes in the cluster. A Heartbeat felt by the NameNode suggests that the DataNode is functioning properly. A Block report comprises lists of all blocks on a DataNode.

26.5 HADOOP MODEL

The Hadoop Model has large-scale distributed batch processing infrastructure. While it can be utilized on a lone machine, its factual power lies in its proficiency to scale to hundreds or thousands of computers, each with some processor cores. Hadoop is furthermore conceived to effectively circulate large amounts of work over a set of machines.

More than hundreds of gigabytes of data compose the *low end* of Hadoop-scale. Actually, Hadoop is constructed to method the 'web-scale' data on the alignment of hundreds of gigabytes to terabytes or petabytes. At this scale, it is probable that the input data set will not even fit on a lone computer's hard propel, much less in memory. Hence, Hadoop encompasses a distributed file system which breaks up input data and drives parts of the initial data to some machines in cluster to hold. The outcomes are being processed in an aligned way, utilizing all of the machines in the cluster and computes pay outcomes as effectively as possible.

26.5.1 Challenges in Processing Large Data

Large-scale computation is not easy. To work with this capacity of data needs distributed components of the different multiple machines to handle in parallel. Whenever multiple machines are utilized in collaboration with one another, the likelihood of flops rises. In single-machine environment, malfunctioning is not what program designers concerned about, when the appliance has smashed into and there is no way for the program to retrieve anyway.

In a distributed environment, however, partial flops are anticipated and widespread occurrences. Networks can know-how partial or total malfunction if swaps and routers shatter down. Data may not reach at a specific time due to unforeseen mesh congestion. Individual compute nodes may overheat, smash into, or run out of recollection or computer disk space. Data may be corrupted or not suitably sent out. Multiple implementations or versions of purchaser programs may talk somewhat distinct protocols from one another. Clocks may become desynchronized; secure files may not be issued; etc. In each of these situations, the distributed system should be adept to retrieve from the constituent malfunction or transient mistake status and extend to make progress.

Different distributed systems expressly address certain modes of malfunction while being concerned less about others. Hadoop presents no security model, neither safeguards contrary to maliciously injected data.

Finally, bandwidth is a most significant resource even in an inner network. While a set of nodes exactly attached by a gigabit Ethernet may usually have high throughput between them, if all of the machines were conveying multi-gigabyte data groups, they can effortlessly saturate the switch's bandwidth capacity. Additionally, if the machines are dispersing over multiple racks, the bandwidth accessible for the data move would be much less.

26.5.2 Using Hadoop for Large Data Processing

Hadoop is developed to be an effective method for large volumes of data by connecting numerous computers simultaneously to work in parallel. In idea, 1000-CPU machines would cost a very large amount of cash, far more than 1000 single-CPU or 250 quad-core machines. Hadoop will bind these lesser and more sensibly cost machines simultaneously into a single cost-effective compute cluster.

Generally, setting a distributed environment requires performing computation on large volumes of data.

In Condor-G scheduling of computers can be done through existing systems. But Condor does not automatically distributed data: a distinct SAN should be organized in supplement to the compute cluster. Additionally, association between numerous compute nodes should be organized with a connection system, for example, MPI (Message Parsing Interface). This programming model demands more to work with and can lead to the introduction of subtle errors.

What makes Hadoop exclusive is its simplified programming model which permits the client to rapidly compose and check distributed systems and its efficient, self-acting distribution of data and work over machines and in turn utilizing the inherent parallelism of the CPU cores.

26.6 MAPREDUCE

The Internet presents an asset for amassing tremendous amount of data, often beyond the capability of individual computer disks and too large for processing with a single CPU. Google's MapReduce, constructed on peak of the distributed Google File System, presents a parallelization structure which has garnered substantial acclaim for its ease-of-use, scalability and fault-tolerance.

The achievement at Google provoked the development of the Hadoop task, an open-source attempt to duplicate Google's implementation, hosted as a sub-project of the Apache Software Foundation's Lucene seek motor library. Hadoop is still in early phases of development.

26.6.1 MapReduce Programming Model

MapReduce is a programming model and an affiliated implementation for processing and developing large data sets. A Map function is created by users, which contains key/value pair and they build an intermediate set of same pairs. A function called reduce merges all intermediate values with the same pairs. Many genuine world jobs are expressible in this model.

Programs written in this purposeful method are automatically parallelized and performed on a large cluster of machines. The run-time system takes care of the minutia of partitioning the input data, arranging the program's execution over a set of machines, managing machine failures and organizing the needed inter-machine communication. This permits programmers with aligned and distributed systems to effortlessly utilize the assets of a large distributed system.

The computation takes a set of input key/value in pairs and makes a set of output key/value pairs. The client of the MapReduce library expresses the computation as two functions:

Map and Reduce

MAP function: Map Function, written by the client, takes an input pair and makes a set of Intermediate Key/Value Pairs. The MapReduce library assembles all intermediate values affiliated with the identical intermediate key 'I' simultaneously and passes them to the Reduce function.

Reduce function: Reduce function, written by the client, acknowledges an intermediate key 'I' and a set of values for that key. It merges these values to pattern a lesser set of values. Typically, just none or one yield value is made per Reduce invocation. The intermediate values are provided to the user's reduce function by an iterator.

By virtue of its ease and obvious error tolerance, MapReduce proved to be an admirable entrance to parallelizing applications. The benefit of a straightforward development and robust computation did arrive at a cost in periods of performance. Furthermore, correct tweaking of the system directed to considerable variance in performance. MapReduce comprises an undertaking main heading for future implementations for parallelizing applications.

26.7 HADOOP VERSUS DISTRIBUTED DATABASES

Hadoop MapReduce parallelizes the computation (spatial operations) over multiple machines each running a Hadoop client. The obvious question that a book reader might lift is 'Why Hadoop when distributed/parallel database systems are currently in place?' What are the criteria that one should select to use the Hadoop for bearing out computation on large data groups over aligned databases and vice versa? What kinds of applications are matched one over the other? We succinctly give the interpretation utilizing some factors.

Scalability: Parallel database systems can be extended to a large number of systems. Recently, this was adequate for most of the analytical database applications. For example, eBay's 6.5 petabytes database, which is an existing large-scale data warehouse is applied on a 96-node Greenplum DBMS. Parallel DBMS have been conceived by holding the assumption in brain that node malfunction is a 'rare' event. The likelihood of a node malfunction rises with the boost in the dimensions of the cluster.

Fault tolerance: Fault tolerance is the proficiency of the system to contend up with node/task failures. An obvious error tolerant analytical DBMS is easily one that does not have to restart a query if one of the nodes engaged in query processing fails. Fault tolerance capability of the aligned DBMS is much inferior to that of Hadoop. Hadoop has been particularly conceived to display very good scalability house and fault tolerance capability. When node fails, the pending task(s) on a node is higher when comparing to Hadoop. In normal DBMS, the intermediate outcomes of query are pipelined to the next query operator or another sub-query without having in writing to disk.

However, in Hadoop, the intermediate outcomes of the mappers (or reducers) are habitually written onto the computer disk before they are fetched by the reducers (or mappers of the next MapReduce stage).

Performance: Parallel DBMS have been conceived to work in genuine system and thus what is significant is the presentation, while Hadoop has been conceived for batch processing. Hadoop devotes some presentation in other localities where there are no trade-offs for scalability. Hadoop was not initially conceived for organized data investigation and therefore is considerably outperformed by aligned database systems on organized data investigation tasks. Another assisting factor for Hadoop's slower performance is that the default configuration of Hadoop stores data in the accompanying distributed file system (HDFS), in the same textual format in which the data was generated. This storage method loads the system as it has to parse the fields. This parsing task requires each Map and Reduce task to frequently parse and convert string fields into the appropriate type.

Data loading: Once a DBMS is started and runs properly, programmers must write a schema to their data and then the data set will be loaded into the database. This method takes longer time in DBMS as compared to the MR system, because the DBMS has to parse and verify each datum in the tuples. In comparison, the default way for MR programmers to burden their data is to duplicate it into the MR system's inherent distributed block-based storage system.

SUMMARY

- Hadoop is an open source program that endows distributed processing of large data over inexpensive servers.
- Hadoop is creating worth for enterprises, organizations and individuals.
- The MapReduce paradigm takes idea from the map and it reduces programming constructs widespread in abundant programming languages.
- The Hadoop environment and will change over time as job structure alterations, data layout developments and increased data capacity.
- Hadoop has nodes inside each Hadoop cluster. They are DataNodes, NameNodes and EdgeNodes.
- The Hadoop Distributed File System (HDFS) is a distribute file system conceived to run on hardware.
- Hadoop is furthermore designed to effectively distribute large amounts of work over a set of machines.
- Hadoop presents no security model, neither safeguards contrary to maliciously injected data.
- Hadoop is developed to be an effective method for large volumes of data by connecting numerous computers to work in parallel.

KEY TERMS

- Cloudera, the Hadoop Company, evolves and circulates Hadoop, the open source programs that force the facts and numbers processing engines using well-liked WWW sites.
- Hadoop was initially evolved to be an open implementation of Google MapReduce and Google File System.
- The Hadoop Distributed File System (HDFS) is a distribute file system conceived to run on a hardware.
- The Hadoop Distributed File System (HDFS) is created to warehouse very large written knowledge collections reliably, and to stream those written knowledge collections at high bandwidth to customer applications.
- MapReduce is a programming paradigm that permits huge scalability over hundreds or thousands of servers within a Hadoop cluster.
- Distributed Database is a database that contains two or more written knowledge records found at divergent sites on a computer network.

REVIEW QUESTIONS

- What is Hadoop?
- What are the advantages of Hadoop?
- What is the need to embrace the Hadoop system?
- What is MapReduce paradigm?
- What are the challenges involved in implementing the Hadoop system?
- List the node types in Hadoop.
- What is NameNode?
- What is DataNode?
- Define EdgeNode?
- What are the primary uses of Hadoop?
- Write few points on the database system in Hadoop.
- What are the challenges faced in large-scale computing?
- How does Hadoop handle maliciously inserted data?
- What may be the underlying threat in replication of data across machines?
- How does the bandwidth of network affect the performance of Hadoop?
- How can a Hadoop system ensure better performance?
- In what way is Hadoop better than the existing grid computing system?
- List the unique features of Hadoop.
- How is Hadoop scaled up in terms of number of machines?
- Explain Google's MapReduce.
- What is the shuffling phase in the reduce function?
- In what ways is Hadoop better than existing distributed databases?
- How is Hadoop better than distributed databases in terms of scalability?
- How is Hadoop better than distributed databases in terms of fault tolerance?
- How is Hadoop better than distributed databases in terms of data loading?
- What is HDFS?

CHAPTER 27

Cloud Tools

27.1 VMWARE

VMware, Inc. is a company providing virtualization software, evolved in 1998. The company was acquired by EMC Corporation in 2004 and functions as a distinct software subsidiary. VMware's desktop software sprints on Microsoft Windows, Linux and Mac OS-X, while VMware's enterprise software hypervisors for servers, VMware ESX and VMware ESXi and are bare-metal embedded hypervisors that run exactly on server hardware without needing an added inherent functioning system.

VMware software presents an absolutely virtualized set of hardware to the visitor functioning system. It virtualizes the hardware for a video adapter, a mesh adapter and hard computer disk adapters. The host presents pass-through drivers for quest USB, serial and parallel devices. In this way, the VMware virtual machine becomes highly portable between computers, because every host examines almost equal to the guest.

Some of the adversities of virtualization on x86-based stages are bypassed by VMware's approach. Virtual machines are considered with offending directions by refurbishing them or by easily running kernel-code in user-mode. The VMware merchandise line can furthermore run distinct functioning systems on a dual-boot system simultaneously by booting one partition natively while utilizing the other as a guest inside the VMware Workstation.

VMware supports:

- Desktop software consisting of:
  - VMware workstation
  - VMware fusion
  - VMware player
- In the server software
  - VMware markets two virtualization products for servers: VMware ESX and VMware ESXi.
  - The VMware server is furthermore supplied as freeware for non-commercial use, like VMware player, and it is likely to conceive virtual machines with it. It is a 'hosted' application, which sprints inside an existing Linux or Windows OS.
- The cloud management software consists of:
  - VMware vCloud
  - VMware Go

27.2 EUCALYPTUS

For Linking Your Programs To Useful Systems can use Elastic Utility Computing Architecture is the GPL-licensed software which presents tooling to create and organize a private cloud that can even be accessed as a public cloud. It is a compatible platform for Amazon EC2 and S3 storage. It makes its services accessible through EC2/S3 compatible APIs. Features in it are:

- Interface compatibility with EC2
- Simple setting up and deployment utilizing rocks

- Simple set of extensible cloud share policies
- Overlay functionality needing no modification into the Linux environment
- Basic administrative tools for system administration and client accounting
- Configuring multiple clusters with private mesh locations into a single cloud
- Portability

Eucalyptus was initially developed to supply an inexpensive, extensible and straightforward platform to establish open source cloud structure for the world of academia. It was developed by computer researchers and scientists requiring elastic compute resources. However, with an increase in demand for private clouds, Eucalyptus provides an inexpensive and workable stepping stone into the cloud for the enterprise.

27.2.1 Components of Eucalyptus

Eucalyptus has three foremost components:

1. *Cloud controller (CLC)*: Comprises the front-end services and the Walrus storage system.
2. *Cluster controller (CC)*: Gives support for the virtual mesh overlay.
3. *Node controller (NC)*: Interacts with VT to classify individual VMs.

The two constituents are utilized for storage administration:

1. *Storage controller (SC)*: Presents continual impede storage for the instances.
2. *Walrus storage controller (WSC)*: Presents continual and straightforward storage service.

Node Controller (NC)

The NC is accountable for executing a task on the private resources that host VM instances such as launch, check shutdown and clean-up. A Eucalyptus cloud may comprise of some node controllers. Since each NC can organize multiple virtual machine instances, only a single NC is needed for each physical machine.

NC is a virtual fatal endowed server capable of running Kernel-based virtual machine (KVM) as the hypervisor. The VMs running on the hypervisor are controlled by the *instances*.

The node controller interacts with the operating system and the hypervisor running on the node, while on the other hand it furthermore interacts with the cluster controller (CC).

NC queries the OS on the node to find out the node's resources. They are a number of cores, memory and disk space. NC furthermore monitors the state of the VM instances running on the node to propagate this data to the CC.

Cluster Controller (CC)

The CC is responsible for managing an assemblage of NCs (cluster) that work together. The CC has access to both the private and public systems and is generally established on the cluster's head node or front-end server. The CC supervises the state data of all instances in the pool of NCs and coordinates the incoming input requests flow.

Walrus Storage Controller (WS3)

WS3 is a continual and straightforward storage service. WS3 uses REST and SOAP APIs, which are compatible with S3 API.

Its features are:

- Store machine images
- Store snapshots
- Store and serve documents utilizing S3 API

It should be considered as a straightforward file storage system.

Storage Controller (SC)

It presents continual impede storage for the instances. It resembles like elastic block storage service from Amazon.

- It creates and organizes continual impede storage devices.
- It creates snapshots of volumes.

Cloud Controller (CLC)

Incoming demands from external clients or administrators are processed by CLC. CLC is responsible for handling demands. Each Eucalyptus cloud will have a distinct CLC. It is the user-visible entry point and decision-making constituent that makes high-level VM instances scheduling conclusions, process authentication and sustains continual system and client metadata.

CLC is the front end to the whole cloud infrastructure. It presents EC2/S3 compliant web services interface to the client tools and interacts with other constituents of the Eucalyptus infrastructure. It furthermore presents a web interface for users to organize delegated facets of the UEC infrastructure.

Its features are:

- Monitoring resources of the cloud infrastructure
- Resource arbitration
- Monitoring running instances

CLC has comprehensive information of the state of the cloud with esteem to accessibility and usage of resources primarily.

27.3 CLOUDSIM

Cloud computing is the expertise which delivers dependable, protected, fault-tolerant, sustainable and scalable computational services. Moreover, these services are suggested in private data hubs (private clouds), commercially suggested for clients (public clouds), or yet it is likely that both public and private clouds are blended in hybrid clouds.

The very high demand for energy-efficient IT technologies, and controllable methodologies for evaluation of algorithms, applications, and principles, made hard-hitting in development of cloud products.

An alternate is the utilization of replication devices, which open the likelihood of assessing the hypothesis prior to the software's development in an environment where one can duplicate tests. Specifically in the case of cloud computing, where access to the infrastructure acquires payments in currency, simulation-based advances offer important benefits. It permits cloud clients to check their services free of cost in a repeatable and controllable environment.

The prime objective of the CloudSim project is to supply a generalized and extensible replication structure that endows seamless modelling, replication and experimentation of cloud computing infrastructures and application services. By utilizing CloudSim, investigators and industry-based developers can aim at the exact system design issues that they desire to enquire, without getting worried about the reduced level associated to cloud-based infrastructures and services. CloudSim is driven by jProfiler.

CloudSim functionalities are as follows:

- Support for modelling and replication of large-scale cloud computing data centres.
- Support for modelling and replication of virtualized server hosts, with customizable principles for provisioning host assets to virtual machines.
- Support for modelling and replication of energy-aware computational resources.
- Support for modelling and replication of data centre mesh topologies and message-passing applications.
- Support for modelling and replication of federated clouds.
- Support for dynamic insertion of replication components, halt and restart of simulation.
- Support for user-defined principles for share of hosts to virtual appliances and principles for share of owner assets to virtual machines.

27.4 OPENNEBULA

OpenNebula is actually the premier and most sophisticated structure for cloud computing. It is exceedingly straightforward to setup. Furthermore, it is flexible, extensible and with very good presentation and scalability to organize tens of thousands of VMs, Private cloud with Xen, KVM and VMware.

Cloud computing arrives and aims only when there is a requirement to boost capability or add capabilities on the go without buying new infrastructure, training new staff or authorizing new software. Cloud computing supports subscription-based or pay-per-use service that, with time over the Internet, expands IT's existing capabilities.

A cloud service has three different characteristics that make a distinction from custom hosting. It is traded on demand, normally by the minute or the hour, it is elastic, that is, a client can have as much or as little service as they desire at any granted time, and the service is completely organized by the provider. Significant innovations in virtualization and distributed computing advanced access to high-speed Internet and accelerated concern in cloud computing.

OpenNebula is a completely open-source toolkit to construct IaaS private, public and hybrid clouds. The first step is habitually to construct a private cloud that can be subsequently expanded as a hybrid cloud by blending localized assets in the private cloud with assets from isolated cloud providers or as a public cloud by revealing cloud interfaces to get access to the private or hybrid cloud.

An OpenNebula private cloud presents infrastructure with an elastic stage for very fast consignment and scalability of services to rendezvous dynamic claims of service end users. Services are hosted in VMs and then submitted, supervised and controlled in the cloud by utilizing the OpenNebula operations centre or any of the OpenNebula interfaces: command line interface (CLI), XML-RPC API, OpenNebula cloud APIs and Libvirt virtualization API or any of its administration tools.

OpenNebula does the following:

- Management of the network, computing and storage capacity
- Management of VM life-cycle
- Management of workload placement
- Management of virtual networks
- Management of VM images
- Management of information and accounting
- Management of security
- Management of remote cloud capacity
- Management of public cloud servers

27.5 NIMBUS

Nimbus is an open-source toolkit concentrated on supplying infrastructure as a service (IaaS). It provides capabilities to the scientific community. To accomplish it focuses on three goals:

- Enables asset providers to construct personal and community IaaS cloud.
- Enables users to use IaaS clouds.
- Enables developers to continue, trial and customize IaaS.

Major features are as follows:

- *Open source IaaS*: Nimbus presents a 100% freely accessible and open source infrastructure as a service (IaaS) system. Every characteristic that a community develops is freely accessible and there are no add-on or improvement costs.
- *Storage cloud service*: Cumulus is a storage cloud service that is matching with the S3 REST API. It can be utilized contrary to numerous existing purchasers (boto, s3cmd, jets3t, etc.) to supply data storage and transfer services.
- EC2 based clients are capable of utilizing Nimbus installations. Both SOAP API and the REST API have been applied in Nimbus. S3 REST API clients can also be utilized for organizing VM storage with the Nimbus system.
- *Easy to use cloud client*: The workspace cloud client permits authorized clients to get access to numerous workspace service characteristics in a client amicable way. It is conceived to

get users up and running in a time-span of minutes, even from laptops, NATs, etc. The workspace cloud client supports for storing data in cloud also acts as IaaS. Even the uninitiated finds this completely incorporated device so straightforward to use.

- *Per-user storage quota*: Cumulus (the VM likeness repository supervisor for Nimbus) can be configured to enforce per client storage usage limits.
- *Easy client management*: New in Nimbus 2.5 are a set of client administration tools that make administering a Nimbus cloud considerably easier. The tools are both straightforward to use and scriptable.

SUMMARY

- ❖ VMware's desktop software sprints on Microsoft Windows, Linux and Mac OS-X.
- ❖ VMware software presents an absolutely virtualized set of hardware to the visitor functioning system.
- ❖ Eucalyptus was initially developed to supply an inexpensive, extensible and straightforward platform to establish an open source cloud structure for the world of academia.
- ❖ Components of Eucalyptus are (i) cloud controller (CLC), (ii) cluster controller (CC), (iii) node controller (NC), (iv) storage controller (SC) and (v) Walrus storage controller (WSC).
- ❖ The NC is accountable for executing a task on the private resources that host VM instances such as launch, check shutdown and clean-up.
- ❖ The CC is responsible for managing an assemblage of NCs (cluster) that work together.
- ❖ WSC presents a continual and straightforward storage service. WSC uses REST and SOAP APIs, which are compatible with S3 API.
- ❖ SC presents continual impede storage for the instances. It creates and organizes continual impede storage devices and snapshots of volumes.
- ❖ Incoming demands from external clients or administrators are processed by CLC. CLC is responsible for handling demands.
- ❖ Cloud computing is the expertise which delivers dependable, protected, fault-tolerant, sustainable and scalable computational services.
- ❖ The objective of the CloudSim project is to supply a generalized and extensible replication structure that endows seamless modelling, replication and experimentation of cloud computing infrastructures and application services.
- ❖ OpenNebula is actually the premier and most sophisticated structure for cloud computing.
- ❖ OpenNebula is a completely open-source toolkit to construct IaaS private, public and hybrid clouds.
- ❖ Nimbus is an open-source toolkit concentrated on supplying infrastructure as a service (IaaS).

