

A Study on Cloud Computing Services

Dr. CH. V. Raghavendran
Associate Professor,
Ideal College of Arts &
Sciences, Kakinada,
India.

Dr. G. Naga Satish
Associate Professor,
Aditya Engineering College,
Surampalem, India.

Dr. P. Suresh Varma
Professor, University
College of Engineering,
Adikavi Nannaya University,
Rajahmundry, India.

Dr. G. Jose Moses
Associate Professor,
Raghu Engineering College,
Visakhapatnam, India.

Abstract—Cloud computing is a computing model of providing IT resources, such as application, infrastructure, and platform in the form of service by using Internet. Cloud Computing provides infrastructure for computing and processing of all types of data resources and adopted to deal with the large amounts of data. This Internet based current technology has brought flexibility, capacity and power of processing. This technology has recognized service-oriented idea and has formed a new system in the computing world with its influence and benefits. The capabilities of Cloud computing have been able to move IT industry one step forward. Nowadays, huge and prominent enterprises have migrated to cloud computing and have relocated their processing and storage to it. In this paper, we provide an overall perception on cloud computing and draw attention to its services.

Keywords—Cloud Computing, Services, Cloud providers.

I. INTRODUCTION

Cloud computing is on demand network access to computing resources which are often provided by an outside entity and require slight management. Those resources include servers, storage space, network, applications and services [1] [2]. A number of architectures and useful models are present for cloud computing, and these are able to be used with other technologies and design approaches [3].

According to Gartner's list, Cloud computing is on the top of the ten most disruptive technologies of the next coming years [4]. It stand for the long-held dream of visualizing computing as a service [5] where the economy of scale principles help to drive the cost of computing infrastructure effectively down. Big players such as Sun Microsystems, Google, IBM, Amazon and Microsoft have initiated to establish new data centers for hosting Cloud computing applications in different locations around the world to provide redundancy and make sure consistency due to site collapse or failure.

Nowadays, cloud is the most excellent solution for those who are looking for quick implementation techniques [6]. Cloud computing is a kind of configurable, parallel, distributed, virtual, and flexible systems that refers to provision of applications such as hardware and software in virtual data centers via internet [7]. Cloud computing services are configurable and customers pay fees based on the use of resources and services [8-12]. Rest of the paper is structured as follows. Section 2 discusses the history of cloud computing. Section 3 explains the characteristics of cloud computing. Section 4 explains the types of clouds. In section 5, the paper give details of main cloud service models. The

section 6 discusses opportunities and challenges in cloud computing. Finally, the paper is concluded in section 7.

II. HISTORY OF CLOUD COMPUTING

Since the sixties, cloud computing has developed along a number of lines, with Web 2.0 being the most recent evolution. However, since the Internet only started to offer significant bandwidth in the nineties, cloud computing for the masses has been something of a late developer. One of the first milestones in cloud computing history was the arrival of Salesforce.com in 1999, which pioneered the concept of delivering enterprise applications via a simple website. The services firm paved the way for both specialist and mainstream software firms to deliver applications over the internet. The next development was Amazon Web Services (AWS) in 2002, which provided a suite of cloud-based services including storage, computation and even human intelligence through the Amazon Mechanical Turk. Then in 2006, Amazon launched its Elastic Compute cloud (EC2) as a commercial web service that allows small companies and individuals to rent computers on which to run their own computer applications. "Amazon EC2/S3 was the first widely accessible cloud computing infrastructure service," which provide its SaaS online video platform to UK TV stations and newspapers.

Another big milestone came in 2009, as Web 2.0 hit its stride, and Google and others started to offer browser-based enterprise applications, though services such as Google Apps. The most important contribution to cloud computing has been the emergence of "killer apps" from leading technology giants such as Microsoft and Google. When these companies deliver services in a way that is reliable and easy to consume, the knock-on effect to the industry as a whole is a wider general acceptance of online services. Other key factors that have enabled cloud computing to evolve include the maturing of virtualization technology, the development of universal high-speed bandwidth, and universal software interoperability standards.

