Cloud Computing: A Prospective and Development Study

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Abstract— The term "Cloud Computing" is a recent popular word in the IT world. Though this term is recently introduced but the idea of centralizing computation and storage in distributed data centers maintained by third party companies is not new. Cloud computing is aimed at providing IT as a service to the cloud users on-demand basis with greater flexibility, availability, reliability, and scalability with utility computing model. In this paper the Cloud computing paradigm from various aspects, such as definitions, development, distinct features, and enabling technologies being studied. This paper brings an introduction review on the Cloud computing and provides the state-of-the-art of Cloud computing technologies.

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I. INTRODUCTION

Cloud computing is the next generation in IT world computation. Maybe Clouds can save the world in many ways; possibly people can have everything they need in the cloud. Cloud computing is the next natural step in the evolution of on-demand and pay-per-use information technology services and products. The Cloud is a metaphor for the Internet, based on how it is represented in computer network diagrams and is an abstraction for the complex infrastructure it keeps out of sight.

It is an excellence of computing in which IT-related capabilities are provided "as a service", allowing users to access technology-enabled services from the Internet (i.e., the Cloud) without knowledge of, expertise with, or control over the technology infrastructure that supports them with minimal management effort or service providers' interaction.

Definitions of Cloud Computing

According to the NIST [[9]]:

"Cloud computing is a model for enabling ubiquitous, 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."

In the paper called "Cloud Computing and Grid Computing 360-Degree Compared" mentions about cloud computer is [[10]]:

"A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet."

A prospective study on Cloud computer (2008) says [[11]]:

"A computing Cloud is a set of network-enabled services, providing scalable, QoS guaranteed, normally personalized, inexpensive computing infrastructures on demand, which could be accessed in a simple and pervasive way."

In the point of my view:

Cloud computing is a distributed system that enabled on-demand access of dynamically configurable resources and managed with minimal effort or interaction.

Essential Characteristics of cloud computing [[9],[12],[13]]:

On-demand self-service:

Most of the time cloud computing is a web-based self-service portal which allows users to provision resources without requiring human interaction.

Broad network access:

Resources of cloud computing are accessible over the network, supporting heterogeneous client platforms (e.g., mobile phones, tablets, laptops, and workstations).

Resource pooling:

Different physical and virtual resources dynamically assigned and reassigned according to consumer demand to serve multiple consumers using a multi-tenant model which are pooled from the provider's computing resources.

Rapid elasticity:

To make sure that the application will have exactly the capacity it needs at any point of time, resources are provisioned and released on-demand and/or automated based on triggers or parameters.

Measured service:

Resource usage is monitored, measured, and reported transparently for both the provider and consumer.

Service Models:

According to NIST and few other studies, there are three service models: Infrastructure-as-a-Service (IaaS), Platform-as-a-service (PaaS), and Software-as-a-service (SaaS) [[9],[11],[1]]. Interestingly, IBM and other major IT and analyst firms have added a fourth service model, namely business process as a service (BPaaS) [[14],[15],[16]]:

Software as a Service (SaaS):

A service provides licenses an application to customers as a service on demand or through a subscription or pay as you go model or no charge when there is an opportunity to generate revenue from streams other than the user, such as from advertisement, user sales list.

Platform as a Service (PaaS):
Platform as a Service can be defined as a computing platform where web applications can be created quickly and easily without the complexity of buying and maintaining the software and infrastructure underneath it.

Infrastructure as a Service (IaaS):
Infrastructure as a Service is a way of delivering cloud computing infrastructures such as servers, storage, network and operating systems as an on-demand service rather than purchasing servers, software, network equipment. IaaS offers clients to buy resources as a fully outsourced service on demand.

Business Process as a Service (BPaaS):
Business process as a service (BPaaS) is a term relatively new service for a specific kind of Web-delivered or cloud hosting service that benefits an enterprise by assisting with business objectives. A lot of companies deliver their services over the internet using cloud computing from different companies like Amazon, Google, IBM etc.

Cloud computing deployment models [[9],[17],[18],[19],[20]]:

Private cloud:
A private cloud computing infrastructure dedicated to a single organization. It may be owned, managed, and operated by the organization, a third party, or some combination of them.
There are two types of private cloud: on-premise private clouds and externally hosted private clouds.

Community cloud:
A community cloud shares infrastructure in between organizations of the same community that have shared concerns such as policy, compliance considerations, mission, security requirements etc). It may be owned, managed, and operated by the organization, a third party, or some combination of them.

Public cloud:
A public cloud is designed to share data center infrastructure of hardware and software that is shared by multiple organizations. The customer has no visibility and control over where computing infrastructure is hosted.