KEY TERMS

- Cloud virtualization software and services are provided by an American software company, VMware, Inc.
- VMWare is an open source program and a request for paid job model makes it not hard to run any virtual devices, by using VMware Workstation and VMware Fusion.
- Eucalyptus is open cause cloud software for constructing AWS-compatible confidential and hybrid clouds.
- CloudSim's aim is to supply a generalized and extensible replication structure that endows modelling, replication and experimentation of appearing cloud technology.
- OpenNebula is a completely open-source toolkit to construct IaaS private, public and hybrid clouds.
- The Nimbus platform is an incorporated set of devices that consign the power and versatility of IaaS-type clouds for technical and science applications.

REVIEW QUESTIONS

- List some cloud computing platforms.
- Define Eucalyptus.
- State the features of Eucalyptus.
- State the three goals of Nimbus cloud.
- List the functionalities of OpenNebula.
- State the objective of CloudSim.
- Expansion Eucalyptus.
- What is use of VMWare software?
- State the use of VMWare.

PART NINE
Cloud Applications

CHAPTER 28

Moving Applications to the Cloud

28.1 CLOUD OPPORTUNITIES

Cloud computing presents an opening for business discovery and supplies platform to turn IT into a more productive and responsive business service. Ensuring on-demand access to pools of trusted infrastructure and services, cloud pledges to de-couple business plans from the IT capabilities driving by them. For IT, it entails some basic re-structuring and re-skilling. For enterprise, it entails potential transformation in the speed, flexibility, effectiveness, competitiveness and discovery of organizations. Some of the cloud possibilities are listed in the following text.

Cloud for cost reduction: Under the pressure to decrease the cost of procedures, organizations of all dimensions anticipate their IT to consign more worth for less expense. By eradicating up-front spend on IT and supplying IT capability on pay-per-use, cloud promises to restructure the IT budget, moving key applications and services to multi-tenancy architectures.

Cloud for enterprise growth: Cloud permits organizations to quickly and effortlessly scale up their procedures to support enterprise goals, in-terms of:

- Expanding into new markets
- Attracting and keeping new clients
- Executing the amalgamation and acquisition system or racing up time-to-market for new goods and services

Cloud for fast innovation: Cloud promises a spectacular change in the enterprises by endowing fast innovation. Cloud eliminates obstacles for larger collaboration while lowering the risk and cost of both going into new markets experimenting and checking new goods and services.

Cloud for enterprise agility: Cloud computing with its flexible infrastructures and on-demand charging is a beginning to reset the anticipations for IT business. It presents the opening for IT to be re-cast as an enabler of enterprise agility other than an inhibitor of enterprise change.

Cloud possibilities will be in three forms. Vendors hoping to find sales should aim on three categories:

1. Working out an organization's cloud system
2. Endowing an organization's readiness to proceed to the cloud
3. Applying a cloud-based solution.

In the first kind, an agency might demand guidance on how to set up designs to apply in a cloud environment. These possibilities might encompass assistance in evolving principles and best practices.

In the second class, an agency has resolved to take up cloud computing and set up the required infrastructure. Work to consolidate data hubs, conceive virtual systems that imitate personal expertise or conceive a service-oriented architecture could all be included.

The whole globe's business on the cloud is nascent at $30 billion. The world's large-scale cloud-based firm, Salesforce.com, is $1.6 billion in revenues. In evaluation, Walmart has taken $421.8 billion in revenues in 2010. The cloud business of Microsoft, IBM, Amazon and Google may be bigger than Salesforce's, but as an untainted play Cloud Company, it is yet to be surpassed. By 2020, the opening on the cloud is projected to be $700 billion. In the next 5 years solely, the market is set to double to $60 billion (4% from India).

28.2 BUSINESS OPPORTUNITIES USING CLOUD

'Transform your business with the cloud.' This declaration has altered every expertise and business dialogue over the past couple of years. Few can notify what businesses are really managing to get advantage from the cloud or how to conceive and establish a cloud system that is really transformative. Cloud adoption is topped up with business and operational trials surrounding expertise, security, Total Cost of Ownership (TCO) and the intersection with business systems and operations.

Most have very little know-how in cloud implementation. Few have addressed the full influence of cloud integration with other applications and data, organizational redesign and change administration, compliance, levies and security. To convey some clarity to the topic, an international review was undertaken amidst more than 900 persons from 15 nations. The review responds from both the consumers' community of end-users, with input from both Information Technology directors and executive administration in businesses with more than US $200 m in revenues and cloud vendors. From all angles the solutions displayed expanded readiness to accept and exploit the advantages of cloud.

Cloud is transformative in that it is creating new business possibilities as businesses harness its power to effectively help new revenues, services and businesses. It is shattering down obstacles in providing a string of connections, creating more productive and timely interaction between consumers and suppliers. It is consigning pace, agility and cost decrease to IT and other purposeful localities inside the business. The transformative influence of cloud can be glimpsed in the localities from HR, CRM and IT infrastructure.

The cloud computing is generic, but its usage depends on the needs of the user. Over half of the business and government business reviewed have currently undertaken either a full or partial cloud implementation of some functions. The majority has checked these new technologies and methods and is utilizing them on a small scale. Some usual localities of cloud implementation are e-mail, sales administration and other accessible Software as a Service (SaaS) offerings.

Executives accept as fact that cloud environments have the potential to change business and functioning models. Cloud providers accept as fact that business and IT executives underestimate the platform of change that could result from cloud adoption.

Substantial cost savings are on their way. Business and IT executives as well as providers accept as a fact that cloud environments will consign cost savings. Private clouds will override the most critical functions. Many components propel the conclusion either to public or private clouds. Private clouds are deployed in healthcare, financial service and diversified organizations. Financial services and healthcare face hefty regulatory and compliance matters which are not unrealistic to overwhelm in the cloud. Organizations' custom-configured applications and infrastructure furthermore assist to the requirements for private cloud solutions versus the normalized solutions amidst public clouds.

28.2.1 The S, P and I

The cloud has three elements: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). There is, of course, a fourth element: IT services on the cloud. The PaaS and IaaS markets are overridden by large incumbents like Google App Engine, Amazon Web Services, Microsoft and telecom operator Verizon.

SaaS can be effective in India, as the technical background and skill sets are good. It is furthermore where the greatest international activity is. Millions of start-ups unearth business in this segment. Over 300 unaligned program vendors from India use Microsoft Azure to construct 8,000 applications.

According to a Nasscom study, cloud assists to slash the repaired IT rate of entry and production. It furthermore decreases application obstacles to commence new companies, particularly for SMEs and unaligned developers.

28.3 APPLICATIONS IN THE CLOUD

In cloud computing, the applications are virtually limitless. Possibly, everything from generic phrase processing programs to customized computer programs formed for a correct business might work on a cloud computing system. Here are a couple of causes why any individual likes to depend on another computer system to run programs and store data:

1. Clients would be adept to get access to their applications and data from any location at any time. They could get access to the cloud computing system utilizing any computer connected to the Internet.
2. It could convey hardware charges down. The cloud computing system would decrease the requirement for sophisticated hardware on the purchaser side.

Corporations that depend on computers have to confirm they have the right software in location to accomplish goals. Cloud computing systems offer these organizations a company-wide entrée to computer applications. The businesses do not have to purchase a set of software or licenses for every employee. Instead, the business could pay a metered charge to a cloud computing company.

28.3.1 Applications Shifted to the Cloud

There are application vendors who have certain application categories that are well established in-terms of reliability, security and fairness. It is a good time to take a gaze at the cloud again. Here are some applications that can be shifted to the cloud.

E-mail: E-mail is the lifeblood of numerous organizations, and as an outcome numerous businesses are not eager to let go of it. E-mail architecture has become rather normalized and there is actually no value-add to holding it inside the firewall other than mitigating regulatory concerns.

Conferencing software: Setting up and sustaining conferencing programs is not fun. To make matters poorer, when it is down, it desires to be up in a hurry. Like e-mail, there is no advantage to pin pointing this inside the firewall, and furthermore the setup and configuration can be convoluted in the need of an expert.

CRM: The conclusion to outsource CRM can be scary. After all, like e-mail, CRM is where many of the company's crest jewels are stored. But there are no technical advantages or benefits in having CRM in-house. The authorizing of numerous CRM systems can be a hassle. Moving to a hosted CRM system can free us to spend more time on more significant issues.

Web hosting: Many vendors have moved to a virtualized hosting environment and this has spectacularly expanded uptime, decreased security risks and permitted them to supply much more open and direct access to the servers. This is great news, particularly for businesses with made-to-order applications that need a deployment after copying some files.

Batch processing applications: One kind of application that polishes in the cloud is the batch processing application, for example, a data warehouse. As long as the data required is accessible into the cloud without disturbing the procedures, the proficiency to quickly scale capability in the cloud can result in marvellous savings.

28.4 MANAGING DESKTOP AND DEVICES IN CLOUD

Desktop and device asset administration assists us to choose, purchase, use and sustain desktop hardware and software. From an administration viewpoint, one should realize that cloud computing desktop virtualization does not eliminate the requirement for administration at the desktop. Additionally, it may still require organizing laptops and PCs that cannot be virtualized and that task may still place a hefty demand on support. Here is a list of essential undertakings to organize desktops and wireless devices thoroughly:

- Establish a comprehensive hardware asset register
- Establish a software register
- Control software licenses
- Manage device costs

28.5 CLOUD DESKTOP

Access anywhere, everywhere, anytime: Cloud Desktops presents completely purposeful, personalizable and continual desktops without the cost and complexity affiliated with getting hardware, configuring OS or constructing Virtual Desktop Infrastructures (VDI). Cloud Desktops provides protected and dependable access to desktops in the cloud from any client device.

Personalized and persistent: Cloud Desktops is neither distributed nor temporary. Personalize the desktops required and add the applications needed. The desktop, data and personalization are with us until we delete it.

Inexpensive and hassle-free: Cloud Desktops is accessible for \$20 a month. Pay no up-front charges and you are not locked into any long-term contracts.

Secure and reliable: Cloud Desktops is constructed on Amazon EC2, which commits to 99.95% accessibility and presents ways for protecting hosted desktops. In addition, it simplifies and protects the cloud desktop login utilizing an encrypted, single-use token to authenticate users into their desktops.

Easy to manage: Cloud Desktops Web interface provides easy designing, imaging, deleting and tracking desktop usage in the cloud environment. One can organize multiple users, each with their own individual desktops. The interface permits to track who is utilizing their desktop and how long they are utilizing it.

28.6 SCIENTIFIC APPLICATIONS IN THE CLOUD

Scientific computing engages the building of mathematical models and numerical solution methods to solve technical, scientific and technology problems. These models often need a huge number of computing assets to present large scale experiments or to slash down the computational complexity in a sensible time frame. These desires have been primarily addressed with dedicated high-performance computing (HPC) infrastructures, for example, clusters or with a pool of networked machines in the same department, organized by some 'CPU cycle scavenger' software like Condor. With the advent of Grid computing, new possibilities became accessible to researchers that could offer on demand large experiments.

Computing Grids introduced new capabilities like the dynamic breakthrough of services and finding the best set of machines meeting the obligations of applications. The use of Grids for technical computing has become so thriving that numerous worldwide tasks led to the establishment of worldwide infrastructures accessible for computational science.

Even though the prevalent use of Grid technologies in technical computing is illustrated, some matters still make the access to this expertise not as straightforward as depicted. Some matters are bureaucratic and significantly these Grids are distributed worldwide. Research study has submitted a suggestion regarding the kind of research they want to do.

Cloud computing can address numerous of the aforementioned problems. By using virtualization technologies, cloud computing boasts end-users a variety of services covering the whole computing stack, from hardware to application level. Another significant feature is that researchers can take advantage in terms of scaling up and scaling down the computing infrastructure as asserted by the application obligations and the budget of users.

By utilizing Cloud-founded technologies, researchers can have a straightforward access to large distributed infrastructures and will customize their execution environment. Moreover, by leasing the infrastructure on a pay per use basis, they can have direct access to needed assets and are free to release them when no longer needed.

Different solutions are available to precede from the customary research Grids and adopt the Cloud computing paradigm. Some vendors, for example, Amazon Web Services and VMware, groundwork on hardware level virtualization and supply bare compute and storage resources on demand. Google AppEngine and Microsoft Azure are more concentrated on application level virtualization by enforcing an exact application model that leverages their large infrastructure and scales up and down on demand. Other solutions supply end users with a platform for evolving Cloud computing applications that can depend on, or create, some of the existing solutions thus supplying a better quality of service to the end-user.

Aneka is a Cloud platform for growing applications that can be climbed onto via harnessing the CPU of virtual resources, desktop PCs and clusters. Its support for multiple programming models presents researchers with distinct choices for expressing the reasoning of their applications: bag of tasks, distributed threads, dataflow or MapReduce. The Service-oriented architecture presents users with an exceedingly customizable infrastructure that can rendezvous the desired quality of service for applications.

Clouds are therefore appearing as a significant class of distributed computational assets, for both data-intensive and compute-intensive applications.

28.6.1 Cloud as a Type of Distributed Infrastructure

To structure the dissimilarities between grid and cloud applications, let us take a look at the three stages of an application's life cycle: development, deployment and execution. In development, the three units (execution unit, connection and coordination) either resource administration or scheduling, influencing the above three vector values. In deployment, clouds can be apparently differentiated from clusters and grids. Specifically, the runtime environment is controlled by the user. This is in contrast to custom computational environments. By supplying ease and simplicity in administration, it is hoped that the alterations at the execution level may feed back to the application development level.

An added topic is compositional and deployment flexibility. A number of applications are tough to construct, due to runtime dependencies or perplexing non-portable systems. There is often a requirement to control the runtime environment at a fine-grained level, which is often tough with grids. This often presents a rationale for utilizing cloud environments. Clouds offer an opening to construct virtual machines one time, then to load them on diverse systems, employed around issues associated to portability on the private systems, because the VM images can be static, while genuine systems (both hardware and software) are often changing.

A third topic is scheduling flexibility. Clouds offer the proficiency to conceive usage modes for applications to support the stand where, when the set of resources required to run an application changes (perhaps rapidly), resources can really be altered (new resources can be supplemented or existing resources can be taken from the pool utilized by the job).

SUMMARY

- For IT organizations, cloud computing entails potential transformation in terms of speed, flexibility, effectiveness and competitiveness.
- Some of the cloud possibilities are (i) cloud for cost reduction, (ii) cloud for enterprise growth, (iii) cloud for fast innovation and (iv) cloud for enterprise agility.
- Cloud adoption is topped up with business and operational trials surrounding expertise, security, total cost of ownership (TCO) and the intersection with the business system and operations.
- The cloud has three elements: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS) and a fourth element: IT services on the cloud.
- Some applications that can be shifted to the cloud are (i) e-mail, (ii) conferencing software, (iii) CRM, (iv) web hosting and (v) batch processing applications.
- Cloud Desktops presents completely purposeful, personalized and continual desktops without the cost and complexity in terms of hardware and OS.
- Cloud Desktops Web interface provides easy design, imaging, deleting and tracking desktop usage in the cloud environment.

- Scientific computing engages the building of mathematical models and numerical solution methods to solve technical, scientific and technology problems.
- Computing Grids introduced new capabilities like the dynamic breakthrough of services and finding the best set of machines meeting the obligations of applications.
- Different solutions are available to precede from the customary research Grids and adopt the Cloud computing paradigm.
- Google AppEngine and Microsoft Azure concentrate more on application level virtualization.
- Aneka is a Cloud platform for growing applications that one can climb onto via harnessing the CPU of virtual resources, desktop PCs and clusters.
- Clouds are appearing as a significant class of distributed computational assets for both data-intensive and compute-intensive applications.

KEY TERMS

- CRM is an industry term, which describes the methodologies, software and capabilities that can help to build better relationship between organization and customer.
- Batch processing is where processing transactions are done in a group or batch. No user interaction is required once batch processing is underway.
- Cloud Desktops is a Windows desktop provided by an outside company, rather than delivered by the internal IT department.

REVIEW QUESTIONS

- List the applications moved to Cloud.
- Define Cloud Desktops.
- State the use of Aneka.
- Explain how cloud computing can be used in solving scientific problems.
- List the advantages of Cloud Desktops.

CHAPTER 29

Microsoft Cloud Services

29.1 INTRODUCTION

Mega technology tendencies are altering how people work today. The cloud, wireless, communal and large-scale data are all affecting how enterprises enlist with their clients, partners and workers in alignment to competence. In the case of cloud computing, we believe that a key step in the direction of assisting the clients is to accomplish better enterprise agility, economics and client experiences. Its power basically changes how enterprises function and contend the cloud is a game changer for the enterprise.

Today, IT is experiencing a move from the customary client/server to the cloud. Going ahead, enterprises and other organizations will gaze to spend and deliver IT as a service. Cloud pledges to make IT not just lower, but also much quicker, simpler, more flexible and more effective. Small enterprises have numerous of the identical rudimentary IT desires as bigger organizations, like connection, security, reliability, storage and desktop management. However, small enterprises have fewer assets, so they have restricted proficiency to make foremost IT capital investments.

Microsoft boasts the advantages of the cloud with the familiarity of Microsoft applications that users, developers, IT professionals and leaders currently understand and trust. Microsoft Cloud Services include Office Web Apps, Microsoft Lync Online, Microsoft Exchange Online, Microsoft Dynamics CRM Online, Windows Live ID, Windows Server Active Directory, SQL Azure, Windows Azure Platform Appliance, Windows Azure, Windows Azure Platform Appliance, SharePoint Online, Office Live Meeting and Windows Intune.

Accelerate the development of the enterprise by deployment or trading cloud solutions based on Microsoft cloud technologies. The next possibilities assists to supply the technical and enterprise carriers that are required to propel new levels of profitability and comparable advantage.

Table 29.1 Business Model and Cloud Solutions

Business Model	Cloud Solutions
Sell	• Recurring revenue • Packaged solutions • Expanded services • New markets and customer segments
Build	• Repeatable IP • Faster deployment • Migrate solutions to the cloud • Scale users • Faster, less costly testing • Extended and customized cloud offerings
Host	• Extended product offerings • Broader marketplace • Increased wallet share

Created expressly for Microsoft OEM partners and the OEM Training Zone, it presents short techniques, evaluations, videos and presentations to assist consumers to realize better about Microsoft offerings and enlist its customers.

Microsoft is positioning 'application platforms' as the perfect way to bundle their technologies for fast enterprise solutions. The inherent 'xRM' development toolset is expressly proposed to technical portable and modular software. This device is perfect for distributed cloud environments supplying database replication between data centres. These are types of mode service providers that can offer worthy to these projects.

At present the society claims a level of security and lawful compliance capabilities that customary IT procedures can no longer contend with but which cloud storage can, and by plug-ins to apps like SharePoint and Exchange it can be directed in a functional and creative manner.

29.2 WINDOWS AZURE PLATFORM

29.2.1 Microsoft Cloud Services

Microsoft has its own cloud hosting services, Azure, but there are still other scenarios where Microsoft softwares can be established in cloud and these offer a fertile merchandise development locality for world wide web hosting providers. These 'Microsoft Cloud Services' (MCS) offer the perfect way to proceed into more of an Microsoft Service Partner (MSP) mode, supplying a fuller variety of IT outsourcing services and increased recurring revenues. Most organizations currently have apps like SharePoint and Exchange established internally, so hosted versions do not offer any pain-solving solutions. In comparison, new, cloud-based services that add worth to these living installations are very well aimed at niche opportunities.

Cloud computing is here. Running applications on systems in an Internet-accessible data centre can convey abounding advantages. Yet while they run, applications are constructed on some kind of platform. For on-premises applications, this platform generally encompasses functioning systems, a way to shop data and possibly more. Applications running in the cloud require a same foundation.

The Microsoft cloud computing platform utilizes Windows Azure to construct and extent world wide web applications using its data centres. Windows Azure is categorized as platform as a service and structure element of Microsoft's cloud computing system along with its software as a service.

The platform comprises diverse on-demand services hosted in Microsoft data hubs and consigned through three merchandise brands:

1. *Windows Azure* (a functioning system supplying scalable compute and storage facilities).
2. *SQL Azure* (a cloud-based, scale-out type of SQL server).
3. *Windows Azure AppFabric* (an assemblage of services carrying applications both in the cloud and on premise).

Windows Azure: It provides a Microsoft Windows Server–based computing environment for applications and continual storage for both organized and unstructured data, as well as asynchronous messaging.

Windows Azure AppFabric: It provides a variety of services that assist consumers to attach users and on-premise applications to cloud-hosted applications, organize authentication and apply data administration and associated characteristics, like caching.

SQL Azure: It is vitally an SQL server supplied as a service in the cloud. The platform furthermore encompasses a variety of administration services that permit users to control all these assets (resources), either through a web-based portal or programmatically. In most situations, there is a REST-based API that can be utilized to characterize how the services will work. Most administration jobs that can be presented through the web portal can furthermore be accomplished utilizing the API.

Microsoft has also released designs to offer the Windows Azure Platform Appliance, which can be hosted in non-Microsoft data centres. This will endow resellers, such as HP, Dell, Fujitsu and eBay, to offer cloud services based on the Microsoft Azure Platform.

Windows Azure is a platform for running Windows applications and saving data in the cloud. Windows Azure sprints on machines in Microsoft data centres. Rather than supplying software, Microsoft clients can establish and run it on their own computers. As a service, clients use it to run applications and share data on Internet-accessible machines owned by Microsoft. Those applications might supply services to enterprises, to buyers or both. Here are some example applications that might be constructed on Windows Azure:

- A self-determining software vendor (ISV) could visualize an application that aims enterprise users; an approach that is often brought up is Software as a Service (SaaS). ISVs can use Windows Azure as a base for business-oriented SaaS applications.
- An ISV might conceive a SaaS application that targets consumers. Windows Azure is conceived to support very scalable programs and so a firm that designs to target a large buyer market will select it as a base for a new application.
- Employees use Windows Azure to construct and run applications within Enterprises. While this position will not likely need the tremendous scale of a consumer-facing application, the reliability and manageability that Windows Azure boasts could still make it an appealing choice.