III. CHARACTERISTICS OF CLOUD COMPUTING

There has been much discussion in industry and academia about what cloud computing actually means [13], [14], [15]. The US National Institute of Standards and Technology (NIST) has developed a working definition that covers the commonly agreed aspects of cloud computing [16]. It summarizes cloud computing as: "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers,

storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". According to this definition, cloud computing has the five essential characteristics,

- 1) *On-demand self-service.*
- 2) *Broad network access.*
- 3) *Resource pooling.*
- 4) *Rapid elasticity.*
- 5) *Measured Service.*

Cloud computing is an emerging distributed computing paradigm that promises to offer cost-effective scalable on demand services to users, without the need for large up-front infrastructure investments [17]. One of the main reasons for the success of cloud computing is the role it has played in eliminating the size of an enterprise as a critical factor in its economic success. An excellent example of this change is the notion of *data centers* which eliminate the need for small companies to make a large capital expenditure in building an infrastructure to create a global customer base [18].

IV. TYPES OF CLOUDS

Cloud computing comes in three forms: public clouds, private clouds, and hybrids clouds. A recent study conducted by KPMG [19] found that 81% of businesses were either evaluating cloud services, planned a cloud implementation or had already implemented a cloud strategy. Businesses can choose to deploy applications on Public, Private, Hybrid clouds or the newer Community Cloud.

A. Public Clouds

Public clouds are owned and operated by companies that use them to offer rapid access to affordable computing resources to other organizations or individuals. With public cloud services, users don't need to purchase hardware, software or supporting infrastructure, which is owned and managed by providers. Public clouds are made available to the general public by a service provider who hosts the cloud infrastructure. Examples of public clouds include Amazon Elastic Compute Cloud (EC2), IBM's Blue Cloud, Sun Cloud, Google AppEngine and Windows Azure Services Platform. A public cloud is the obvious choice when:

- Your standardized workload for applications is used by lots of people, such as e-mail.
- You need to test and develop application code.
- You need incremental capacity.
- You're doing collaboration projects.

B. Private Clouds

Private clouds are data center architectures owned by a particular organization that provides flexibility, scalability, provisioning, automation and monitoring. The goal of a private cloud is not sell "as-a-service" offerings to external customers but instead to gain the benefits of cloud architecture without giving up the control of maintaining your own data center. Private clouds are more expensive but also more secure when compared to public clouds. Private cloud is needed in the following cases:

- You need data sovereignty but want cloud efficiencies
- You want consistency across services

- Your data center must become more efficient
- You want to provide private cloud services

C. Hybrid Clouds

Hybrid Clouds are a composition of two or more clouds (private, community or public) that remain unique entities but are bound together offering the advantages of multiple deployment models. In a hybrid cloud, you can control third party cloud providers in either a full or partial manner; increasing the flexibility of computing. For instance during peak periods individual applications, or portions of applications can be migrated to the Public Cloud. Here are situations where a hybrid environment is suitable:

- Your company wants to use a SaaS application but is concerned about security.
- Your company offers services that are tailored for different vertical markets.
- You can provide public cloud to your customers while using a private cloud for internal IT.

D. Community Clouds

A Community Cloud is designed to meet the needs of a community. Such communities involve people or organization that has shared interests. This includes industrial groups, research groups, standards groups, and so on. Community clouds are a hybrid form of private clouds built and operated specifically for a targeted group. These communities have similar cloud requirements and their ultimate goal is to work together to achieve their business objectives. The goal of these clouds is to have participating organizations realize the benefits of a public cloud with the added level of privacy, security, and policy compliance usually associated with a private cloud. Situations where a community cloud is best:

- Government organizations within a state that need to share resources
- A private HIPAA compliant cloud for a group of hospitals or clinics
- Telco community cloud for Telco DR to meet specific FCC regulations

V. SERVICES OF CLOUD COMPUTING

Nowadays Cloud computing has become a well-known buzzword. As a brand new infrastructure to offer services, Cloud Computing has many advantages in comparing to those existing conventional service providers, such as tremendous fault-tolerance capability, high availability, reduced investment, infinite scalability, probable performance and so on and therefore followed by most of the IT companies, such as Google, Microsoft, Salesforce, Amazon [20]. Cloud computing services are used by government and companies to deal with a variety of application and infrastructure needs such as database, CRM, data storage, and compute. Cloud computing services have several common attributes like – *Multi-tenancy, Elastic, Network-access, On demand, Virtualization and Metering/chargeback.*