Windows Azure is the application service in cloud which allows Microsoft data centres to host and run applications. It presents a *cloud functioning system* called Windows Azure that assists as a runtime for the applications and presents a set of services that permits development, administration and hosting of applications off-premises. All Azure services and applications created using them run on peak of Windows Azure.

Windows Azure has three centre components:

1. *Compute* which presents a computation environment with *Web Role*, *Worker Role* and *VM Role*.
2. *Storage* which focuses on supplying scalable storage (*Blobs, non-relational Tables and Queues*) for large-scale needs.
3. *Fabric* which values high-speed attachments and swaps to interconnect nodes comprising some servers. Fabric resources, applications and services running are organized by the *Windows Azure Fabric Controller* service.

The Windows Azure Platform presents an API constructed on REST, HTTP and XML that permits a developer to combine with the services supplied by Windows Azure. Microsoft also presents a client-side, organized class library which encapsulates the purpose of combining with the services. It also incorporates with Microsoft Visual Studio in order that it can be utilized as IDE to evolve and release Azure-hosted applications.

Hardware assets are abstracted by the Windows Azure platform using virtualization. Each application that is established to Windows Azure sprints on one or more Virtual Machines (VMs). These established applications act as though they were on a dedicated computer, whereas they might share physical resources, for example, computer disk space, network I/O or CPU centres with other VMs on the identical physical host. Portability and scalability are the advantage of an abstraction level in hardware. Virtualizing a service allows it to be moved to several numbers of physical hosts in the data centre.

The Compute Service

The Windows Azure Compute Service can run numerous distinct types of applications. A prime aim of this platform is to support applications that have a very large number of simultaneous users. Windows Azure is conceived to support applications that scale out, running multiple exact replicates of the identical code over numerous product servers.

To allow this, a Windows Azure application can have numerous occurrences which executes in its own virtual machines (VM). These VMs run 64-bit Windows Server 2008 and they are supplied by a hypervisor (based on Hyper-V) that has been changed for use in Microsoft's cloud. To run an application, a developer accesses the Windows Azure portal through his/her web browser, using with a Windows Live ID. He/she then selects whether to create a hosting account for running applications, a storage account for saving data or both. To create Windows Azure applications, a developer values the identical languages and tools as for any Windows application. The user might compose a web function utilizing ASP.NET and Visual Basic or with WCF and C#.

The Storage Service

Applications work with data in numerous distinct ways. Accordingly, the Windows Azure Storage service presents some options. The simplest way to store data in Windows Azure storage is to use blobs. A blob comprises binary data and there is a straightforward hierarchy. A storage account can have one or more containers, each of which retains one or more blobs. Blobs can be large-scale up to 50 gigabytes each and they can furthermore have affiliated metadata, for example, data about when a JPEG image was taken or who is the vocalist of an MP3 file.

Blobs and tables are both concentrated on saving and accessing data. The third choice in Windows Azure storage, queues, has quite a distinct purpose. A prime function of queues is to supply a way for web instances to broadcast with worker instances. Regardless of how data is retained, that is, in blobs, tables or queues, all data held in Windows Azure storage is duplicated three times. This replication permits obvious error tolerance, since mislaying an exact duplicate is not fatal. It presents powerful consistency, although an application that directly reads data that has just been written is assured to get back what it just wrote.

Windows Azure storage can be accessed by a Windows Azure application, by an application running on-premises inside some organization, or by an application running at a host machine. In all these situations, all three Windows Azure storage methods use the REST services to recognize and reveal data. In other words, blobs, tables and queues are entitled utilizing URIs and accessed by benchmark HTTP operations. To manage this, a .NET client should use the ADO.NET Data Services libraries. But it is not required when an application makes use of raw HTTP calls.

SUMMARY

- Cloud promises to make IT not just lower, but furthermore much quicker, simpler, more flexible and more effective.
- Microsoft boasts the advantages of cloud with the familiarity of Microsoft applications that users, developers, IT professionals and leaders currently understand and trust.
- Cloud-based services that add worth to these existing installations are very well aimed at niche opportunities.
- The Microsoft cloud computing platform utilizes Windows Azure to construct and extent world wide web applications using its data centres.
- Windows Azure provides a Microsoft Windows Server–based computing environment for applications and continual storage for both organized and unstructured data, as well as asynchronous messaging.
- The Windows Azure AppFabric provides a variety of services that assist consumers to attach users and on-premise applications to cloud-hosted applications, authentication and data administration.
- SQL Azure is vitally an SQL server supplied as a service in the cloud.
- Windows Azure is the application service in cloud which allows Microsoft data centres to host and run applications.
- Windows Azure has three centre components (i) compute, (ii) storage and (iii) fabric.
- The Windows Azure Compute Service can run numerous distinct types of applications.

KEY TERMS

- *Windows Azure*: A functioning system supplying scalable compute and storage facilities.
- *SQL Azure*: A cloud-based, scale-out type of SQL server.
- *Windows Azure AppFabric*: An assemblage of services carrying applications both in the cloud and on premise.

REVIEW QUESTIONS

- State the benefits offered by Microsoft with cloud computing.
- Name and brief the three components provided by Windows Azure.
- Define Windows Azure.
- State the job of software vendor.
- Name and state the importance of Microsoft Windows Azure brands.

CHAPTER 30

Google Cloud Applications

Google's domain is constructed on the World Wide Web advertising. In 2010, 96% of its $29 billion income came from online ads. Google deals subscriptions to enterprises, applying its web know-how to market conventionally controlled by a very distinct kind of Software Company.

In September 2009, Gmail was offline for 1 hour 40 minutes. Users over the globe were unable to access the service after the company made a mistake when updating the demand to routers that direct queries to Gmail's web servers. The occurrence pursued a sequence of other, lesser Gmail outages, but Google habitually contended that, in evaluation to client-server e-mail systems, the service was far more reliable.

Nearly a year and a half on, the contention retains up. Like Google's search engine, Google Apps is constructed atop a highly distributed infrastructure that disperses both data and code over myriad servers and data centres. This consistent back-end is conceived in order that if one data centre goes down, another can directly step into the breach. Google values custom-built devices that permit it to improve services without taking them.

Obviously, Google is not immune to outages, this distributed backend has permitted the business to pledge 'no arranged downtime', and if there is downtime it gets counted in the direction of the customer's affirmation, which assures 99.9% availability. In 2010, as asserted by Google, Gmail was accessible to both enterprise users and buyers 99.98% of the time and there was no arranged downtime.

At $50 per client per year, Google Apps is furthermore somewhat inexpensive. Some approximated estimates show that customary systems consume nearly to $200 a year. Setup is far easier with a web-based system and yet numerous enterprises are reluctant to make the switch. Some are worried with security. Others chafe at the concept of hosting their data on somebody else's servers. Some do not like the UI.

30.1 GOOGLE APPLICATIONS UTILIZING CLOUD

30.1.1 Gmail

Gmail makes organizing the e-mail system so straightforward and efficient. Gmail boasts 25 GB of storage per client, mighty spam filtering, BlackBerry and Outlook interoperability and a 99.9% uptime SLA (Service Level Agreement).

- *E-mail, IM, voice and video chat*: Each client gets 25 GB of e-mail and IM storage.
- *Anytime, any location, get access to your e-mail*: Gmail is securely powered by the World Wide Web, so you can be creative from your table, on the street, at home and on your wireless telephone, even when you are offline.
- *Sync with Android, iPhone and BlackBerry*: Get the advantages of Apps on premier wireless platforms.
- *Search and find e-mails instantly*: Spend short time in managing e-mail and locate e-mails quickly with Google-powered search to your inbox.
- *Get less spam*: Gmail spam is powerful filtering which assists you to concentrate on important ones.

30.1.2 Google Calendar

Organizing the agenda should not be a burden. With Google Calendar, it is so straightforward to hold track of life's significant happenings all in one place.

- *Easily schedule appointments*: Overlay multiple calendars to glimpse when people are available. Google Calendar drives requests and organizes them.
- *Integrate with e-mail system*: Google Calendar is incorporated into Gmail and interoperable with well-liked calendar applications.
- *Share task calendars*: Calendars can be distributed company-wide or with chosen co-workers. A variety of distributing consent controls assist to sustain security and privacy.
- *Access with your wireless device*: View and edit happening minutia, add new happenings and ask for visitors on wireless devices like the BlackBerry and iPhone. Even obtain calendar notifications by SMS.
- *Publish calendars*: Publicize external business happenings by announcing a calendar to make it searchable in the Google Calendar gallery. Easily embed calendars into web pages.

30.1.3 Google Docs

Google Docs is an easy-to-use online phrase processor, spreadsheet and production reviewer that endows to conceive, store and share instantly and securely and cooperate online in less time. Users can conceive new articles from the rub or upload living articles, spreadsheets and presentations. There are no software programs to download and all your work is retained securely online and can be accessed from any computer.

- *Works over other operating systems*: Google Docs works in the browser on PC, Mac and Linux computers and carries well-liked formats, for example, .doc, .xls, .ppt and .pdf.
- *Easily upload and share files*: Files retained on Google Docs are habitually accessible and backed-up online.
- *Secure access to controls*: Administrators can organize document distributing permissions system-wide and article proprietors can share and revoke document access at any time.

30.1.4 Google Sites

Google Sites are the easiest way to make knowledge accessible to the population who want speedy, up-to-date access. People can work concurrently on a site to add record supplements, knowledge from other Google requests for paid jobs (like Google Docs, Google Calendar, YouTube and Picasa) and new free-form content. Google Sites are accessible from any internet-bound computer.

- *Organize knowledge in a central place*: Use Google Sites to centralize written material, spreadsheets, demonstrations, videos, slideshows and more to aid to retain the teams organized.
- *Anytime, everywhere access*: Google Sites are securely propelled by the web, so you can gather pages from your office desk, on the move, at home and on your portable phone.

- *Works through various operating systems*: Google Sites work on the browser installed on PC with Mac and Linux computers.
- *System and site-level security controls*: Administrators can supervise site sharing permissions through the enterprise and authors can share and revoke file access at any time.

30.1.5 Google Groups

The Google Groups service creates a Google Group which is a user-owned group. Google Groups not only sanctions us to supervise and archive the mailing list, but in addition gives a manner for accurate communication and collaboration with gathered members. Unlike other free mailing list services, Google Groups bids lavish storage fixes, customizable pages and unique organization options.

Google Groups are all about aiding users to bind with peoples, to access knowledge and convey effectually over computer communication and on the web.

- *Fast setup*: Create and supervise gatherings without burdening IT.
- *Sharing with a group*: Employees can share docs, calendars, sites, divided folders and videos with a gathering instead of individuals.
- *Searchable archives*: Group members can access and explore archives of posted items, conveyed to their e-mail lists to expeditiously find topics of interest.

30.1.6 Google Video

The Google Video index is the most comprehensive on the world wide web, comprising millions of videos indexed and obtainable for viewing. Using Google Video, one can explore and watch an ever-growing accumulation of video presentations, cinema clips, videos tunes, documentaries, private productions and more from all over the web.

- *A video channel for your business*: Video sharing makes valued communications like inside training and company announcements more engaging and effective.
- *Keep videos secured and private*: Employees can securely share videos with co-workers without uncovering private information.
- *Anytime, everywhere access*: Google Video is securely propelled by the web, so you can view videos from your office desk, on the road and at home.
- *Works in various operating systems*: Google Video works on a browser installed on PC with Mac and Linux OS.

30.2 GOOGLE APP ENGINE

Google App Engine is Google's stimulating application development and hosting platform in the cloud. With it, the client can construct and establish web applications on Google's scalable high-traffic infrastructure. App Engine carries apps written in Python or Java and they will execute on servers that use the identical expertise that forces Google's websites for pace and reliability.

App Engine applications are so straightforward to construct and scale as the traffic and data grows. To maintain App Engine, there are no servers available. It helps the user to upload the application.

Google App Engine devotes you to get access to the identical construction blocks that Google values for its own applications. It makes it simpler to construct an application that sprints reliably, even under a hefty load and with a large amount of data. The development environment encompasses the following features:

- Dynamic world wide web assisting with full support of widespread web technologies.
- Persistent storage with queries, sorting and transactions that are powered by Bigtable and GFS.
- Scalability and load balancing are done automatically.
- Google APIs for authenticating users and dispatching e-mail.
- Fully boasted localized development environment.

Google App Engine bundles the construction blocks and takes care of the infrastructure stack, departing you more time to aim on composing code and advancing your application.

30.2.1 Google Apps for Business

Powerful cloud-based messaging and collaboration tools are offered by Google Apps for Business, from tiny organizations to huge organizations. Google Apps is 100% hosted by Google, which decreases IT charges, minimizes up-keeping and management and simplifies primary setup. With Google Apps for Business, client gets:

- Customized e-mail addresses
- Mobile e-mail, calendar and IM access
- No added hardware or programs
- Industry-leading spam filtering
- 24/7 internet note and telephone support
- 99.9% uptime assurance
- Dramatic cost savings

Choosing Google Apps not only saves money, but also saves an unbelievable amount of time. If the entire IT group focuses on methods and forward-thinking that can really advance the way enterprise operates.

30.2.2 Google Apps for Education

Google Apps for Education boasts worth that is yet to be agreed in the world of cloud-based messaging and collaboration. For $0/user/year, school, employees and scholars of informative organizations at all levels can leverage this huge set of customizable connection and collaboration tools. Tools like Google Sites and Google Groups are ready-made for the world of learning, endowing data exchange and direction at solely new levels. Google Apps adds the newest technologies and establishes best practices for data-centre administration, network application security and data integrity. Eight ways how Google Apps advantages the campus are listed herewith:

- Students will love you for it
- Free up your IT
- Easy to deploy
- Save money
- Google defends your privacy
- Security as powerful as Google
- Innovation in real-time
- Collaborate globally

30.2.3 Google Apps for Government

Google Apps for Government presents all of the identical advantages that Google Apps for Business does, but with a supplemented level of security that stands up to even the largest levels of government standards. With Google Apps, the government department benefitted from the scale and redundancy of distributed data centres around the globe.

SUMMARY

- ❖ Google's domain is constructed on web advertising.
- ❖ Google deals subscriptions to enterprises, applying its web know-how to the market controlled in a very distinct kind.
- ❖ Gmail makes organizing e-mail system straightforward and efficient.
- ❖ With Google Calendar, it is straightforward to hold track of life's significant happenings all in one place.
- ❖ Google Docs are an easy-to-use online phrase processor, spreadsheet and production reviewer that endows to create, store and share instantly and securely and cooperate online in less time.
- ❖ Google Sites are the easiest way to make knowledge accessible to a population who wants speedy, up-to-date access.
- ❖ Google applications utilizing cloud are (i) Gmail, (ii) Google Calendar, (iii) Google Docs, (iv) Google Sites, (v) Google Groups and (vi) Google Video.
- ❖ Choosing Google Apps not only saves money, but also saves an unbelievable amount of time.
- ❖ Google Apps for Education boasts worth that is yet to be agreed in the world of cloud-based messaging and collaboration.

KEY TERMS

- Google App Engine is Google's stimulating application development and hosting platform in the cloud.
- With Google Apps for Business, we have anytime, anywhere access to web-based tools such as e-mail, calendar, documents and more.
- Google Apps for Education is a free suite which supports e-mail and applications for schools and universities.

REVIEW QUESTIONS

- List some Google cloud applications.
- State the use of Google App Engine.
- List the advantages of Google Apps for Business and Education.
- State how Google Apps can be used in government operations.

CHAPTER 31

AMAZON CLOUD SERVICES

Amazon commenced its Web Services in 2006 and is widely used and accepted by the industry as a general cloud initiative. Amazon Web Services are supplied by Amazon, under which Amazon EC2 and Amazon S3 make up the most well liked services.

The Amazon Elastic Compute Cloud or EC2 permits users to pay for what they use. Servers are 'increased' on demand and are 'decreased' when usage ceases. These instances are easily virtual machines based on peak of the Xen VM that are organized by Amazon's interior asset administration facility. The VMs are better renowned as elastic compute units (ECU), which are pre-packaged and can be 'ordered' and one can easily choose and select what one desires and pay for it after one is done. Pricing is done on the kind of ECU and size of data moved or the time used.

31.1 UNDERSTANDING AMAZON WEB COMPONENTS AND SERVICES

Cloud computing adopts scalable computing assets supplied as a service from out-of-doors on the natural environment on a pay-per-use basis. One can get access to any of the assets that reside in the 'cloud' at any time and from any location over the Internet. The user does not have to care about how things are being sustained behind the scenes in the cloud.

Cloud computing draws from the widespread portrayal in expertise architecture designs of the Internet, or IP accessibility, displayed as a cloud. Cloud computing is also called utility computing or grid computing. Cloud computing is a paradigm move in how we architect and consign scalable applications. In the past, thriving businesses expended time and assets in construction infrastructures that in turn supplied them a comparable advantage. In most situations, this approach:

- Left large tracts of unused computing capability that took up space in large-scale data hubs
- Needed somebody to babysit the servers
- Had affiliated power costs

The unused computing power trashed away, with no way to impel it out to other businesses or users who might be eager to pay for added compute cycles. With cloud computing, surplus computing capability can be put to use and be profitably traded to consumers.

31.1.1 Amazon Web Services

Amazon Web Services give programmatic entry to Amazon's ready-to-use computing infrastructure. The robust computing podium that was assembled and enhanced by Amazon is now obtainable by anyone who has entry to the internet. Amazon gives numerous web services, building-blocks that fulfil some of the quintessence wants of most systems: storage, computing, messaging and datasets. Amazon Web Services can aid us to architect scalable procedures by providing:

- *Reliability*: The services run in Amazon's battle-tested, highly obtainable data centres that run Amazon's own business.
- *Security*: Basic security and authentication methods are obtainable out of the packing box and customers can enhance them as wanted by layering his/her application-specific security on apex of the services.

- *Cost benefits*: No fastened charges or support costs.
- *Ease of development*: Simple APIs allow us to harness the full power of this virtual infrastructure and libraries, obtainable in most extensively employed programming languages.
- *Elasticity*: Scale the computing supplies based on demand.
- *Cohesiveness*: The four quintessence building-blocks using which services (storage, computing, messaging and datasets) are created from scratch currently work well and give a whole result through a large type of request for paid job domains.
- *Community*: Tap into the vibrant and dynamic customer community that is propelling the extensive adoption of these web services and is bringing ahead sole requests for paid jobs assembled on this infrastructure.

There are two grades of supports accessible for users of Amazon Web Services:

1. Free forum-based support
2. Paid support packages

Amazon publishes the well-being rank of all its web services in a dashboard (accessible publicly) that is revised with any issues about the services.

Amazon presents standards-based SOAP and REST interfaces for combining with each of the services. Developer libraries either from Amazon or third parties are accessible in multiple languages, encompassing Ruby, Python, Java, Erlang and PHP, for broadcasting with these services.

Amazon S3 (Storage)

Amazon Simple Storage Service (S3) presents a web service interface for the storage and retrieval of data. The data can be of any kind and can be retained and accessed from any location over the internet. Users can shop an unlimited number of things in S3, and the dimensions of each retained object can vary from 1 byte to 5 GB. The data is retained securely utilizing the identical data storage infrastructure Amazon values to power its worldwide mesh of e-commerce websites. Access limits can be particular for each object that is retained in S3 and the things can be accessed with straightforward HTTP requests.

S3 absolutely releives from its concern about storage space, get access to data or protecting the data. Amazon double-checks high accessibility of the documents, so they are accessible when we require them. The service-level affirmation supplied by Amazon for S3 commits to a 99.9% uptime, assessed monthly.

Amazon EC2 (Elastic Computing)

Amazon EC2 is a web service that permits us to use virtual machines within minutes and effortlessly scale the capability up or down founded on demand. These instances are based on Linux and can run any submission or software. The EC2 natural environment itself is constructed on the peak of the open source Xen hypervisor. Amazon permits us to conceive Amazon Machine Images (AMIs) that act as templates for the instances. Access to these can be controlled by identifying the permissions. Recently, Open Solaris support was broadcast by Amazon in a joint project with Sun Microsystems, but the majority of the free and commercially accessible prebuilt images for EC2 are based on Linux.

Amazon EC2 presents factual web-scale computing, which makes it so straightforward to scale computing assets up and down. Amazon presents five kinds of servers. These servers vary from product single-core x86 servers to eight-core x86_64 servers.

Amazon SQS (Simple Queue Service)

Amazon Simple Queue Service (SQS) presents get access to the dependable messaging infrastructure utilized by Amazon. Users can send and receive messages from any location utilizing straightforward REST-based HTTP requests. The message is retained by Amazon over multiple servers and data hubs to supply the redundancy and reliability required from a messaging system. Each message can comprise up to 8 KB of text data.

SQS incorporates very well with the other Amazon Web Services. It presents a large way to construct a decoupled framework where EC2 instances can communicate with each other by dispatching a message to SQS and coordinating the workflow. One can furthermore use the queue for constructing a self-healing, auto-scaling EC2-based infrastructure for their application.

31.1.2 Amazon SimpleDB

Amazon SimpleDB (SDB) is a web service for saving, processing and querying, organized datasets. It is not a relational database in the customary sense, but it is a highly accessible schema, with a less-structured data shop in the cloud. SDB is straightforward to use and presents most of the purposes of a relational database. The upkeep is much easier than a usual database. Administrative tasks are taken care of by Amazon. The data is mechanically indexed by Amazon and is accessible to us anytime from anywhere. A key benefit of not being guarded to schemas is the proficiency to inject data on the fly and add new columns or keys dynamically.

31.2 ELASTIC COMPUTE CLOUD (EC2)

Amazon Elastic Compute Cloud is a most important component of Amazon.com's cloud computing platform, Amazon Web Services. EC2 permits scalable deployment of applications by supplying a web service. Clients can use an Amazon Machine Image to conceive a virtual machine, encompassing any software programs desired. A client can conceive, launch and terminate server instances as required, giving time for active servers, therefore the period 'elastic'. EC2 presents users with command over the geographical position of instances that permits for latency optimization and high grades of redundancy.

Amazon's features are:

- A service grade affirmation for EC2
- Microsoft Windows in beta pattern on EC2
- Microsoft SQL Server in beta pattern on EC2
- Designs for an AWS (Amazon Web Service) administration console
- Designs for load balancing, auto-scaling and cloud supervising services

Amazon Elastic Compute Cloud (Amazon EC2) is a world wide web service that presents resizable computing capability that is utilized to construct and host software systems.

Following are the list of the major constituents of EC2 which are briefed.

31.2.1 Amazon Machine Images and Instances

An Amazon Machine Image (AMI) is a template that comprises a software program configuration (e.g., functioning scheme, submission server and applications). From an AMI, a client can launch *instances*, which are running exact replicates of the AMI. Also he/she can launch multiple instances of an AMI, as shown in Figure 31.1.

Instances hold running until the client halts or terminates them, or until they fail. If an instance falls short, it can be commenced from the AMI. One can use a lone AMI or multiple AMIs counting on needs. From a lone AMI, distinct *types of instances* can be launched. An *instance type* is vitally a hardware archetype.

Amazon publishes numerous AMIs that comprise widespread program configurations for public use. In supplement, constituents of the AWS developer community have released their own made-to-order AMIs.

31.2.2 Storage

When utilizing EC2, data have to be stored. The two most routinely utilized storage kinds are:

1. Amazon Simple Storage Service (Amazon S3)
2. Amazon Elastic Block Store (Amazon EBS) volumes

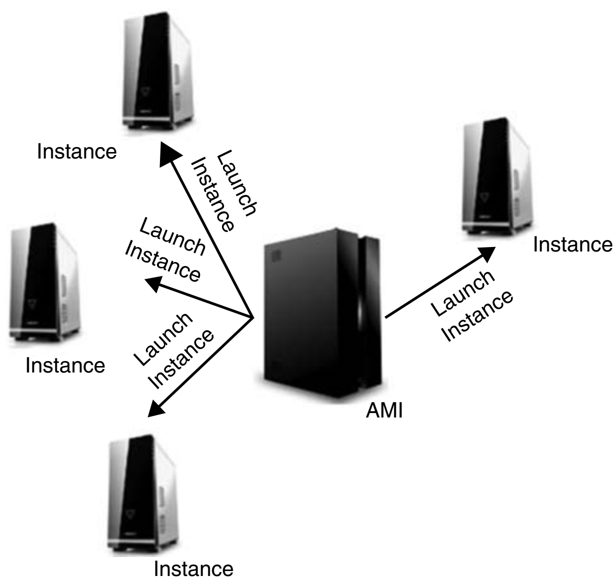


Figure 31.1 Amazon Machine Images and Instances

31.2.3 Amazon S3

Amazon S3 is storage for the internet. It presents a straightforward World Wide Web service interface that endows us to shop and get any amount of data from any location on the web. Amazon EBS presents the instances with continual, block-level storage. Amazon EBS volumes are vitally hard computer disks that can adhere to a running instance. Volumes are particularly matched for submissions that need a database, a document system or get access to raw block-level storage. One can adhere multiple volumes to an instance. To hold exact duplicate, a client can conceive a *snapshot* of the volume. The user can furthermore detach a volume from an instance and adhere it to a distinct one.

31.2.4 Databases

The submission running on EC2 might require a database. Following are two widespread modes to apply a database for the application:

1. Use Amazon Relational Database Service (Amazon RDS), which endows us to effortlessly get an organized relational database in the cloud.
2. Launch an instance of a database AMI and use that EC2 instance as the database.

Amazon RDS boasts the benefit of managing the database administration jobs, for example, patching the programs, endorsing, saving backups, etc.

31.2.5 Amazon CloudWatch

Amazon CloudWatch is a web service that presents real-time supervising to Amazon's EC2 clients on their asset utilization, such as CPU, computer disk and network. CloudWatch does not supply any recollection, computer disk space or load average metrics. The data is aggregated and supplied through the AWS administration console. It can furthermore be accessed through online tools and web APIs. The metrics assembled by Amazon CloudWatch endow auto scaling characteristics to dynamically add or eliminate EC2 instances. The clients are ascribed by the number of supervising instances.

31.3 AMAZON STORAGE SYSTEM

Amazon Simple Store Service (S3) is a service from Amazon that permits the users to store documents into dependable isolated storage for a very comparable price. S3 is utilized by businesses to store photographs and videos of their clients, back up their own data and more. S3 presents API for both SOAP and REST.

S3 manages *objects* and *buckets*. An object agrees to a retained file. Each object has an identifier, an owner and permissions. Objects are retained in a bucket. A bucket has an exclusive name that should be well-trained with internet domain calling policy. The object identifier consists of a filename with its relative path. With this, S3 storage can emerge as a normal file system with folders and subfolders.

S3 stores random things (computer files) up to 5 terabytes in dimensions, each escorted by up to 2 kilobytes of metadata. Objects are coordinated into *buckets* and recognized inside each bucket by an exclusive, user-assigned key. Amazon Machine Images (AMIs) are changed in the Elastic Compute Cloud (EC2) that can be bundled to export to S3.

Amazon S3 is required for those who have the following issues:

- *Running out of bandwidths*: Amazon S3 presents unlimited bandwidth and clients can be assisted with any amount of bandwidth the location needs.
- *Better scalability*: Amazon S3 utilizes cloud hosting and assisting is somewhat fast. Separating them away from the usual HTTP demand will decisively alleviate the server burden and therefore assures better stability.
- *Store documents online*: Instead of endorsing up files in CDs/DVDs to save more computer hard disk space, another choice is to store them **online**. Users have the choice to hold documents with them in a personal account or make them publicly accessible.
- *Easier documents retrieval and sharing*: If a document is online, the client can get access to it from any location as long as there is an internet connection. Amazon S3 furthermore permits one to communicate documents with other associates, purchasers and blog readers in a better way.

31.4 AMAZON DATABASE SERVICES

Amazon Relational Database Service (Amazon RDS) is a worldwide well-known web service. It makes relational database to set up, function and scale in the cloud much simpler. It presents cost-efficient, resizable capability for multiple industry-standard relational databases and organizes widespread database management tasks.

Amazon RDS guides the users to get access to the capabilities of a well-renowned MySQL or Oracle database server. Amazon RDS mechanically backs up the database and sustains the database programs that force the DB Instance. Amazon RDS is flexible.

Amazon RDS has these advantages:

- *Accelerated deployment*: Amazon RDS decreases friction, when going from task development to deployment.
- Can use straightforward API calls to get access to the capabilities of a production-ready relational database without being concerned about infrastructure provisioning or establishing and sustaining database software.
- *Managed*: Amazon RDS manages generic database administration tasks.
- *Compatible*: One can easily get native access to a MySQL or Oracle database server with Amazon RDS.
- *Scalable*: With a straightforward API call, clients can scale the compute and storage assets accessible to the database to rendezvous enterprise desires and submission load.
- *Reliable*: Amazon RDS sprints on the identical highly dependable infrastructure utilized by other AWS. Amazon RDS's automated backup service mechanically organizes the backup the database and lets us refurbish at any point.
- *Secure*: Amazon RDS presents World Wide Web service interfaces to configure firewall backgrounds that command network get access to the database instances and permits SSL (Secured Socket Layer) attachments to the DB Instances.
- *Inexpensive*: In terms of deployment.

31.4.1 DynamoDB

Amazon DynamoDB is found on the values of Dynamo, a progenitor of NoSQL. It adds the influence of the cloud to the NoSQL database world. It boasts the client's high availability, reliability and incremental scalability, with no restricts on dataset dimensions or demand throughput for a granted table. It is very fast; furthermore, it sprints on the newest in solid-state drive (SSD) expertise and integrates many other optimizations to consign reduced latency at any scale.

Amazon DynamoDB is a NoSQL database service that boasts these benefits:

- Managed
- Scalable
- Fast
- Durable
- Highly available
- Flexible

SUMMARY

- ❖ Amazon Web Services are supplied by Amazon, under which Amazon EC2 and Amazon S3 make up the most well-liked services.
- ❖ Cloud computing adopts scalable computing assets supplied as a service from out-of-doors on the environment on a pay-per-use basis.
- ❖ Cloud computing draws from the widespread portrayal in expertise architecture designs of the internet or IP accessibility, displayed as a cloud.
- ❖ Cloud computing is a paradigm shift in how we architect and consign scalable applications.
- ❖ Amazon Web Services can aid us to architect scalable procedures by providing (i) reliability, (ii) security, (iii) cost benefits, (iv) ease of development, (v) elasticity, (vi) cohesiveness and (vii) community.
- ❖ Amazon Simple Storage Service (S3) presents a web services interface for the storage and retrieval of data.
- ❖ Amazon EC2 is a web service that permits us to use virtual machines within minutes and effortlessly scale the capability up or down founded on demand.
- ❖ Amazon Simple Queue Service (SQS) presents get access to the dependable messaging infrastructure utilized by Amazon.
- ❖ Amazon SimpleDB (SDB) is a web service for saving, processing and querying organized datasets.
- ❖ Amazon S3 is required for those who have the following issues: (i) running out of bandwidths, (ii) better scalability, (iii) store documents online and (iv) easier documents retrieval and sharing.

KEY TERMS

- Amazon Web Services offers a set of infrastructure and application services that enable us to run everything in the cloud, that is, from enterprise applications and high knowledge endeavours to social sporting activities and mobile apps.
- Amazon S3 is storage for the internet. It is created to make web-scale computing less difficult for developers.
- Amazon Simple Queue Service (SQS) presents control to the dependable messaging infrastructure utilized by Amazon.
- Amazon Elastic Compute Cloud (Amazon EC2) is a service available in network, providing the required capacity for computing within the cloud.
- Amazon CloudWatch is a web service that presents real-time supervising to Amazon's EC2 clients on their asset utilization, such as CPU, computer disk and network.
- An Amazon Machine Image (AMI) is an exceptional kind of pre-configured functioning system and virtual application program which is utilized to conceive a virtual instance inside the Amazon Elastic Compute Cloud (EC2).

REVIEW QUESTIONS

- List Amazon Web Service components.
- State the components of EC2.
- What are Amazon Web Services?
- List some Google Cloud Applications.
- What is Windows Azure Platform?
- List the uses of Amazon S3.
- Define DynamoDB.

CHAPTER 32

Cloud Applications

Major companies encompassing Amazon, Google, IBM, Sun, Cisco, Dell, HP, Intel, Novell and Oracle have bought into cloud computing and offer persons and enterprises a variety of cloud-based solutions.

32.1 CLOUD-BASED SOLUTIONS

32.1.1 Social Networking

Perhaps the most well-renowned use of cloud computing, which does not hit persons as 'cloud computing' at the start glimpse is communal networking websites, encompassing Facebook, LinkedIn, MySpace, Twitter and numerous others. The major concept of communal networking is to find persons you currently understand or persons you would like to understand and share your data with them.

While the prime reason of communal networking earlier was connecting persons, businesses can use communal networking too. By creating a Facebook follower sheet, an enterprise can connect with its clients and at the same time those clients will be encouraging the business.

32.1.2 E-mail

Some of the large-scale cloud computing services are web-based e-mail. Using a cloud computing e-mail answer permits the mechanics of hosting an e-mail server and alleviates in sustaining it.

32.1.3 Document/Spreadsheet/Other Hosting Services

Just like Google Docs, several services like Zoho Office live on the internet permit us to hold and edit articles online. By managing so, the articles will be accessible from any location and one can share the articles and cooperate on them. Multiple persons can work in the identical article simultaneously. A new online task administration device, Onit, is for 'anyone, who organizes projects: large-scale, little, enterprise, legal'.

Yahoo's Flickr and Google's Picasa offer hosting for photos that can be distributed with associates, family and the world. People can comment on the photos, much like they can on Facebook, but these focused photograph-hosting services offer some perks for the photographers.

Perhaps nothing has revolutionized amusement more than YouTube, a video distributing site. Other video distributing sites encompass Vimeo and MetaCafe. Users are allowed to upload their own video content and the services be careful of putting it into a pattern that can be effortlessly examined by users without downloading much, if any, exceptional software.

32.2 CLOUD COMPUTING SERVICES

32.2.1 Google Apps

Reliable, protected web-based agency devices for any dimensions enterprise. Powerful, intuitive submissions like Gmail, Google Calendar and Google Docs can assist to decrease IT charges and assist workers to cooperate more competently, all for just $50 per client per year.

32.2.2 PanTerra Networks

PanTerra Networks are the premier provider for cloud-based unified Software-as-a-Service (SaaS) communication answers for small and intermediate dimensions enterprises. The company's WorldSmart answer is consigned from the cloud through a 100% browser-based purchaser, eradicating any premise-deployed hardware or software. WorldSmart presents unified connection services for unlimited digital voice, video and fax, instant note, wireless text and Internet note, all with occurrence through a lone client and administrative interface.

32.2.3 Cisco WebEx Mail

Cisco WebEx Mail decreases the problem of Internet note administration so IT can aim on strategic tasks rather than usual tasks. Yet, managers stay completely in command through a web-based console, permitting them to acclimatize to ever-changing organizational needs. Cisco WebEx Mail encompasses sophisticated migration devices that simplify the migration process. The answer interoperates with a living internet note infrastructure as well as archiving and security solutions. This minimizes disturbances throughout the transition to a hosted Internet note solution.

32.2.4 Yahoo Zimbra

Zimbra is a next-generation collaboration server that presents the association's larger general flexibility and ease with incorporated internet note, associates, calendaring, distributing and article administration in addition to mobility and desktop synchronization to users on any computer. Zimbra Collaboration Suite's sophisticated world broad web submission and server is constructed on open measures and technologies to consign unparalleled per-user scalability and smaller general Total Cost-of-Ownership (TCO).

32.2.5 IBM LotusLive iNotes

LotusLive iNotes e-mail is a business-class messaging answer for everyone. Remote workers, retail employees and any individual who does not work behind a table will realize the straightforward get access to business e-mail. With web-based e-mail, all workers will have real-time e-mail access to and from a web browser and Internet connection. In addition to a web-based interface, all e-mail anecdotes are endowed with POP, authenticated SMTP and IMAP capabilities for use with e-mail purchasers, for example, Lotus Notes or Microsoft Outlook.

32.2.6 ElasticEmail

Elastic Internet note makes Internet note to be dispatched simpler for both the developer and the enterprise supervisor of a cloud application. Several cloud applications, for example, Windows Azure and Amazon EC2, manage to supply an internet note consignment service and may even set restricts on internet note sending. ElasticEmail presents direct internet note dispatching through a straightforward REST API. Hence, rather than having to setup and configure an SMTP internet note server or service, one can start dispatching Internet note immediately.

32.2.7 Microsoft Exchange Online

Microsoft Exchange Online is a world broad web type of the ubiquitous on-premise e-mail client. Features encompass the proficiency to log on to the account and swab a wireless telephone of perceptive facts and numbers if it is lost or stolen. Drawback: The program works best on Internet Explorer.

32.2.8 Salesforece.com

Salesforce.com is a vendor of customer relationship management (CRM) solutions, which it consigns to enterprises over the Internet utilizing the programs as a service model. It is utilized to hold the pathway of and reinforce a company's connection with its living and promise clients.

32.3 CLOUD SOFTWARE FOR PRIVATE BANKING

Cloud computing can endow banks to reuse IT assets more effectively, if they are bought up-front or leased without any long-run commitment. Based on a study by Gartner, the market for cloud services will be increasing now from $36 billion to $160 billion by 2015. Gartner highlights that 20% of businesses will be utilizing cloud computing for important components of their expertise natural environment by 2012. However, cloud computing is much more than easily leasing servers and storage on-demand to decrease infrastructure charges as numerous believe.

The cloud boasts an owner of possibilities for banks to construct a more flexible, nimble and customer-centric enterprise form, with outcomes in moneymaking growth. The period 'cloud computing' is somewhat the latest, and components of the notion, for example, timesharing and virtual appliances have been around for a few decades. What makes cloud computing original? Now, there is the pervasiveness of the internet and internet technology growth, virtualization, hardware commoditization, standardization and open source software.

Clouds can take two forms: private and public. For most banks, the first foremost foray into cloud computing will be by private clouds.

In evaluation, public clouds continue the data centre's capabilities by endowing the provision of IT services from third-party providers over a network. It presents the capabilities enterprises require on a flexible cornerstone, assisting them cost-effectively reply to altering conditions.

At the infrastructure grade, businesses have currently started to source raw computing assets, that is, processing power, mesh bandwidth and storage from out-of-doors and on-demand basis. In most situations, these assets are utilized to augment rather than restore living in-house infrastructure, which itself is progressively virtualized. Unlike customary hosting services, which supply dedicated hardware to clients, infrastructure cloud providers draw from a pool of distributed assets and dynamically elaborate an agreement to accommodate fluctuating demand from distinct client organizations. As an outcome, they supply far larger elasticity, finances of scale and cost benefit in evaluation to standalone data centres.

Indeed, one of the advantages of the cloud is low costs. Accenture, for example, approximates its own IT association could save up to 50% of its hosting charges every year by moving most of its submissions to infrastructure clouds. At the stage cloud grade, Bank of America is utilizing Force.com as a way to eradicate numerous localized submission servers that are hosting departmental applications.

The cloud furthermore can considerably decrease the time it takes for banks to roll out new applications. For example, SunTrust Bank rolled out its Salesforce.com CRM submission to 2,000 workers in just over 2 months rather than the 6–12 months a usual non-cloud CRM solution would take to implement.

But bank heads should not take cloud savings as given. They should request rigorous ROI case investigations founded on genuine cloud usage, other than approximates of foreseen savings. Hardware, after all, is a somewhat little constituent of facts and numbers centre costs. Executives require uncovering the concealed administration, transition and usage charges that disclose themselves only when associations start to work with the technology. They require assessing the charge forms of distinct types of cloud services and they require to work with the investment department to evolve a reliable and agreeable set to assess the charges and come back from clouds. Only then can they reliably approximate the savings.

In general, several components can play a significant function in working out how much cash a bank can finally save by utilizing the cloud:

- Adopting widespread measures that make data distributing and action easier.
- Applying security and data privacy limits appropriately and afresh, normalizing the number of distinct grades as much as possible.
- Overcoming any departmental ownership matters so as to shift as much work as possible to the distributed cloud.
- Taking care to sustain flexibility round procurement to bypass being locked into exact supplier arrangements.

Building a frictionless and flexible ecosystem: Cloud computing's most convincing use case for banks will probably be in the way innovative services can be created. The cloud devotes banks an opening to shatter apart their own worth string of connections, be it borrowing acceptance or back-office fulfilment. A bank can re-configure its enterprise in real time by dynamically locating from some service providers.

Cloud services continue into the back agency as well: Paypal, while relying on both banks and borrowing cards in its scheme, likes to simplify the way cash moves. Twitpay, Zong and Square are new entrants into the payments and transaction processing enterprise and all are aspiring to decrease charges and accelerate the action of money. Nimble submission developers are conjuring up the newest cloud services that request to bypass any entity that slows down steps in both the front and back office.

Another advantage of the cloud is giving buyers $24 \times 7 \times 365$ access to their banks. Process clouds and collaboration clouds can permit professionals to attach to any agency position and become virtual advisors to response inquiries about goods and services. Such proficiency to reply to customers entails a bank will never have to state no, perhaps or subsequent to a request. Automated and human-directed agency can further continue in periods of time, position and merchandise expertise.

32.4 CLOUD SOFTWARE FOR ASSET MANAGEMENT

Increased guidelines enforced on the economic services space and its participants are anticipated to have a material influence on the expertise and operational conclusions they will require to make. The new guidelines are probable to impel some companies to farther migrate purposes which are conventionally sustained inside the partitions of the asset administration firms.

32.4.1 What Solutions Does the Cloud Provide?

For asset administration companies, the recession of 2010, connected with farthest market instability, has let down both assets under administration and fees. Post-crisis asset managers find themselves battled by three foremost trials:

1. Lower the total cost of ownership
2. Double-check a high grade of security
3. Detail the operational capabilities to be responsive to magnified compliance audits

The Total Cost of Ownership (TCO) is the period utilized to assess the charges to run a scheme over its lifetime and is the most productive metric to contrast the charges of cloud computing and established software. It is not only integrates the charges paid to vendors, but furthermore gear and employees costs. One of the prime causes companies turn to the cloud is to lessen the TCO of the IT ecosystem.

Today, with shrinking margins and intensified regulatory obligations, buy-side companies are looking to migrate purposes that are not centre to their enterprise strategy. This in turn increases some of the agony of know-how from overgrown interior schemes and finally decreases the total cost of ownership. Table 32.1 displays a comparison between customary IT and cloud computing.

One of the centre precepts of cloud computing is to bypass over-provisioning and under-provisioning of the IT function. Along with the cloud's cost, income and margin benefits, fast deployment of cloud services boasts a reduced application cost and promises to go in and exploit new markets. Additionally, the cloud's pace and rate of cost decrease can be much quicker than

Table 32.1 Comparison of SaaS with Traditional IT

Customary Hardware and Software	Cloud Computing
Pay full capital expense	Pay only operational expense
More upfront and yearly maintenance costs	Less up-front subscription costs
Investment for all kinds of applications, maintenance, infrastructure and IT/ application resources	Cost for yearly subscription and minimum IT/application resources
More time required to install and configure applications	No need to install, quick implementation and time-to-productivity
Control over vendor is limited after purchase	Control over vendor is more

customary IT. In cloud computing, a purchaser can buy a service subscription from a provider rather than buying, owning, organizing and updating a customary IT stage themselves. Other productivity advantages can include:

- Pay-as-you-go
- Scalability
- Ease of implementation
- Automatic, seamless upgrades
- Facilitates M&A undertaking
- Redeploy assets to income developing undertakings
- Evolutionary

The cloud-based solution provider should have powerful capabilities in all of these critical areas:

- High comprehending of asset administration commerce
- Knowledge of compliance and regulatory issues
- Range of supplying cloud-based services
- Cloud provider does not blame the third-party expert vendor
- Responsibility for cloud technology
- Robust enterprise continuity designing form with ample data centres for back-up
- Automatic upgrades through the cloud
- Predictable payments without a more up-front cost
- Security and privacy protections that rendezvous or pass interior IT and facts and number security policies
- Fast scalable up and down as assets are required
- Clear meaning about the facts and numbers are retained and managed
- Comprehensive SLA that encounters or passes organization's needs
- Proven economic stability
- A pathway record of achievements, encompassing references

For economic companies, cloud computing can comprise the foundation of a mighty enterprise scheme that blends decreased charges and expanded regulatory responsiveness while sustaining a high grade of security. Clouds let businesses redeploy precious assets to attempt more enterprise development initiatives. The key to accessing this expertise, although, is the promise that the selected cloud provider has the depth of information and know-how needed for companies that function conclusively in today's international economic markets.