Big companies like Microsoft in software industry, Google and Amazon in Internet technology field are joining

to develop cloud services [21], [22]. The most common cloud computing services offered internally or by third party providers are: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

A. Software-as-a-Service (SaaS)

A software that is deployed over the Internet is considered as Software as a Service (SaaS). In SaaS, a provider licenses an application to customers either as a service on demand, through a subscription, charged as per their usage, or at no charge when there is a chance to make income from streams other than the user, such as from advertisement or user list sales. This minimizes the support and maintenance cost effectively. Recent reports show that SaaS will soon become common in every organization and it is important that buyers and users of technology understand what SaaS is and where it is suitable. Some defining characteristics of SaaS include

- Software delivered in a “one to many” model
- Users not required to handle software upgrades and
- Web access to commercial software
- Software is managed from a central location
- APIs allow integration between pieces of software

B. Platform-as-a-Service (PaaS)

A computing platform that allow the designing of web applications quickly and easily without the complexity of buying and maintaining the software and infrastructure is defined as Platform as a Service. PaaS is comparable to SaaS except that, rather than being software delivered over the web, it is a platform for the creation of software, delivered over the web. Here the service provided by the company includes basic standards of development and how you can distribute them effectively. Here the environment would contain an OS, a database, an environment where programming language can be executed and a web server. This let the developer to design, test and implement their own software on the same platform that their end-user clients operate to run the application. The Google App Engine and the Microsoft Azure is a good example of this service model. Some basic characteristics of PaaS include

- Built in scalability of deployed software including load balancing and failover
- Web based user interface creation tools help to create, modify, test and deploy different UI scenarios
- Integration with web services and databases via common standards
- Support for development team collaboration

C. Infrastructure-as-a-Service (IaaS)

Infrastructure as a Service (IaaS) is a way of distributing Cloud computing infrastructure – servers, storage, network and operating systems – as an on-demand service. Instead of buying servers, software, datacenter space or network equipment, clients instead buy those resources as a fully outsourced service on demand [23]. Internet Engineering Task Force (IETF) has defined the IaaS model to be the most basic service model. This model is related with a virtual engine [24] and users can access to infrastructures with virtual machine [25]. The line between PaaS and IaaS is

becoming more blurred as vendors introduce tools as part of IaaS that help with deployment including the ability to deploy multiple types of clouds [26]. IaaS is generally accepted to comply with the following;

- Resources are distributed as a service
- Includes multiple users on a single piece of hardware
- Has a variable cost, utility pricing model
- Allows for dynamic scaling

D. Big-Data-as-a-Service (BDaaS)

BDaaS provides a cloud based structure that presents end-to-end big data solutions to companies. It is a combined structure of Hadoop as a Service (HDaaS), Data-as-a-Service (DaaS) and Data Analytics as a Service (DAaaS). The extensive growth of data is one of the key drivers prevailing in this space. The global Big-Data-as-a-Service (BDaaS) market is likely to grow from \$1.8 billion in 2015 to \$7 billion by 2020, at a CAGR of 31.5 % during the forecast period. On the basis of type of solutions, BDaaS to follow submarkets:

- Hadoop-as-a-Service (HaaS/HDaaS)
- Data-as-a-Service (DaaS)
- Data Analytics-as-a-Service (DAaaS)

E. Hadoop-as-a-Service (HaaS)

Hadoop is a keystone technology for many big data projects and applications. This is a data storage processing system that enables data storage, file sharing, data analytics etc. With growing of social media and Internet communication, Hadoop is being largely used by companies ranging from Facebook to Yahoo. According to Research and Markets, the Hadoop-as-a-service market will grow approximately by 85% year by year from 2014 to 2019. HaaS has emerged as a replacement to On-premises Hadoop. The following points help distinguish the variety of HaaS options.

- Data Scientists and Data Center Administrators needs must be satisfied
- HaaS Should Store “Data at Rest” in HDFS
- HaaS Should Provide Elasticity
- HaaS Should Support Non-stop Operations
- HaaS Should Be Self-Configuring

HaaS companies offer a “fully baked” version of Hadoop. It is usually their own version of Hadoop that follows closely to the original Apache Hadoop version. Following is a list of benefits of HaaS.