Most of the asset managers changed to cloud computing environment with a prime aim to save cash, they will rapidly glimpse that the cloud is actually an application issue to evolving more effective by extending the evolution of expertise architectures, administration devices and operational processes.

32.5 CLOUD SOFTWARE FOR FUND MANAGEMENT

When it arrives to expertise supplies, investors have their heads in the cloud. According to some of the expertise portfolio managers whose mutual capital drew the largest tallies from Bloomberg Rankings as of September 2010, the warm topic in expertise is cloud computing, in which hosted services—for example, communications infrastructure, programs and facts and numbers storage that are utilized to be carried out in the local area, on servers—are consigned by the internet.

Although more powerful enterprise fundamentals were employed in their favour, the price-to-earnings multiples for such businesses as Salesforce.com (CRM) and Akamai Technologies (AKAM) amplified much more spectacularly than inherent profits throughout their third quarters.

Large businesses in evolved nations, keen to slash charges because they are worried about the suppler financial expectations, are rotating to cloud-based data expertise, which is lower than owning and organizing their own infrastructure.

There is an estimation that tablet sales can boost to 74.3% for the preceding quarter's total of 30.1 million flats, which would consume into sales of netbooks and laptop computers. That bodes badly for laptop manufacturers, for example, Dell and Hewlett-Packard, and for such net-book manufacturers as Acer, Asustek and LG Electronics.

32.5.1 Hedge Capital Utilizing Cloud Computing

> *'This is an expertise answer that is absolutely scalable and adept to augment and shrink with the fund.'*
>
> *'We are seeing a large deal of concern in and later action to, cloud computing. I accept as factual it is wholeheartedly the only way to proceed for a start-up manager.'*

These are the remarks granted by Pat Mullevey and Sam Wheeler considering utilizing cloud computing in funds management.

Pat Mullevey heads Systems Integration and Technical Support at Gravitas, one of the premier IT providers, and study for the alternate buying into industry.

Sam Wheeler is responsible for the investigation and description of Signet's portfolios and inherent places representing investors.

Following is the Q&A meeting by Pat Mullevey and Sam Wheeler considering utilizing cloud computing in funds management. The meeting was coordinated by HFMWeek.

HFMWEEK (HFM): How does a cloud computing service advantage a hedge fund? How to manage and characterize the cloud and can it save capital money?

Pat Mullevey (PM): Cloud computing is fundamentally altering the way capital believes about gathering these in a cost-effective, flexible and scalable manner.

In periods of cost, cloud computing consigns IT infrastructure and submissions as a flexible, on-demand service as are against to a repaired capital cost and has spectacularly decreased time-to-market for new funds. Funds can now organize IT infrastructure as part of its operational total cost as are against to repaired capital expenditure.

Sam Wheeler (SW): Cloud services supply numerous advantages for hedge funds. First, it is more cost-effective to lease hardware than buy it exactly, in supplement to not having to assign floor space for servers, yield IT upkeep professionals or cover the raw electrical power to power the equipment. Second, cloud services supply fast access to and deployment of centre services and infrastructure. Third, the huge pools of computing power accessible through cloud services supply managers with access to larger computing power.

HFM: Why is cloud computing evolving more well liked with hedge funds?

PM: Uncertainty in economic and a more comparable buying has performed a large part in the emergence and acceptance of cloud computing. Funds expected from various sources are purely based on new technologies to protect the method and keep critical shareholder data. Cloud computing considerably decreases operational downtime due to IT problems. This expertise considerably decreases the time needed to determine IT-related issues.

SW: Cost is a foremost cause, but there are others. Cloud presents get access to a huge allowance of computing power that can be harnessed to run your business. It also boasts new and more effective modes to broadcast with the investors, service providers and partners.

HFM: How can investors take advantage from a hedge fund's cloud computing service?

PM: Investors anticipate hedge capital to have best-in-class infrastructure, security and data keeping and this is often a dispute due to cost and complexity. The cloud presents capital with get access to on-demand assets, complicated expertise and security to execute deals and support everyday operations. Through the cloud, hedge capital has the flexibility to quickly apply the newest trade stage, enterprise CRM schemes, or risk administration stages.

SW: Managers can gaze to decrease charges by utilizing cloud service charges that could be passed on to investors exactly or reinvested in the firm, both of which finally advantage investors themselves. It entails that the affray between managers utilizing such advances is higher, which could lead to their enhancement and refinement again, beneficial to end investors. The cloud furthermore undoes new modes companies can incorporate and broadcast with one another.

HFM: Are controllers involved in how a hedge finance values a cloud computing service?

PM: As with other facets of economic services, cloud services for hedge capital should be conceived, not just with presentation and security in brain, but furthermore as asserted by regulatory obligations and best practices. Cloud presents a third option to rendezvous compliance obligations for data keeping and enterprise continuity, painlessly.

SW: Yes. The diverse facets of cloud services drop inside living guidelines, although as they extend to develop our concept of what constitutes, for demonstration, 'Personal data' is probable to change, spark argument and subsequently perfect regulation. Cloud computing never distrubs the local boundaries, where data may be at any granted instant and is a origin for all involved.

HFM: What can you glimpse for the next 12 months retaining for cloud computing in the hedge finance space?

PM: Hedge capital will extend to recognize the finances of scale in cloud computing. The 'as a service' offerings will gain important traction in the hedge finance space in coming years.

Managers will take advantage from the cost savings and fast accessibility of cloud services, for example, IaaS (Infrastructure as a Service, such as storage, hardware, servers and networking components), PaaS (Platform as a Service, for demonstration Salesforce.com), AaaS (Application as a Services, e.g., Microsoft SharePoint) and SaaS (Security as a Service, for demonstration intrusion detection systems).

SW: The next 12 months will glimpse a stable development in the perception and adoption of cloud services. Much of what we manage every day is now connected to the cloud in some way, and with the increasing ubiquity of wireless apparatus its significance and relevance has been solidified. There are still anxieties that require to be worked on and alleviated before hedge capital are less uncertain over bigger scale reliance on cloud services, but as providers extend to work with managers, these are certain to be resolved.

SUMMARY

- ❖ Cloud computing is used for communal networking websites, such as Facebook, LinkedIn, MySpace, Twitter.
- ❖ The goal of communal networking is to find persons you currently understand and share your data with them.
- ❖ Some of the large-scale cloud computing services are web-based e-mail.
- ❖ Using a cloud computing e-mail solution permits the automation of hosting an e-mail server and alleviates in sustaining it.
- ❖ Some cloud computing services are (i) Google Apps, (ii) PanTerra Networks, (iii) Cisco WebEx Mail, (iv) Yahoo Zimbra, (v) IBM LotusLive iNotes, (vi) ElasticEmail and (vii) Microsoft Exchange Online.
- ❖ Cloud computing can make banks to reuse IT assets more effectively.
- ❖ Cloud computing gives possibilities for banks to construct a more flexible, nimble and customer-centric enterprise model.
- ❖ In general, several components can play how a bank can save by utilizing the cloud.
- ❖ Cloud computing is the most convincing use case for banks and many innovative services can be created.
- ❖ Process clouds and collaboration clouds permit professionals to attach to any agency position and become virtual advisors.
- ❖ The cloud-based solution provider should have powerful capabilities in 14 critical areas.

KEY TERMS

- ❖ A social networking service is an online service, stage or location that focuses on building social systems or social relatives amidst persons who want to share interests, activities, backgrounds or real-life connections.

- PanTerra Networks is the premier provider for cloud-based unified Software-as-a-Service (SaaS) communications answers for little and intermediate dimensions enterprises.
- Cisco WebEx Mail encompasses sophisticated migration devices that simplify the migration process.
- Zimbra is a next-generation collaboration server that presents the association's larger general flexibility and ease with incorporated internet note, associates, calendaring, distributing and article administration in addition to mobility and desktop synchronization to users on any computer.
- Elastic internet note makes internet note to be dispatched easily for both the developer and the enterprise supervisor of a cloud application.
- Fund management is the management of the cash flow of a fiscal institution. The finance director assures that the maturity plans of the bank deposits coincide with the demand for loans.
- Asset management is a management of the consumer's investments by a financial services company, that is, investment bank.

REVIEW QUESTIONS

- List some Google cloud applications.
- Define social networking.
- List some cloud computing services.
- State the benefits of cloud computing in the banking sector.
- State the benefits of cloud computing in asset management.
- List the benefits of cloud computing in fund management.

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PART TEN
Future Cloud

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CHAPTER 33

FUTURE TRENDS

33.1 FUTURE TRENDS OF CLOUD COMPUTING

Sky is the limit for cloud computing. This has been acquiesced by most of the expertise companies, study analysts and even peak IT enterprises that the future of data expertise is in the clouds. Cloud computing is still far from maturity. There are numerous expertise breaches that are not yet topped up, particularly in the localities of cloud enablement, administration, supervising and security. According to a review undertaken by the well-renowned study firm Gartner, more than 50% of enterprises and associations have currently taken benefit of cloud founded answers that is slated to make a development rate of 17% every year. On the other hand, Apple CEO Steve Jobs did sense the promise of cloud when he determined to issue the iCloud storage service for the iOS devices. We cannot measure the power of this expertise except that we delve into the future tendencies of cloud computing. Here is a nearer gaze to it.

There is no doubt that cloud computing is the enterprise form of the present business world. CIOs and IT bosses are literally 'getting their skates on' to locate the flawless cloud-based answer for their enterprise operations.

Businesses these days actually find it hard to stand out in this comparable environment. But with cloud computing, there is habitually a new start and answer to the most convoluted difficulties that too in a much quicker and cost-productive manner. Cloud computing has just reached in time to rendezvous some of the most critical enterprise claims with technological tendencies, particularly in the wireless realm. Smaller enterprises without a distinct IT department can anticipate a brilliant future with cloud's 'pay-as-you-avail' services.

Earlier, cloud had certain anxieties with security but it has arrived out of its drawbacks. Newer systems with convoluted levels as well as architecture in the distinct forms have changed cloud into a protected and dependable alternate for clients. Cloud computing is now applicable because of its negligible costing and much quicker recovery rate, particularly throughout urgent positions as contrary to the accepted hardware reliant catastrophe solutions.

33.2 FUTURE OF CLOUD COMPUTING: A SURVEY

A review was done by 39 commerce collaborators spanning established managers with fast-growth businesses and start-ups. It apprehended present commerce insights, sentiments and appearing tendencies in cloud computing. Respondents are inquired about a broad variety of key matters affecting cloud computing, encompassing drivers for cloud computing, inhibitors, best practices, locating the total cost of ownership (TCO), cloud's influence on multiple enterprise parts and appearing cloud technologies. The review presents numerous insights into the adoption of cloud computing, encompassing the cloud configurations and applications that are forming round exact enterprise desires encompassing Big Data, enterprise continuity, collaboration and storage.

Key findings in the survey include the following:

- Companies are accelerating their belief in cloud solutions, with 50% of respondents assured that cloud solutions are viable for objective critical enterprise applications.
- Scalability continues to be the peak cause for taking up the cloud, with 57% of businesses recognizing it as the most significant person going by car for cloud adoption. Business

agility graded second amidst drivers for cloud adoption, with 54% of respondents concentrated on agility.

- Security continues to be the prime inhibitor to adoption in the burgeoning cloud marketplace with 55% of respondents recognizing it as an anxiety, pursued by regulatory compliance (38%) and vendor lock-in (32%).
- Software as a Service (SaaS) is anticipated to stay the prime kind of cloud buying into, with 82% of respondents citing it as in use today and 88% anticipating to use it 5 years from now.
- Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) will glimpse important development in the next 5 years, with PaaS increasing from 40% to 72% and IaaS increasing from 51% to 66%.
- The peak four localities in which 'cloud formations' are backup and archiving (43%), enterprise continuity (25%), collaboration devices (22%) and big facts and numbers processing (19%).
- Cloud users are moving sentiments with consideration to public versus hybrid cloud platforms.
- With a boost in belief of the cloud, large-scale facts and numbers appear as a foremost aim for vendors and end users alike.
- Eighty per cent of respondents recognize large-scale facts and numbers as the most probable part to be disturbed by cloud computing.
- Most respondents (53%) accept as a fact that cloud computing sustains a smaller TCO and conceives a less convoluted IT workflow.

33.3 TEN EMERGING FUTURE TRENDS IN CLOUD COMPUTING

We can anticipate more from the future of cloud computing. Some of the peak 10 tendencies are as follows:

1. A large *businesses* will *conceive* personal cloud systems
2. Cloud security will become more trusted and normalized
3. Cloud adoption will have an upward trend
4. More applications will proceed into the cloud
5. Compression methods will be significant in reducing storage charges
6. Analytics will become a large-scale cloud characteristic
7. Cloud computing will adjust and shrink IT agencies
8. Cloud computing will become more customizable
9. Large cloud databases will centralize gigantic allowances of data
10. Mobile apparatus will take benefit of offloaded computing

With the relentless supervising of tendencies and revisions for cloud computing, service providers will be adept to bypass costly mistakes.

Cloud Computing has altered the mode enterprises and persons select to consign or come by IT services with less focus on customary hardware and programs authorizing constraints. It has made a significant result on every facet of IT and the way users use enterprise, data and application services.

The diverse advantages of cloud computing can consign, an enterprise association can optimize its cloud buying into by very careful written check and mapping of distinct trials for example integration desires, authorizing constraints, supplier lock-in, accessibility and presentation anxieties, transparency and security. Cloud Computing can furthermore assist as a base for enterprise discovery as well as decrease promise risks.

Hybrid cloud will play a significant function in cloud computing. Hybrid computing boasts the blend and coordination of off-site cloud services with an on-premise application or infrastructure services. It may be adept to unify all stages into a lone cloud.

With the expansion of cloud adoption, there is now an obligation for utilization assistance. A cloud brokerage, a service provider, can play a crucial function in cloud computing.

An allotment of association is needed for possibilities to migrate their present workloads to the cloud. When workloads are regarded as a significant asset or when an application routinely presents scalability, a Cloud-centric structure becomes important. Each application should be conceived with specific possibilities, limitations and characteristics fitted for cloud computing. Cloud computing can leverage on future operational data centre models. Cloud Computing notions can be directed to infrastructure and data centre investments to maximize effectiveness and agility.

33.4 NEXT GENERATION NETWORKING (NGN)

Intense affray is anticipated in the data networking arena over the next 5–10 years. As the affray rises, it will be absolutely crucial for businesses to place themselves appropriately to take benefit of their centre competencies and to arrange for the appearing telecommunications environment. Today's service providers are striving to differentiate themselves inside this increasingly comparable countryside by seeking for modes to emblem and package new services, accomplish operational cost decreases and strategically place themselves relative to their competition. Many service providers are looking to Next Generation Network (NGN) services as it entails to appeal and/or keep the most lucrative customers.

Now the internet community is well on its way to take care of all our appearing and new service requests. So, why should usual telecommunications carriers mind about NGN services? Why do they not just hurl in and overlook about supplying network-based NGN services and aim on their wholesale 'pipe' business? The causes are as follows:

- Public mesh carriers may endure with this scheme (if they are lucky), but they absolutely will not prosper. Network Providers are being compelled to contend by cost for ever-shrinking earnings margins. At the same time, competitors are proposing more complicated services to skim off the incumbent's high-margin customers. NGNs support new sophisticated services, which will permit them to keep the key clients and elaborate their markets in new areas.
- Network-based services make sense. Firstly, network-based solutions permit for distributed assets and finances of scale to rendezvous these demands. Secondly, it is tough to support service and client mobility with CPE (Customer Premises Equipment)-based approaches.

With network-based services, users can authenticate themselves from where they are and gain access to their entire suite of services. Finally, clientele care, billing, configuration administration, provisioning and other administration anxieties are more effortlessly managed with network-based solutions.

- The mesh is the computer. Scott McNealy, CEO of Sun Microsystems, accepts as a fact that the customary telecommunication carriers are the most ordered providers of this new network.

33.5 NEXT GENERATION SERVICES

It is tough to forecast what the next murdered applications will be, we can infer the kinds of service characteristics and capabilities that will be significant in the NGN natural environment by analyzing present service-related commerce trends. It is absolutely true that we are going from Time Division Multiplex (TDM)-based circuit-swapped systems to packaged cell and border-founded networks. However, these alterations in the transport systems are only enablers for the spectacular alterations at the service level.

The foremost push of customary mesh service providers has been to offer the mass market rudimentary transport of data between end users, with diverse value-added capabilities. These services tended to engage narrowband voice calls, with a lone point-to-point attachment per call. However, this outlook of services is quickly altering as the world's finances are evolving progressively reliant on data as a rudimentary resource.

End users will combine with the mesh by complicated CPE and be adept to choose from a broad variety of Quality-of-Service (QoS) and bandwidth. In the future, mesh understanding will not just concern the creative routing of attachments founded on straightforward database lookups but may take on a much broader meaning.

The prime aim will be to endow users to get the data content they desire, in any media/format, over any amenities, anytime, any location and in any volume. Following are the abstracts of some service characteristics probable to be significant in an NGN environment:

- Ubiquitous, real-time, multi-media communications.
- More 'personal intelligence' circulated all through the network.
- More 'network intelligence' circulated all through the network.
- More ease for users.
- Personal service customization and management.
- Intelligent data management.

SUMMARY

❖ Cloud Computing is still far from maturity.

❖ There are numerous expertise breaches that are not yet solved such as localities of cloud enablement, administration, supervising and security.

❖ Cloud Computing is the enterprise form of the present business world.

- With Cloud Computing, there is a new start and answer to the most convoluted difficulties in a quicker and cost-productive manner.
- Cloud Computing has certain anxieties with security but it arrived out of its drawbacks.
- Cloud Computing is now applicable because of its negligible costing and much quicker recovery rate.
- A review was undertaken with the participation of 39 commerce collaborators spanning established managers, fast-growth businesses and start-ups.
- The review highlighted into the adoption of Cloud Computing, encompassing the cloud configurations and applications that are forming exact enterprise desires encompassing big data, enterprise continuity, collaboration and storage.
- There are ten emerging future trends in Cloud Computing.
- Cloud Computing has altered the way enterprises and people select to consign or use IT services.
- Cloud Computing assisted as a base for enterprise discovery as well as decreased risks.
- Hybrid Cloud will play a significant function in cloud computing.
- Hybrid Computing boasts blend and coordination of off-site cloud services with on-premise applications or infrastructure services.
- With the expansion of cloud adoption, there is now an obligation for utilization assistance.
- A Cloud brokerage, a service provider, can play a crucial function in cloud computing.
- Cloud Computing notions can be directed to infrastructure and data centre investments in alignment to maximize effectiveness and agility.
- Many service providers are looking towards Next Generation Network (NGN) services as it entails to appeal and/or keep the most lucrative customers.
- NGNs support new sophisticated services, which will permit them to keep key clients and elaborate their markets in new areas.
- Network-based solutions permit for distributed assets and finances of scale to rendezvous these demands.
- Customary telecommunications carriers are the most ordered providers of this new network.
- There are six service characteristics significant in an NGN environment.

KEY TERMS

- Software as a Service (SaaS) is the prime kind of cloud buying with 82% of respondents citing it as in use today and% anticipating to use it within 5 years.
- Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) glimpse important developments in the next 5 years.

- Scalability continues to be the peak cause for taking up the cloud, with 57% of businesses recognizing it as the most significant person going by car for cloud adoption.
- Next Generation Network (NGN) endows the deployment of get access to unaligned services over converged repaired and wireless systems.

REVIEW QUESTIONS

- How has cloud computing influenced the corporate industry?
- How does cloud computing help fresh enterprises?
- How have security issues come out of their drawbacks?
- What are the top 10 trends expected out of cloud computing in the near future?
- How has cloud computing changed the IT services industry?
- What is the role of hybrid cloud in IT services industries?
- What is next generation networking (NGN)?
- What are the possible next generation services?
- What are the future trends in network services?
- What are the service characteristics in an NGN environment?

CHAPTER 34

Mobile Cloud

34.1 INTRODUCTION

Mobile Cloud Computing (MCC) combines mobile computing and cloud computing. MCC is not yet fully developed, and it is necessary to understand the core capabilities of this technology for better getting research directions.

Advancement in the area of network-based computing and applications on demand have led to an extensive growth of application models such as cloud computing, SaaS, community network and web store for the past few years. Cloud computing becomes a significant topic in the scientific and industrial communities and it is the major application system in the era of the Internet.

Commonly, cloud computing is described as a different range of services provided by an Internet-based cluster system. These clustered systems contain a group of low-cost servers and personal computers (PCs). Comprising the various resources of computer obtained based on the management strategy. It provides safe, reliable, fast, convenient and transparent services such as computing, data storage, retrieval and computing to clients.

Ubiquity and mobility are two main features in the next generation network, which offers a different range of personalized network services through various network terminals and modes of accessing. The key technology of cloud computing is centralized computing, services and particular applications as a utility to be sold, such as water, gas or electricity to users. Thus, MCC is a mixture of a ubiquities mobile network and cloud.

In the recent development of MCC, resources are virtualized and assigned in different groups of various distributed computers rather than in local computers or servers and are provided to mobile devices such as mobiles, portable terminals and so on. At the same time, various applications based on MCC have been developed and provided to users, such as Google's Gmail, Maps and Navigation systems for mobile, voice search and some applications on an Android platform, MobileMe from Apple, Live Mesh from Microsoft and MotoBlur from Motorola.

34.2 MOBILE CLOUD COMPUTING

Currently mobile devices are upgraded with latest hardware and software. Some smart phones such as iPhone 4S, Android mobiles, Windows Mobile serials and Blackberry are no longer just traditional mobile phones used for conversation, SMS, Email and website browsing, but are daily necessities to users. At the same time, these smart phones include various sensing modules like navigation, optics, gravity and orientation creating an easy and intelligent mobile experience to users.

As shown is the Figure 34.1, MCC can be classified as cloud computing and mobile computing. Mobile devices such as laptops, PDA and Smartphone are connecting with a hotspot or base station by 3G, WIFI or GPRS. The requirement for mobile devices in computing is limited as major processing phases are shifted to cloud. MCC can be achieved by using some low-cost mobile devices or even non-Smartphone with cross-platform mid-ware. When the PCs or standalone machines are changed to mobile devices for acting as the client in MCC, the main concept is still cloud computing. Mobile users use web browser to send the service requests to the cloud.

Cloud Computing represents a huge opportunity for the mobile industry as a whole. ABI Research analyzed that there will be an increase in subscribers for MCC worldwide, over the next 6 years. According to this firm, businesses applications will render and dominate using cloud

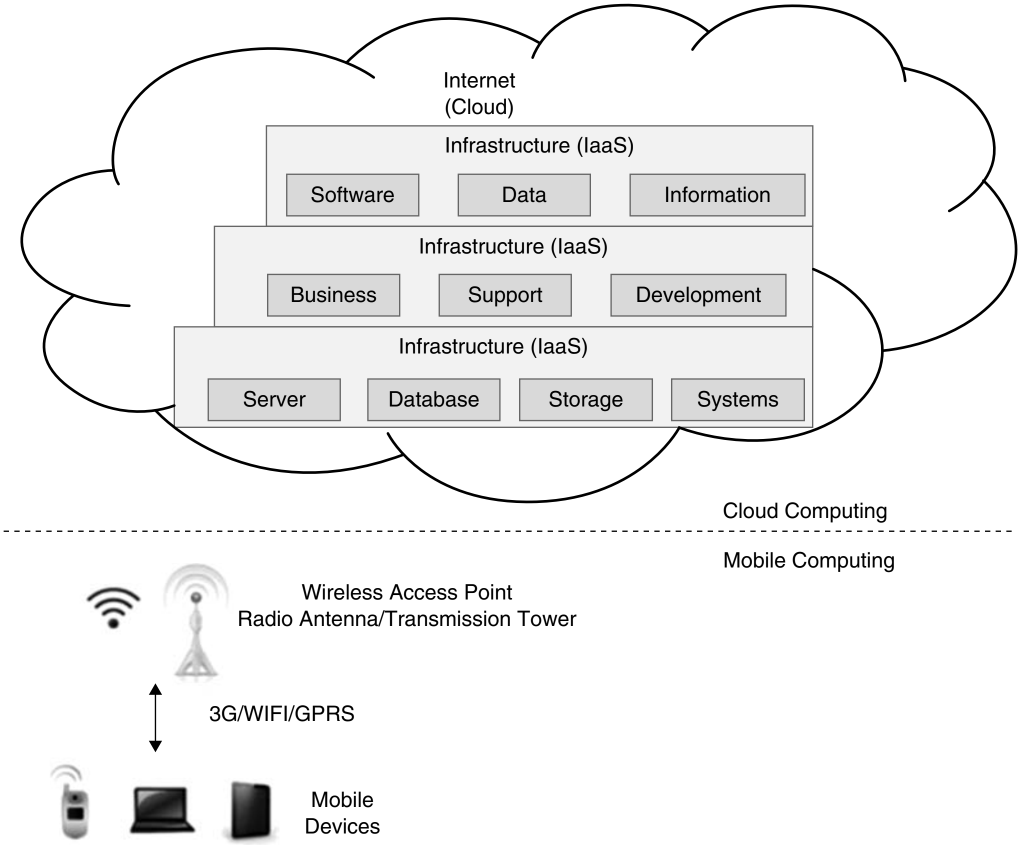


Figure 34.1 Architecture of Mobile Cloud Computing

computing, particularly using MCC. The dominations will be in online sharing of document, sales and scheduling of apps.

A ubiquitous mobile cloud will benefit the telecom industry as a whole, by making it much more attractive for application service providers to create new services, or to enrich existing services that use capabilities, information and intelligence provided by mobile and fixed telecoms operators. Avoiding fragmentation will result in a much higher addressable market of ASPs, resulting in increased service innovation, customer satisfaction and new income sources for the companies as a whole and consequently for individual operators.

34.3 KEY REQUIREMENTS FOR MOBILE CLOUD COMPUTING

In addition to the basic requirements for exposing network services, there are some important features of MCC that make it possible to execute seamless service delivery in a cross-network environment. According to the perspective of the enterprise solution provider or web/mobile application developer, the aims of the MCC platform are as follows:

- Clear and simple API for transparent access, without the knowledge of underlying network.
- Capability of using single SLA for deploying applications in multiple networks.
- Maintaining of specific network policy.

SUMMARY

- Mobile Cloud Computing (MCC) combines mobile computing and cloud computing.
- Cloud Computing becomes a significant topic in the scientific and industrial communities and is the major application system in the era of the Internet.
- Cloud Computing is described as a different range of services provided by an Internet-based cluster system.
- Cloud Computing represents a huge opportunity for the mobile industry as a whole. ABI Research analyzed that there will an increase in subscribers for MCC worldwide, over the next six years.
- A ubiquitous mobile cloud benefits the telecom industry as a whole, by making it much more attractive for application service providers to create new services and to enrich existing services.

KEY TERMS

- Mobile cloud paradigm is an undergoing research for developing cloud-based media services for mobile devices.
- Combined ubiquities mobile network and cloud computing refer to a new computing mode called mobile cloud computing.

REVIEW QUESTIONS

- What is mobile cloud computing (MCC)?
- What are the major features of MCC?
- How will MCC benefit the end-users?
- What are the key requirements for MCC?
- How will ubiquitous mobile clouds benefit mobile users?

CHAPTER 35

Autonomic Cloud Engine

35.1 AUTONOMIC COMPUTING

Autonomic computing is a computing form of self-managing. An autonomic computing scheme would command the functioning of computer submissions and schemes without input from the client, in the identical way that the autonomic tense scheme regulates body schemes without attentive input from the individual. The aim of autonomic computing is to conceive schemes that run themselves, adept of high-level functioning while holding the system's complexity unseen to the user.

Autonomic computing is one of the construction blocks of pervasive computing, a foreseen future computing form in which minute computers will be all round us, broadcasting through progressively interconnected networks. In an effort to encourage open measures for autonomic computing, IBM lately circulated an article that it calls 'a proposal for construction self-managing systems', along with affiliated devices to assist put the notions into practice. Net Integration Technologies advocates its Nitix merchandise as 'the world's first autonomic server functioning system'.

According to IBM, there are eight vital components in an Autonomic Computing scheme, they are as follows:

1. It should sustain comprehensive and exact information about all its constituents.
2. It should have the proficiency to self-configure to match changing and probably unpredictable situations.
3. It should certainly supervise itself for optimal functioning.
4. It should be self-healing and adept to find alternate modes to function when it comes across difficulties.
5. It should be adept to notice risks and defend itself from them.
6. It should be adept to acclimatize to ecological situations.
7. It should be founded on open measures other than proprietary technologies.
8. It should foresee demand while residual clear to the user.

An autonomic scheme makes conclusions on its own using high-level policies, it will certainly ascertain and optimize its rank and mechanically acclimatize itself to altering conditions. An Autonomic Computing structure is created of autonomic constituents (AC) combining with each other. An AC can be modelled in periods of two major command loops (local and global) with sensors (for self-monitoring), effectors (for self-adjustment), information and planners/adapters for exploiting principles founded on self and natural environment awareness.

35.2 AUTONOMIC SYSTEM

The Autonomic Computing Initiative (ACI) aspires at supplying the base for autonomic systems. It is motivated by the autonomic tense scheme of the human body. In a self-managing autonomic scheme, the human operator takes on a new function rather than commanding the scheme exactly, he/she characterizes general principles and directions that direct the self-management process. For this method, IBM characterized the next four purposeful areas: self-configuration, self-healing, self-optimization and self-protection.

IBM characterized five evolutionary grades for the autonomic deployment form; they are as follows: Level 1 is the rudimentary grade that presents the present position where schemes are vitally organized manually. Levels 2 through 4 insert progressively automated administration purposes, while Level 5 comprises the supreme aim of autonomic, self-managing systems.

35.3 AUTONOMIC CLOUD COMPUTING

In alignment to supply good service value and exploit finances of scale, the cloud computing paradigm, proposing computing as a utility, has become exceedingly popular. However, administrating such elastic infrastructures, proposing numerous qualifications of flexibility, is a convoluted issue. The present undertakings aim on form-propelled advances for effective submission deployment, QoS-cognizant deployment of services, exploiting elastic submission demeanour to optimize runtime demeanour and virtualization of cloud and mesh resources.

35.3.1 Autonomic Management Architecture for Cloud Platform

The stage services segment of cloud is multi-faceted. Autonomic administration capabilities can be characterized as anything that occurs without the client having to specifically notify the scheme to manage it. The client may characterize principles or identify directives that form the system's demeanour, but when the time arrives to really take action, it happens. Cloud users, expressly stage service users, are gradually approaching to anticipate a certain set of administration activities, for example, elasticity and well-being administration, to be autonomic. Increasingly, we glimpse stage service providers answering to these anticipations to conceive smarter, self-aware stage administration capabilities for the cloud.

Now, users require not understanding much about the way autonomic administration methods work. Beyond understanding what capabilities their stage provider boasts and how to take benefit of those, the end-user can be blissfully unaware. The client likely does not require understanding much about the algorithms and inward workings that convey out the autonomic actions.

35.4 COMET

Clouds normally have highly dynamic claims for assets with highly heterogeneous and dynamic workloads. For example, the workloads affiliated with the submission can be rather dynamic, both in periods of the number of jobs processed as well as computation obligations of each task. Furthermore, distinct submissions may have very distinct and dynamic QoS obligations, for example, one submission may need high throughput while another may be guarded by an allowance and a third may have to balance both throughput and budget. The presentation of a cloud service can furthermore alter founded on these changing burdens as well as flops, mesh situation, etc., producing a distinct value of service to the application.

Combining public cloud stages and incorporating them with living grids and facts and numbers hubs can support on-demand scale-up, scale-down as well as scale-out. Users may desire to use assets in their personal cloud (or data centre or grid) first before climbing out up on a public cloud and may have fondness for a specific cloud or may desire to blend multiple clouds.

However, such integration and interoperability is reality non-trivial. Furthermore, incorporating these public cloud stages with exiting computational grids presents possibilities for on-demand scale-up and scale-down, that is, cloudbursts.

35.4.1 CometCloud

Autonomic Computing motor for the cloud and grid environments is CometCloud. It is founded on the Comet decentralized coordination substrate and carries highly heterogeneous and dynamic cloud/grid infrastructures, integration of public/private clouds and autonomic cloudbursts. CometCloud presents a distributed coordination space over the Chord overlay mesh and diverse kinds of programming paradigms, for example, Master/Worker, Workflow and MapReduce/Hadoop.

CometCloud carries autonomic cloudbursts and autonomic cloud-bridging on a virtual cloud which incorporates localized computational environments and public cloud services on-the-fly. Also, it carries real-world technical and technology applications.

The aim of CometCloud is to recognize a virtual computational cloud with resizable computing capability, which incorporates localized computational environments and public cloud services on-demand and supply abstractions and means to support a variety of programming paradigms and submissions requirements. Specifically, CometCloud endows policy-based autonomic cloud spanning and cloud bursting. Autonomic cloud spanning endows on-the-fly integration of localized computational environments (data centres, grids) and public cloud services (such as Amazon EC2 and Eucalyptus) and autonomic cloud bursting endows dynamic submission scale-out to address dynamic workloads, spikes in claims and other farthest requirements.

CometCloud originates on a decentralized coordination substrate and carries heavily heterogeneous and dynamic cloud/grid infrastructures, combination of public/private clouds and cloudbursts. The coordination substrate is furthermore utilized to support a decentralized and scalable task space that coordinates the arranging of task, submitted by a dynamic set of users, up on groups of dynamically provisioned employees on accessible personal and/or public cloud assets founded on their QoS constraints, for example, cost or performance. These QoS constraints along with principles, presentation annals and the state of assets are utilized to work out the befitting dimensions and blend of the public and personal clouds that should be assigned to an exact submission request.

What is a CometCloud adept of?

- Support centre programming paradigms for real-world facts and numbers and compute intensive submissions.
- Enable autonomic cloudbursts and cloud-bridging and on-demand scale-out and scale-in, propelled by dynamic principles, financial forms, QoS constraints, etc.
- Programming scheme support deployment of native (Java as well as non-Java) applications with and without change.
- Current deployments encompass a virtual cloud integrating Amazon EC2, Eucalyptus, localized clusters and the TeraGrid.
- Incorporate means for fault-tolerance to handle node and connection flops and recovery.

Features of CometCloud are as follows:

- Pull-based task utilization
- Policy-based autonomic cloudbursts
- Cloud-bridging
- Support for multi-core processors
- Support MapReduce with naïve computer disk writing
- Master throttling
- Multiple masters
- Task update,
- Garbage collection
- Distributed task lifetime by workers
- Fault-tolerance by duplicating task space

SUMMARY

- ❖ Autonomic Computing is a computing model of self-managing.
- ❖ The objective of autonomic computing is in enabling systems that execute themselves and have high-level performance.
- ❖ Autonomic Computing is one of the construction blocks of Pervasive Computing.
- ❖ There are eight essential elements in an Autonomic Computing scheme.
- ❖ An autonomic system makes conclusions on its own by employing high-level guidelines, optimizing its rank and automatically acclimatizing it to changing conditions.
- ❖ An Autonomic Computing structure contains Autonomic Constituents (AC) aggregating with each other.
- ❖ The Autonomic Computing Initiative (ACI) aspires at delivering the foundation for autonomic systems.
- ❖ IBM identified four purposeful areas in Autonomic Computing: (i) self-configuration, (ii) self-healing, (iii) self-optimization and (iv) self-protection.
- ❖ IBM identified five evolutionary levels, for the autonomic deployment configuration.
- ❖ Autonomic administration capabilities can be identified as any kind that without the client having to explicitly notify the system to supervise it.
- ❖ Cloud users, expressly platform service users, anticipate a certain set of administration services, such as instance elasticity and administration to be autonomic.
- ❖ Clouds usually have high dynamic claims for assets with heterogeneous and dynamic workloads.
- ❖ Combining public cloud platforms and including them with existing grids and data hubs can support on-demand scale-up, scale-down as well as scale-out.

- Including public cloud platforms with exiting computational grids presents possibilities for on-demand scale-up and scale-down, that is, cloudbursts.
- CometCloud is an AC engine for the cloud and grid environments.
- CometCloud carries autonomic cloudbursts and autonomic cloud-bridging on a virtual cloud which includes localized computational environments and public cloud services on-the-fly.
- CometCloud is a combinatory of decentralized coordination substrate and carries heterogeneous and dynamic cloud/grid infrastructures, aggregation of public/private clouds and cloudbursts.

KEY TERMS

- An Autonomic Computing system controls the functions of applications without the intervention of the client.
- An Autonomic System may be coordinated as monitor-analyse-plan-execute loops, where artificial understanding methods are utilized in the investigation and designing stages.
- CometCloud presents a distributed coordination space over the Chord overlay network and assorted varieties of programming paradigms, for example, Master/Worker, Workflow and MapReduce/Hadoop.

REVIEW QUESTIONS

- What is Autonomic Computing?
- What is the future of Autonomic Computing?
- What are the crucial elements in an Autonomic Computing System?
- What are the components of Autonomic System?
- What is an Autonomic Computing Initiative?
- What are the service qualities in Autonomic Cloud Computing?
- What are the autonomic management architectures for cloud platforms?
- What is CometCloud?
- What are the goals of CometCloud?
- What is CometCloud capable of?
- What are the features of CometCloud?

CHAPTER 36

MULTIMEDIA CLOUD

36.1 INTRODUCTION

Cloud Computing opened the opportunity for media operators who serve content providers, IPTV (Internet Protocol Television) operators and multimedia players. When we consider multimedia players, adopting cloud computing is often one of the important priorities in the coming years. Some media players, for example, companies like media post-production, already utilize these kinds of cloud computing–based service capabilities for managing the digital delivery.

In the future, multimedia companies will use cloud computing first, who started looking to move their storage requirements into cloud computing. The cost and the investment return for these kinds of services have accelerated the growth of cloud computing services market.

Because of different offerings by IaaS (Infrastructure as a Service), many telecom companies already distributed the content. The relationships between the media and content value chain are more exposed because of cloud computing. For example, HBO and Verizon are now using content delivery via cloud computing.

Companies those who have invested in media business now have the opportunity to use those things to other players, for example, to content providers. The different types of services that can be proposed are as follows:

- Using hosted hardware
- Content access securely
- Sharing the content
- Transcoding services
- Delivery of content

36.2 IPTV

IPTV (Internet Protocol Television) offers a revenue opportunity for media operators looking to use cloud computing services. For using this service, normally we need a set-top box called STB. To reduce costs, the processing power and graphic capabilities of STBs are limited. Providers are not able to take the benefit from the latest technology, which has powerful STBs, offered at low cost. The reason is due to the installation base is not economically cost effective, as a result, the low cost and less capable STB offers less service and the innovation in delivery of media to TV is limited.

IPTV providers have to overcome the barriers because of the low capable STBs, in terms of limited processing power, in order to:

- Deliver very good service with graphics quality
- Be competitive with other emerging video service providers using new STBs

By adopting cloud computing services to manage the STB, IPTV provides customers with services and applications which are not available in STB, and also provides applications that are more resource intensive than the latest STBs.

This kind of approach results in low cost, compared with replacing old STBs. The reasons are as follows:

- Resources are shared
- The cost involved by using cloud servers is much lower than replacing old STBs
- Moving complexity simplifies operations at the customer end

When deploying cloud exploitation, they may impose some challenges. For example, video editing systems cannot be addressed because of technical constraints, especially because of more bandwidth demands. A significant increase in revenue generation remains while adopting cloud exploitation.

Many operators started to invest in the concept of private cloud for rendering media services. They now need community cloud architecture to make use of these media market opportunities and can render services to a greater number of customers. Exposing media cloud capabilities does not require major investment. Using cloud computing services, this can be achieved cost effectively. An example is the Alcatel-Lucent Cloud Application Enabler.

SUMMARY

- ❖ Cloud computing opened the opportunity for media operators who serve content providers, IPTV operators and multimedia players.
- ❖ Using IaaS offerings, many telecom companies already started distributing the content.
- ❖ Using Cloud Computing, relationships between the media and the content value chain are more exposed. For example, HBO and Verizon are now using content delivery via cloud computing.
- ❖ The IPTV offers a revenue opportunity for media operators looking to use the cloud computing services.
- ❖ IPTV providers have to overcome the barriers because of the low capable STBs. by adopting cloud computing services, IPTV provides customers with better services and applications.
- ❖ Exposing media cloud capabilities does not require major investment. An example is the Alcatel-Lucent Cloud Application Enabler.

KEY TERMS

- ❖ Clouds multimedia presents a full line of multimedia services encompassing sound design, graphic design, audio production, video production and web site production.
- ❖ Internet Protocol Television (IPTV) is a scheme through which television services are consigned utilizing the Internet protocol suite over a packet-switched network, for example, the Internet, rather than being consigned through customary terrestrial, satellite pointer and cable TV formats.

- Transcoding is the direct digital-to-digital data alteration of one encoding to another, for example, movie data files or audio files.
- A set-top box (STB) is a device used to decode digital signals from the satellite to television sets.

REVIEW QUESTIONS

- What are Multimedia Cloud?
- What are the ranges of services in Multimedia Infrastructure?
- What is the IPTV?
- What are the significant revenue-generating opportunities adopted by industries?
- How does IPTV get benefited by adopting cloud computing?

CHAPTER 37

Energy Aware Cloud Computing

37.1 CLOUD COMPUTING ENERGY EFFICIENCY

Energy efficiency is increasingly most important for information and communication technologies. The reasons are the increased use in advanced technologies, increased energy costs and the need to reduce GHG (greenhouse gas) emissions. These reasons called for energy-efficient technologies that tend to decrease the overall energy consumption in terms of computation, communications and storage. Cloud Computing has been recently attracted as a promising approach for delivering these advanced technology services by utilizing the data centre resources.

We know that cloud-based computing can reduce IT capital costs, labour costs, enhance productivity and also be remarkably efficient. One of the analyses shows that a particular organization or company that switched to the cloud has saved around 68–87% energy for its office computing and carbon emission has been reduced.

The value for cloud computing services has continued to increase in spite of a decline in economic activity. Also the growth in cloud computing revenue increased worldwide at a compound annual growth rate of 28.8%, with the market increasing from $46.0 billion to $210.3 billion.

Growth in cloud computing has some consequences because of GreenHouse Gas (GHG) emissions and sustainability. Clouds are utilized better and are less expensive to operate than the traditional data centres. Moreover, only the large organizations both commercial and governmental will have the capital and expertise to achieve a similar level of efficiency at a lower cost. Because of this, most of the work done in internal data centres can be outsourced to the cloud in the coming years, resulting in reductions in energy consumption, energy expenses and emissions from data centre operations.

A research report analyzed the energy efficiency benefits of cloud computing, which includes an assessment for SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service) markets. The study examines the drivers and technical developments related to cloud computing. Market forecasts include a quantification of energy savings and reduction possibilities under a cloud computing scenario. Key issues addressed are:

- Cost-wise advantage of public cloud computing providers over traditional data centres.
- Objectives for computing by business providers of cloud.
- Strategies among cloud computing providers regarding energy efficiency.
- Improvement of sustainability while shifting to the cloud.
- Kind of ROI that the cloud computing delivered from an energy efficiency perspective.
- Impact of using cloud computing on carbon emission from the data centre operations.

Three points stand out from these results.

1. First, by migrating to the cloud, industries can achieve significant energy savings and reduced pollution, in addition to savings from reduced server purchases and maintenance.
2. Second, the reduction in energy consumption was larger and not by a reduced number of servers. This was due to two factors: usage of server is lower, power consumed is less and forming the servers in subset based on PUE (power usage effectiveness), reduces the energy consumption.
3. Third, the results do not reflect the energy consumed by the client devices.

There are two models for saving energy in office computing: the standard model and the cloud-based model which are enabled by Google Apps. Migration to Google Apps affects energy consumption in three ways.