- Managed Hadoop – No need to hire a system admin
- Ease of use – Built to get started quickly
- No hardware/infrastructure – Just add/remove servers as you need it
- Support – Each company has a team of Hadoop experts to help when needed

F. Data-as-a-Service (DaaS)

As SaaS continues to triumph the technology world with innovative products and innovative software platforms, DaaS, its identical twin brother, helps infuse quality data into business and marketing campaigns. Technology based DaaS solutions provide real time market information and customer

data. Without considering the platform or location DaaS separate data from its related applications to bring meaningful information to users. DaaS brings together the technologies necessary to retrieve data from heterogeneous sources such as transactional databases, data warehouses, enterprise resource planning (ERP) systems, and customer relationship management (CRM) solutions. The DaaS approach delivers the following benefits:

- Ability to move data easily from one platform to another
- Preservation of data integrity by implementing access control measures
- Ease of administration and collaboration
- Compatibility among diverse platforms
- Global accessibility

G. Data-Analytics-as-a-Service (DAaaS)

Data Analytics as a Service (DAaaS) or Analytics as a Service (DAaaS) uses the cloud based delivery model and provides the extensible analytical tools [27]. In this service, different analytical tools are available and able to analyze the heterogeneous data. The service users uploads their enterprise data over the cloud and gets the analyzed data useful for business purpose via cloud which consists of the analytical algorithms of machine learning concepts. DAaaS combines the two trends – Big data and Cloud. It represents an approach to the extensible platform that provides cloud based analytical capabilities and covers wide ranging functionalities from data acquirement to end user visualization, reporting and interaction. Analytics as a service allows personalized access of information data sets for knowledge workers. This means that information consumers like business analysts and data scientists, can explore information in an interactive manner and get richer insights rapidly. The advantage of DAaaS is to lower the hurdle of entry to higher analytical capacity, without demanding that the user commits to large internal infrastructures and human resources to the project. Instead of a complex custom project the customer follows simpler steps:

- Data Scientists working for the organization explore the AppStore for an Analytical App that fits the problem
- They rent the Analytical App for a specific time or quantity of data
- They configure the Analytical App to its needs
- Then the data is fed from the internal systems to the Analytical App
- Outcomes are available for all other uses

H. Database-as-a-Service (DBaaS)

Database-as-a-service (DBaaS) is a cloud computing service model that provides users with some form of access to a database without the need for setting up physical hardware, installing software or configuring for performance. In DBaaS, customers are charged based on the used features; capacities used and use of database administration tools. Database manager module of DBaaS controls all underlying database instances via an Application Program Interface (API). This API is available to the user by management console – Web

application, which the user may use to manage and configure the database and even provision or de-provision database instances. Markets and Markets forecast the cloud database and DBaaS market to rise from \$1.07 billion in 2014 to \$14.05 billion by 2019, at a Compound Annual Growth Rate (CAGR) of 67.30% in the projected period of 2014-2019 [28]. With the DBaaS market projected to reach \$1.8 billion by 2016 [29], the need for an agile data tier in the cloud has become paramount.

I. Information-as-a-Service (INaaS)

Information as a Service (INaaS) is the facility to present consistent and secure methods to create, manage, exchange, and extract meaningful information from all available data in the right format at the right time. This allows any application to access any type of information using API, and refers to the ability to use any type of remotely hosted information. Enterprises use information from many different sources through a single application or mash up [30]. The concept of INaaS is “to decouple the information consumer from the underlying complexity of the data landscape”. It is a mechanism to organize the transformation of data to information and derive actionable business insights in a structured and modernized manner, despite of the type or place of data.

J. Business-Process-as-a-Service (BPaaS)

Businesses are embracing process optimization, to improve their performance and define clear business outcomes. Business process such as payroll, printing, ecommerce distributed as a service over the Internet and accessible by one or more web enabled interfaces like PC, smart devices and phones can be considered as a Business Process as a Service (BPaaS). Advertising services such as Google AdSense, IBM Blueworks Live for business process management are some of the numerous publicly available services, whereas there are number of other services that today IT departments provide to their users within the firewall or to the trusted partners. The BPaaS market contains a variety of business solutions that help clients and companies effectively adapt to the new changing business circumstances and reduce labor costs. The most popular services offered under the BPaaS umbrella include – Customer service, HR functions (payroll, incentive compensation), Procurement, Sales operations, Industry operation processes. The BPaaS market range is likely to raise from \$1.62 Billion in 2015 to \$4.71 Billion by 2020, at a CAGR of 23.7% from 2015 to 2020 [31]. More BPaaS providers are embarking on this exciting journey in the cloud. The market annual growth by 2016 is projected to reach 10.7%, according to Gartner, and strong demand is anticipated for all types of cloud services offerings [32].