1. *Reduces direct energy for servers by 70–90%*: The operations required for far fewer servers and Google's servers are fully loaded with more efficiency. An organization that hosts its own IT services must have redundancy to prevent safety and more servers to manage the demand. From the above, it results in more servers and server utilization of 10% or less.
2. *Reduces energy for server cooling by 70–90%*: More energy consumed by server means more heat produced. This makes the AC cooling systems to work harder than their usual load. The energy 1.5 watts of cooling required for each watt of direct power consumption by the server. In addition, the large corporate data centres indirectly consume ~0.5 watts of power for each watt of direct power consumption.
3. *From the use of Google servers and heavy network traffic, the energy increased by 2–3%*: The impressive savings from points 1 and 2 are not achieved easily. As a result of cloud-based services, some of the energy consumption is added by using Google's servers and heavy traffic on the Internet.

SUMMARY

- Energy efficiency is more and more valued for knowledge and making acquaintance technologies.
- Energy-efficient technologies are likely to diminish the complete vitality of use in terms of computation, communications and storage.
- Cloud Computing is agreed for bringing ahead of superior technical knowledge services.
- Growth in Cloud Computing has some extra subjects because of greenhouse gas (GHG) emissions and sustainability.
- Clouds are utilized better and cost less to run than the conventional knowledge centres.
- The large administration in both economic and governmental will have the capital and skill to realize a same efficiency at less cost.
- A research report predicts a quantification of vitality savings and lessening possibilities are under a cloud computing scenario.
- Key subjects to be addressed in viewing vitality recognition are: (i) cost-wise, (ii) operational objectives, (iii) strategies taken by cloud computing providers, (iv) sustainability, (v) kind of ROI brought ahead and (vi) carbon.
- Migration to Google Apps acts on vitality use in three ways: (i) reduces direct vitality for servers by 70–90%, (ii) reduces vitality for server cooling by 70–90% and (iii) from the use of Google servers and heavy traffic, the vitality is advanced by 2–3%.

KEY TERMS

- ❖ A GreenHouse Gas (sometimes abbreviated GHG) is a gas in an air that soaks up and emits emission within the thermal infrared range.
- ❖ Power Usage Effectiveness (PUE) is an estimate of how efficiently a computer knowledge centre engages its power.

REVIEW QUESTIONS

- ❖ Define GHG emission.
- ❖ Define PUE.
- ❖ What are cloud computing energy efficiency techniques?
- ❖ How does cloud-based computing reduce cost?
- ❖ State the effect of using cloud computing on GreenHouse Gas.
- ❖ List the key issues related to cloud computing energy efficiency.
- ❖ In what ways are energy saved when migrating applications in Cloud?

CHAPTER 38

Jungle Computing

The application of high-performance and Distributed Computing in scientific practice has become more important among the most available platforms such as clusters, grids and cloud systems. These infrastructures are now undergoing many changes due to the integration of core technologies, providing speed improvements for selected compute kernels. As distributed and high-performance computing is becoming more heterogeneous and hierarchical, complexity in programming is increased. Further, these complexities arise due to an urgent desire for scalability and issues like data distribution, heterogeneity in software and hardware availability. Scientists were forced to use multiple platforms simultaneously for the above issues (e.g., clusters, grids and clouds used concurrently).

38.1 JUNGLE COMPUTING

Jungle Computing is a Distributed Computing paradigm. It just emerged out of the plethora of available distributed resources. A Jungle Computing System provides the user to use all computing resources available in this environment, which contains clusters, clouds, grids, desktop grids, supercomputers, stand-alone machines and mobile devices.

There are many reasons to use Jungle Computing Systems. To run an application in a single system is not possible, because it may need more computing power than available. A single system may not support all the requirements from different parts of an application, because the computational requirements differ in some part of an application.

From the abstract view, all resources in a Jungle Computing System are equal in some way. The system contains some amount of processing power, memory and storage, etc. The end-users no need to consider about the resource located in a remote cloud or down the hall in a cluster, but the compute resource run their application effectively. A Jungle Computing System is heterogeneous because the properties of the resources differ in processor architecture, memory capacity and performance. In the absence of central administration of these unrelated systems, software systems like libraries and compilers may differ.

For example, if a permanent stand-alone system is available then grid resources have to be reserved, whereas a cloud requires a credit card to get access. Also, using different interfaces, the middleware used to access a resource will differ.

It is hard to run the applications on several resources due to the heterogeneity of Jungle Computing Systems. The application have to be re-compiled or even partially re-written for each used resource is to handle the changes available software and hardware resources. A different middleware interface is required to use different middleware client software for each resource. Jungle Computing Systems lack in terms of connectivity between resources. This aspect reduces the usage of Jungle Computing.

38.2 JUNGLE COMPUTING SYSTEM

The main aim of introducing Grid Computing over a decade ago was to provide efficient and transparent wall-socket computing over a distributed set of resources. From then onwards, several other distributed computing paradigms have been introduced such as peer-to-peer computing, volunteer computing and recently Cloud Computing. These paradigms allocate the majority of targets of grid computing to supply end-users with controlled, distributed resources with as few exertions as possible. These novel paradigms lent towards a diverse bundle of resources available for innovation in computing research, which incorporate stand-alone systems, clusters, grids and clouds, etc.

It is very difficult for scientists to program and use clusters, grids and clouds being equipped with multi-core processors and many-core 'add-ons'. Despite the fact that the programming and efficient use of many-cores is known to be hard, this is not the only problem. Even the programmers must care about the potential for parallelism at all levels of granularity. Even now the problem is more severe, because the use of a single high-performance computing environment is not sufficient while increasing the desire for speed and scalability in most scientific research domains.

The need to access multiple platforms concurrently from within a single application often is due to the impossibility of reserving a sufficient number of compute nodes at once in a single multi-user system. Also, the nature of consumers consisting different platforms is another issue.

SUMMARY

- The expanding complexity of the high-performance computing environment has supplied a puzzling variety of alternatives besides supercomputers and clusters.
- The emergence of many-core technologies, for example, GPUs, as well as supercomputers on chip inside these environments has added the complexity.
- High-performance computing can use multiple varied platforms and systems simultaneously.
- Platform with scalability and speedy processing in technical and diverse areas is needed.
- Resources utilized by consumers are not just cluster, grid or cloud. Diverse collections of assets are required for speedy processing and high scalability. Jungle computing evolved.
- Jungle Computing is a circulated computing paradigm evolved in practice rather than developing from theory.
- A Jungle Computing System comprises all types of compute assets which encompass clusters, clouds, grids, desktop grids, supercomputers as well as stand-alone appliances and wireless devices.

KEY TERMS

- Jungle computing refers towards the collection of diverse, allocated and greatly non-uniform operations of computer systems towards accomplishing peak performance.
- Jungle Computing Systems refer towards the mixture of heterogeneous, hierarchical and allocated resources.

REVIEW QUESTIONS

- What is Jungle Computing?
- What are the features of Jungle Computing?
- What are Jungle Computing Systems?

CHAPTER 39

CASE STUDIES

39.1 HOSPITAL LOWERS IT COSTS AND IMPROVES CLINICIAN PRODUCTIVITY WITH VIRTUAL DESKTOPS (CISCO)

Metro Health executed Virtualization Experience Infrastructure (VXI), incorporating Virtualization Experience Client (VXC) endpoints.

SUMMARY

- *Customer name*: Metro Health
- *Industry*: Healthcare

CHALLENGE

- Provide high-quality care
- Minimize IT costs
- Increase productivity for mobile clinicians by providing faster access to clinical applications

SOLUTION

- Built scalable foundation with Cisco Virtualization Experience Infrastructure (VXI) with VMware View
- Lowered costs by replacing thin clients and PCs with Cisco Virtualization Experience Client (VXC) 2211 endpoints

RESULTS

- Decreased data center infrastructure costs by 30 percent
- Reduced time spent on clinical work flows, including remote image access, clinical desktop access for nurses, and dictation for physicians.

39.1.1 Challenge

Metro Health will be an incorporated health framework, which incorporates another healing facility, the Metro Health Medical Group which deals with associated doctors, focuses neighborhood outpatients, and establishes an humanitarian concern and so on.

As a major aspect of progressing exertions to enhance nature of consideration and the patient experience, Metro Health actualized the Epic Electronic Medical Records(EMR) framework. The IT group needed to furnish access to the framework on any unit, from any where, both inside the doctor's facility and at home. Its main objective was to stretch out the framework out to a mixture of structure variables and areas to give whenever, wherever access to patient data.

Metro Health confronted three real choices on the EMR engineering—the virtualization programming, the information focus stage for facilitating the virtual machines, and the endpoints that faculty might use to gain entrance to their virtual desktops.

39.1.2 Solution

Metro Health discovered a solid, adaptable, effectively reasonable stage in the Cisco® Virtualization Experience Infrastucture (VXI) with Vmware View. CiscoVXI, brings together virtual desktops with voice and movie administrations, works a Flexpod stage that incorporates Cisco Unified Computing System™ (UCS®) B-Series Blade Servers and Netapp space.

Cisco VXI helps the PC over IP(PCoIP) convention, which Metro Health favored over Remote Desktop Protocol (RDP), since it gives an improved film experience with movie and with fringe apparatuses associated with dainty customers.

Further, Metro Health started assessing endpoints that staff might use to access their virtual desktops in patient rooms, nursing workstations, and executives work places. Criteria incorporated USB ports for scanners and other fringe apparatuses, sound ports for earphones and an amplifier for correspondence and backing for film, for preparing and tele-vicinity sessions. The IT group likewise needed to minimize the time required to stay up with the latest. From the get go, Metro Health was wanting to displace their maturing PCs with flimsy customers. Be that as it may the programming picture on the meager customers rapidly exceeded memory limit, heading the IT group to presume that zero customers might be better since there is no OS picture to oversee on them. After broadly assessing three zero customers, Metro Health chose the Cisco.

Virtual Experience Client (VXC) endpoints. Metro Health sent 1400 Cisco VXC endpoints. Workers can likewise access their virtual desktops from outside the healing center, even at home, utilizing individual tablets or laptops with Vmware View customer programming.

Metro Health additionally takes advantage of other Cisco interchanges and coordinated effort requisitions, incorporating Cisco Unified Communications Manager and Cisco Jabber™ for vicinity and texting. Cisco Unified Workspace Licensing holds costs down and helps Metro Health rapidly include new requisitions. Furthermore, to minimize information focus costs, Metro Health has Cisco Unified Communications Manager as virtual machine on Cisco UCS C-Series Rack Server.

39.1.3 Results

30 Percent Reduction in Infrastructure Costs

Executing Vmware View on Cisco VXI decreased foundation sets back the old finances by 30 percent. These reserve funds incorporate capital expenses, working cost, power utilization, higher provision accessibility, and benefit enhancements in three discriminating workflows.

- *Remote picture access*: Physicians probably will not have to utilize a specific workstation at the clinic to view therapeutic pictures. Rather, they can view pictures any where, on any gadget, incorporating any Cisco VXC endpoint at the doctor's facility or a particular smart phone or tablet at home. Empowering doctors to survey pictures without making a trip to the healing center can quicken choice making to enhance nature of forethought, and additionally enhances work-life equalization.
- *'Take after me' clinical desktops for medical caretakers*: In a common 10-hour shift, Metro Health attendants require to recover or enter data no less than 50 times. Presently, medical caretakers can log into any Cisco VXC at any area within seconds to enter the sum of their requisitions, recovering the three minutes they previously used to need to start utilizing their provisions on a PC.

- *Dictation for medical practitioners*: Instead of searching for a particular transcription workstation, doctors can unite their receivers to a sound port on any Cisco VXC endpoint. They spare strolling time, and having the ability to record notes sooner after the patient session serves to expand exactly.

39.1.4 Lower-cost Endpoints

Displacing the unique meager customers with Cisco VXC 2211 endpoints further brought down expenses.

- *Freed up 3850 hours of IT staff time for provisioning*: Installing a Cisco VXC endpoint takes 15 minutes, contrasted with 3 hours for a PC. For 1400 endpoints, the funds sums to 3850 hours, or very nearly two full-time workers (Ftes) for one year.
- *Saved 240 hours on every programming picture overhaul*: When Metro Health utilized slender customers, introducing another scanner driver took two weeks for three Ftes, or 240 hours, spending US $12,000 in staff time.
- *Lower gear costs*: Cisco VXC endpoints take one-third less than PCs.
- *Lower permitting expenses*: Eliminating antivirus licenses for 1400 desktops spared $13,000 every twelve months.

39.2 ACCESS P CLOUD REDUCES IT COSTS FOR SCHOOL DISTRICTS (CISCO)

Access P cloud sends Cisco UCS to increment administration offerings to nearby school areas while decreasing the expense of administrations.

ACCESS P CLOUD

- *Industry*: Education (K-12)
- *Location*: India
- *Number of school districts*: 210

CHALLENGE

- Offer scalable, secure services to school districts
- Provide new services hosted in cloud
- Reduce cost of services

SOLUTION

- Virtualize data center to increase scalability
- Update data center technology to enhance services

RESULTS

- ❖ Increased number of services offered
- ❖ Reduced cost of services for end users
- ❖ Improved security of cloud environments

39.2.1 Challenge

Access P cloud furnishes open school areas in Illinois with access to virtual administrations (on-demand virtual machines), online space, and fast system conductivity.

The organization has found that these results work for school areas to spare them cash.

More than 200 school regions in the state utilized its administrations; that is one-quarter of all school areas in Illinois. Access P cloud strives to tackle numerous issues identified with state funded school K-12 engineering, incorporating:

- Creating a model of figuring where locals depend not on capital consumptions on working uses.
- Using economy-of-scale to furnish state-of-the-workmanship processing space and system assets to all locals paying little mind to size.
- Helping empower regions with the capability to give existing assets more effectively, with minimal overhead and out of pocket for extension of extra assets.

With 860 school regions in Illinois, Access P cloud could not comprehend why each one school region was building its own particular IT base when they are all needed to give the same administration and curriculum applications.

With plans recently extended and a developing interest for innovation, school district chief technology officers (CTOs) met and started examining collocations and different alternatives and began taking a gander at their IT and how to start imparting it to different schools. With the coming of virtualization, there are more changes as to data imparting. The CTOs deduced an approach to work with state authorities to get the server farms to manufacture a 'neighborhood' cloud and after that offer imparted administrations.

For quite some time, helpful purchasing of paper supplies, diesel gas for transports, and actually brandishing offices has helped school regions cut expenses. Access P cloud performs a comparative capacity with respect to IT. Each school region need to make report cards, keep tests scores, look after lunch and understudy participation records, and perform horde different capacities, so information focus combining and imparted administrations were characteristic expansions to an agreeable purchasing methodology.

39.2.2 Solution

To start offering administrations to numerous school regions, Access P cloud required a stage where upon it could grow and broaden offerings all in a nature. To do this, the organization looked to Cisco Unified Computing System™ (UCS®) and Cisco Nexus® server farm items as contrasted with other server and system sellers.

As a brought together server farm framework, Cisco UCS joins industry-standard x86 cutting edge servers, access and space systems administration, virtualization, and administration into a solitary framework, taking out excess gadgets and layers of administration unpredictability. A solitary administration interface controls various skeleton and many virtual machines, diminishing the multifaceted nature of quite virtualized situations and hence expanding nimbleness, adaptability, and worker profit. The productive configuration of Cisco UCS likewise quickens and disentangles provision organization with more terrific unwavering quality and security.

Also for bound together systems, administration in the server farm, the Cisco Nexus 7000 Series offers a thorough one-stage answer for the server farm center system. It additionally offers collection, high thickness, and finish of-line and top-of-rack server connectivity. For yard center organizations, it furnishes an adaptable, quite strong, high-execution, inter-connected result.

'We needed to work with merchants that are now giving administrations to schools and afterward put those administrations in the cloud and start renegotiating the cost as it is much shabbier to offer benefits in the cloud,' says Jim Peterson, boss innovation officer, Access P cloud. 'It was discriminating that we make confide in the cloud. Our finish clients required self-rule and necessity to realize that their data is secure'.

39.2.3 Results

Today, Access P cloud has the capacity to give three principle benefits as a consequence of its new server farm:

- *Disaster recuperation*: In a circumstance, for example, the May 2011 tornado in Joplin, Mo., having workstation index space off-site is a protection arrangement.
- *Infrastructure as a Service (Iaas)*: With off-site supplies, areas do not need to stress over administering or obtaining servers.
- *Software as a Service (Saas)*: It furnishes chances for online addresses and substance, and in addition information examination projects to help understudies, likewise sparing cash and expanding assets.

Access P cloud's exertions permit school regions to place cash into direction rather than base. Every school region that joins Access P cloud can conceivably lessen its use on IT by 30 to 50 percent. These expense funds are discriminating for school areas confronting exceptional plan cuts.

'Schools need framework. We give minimal effort virtual servers, with the goal that schools do not need to stress over supporting it,' says Peterson. 'Access P cloud has been a model for maintainability and expense investment funds with different states building comparative stages. As an after effect of our prosperity, we are looking to extend administration offerings into higher instruction foundations and state and neighborhood governments.'

39.3 HOSPITAL DOWNSIZES DATA CENTER, CUTS COSTS USING VIRTUALIZATION (CISCO)

Denver Health conveys Cisco answers for virtualizing information focuses, streamline troubleshooting, help execution, and lessen costs.

39.3.1 Challenge

Established in 1860, the Denver Health and Hospital Authority will be the Rocky Mountain Region's Level I scholarly trauma focus and the security net healing center for the Denver territory. The Denver Health system, which coordinates intense and crisis mind with open and

> **SUMMARY**
>
> - *Customer name*: Denver Health
> - *Industry*: Healthcare
> - *Location*: Denver
>
> **CHALLENGE**
>
> - Streamline troubleshooting of complex data center problems
> - Downsized at a center while optimizing utilization and performance
> - Provide universal access to data center, application, and network data from centralized location
>
> **SOLUTION**
>
> - Cisco Unified Computing System enables virtualization and unified management
> - Cisco architecture integrates with VMware for cohesive management
> - Cisco UCSB-Series Blade Servers enhance performance
>
> **RESULTS**
>
> - Achieved clear, comprehensive view of data center operations
> - Experienced dramatic improvements in performance, leading to better utilization of resources
> - Allowed IT team to troubleshoot network issues faster and more effectively

group health, incorporates the Rocky Mountain Regional Trauma Center, Denver's 911 crisis medicinal reaction framework, Denver Health Paramedic Division, eight family health focuses, 13 school-based health focuses, the Rocky Mountain Poison and Drug Center, Nurseline, Denver CARES, Denver Public Health, the Denver Health Foundation, and the Rocky Mountain Center for Medical Response to Terrorism, Mass Casualties, and Epidemics.

To help this gigantic conveyed association, Denver Health works two server farms. In the wake of appropriating an order to cut expenses, David Boone, Denver Health's operations and server chief, chose to virtualize the second server farm utilizing Vmware. However, after virtualizing 75 percent of the servers, he understood the existing server farm construction modeling could not enough help a nature's domain.

'We had 54 overseeing just about 700 visitors, yet numerous of these were unique hosts,' says Boone. 'At whatever point a seller discharged a patch, we needed to actualize it to each server in a bunch. It was a logistical bad dream.' Boone was additionally disillusioned that cost funds were negligible, and execution was still an issue. 'I'd trusted for additional,' he says. 'More combination, more power and cooling funds, more space authorized, yet it didn't emerge.'

To intensify matters, despite the fact that most frameworks were virtualized, Boone still experienced issues getting an extensive perspective of the whole server nature's turf. 'We necessity to quickly recognize purposes of disappointment, judge the effect on operations, and rapidly actualize results at whatever point issues come up,' he says. 'Essentially getting sufficient data to do simple troubleshooting was uncommonly troublesome.' To address this horde of issues, Boone started to search for an adaptable, strong, without a doubt venture level server farm foundation result.

39.3.2 Solution

The point when Boone started acknowledging his alternatives, one key element was top of brain: straightforwardness of combination. 'I needed to determine that the result we chose might fit pleasantly with what we as of now have in nature. Cisco UCS offers consistent reconciliation with Vmware,' he says. 'We additionally needed to reconcile the Microsoft System Center into our system, and had as of recently begun down the way of creating a 10-gigabit private system to meet our space necessities.' As a major aspect of its new framework, Denver Health introduced Cisco Nexus 2000, 5000, and 7500 disseminated switches, and furnished every server farm with eight Cisco® UCS B230 M1 Blade Servers. More than 800 requisitions run crosswise over both server farms, incorporating Sharepoint 2010 for business brainpower, therapeutic records seller provisions, for example, Openlink, and various occurrences of Microsoft SQL Server that backing 85 SQL databases holding patient consideration data, very nearly all of which have been virtualized.

When the usage started, Boone feared the move to the new structural engineering. In any case, as he depicts, there was no need to stress; the UCS relocation was effortless. 'The Cisco Services group came in, got up to speed on our surroundings instantly, and introduced and arranged the units for us,' says Boone. 'We were fit to begin moving our Vmware visitors immediately, with just negligible downtime. Cisco's execution was basically impeccable.'

39.3.3 Results

In the wake of sending Cisco server farm results, the Denver Health IT group now has an agreeable perspective of its server the earth. 'With Cisco UCS, I can get all framework, requisition, and system information from a solitary spot,' Boone says. 'This gives us a chance to recognize and track any issues that emerge, perform main driver investigations, and exploit Microsoft Service Manager to take off results.'

Boone and his group have likewise seen memorable enhancements in execution. 'We're seeing much better execution from the Cisco sharpened pieces of steels. We're equipped to attain higher virtual machine thickness, and we can use both memory and CPU assets all the more viably. The Cisco stage has helped us acknowledge picks up no matter how you look at it.' According to Boone, the best profit for Denver Health, be that as it may, is the way that IT operations are 'no more in an emergency circumstance.' He proceeds, 'We have all the information in one spot. We could be repeatable, reliable, and exact about finding, following, and altering any issues. Also that is enormous.'

39.4 EXAMWORKS INC. BUILDS PRIVATE CLOUD

Examworks, Inc. utilizes Data Center 3.0 answers for diminish progressing expenses and expansion deftness.

39.4.1 Challenge

A national free survey association, Examworks, Inc. matches customers in law offices and insurance agencies with therapeutic specialists for trial confirmation, physical examinations, and associate surveys.

EXAMWORKS, INC.