K. Integration-as-a-Service (INaaS)

Integration as a Service (INaaS) is a cloud service delivery model for integration. Integration-as-a-Service bring an integrated solution that presents connectivity to backend systems, sources, files, and operational applications through the implementation of well-defined interfaces, web services, and calls between applications and data sources. Top

organizations are providing Integration as a service such as Dell Boomi, CloudSwitch, and MuleSoft and so on.

L. Security-as-a-Service (SECaaS)

The users are exposed to security attacks, as they access the Internet through relatively unsecured highways. This is where SECaaS comes in; serving as a buffer against the most unrelenting online threats [33]. SECaaS is based on the Software as a Service (SaaS) model but restricted to particular information security services. This is an outsourcing model for security management. SECaaS involves applications such as anti-virus software delivered over the Internet but the term can also refer to security management provided in-house by an external organization. The goal of SECaaS is to offer security for the information systems while still allowing the achievement of business goal and preserving the integrity, availability and confidentiality of the information resources. Security-as-a-Service offers a number of advantages, which include:

- Regular updates of virus definitions that are not dependent on user compliance
- Faster user provisioning
- Greater security expertise than is typically available within an organization
- Outsourcing of administrative tasks, such as log management
- Using a cloud-based security product also bypasses the need for costly security experts and analysts

Security as a Service product vendors include Cisco, McAfee, Panda Software, Symantec, Trend Micro and VeriSign. In the coming next four years cloud-based SECaaS implementation is expected to increase significantly and likely to double in growth by 2017 [34]. Gartner is forecasting the cloud-based security services market, which includes secure email or web gateways, Identity and Access Management (IAM), remote vulnerability assessment, security information and event management to raise to \$4.13 billion by 2017 [35].

M. Testing-as-a-Service (TaaS)

Cloud computing leads a chance in presenting Testing as a Service (TaaS) for SaaS, clouds, and cloud-based applications. TaaS is an outsourcing model in which testing activities associated with an organization's business activities are outsourced to a third party that specializes in simulating real world testing environments as per client requirements. TaaS may engage experts to help and advise employees or simply outsourcing an area of testing to a service provider. This brings new business opportunities, challenges, and demands in innovative service models, testing techniques, QoS standards, and requirements [36]. There are four key factors which govern the process of taking an existing application requirement to the cloud. These provide the appropriate framework for delivering enterprise ready testing on the cloud – People, Process, Governance and Infrastructure.

N. Anything-as-a-Service (XaaS)

XaaS is a combined term said to stand for a number of things including “X as a service,” “anything as a service” or

“everything as a service.” The term XaaS describes a wide class of services related to cloud computing and remote access. XaaS is the next generation of cloud computing services. This combines the online delivery of separate private or public cloud services to users. With so many diverse classes of IT resources now delivered this way, XaaS is a somewhat ironic term for the propagation of cloud services. The most common examples of XaaS are Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). The combined use of these three is referred as the SPI model (SaaS, PaaS, IaaS). Other examples of XaaS include Storage as a Service, Communications as a Service, Network as a Service, Desktop as a Service, Disaster recovery as a Service, Monitoring as a Service and even emerging services such as Marketing as a Service and Healthcare as a Service.

VI. CONCLUSION

Today cloud computing is top of mind with IT companies around the world. Cloud computing has the potential of offering enormous benefits for companies that use it for the deployment and scaling of IT for business processes. More and more industries, from accountancy firms to zoological societies, are adopting cloud computing services. Every day, millions of customers are using online cloud services viz., Apple iCloud, Gmail and Dropbox across desktop and mobile devices. But competition between cloud and outsourcing providers is increasing as new start-ups continue to enter the \$80 billion global cloud computing market. We expect that the cloud computing will rise, so developers should take it into account. In spite of whether a cloud provider sells services at a low level of concept or a higher level, we believe computing, storage, and networking must all focus on horizontal scalability of virtualized resources rather than on single node performance.

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