- *Name*: Medical Independent Review
- *Location*: Atlanta, Georgia
- *Number of employees*: 450

BUSINESS IMPACT

- Saved US $200,000 annually in IT resources
- Avoided US $333,000 annually in new desktop computers
- Will support 1000 employees with four-person IT department (expected)

Most organizations in the business will be little, neighborhood associations. Examworks separates itself by furnishing a national system with nearby work places. The organization develops through securing, and has extended from 12 representatives in one area to 450 workers in 14 areas in 2009.

To direct business on a national scale, Examworks required concentrated reinforcements, calamity recuperation, and the capability to conform to regulations, for example, the Health Insurance Portability and Accountability Act (HIPAA). 'We likewise required a proficient approach to rapidly coordinate the IT frameworks from the greater part of our gained organizations,' says Brian Denton, boss innovation officer, Examworks.

39.4.2 Solution and Results

Examworks manufactured a private cloud to host its primary business requisition and virtual desktops, utilizing the Cisco® Unified Computing System (UCS) B200 M1 and Cisco Nexus 5010 Switch. 'We picked the Cisco UCS in light of the fact that it will be assembled for virtualization,' Denton says. 'We took a gander at edge frameworks too, yet just the Cisco UCS helps the scale and rate we require, and in a little structure variable.'

The Cisco UCS has one undercarriage with three server razor-sharp edges that help all virtualized requisitions and 450 desktops. Examworks hopes to include one cutting edge for every extra 150 representatives. The Cisco UCS is provided with a couple of Cisco UCS 6100 Series Interconnects, which associate with a Cisco Nexus 5010 Switch over lossless 10 Gigabit Ethernet. The Cisco UCS likewise join specifically to space over two trunked 10 Gigabit Ethernet ports, and utilization system joined space with a Network File System (NFS) mount.

A large portion of the organization's information never retreats the server farm. Representatives utilize slight customer gadgets to access virtual desktops that live on the Cisco UCS, and the just data that goes over the system is a screen picture. Limb business settings just need a Cisco Catalyst® 3750 Switch with Power over Ethernet (to help Cisco Unified IP Phones), a Cisco 2800 Router going about as a voice door, and a Cisco Wide Area Application Services (WAAS) apparatus. The recent unites with a Cisco WAAS Engine in the server farm to quicken print administrations and Active Directory validation for the few representatives who do not yet have virtual desktops.

Major Benefits for ExamWorks Include

- *Quite low IT asset prerequisites*: Simply two concentrated IT staff help 450 representatives in numerous areas, an achievement that Denton ascribes to virtualization. Case in point, the organization does not require an IT help work area in light of the fact that representatives who have issues with their desktops can simply recompose. Furthermore, restricting just about all activity to the server farm wipes out the necessity to look after or troubleshoot switches at the system edge. 'With Cisco UCS, Examworks can help the same number of individuals with a staff of four. Avoiding the need for 16 full-time positions spares more than $1.1 million every twelve months.'
- *Reduced capital liability*: Examworks computed that the breakeven focus for a Cisco UCS contrasted with a conventional server might be 250 virtualized servers and workstations. A Cisco UCS designed to have 1000 virtual desktops will require give or take two-thirds not exactly an universal server.
- *Lower cabling and desktop costs*: The Cisco UCS utilizes eight 10-Gigabit Ethernet associations, far fewer than the 35 Gigabit Ethernet associations required for the old cutting edge servers. 'We use far less time on link administration and requirement fewer switch ports,' Denton says. Additionally, representatives' flimsy customer gadgets do not need to be customarily redesigned, as PCs do. Examworks escaped the requirement to supplant one-third of our desktops consistently, which will spare give or take $333,000 every twelve months when the organization is completely staffed.
- *Reduced vigor utilization*: As at present arrangement, Examworks' Cisco UCS can be backing up to 1000 representatives with only two racks, one each for processing and space access. 'The edge server that we supplanted obliged six racks,' says Denton. 'I gauge that the more modest foot shaped impression of the Cisco UCS lessens our vigor utilization by no less than 50 percent contrasted with our old razor sharp edge server.'
- *Simplified organization acquisitions*: The point when Examworks procures an organization, the IT office utilizes a Vmware instrument to change over the physical machines to virtual machines, which are then moved onto the Cisco UCS. Moving virtual servers rather than physical servers requires far less and could be fulfilled in only one weekend.

- *Simplified data security*: The cloud figuring model helps Examworks go along with HIPAA necessities for information security. The main data that passageways the Cisco UCS frame will be desktop screen pictures. And all access, either from representatives or clients, is channeled through a Cisco Adaptive Security Appliance before the Cisco UCS. Indeed system directors access the server farm cloud environment through Ipsec tunnels.
- *Increased adaptability*: The organization utilizes Cisco UCS Manager to rapidly reallocate register assets wherever required. In spite of the fact that the Cisco UCS is streamlined for virtualization, it can likewise help physical servers in the same frame as Vmware. Examworks exploits this adaptability when a requisition does not perform enough as a virtual machine. Utilizing Cisco UCS Manager administration profiles, the IT office can rapidly procure assets for any server, either virtual or physical.
- *Cost-successful development*: Examworks as of late bought a Cisco UCS B250 razor sharp edge, which utilizes Cisco Stretched out Memory Technology to give more than twice as much memory (384 GB) as conventional two-attachment servers. This will expand the amount of virtual machines that a solitary cutting edge can help, giving Examworks the execution and limit to virtualize every last bit of its requisitions and desktops as it keeps on including employees.

39.5 A MODEL OF VIRTUALIZATION (DELL)

The Dell IT bunch has virtualized more than 5,000 servers and spared the organization over US $29 million utilizing a versatile, worldwide virtualization model.

39.5.1 Challenge

A large number of individuals depend on the developments in PC innovation to help them enhance benefit and recovery time. Dell designs always strive to convey those developments in the structure of imaginative registering and organizing items. With significant improvement ventures increase constantly, the Dell IT group requirements to continually convey all the more processing power and new or redesigned provisions for Dell item improvement assemblies and other inside specialities units.

Keeping up with inside needs got to be particularly testing as the organization extended and globalized. ‘Like IT associations at numerous developing organizations, we gambled not being capable to convey the vital provision stages rapidly enough to take care of expanded inward demand,’ says Matt Brooks, Dell IT strategist. ‘From requesting the equipment to finishing the establishment, every new arrangement could take as long as 45 days. We required to decrease that time to keep up with the pace of the business.’ The IT group likewise started to run up against server farm space restrictions. ‘We had slowly included new servers through the years to handle the development of our business,’ illustrates Brooks. ‘We were using up space for new servers and were straining the force and cooling cutoff points of our offices. We realized that if we debilitated the remaining limit, we might be compelled to fabricate or rent new server farm space at a colossal expense. We needed to escape this expenditure by getting all the more figuring power out of our existing space while at the same time lessening our vigor utilization.’

CUSTOMER

- *Country*: United States
- *Industry*: Technology
- *Founded*: 1984
- *Number of employees*: 65,200
- *Web address*: www.dell.com

CHALLENGE

- Business growth and a fast-paced product development cycle require the Dell IT team to accelerate deployment of new servers and applications—without exceeding data center space and within power constraints.

SOLUTION

- Virtualizing on Dell Power Edge Servers enables the Dell IT team to speed new server deployment, use data centers more efficiently and dramatically reduce server costs.

BENEFITS

- Get It Faster
- Run It better
- Grow It smarter.

39.5.2 Increased Demand and Under Utilized Server Resources

Indeed as interest for new servers expanded, the Dell IT group was not ready to completely use existing servers' assets. 'We encountered much the same issue with server underutilization as the rest of the business,' says Brooks. 'Out of the 20,000 or more servers that we oversee internationally, we decided that about seventy-five percent of them never surpassed 20 percent processor usage since most servers were running stand out or two requisitions. Rather than simply adding more servers to address expanded interest, we acknowledged that we had to use our assets more astutely and productively.' Many of the servers at Dell's server farms were likewise more senior models that were lengthy and unreasonable to support. 'We assessed that almost 30 percent of our servers were three to four eras old. More advanced in years gear is typically the reason for most IT administration and repair issues,' says Brooks. 'We understood that we required to lessen the amount of more senior servers.'

The Dell IT group chose to address these tests by virtualizing and combining its server farm servers. Then again, the IT group required better information accumulation and dissection apparatuses to direct an in-profundity investigation of the present environment and future development. The answer turned out to be for all intents and purpose next entryway the IT group cooperated with the Dell ICS virtualization practice to exploit their complex devices and mastery.

Dell ICS Helps the IT Team Develop A Powerful Virtualization Model

Dell IT and the Dell ICS virtualization practice joined together constrains and directed a pilot Virtualization Readiness Assessment (VRA) to distinguish the most guaranteeing server virtualization chances and decide the effect of executing a virtual base. The aggregation reviewed a specimen of pretty nearly 500 servers, speaking to a cross-segment of the organization's servers. The group followed each of the servers to measure CPU, memory, and plate usage. 'VRA is an incredible administration,' says Brooks. 'This empowered us to settle on profoundly educated choices about where to begin and how to move ahead and provided for us the data we required to decide the most suitable server model for nature's domain.'

The IT group utilized information from the evaluation to help create a standard virtualization model for utilization in Dell server farms worldwide. The centerpiece of this model will be the four-attachment Dell Power edge R900 server with Intel Xeon processors running Vmware ESX Server virtualization programming. 'The Power edge R900 is one of the top servers available today for virtualization,' says Brooks. 'With 16 centers for every server and up to 256 GB of RAM, the Power edge R900 provides for us the handling force and memory limit to augment the amount of virtual machines on every physical server.'

39.5.3 Benefits

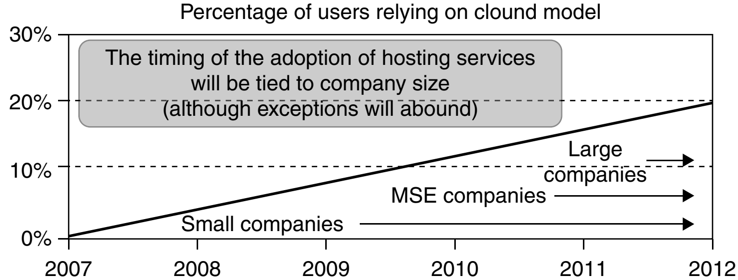
- Application sending time is diminished by pretty nearly 90 percent.
- Dell IT group attains solidification degrees of 20:1 and 10:1.
- Server usage enhanced by roughly 30 percent.
- Dell power edge R900 copies server farm transforming thickness.
- Virtualizing on Dell servers spares an expected US $29 million.
- IT group ventures investment funds of US $52 million from virtualization by 2009.

39.6 CASE STUDIES IN CLOUD COMPUTING

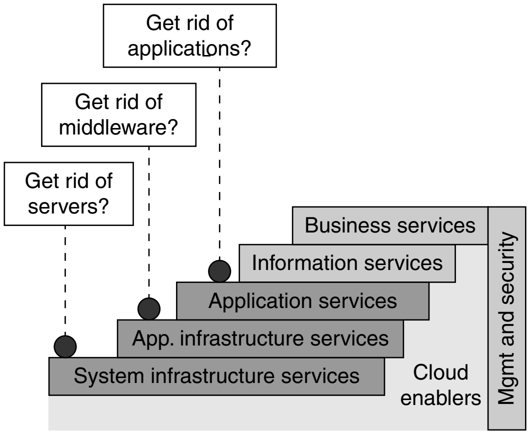
39.6.1 Use of Cloud: Rapid Growth is Predicted and Why?

The reasons are:

- Exploitation of cloud matters of trade and profit, particularly according to worldwide subsidence
- Acceptance of Saas models
- Offerings and sellers every step of the way



Cloud computing is a style of processing in which versatile and flexible IT-related proficiencies are given 'as an administration' to clients utilizing Internet advances.



Key issues are to dispose of:

1. How have organizations effectively utilized cloud framework foundation administrations, and what lessons might be taken in?
2. How have organizations effectively utilized cloud provision framework administrations and what lessons could be taken in?
3. How have organizations effectively utilized cloud provision administrations and what lessons might be taken in?

Beneath are some research endeavors, which gives insights about organizations who embraced distributed computing and the profits obtained from it.

39.6.2 Wipro: Private First, Public Later

In the year of 1945, in pre–independent India, a dream was conceived, which would inevitably emerge as a brand name synonymous with enhancement and honesty. Beginning off with customer items business, Wipro then enhanced into more current ranges incorporating IT fittings and IT administrations. Such has been the element power of the association that in the course of recent years, Wipro has advanced into a heading worldwide IT organization, an organization which has pioneered numerous an improvement in the IT benefits, BPO and R&d administrations space.

Headquartered at Bangalore, India, we at Wipro actualize the logic of 'Applying Thought', in this way helping customers to 'Improve Business'. Our way breaking developments and plans have built up and finally finished into the 'Wipro Way'—a methodology which straightforwardly sways client profits by enhancing time-to-market, improving unoriginality and dependability, and cutting expenses.

Wipro Global IT Business conveys winning business results through its profound industry experience and a 360 degree perspective of 'Business through Technology'—making a difference customers make great and adjustable organizations. An organization distinguished universally for its complete portfolio of administrations, a professional's methodology to conveying enhancement and an association wide duty to supportability, Wipro has over 140,000 representatives and customers over 57 nations.

Explanations Behind Embracing Distributed Computing

- Decreased provisioning time for activities and COEs

Challenge

- Traditional provisioning for new undertakings and COEs was inordinate

Solution—Private Cloud

- Self-administration entryway for mechanization of server provisioning

Benefits

- *Internal server provisioning*: 46 days to 35 minutes
- *Utilization*: <10% to 40%
- *Re-provisioning of benefits*: Nil to lessened capex 30%
- *Average server cost*: From US $2,000 to US $800
- *Improved permit administration*: System transfer speed usage and vigor costs

Key Benefit

- Time to conveyance could be enhanced while using stakes of all the assets

39.6.3 Eli Lilly

The tenth biggest pharmaceutical organization in the world, Lilly has remained committed to making drugs that help enhance people groups' personal satisfaction for more than 135 years. At the heart of Lilly's operations are its center qualities—magnificence, uprightness and appreciation for individuals.

Purposes Behind Receiving Distributed Computing

- Less-unreasonable, fast, consistent access in/outside

Challenge

- Traditional foundation sending was hindering business
- Desire to move from settled to variable expense model

Solution

- Multiple cloud suppliers
- Google for consumerization

Benefits

- *Reduced provisioning process duration*
- *New server*: 7.5 weeks to 3 minutes
- *New nature's domain*: 8 weeks to 5 minutes
- *64-hub Linux bunch*: 12 weeks to 5 minutes

Key Benefit

- Time to delivery is paramount

39.6.4 Razorfish: An Easy Move

Razorfish is a full-benefit office with computerized and engineering at the center. We make encounters that assemble organizations, joining the best thought administration of the counseling scene with the heading proficiencies of the advertising administrations industry. Hone regions incorporate web improvement, media arranging and purchasing, innovation and development, developing media, dissection, versatile, promoting innovative, social impact showcasing, and inquiry.

Challenge

- Needed to enhance their capacity to react rapidly to client requests to backing profoundly obvious web fights
- Support high volume short run battles more cost successfully

Solution

- Using Rackspace as a cloud foundation stage.
- Build Blogs, Microsites, fight-related pages for extensive organizations, for example, Southwest Airlines, H&r Block

Benefit

- From 4–6 weeks and a huge number of dollars to set up to 24 to 48 hours and 3k–5k on normal 25% of expense

Key Benefit

- Take a gander at your methodology displays first. In the event that you are moving web-driven requisitions with strong security and administration drills, you can move them with little deviation to cloud infrastructure.

39.6.5 Japan Post: Business-critical Cloud

Japan Post was a legislature possessed company in Japan that existed from 2003–2007, offering postal and bundle conveyance administrations, keeping money administrations, and life coverage. It had over 400,000 workers and ran 24,700 post business settings all around Japan furthermore was the country's biggest superintendent. One third of all Japanese government representatives worked for Japan Post. Starting 2005, the president of the organization was Masaharu Ikuta, once executive of Mitsui O.S.K. Lines Ltd.

Japan Post ran the world's biggest postal investment funds framework and was frequently said to be the biggest holder of particular funds on the planet: with ¥224 trillion ($2.1 trillion) of family stakes in its yū-cho bank accounts and ¥126 trillion ($1.2 trillion) of family holdings in its kampo life coverage administrations, its property represent 25 percent of family possessions in Japan. Japan Post additionally held about ¥140 trillion (one fifth) of the Japanese national obligation as government bonds.

Foundation

- Massive as of late privatized association (20,000 + limbs)

Solution

- Applications created inside with direction from outer consultancy
- Seven custom provisions in generation, with five all the more being worked on
- One vast venture enveloped 57,000 clients, with up to 25,000 simultaneous appeals.
- Optimizing inner advancement procedure to match Paas

Results

- Live across the nation since October 2007.
- Average advancement time of 3–4 months (3 to 4 times quicker than accepted advancement).
- High client fulfillment (utilitarian, execution).
- No execution or security issues so far.

Key Benefit

- Quick organization, unanticipated stage models

39.6.6 Presidio Health: Move it All to the Cloud

Presidio Health was established in 2004 with the essential mission of rearranging your work day. Using imaginative web innovations, we combine your basic business data so you can without much of a stretch deal with the sum of your patient installments, and your practice report workflow required for coding and charging, all in one framework. Make execution your energy with our Performpos, Performmd, and Performrn results.

Challenge

- Rapid business development limited by foundation

Solution

- Appistry for programming; Gogrid for stage
- Homegrown applications for medical practitioner execution administration and purpose of administration accumulations.

- No re-architecting of on-premises requisitions encouraged by front-finishing applications with message representative.
- Transient information in cloud; touchy perpetual information in conventional database.

Benefits

- PCI and HIPAA agreeability
- No unscheduled downtime
- Flat expenses for half more limit

Key Benefit

- The cloud is primed for applications however maybe not for touchy inform.

39.6.7 Packaged Shipping Company: Just the Private Cloud, Please

Fedex Express created express dissemination and is the industry's worldwide pioneer, giving fast, solid, time-positive conveyance to more than 220 nations and domains, interfacing markets that involve more than 90 percent of the world's terrible household item inside one to three business days. Unmatched air way powers and transportation framework, joined with heading edge data advances, make Fedex Express the world's biggest express transportation organization, furnishing quick and dependable administrations for more than 3.6 million shipments every business day.

Challenge

- Support complex calculations with bunches of registering force to process substantial, complex information streams from numerous sources.
- Break substantial reconciled clump forms into additional discrete-interfaced procedures that can execute in parallel to enhance reaction time.

Solution

- Implemented Appistry network figuring environment on inside frameworks to make a private cloud network base administration at first for a solitary provision.
- Opportunistically move new or existing cluster and transactional provisions.

Benefits

- Able to create new explanatory provision that was not monetarily plausible utilizing prior foundation models.
- Considering different zones where HPC and 'scatter/gather' offers esteem.
- 4-hour group now runs in 20 minutes. Creating requisitions in 60% less time.

Key Benefits

- Easy to break down existing group employments.
- Need to change the outlook of designers and their methodology to advancement.

- From solid provision all to utilization of center imparted administrations in the cloud.
- From batch/linear to parallel execution and scatter/gather.

39.6.8 Author Solutions: Running the Business in the Cloud

Author Solutions, Inc. give the innovation and administrations that make distributed simple, competitive, and accessible to anybody, at any rate, any place, any time.

At Author Solutions (ASI), there are more than 100,000 creators distribute more than 170,000 titles and achieve their distributed objectives. Through the heading distributed toward oneself engravings Authorhouse, iuniverse, Trafford and Xlibris, and through key cooperations with heading exchange distributors, for example, Thomas Nelson and Hay House, they have helped lead an independent unrest in distribution.

Challenge

- Automate distributed toward oneself workflow for creators and distributors.
- Integrate divergent back- and front-office frameworks into a complete result.

Solution

- Created an close to-end self distributed requisition utilizing salesforce destinations, force.com and Amazon administrations.
- Integrates with existing on-premises frameworks incorporating precious stone reports, Microsoft Elements, Great Plains.

Benefits

- Developed requisition in altogether less time and for easier cost than that evaluated for a customary custom in-house provision.
- Lower continuous operational expenses.
- 50%–75% decrease in time and expense to adjust workflow and include items.

Key Benefit

- Hybrid cloud/on-premises results are unpredictable, however they work.

39.6.9 David Allen Company: Business Critical Cloud Services

David Allen Company is a worldwide preparing and counseling organization, broadly recognized the heading power in the fields of organizational and individual profit. The organization furnishes benefits far and wide to extensive ventures, government offices, non-benefits, business people, teachers, and learners. The organization's deliverables are accessible in both the corporate and private segment and are intended to expand execution, limit, and adjusted execution.

Challenge

- Needed to assemble a more bound together CRM framework to process complex tasks.
- Replace various divergent legacy frameworks incorporating a notes-based CRM component.

- Needed to have the capacity to adjust framework rapidly and effortlessly.
- Did not begin with a craving to move outside.

Solution

- Provided operational determinations to an assortment of Apaas sellers to create confirmation of notions. Chose a Longjump based framework.
- Running the business on a cloud-based CRM provision with customizations for all gatherings that touch clients.

Benefits

- Significant improvement funds contrasted with accepted advancement.
- Lower operational expense contrasted with inside frameworks.
- Developed and sent framework in a few weeks. Ongoing upgrades can be actualized quickly. More adaptability to match the framework to changing requirements.

Key Benefit

- It is not dependably doable to get existing framework and requisitions and essentially drop them into the cloud.

39.6.10 SaaS Vendors Use the Cloud

HRAnswerLink is an exclusive enterprise situated in Pleasanton, California with an office in Portland, Oregon and a system of HR Professionals over the United States. We offer Saas based, uniquely marked HR administrations to about 50,000 little and medium measured organizations.

Challenge

- Business distinguished requirement to convey various HRIS requisitions in a Saas model, however an accepted methodology might take 24 months to convey.

Solution

- Private usage of Longjump Apaas.
- Built cloud provision administrations for HR to be conveyed through their accomplice channel.

Benefits

- Developed in 4½ months vs. 24 months.
- Able to furnish a quite customizable administration to their clients.
- Focus improvement on requisition outline rather than foundation, database and security model plan.

Key Benefit

- The cloud might be utilized to convey remarkably customizable administrations.

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