Hybrid cloud:
A hybrid cloud infrastructure is a combination of two or more cloud infrastructures like private, community, or public where organizations host critical applications on private clouds and applications with relatively less security concerns on the public cloud and or community cloud.

A historical background and development over the period
References to "Cloud Computing" in its modern sense appeared as early as 1996 [0]. It is conceivable that August 25, 2006, will go down as the birthday of Cloud Computing as it was on this day that Amazon made the test version of Elastic Computing Cloud (EC2) public [0].
Nobody at that time spoke of Cloud Computing. The term first became popular in 2007, to which the first entry in the English Wikipedia from March 3, 2007, [**Error! Reference source not found.**] attests, which, again significantly, contained a reference to utility computing. Around this time, Dell attempted to trademark the word mark. IBM unveiled plans for "Blue Cloud" on 15th November 2007 through 'Shanghai Today' [0] a series of cloud computing offerings that will allow corporate data centers to operate more like the Internet by enabling computing across a distributed systems which are globally accessible resources, rather than on local machines or remote server farms.
According to GCN[0]:
Developments in bandwidth, processing, and open-source networking over three decades have made cloud very ordinary.

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1982
The first Ethernet adapter card for the IBM PC released, introducing fast, inexpensive connections that would enable cloud computing.

1989
Software Tool & Die founded, first public dial-up Internet Service Provider and "still proud to be the best."

1992
In a $500 million deal, FAA undertakes wholesale IT outsourcing to Electronic Data Systems Corp. under the Computer Resources Nucleus program.

1996
Navy launches IT-2 to build secure, global network to deliver fast Ethernet to 270,000 users worldwide, with browsers, continuous TCP/IP connections.

1997
The term "cloud computing" is coined by University of Texas professor Ramnath Chellappa in a talk on a "new computing paradigm."

1998
VMware founded, introduces software providing completely virtualized set of hardware to a guest operating system.
Walter Reed Army Medical Center upgrades to 100 megabits/sec Asynchronous Transfer Mode network to

accommodate virtual LANs, a stepping stone to the cloud-enabled office.

1999

Salesforce.com founded in San Francisco apartment.

Defense Department shifts communications networks from ATM to a 1-gigabit/sec Ethernet backbone.

2000

Government agencies begin developing computer "grids," an open-source networking technology that lets users share resources in a manner not subject to central control.

2001

Interior Department becomes one of the several agencies to experiment with adopting the application service provider model for delivering applications to the workforce.

Agriculture Department links XML soil survey data with GIS, an early example of using the software as a service to link devices across the Internet.

2004

State Department launches a pilot to switch out PCs for thin clients at overseas posts and domestic offices.

2005

EPA announces a project to use grid computing for air quality monitoring, a sign that government acceptance of collaborative networks is widening.

Intel releases Pentium 4 models, first Intel processors to support virtualization on the x86 platform.

2006

AMD releases Athlon 64 processors, the first to support virtualization.

Amazon launches Elastic Compute Cloud, an infrastructure-as-a-service that lets organizations contract for computers to run their applications.

2007

File hosting and synchronization service Dropbox Inc., founded by MIT student, making cloud storage a commodity.

2008

Apptis Inc. and ServerVault Corp. announce secure, managed, federally compliant cloud infrastructure.

2010

OMB issues "cloud first" mandate, requiring agencies to identify three services to move to the cloud and retire associated legacy systems.

GSA announces it will use cloud computing as primary means for hosting the government's official information portal, USA.gov.

SAP offers agencies Enterprise Resource Planning via the Terremark cloud, enterprise-level Software-as a-Service.

2011

GSA moves 17,000 e-mail users to Google Apps for Government

DARPA seeks mission-resilient cloud to ensure military can withstand attack against pieces of the network.

2012

Energy Department sets up YourCloud to broker secure cloud services for agency and national labs.

Salesforce.com unveils Government Cloud and AppExchange, multitenant services designed for the public sector.

2013

CIA inks $600 million deal with Amazon Web Services to build a private cloud, bolstering confidence in the security of the cloud. "[0]

2014

After a survey with 1200 cloud9 users to find out the state of cloud development environment, Desktop IDE users spend less than 52% of their time with designing and coding; 64% of developers using a cloud IDE, will not switch back to a local environment. [0]

2015

Market realized the great promise of Cloud Computing is the immediate access to enterprise-grade software and next generation Information Technology solutions enable SMEs anywhere to expand their market reach, delivery and service, and customer interaction.

Asia Cloud Computing Association studied on cloud computing attractiveness to small and medium enterprises (SMEs) in the Asia Pacific. [0]

SME Cloud Computing Market Attractiveness Index 2015
Overall Ranking

RANK / ECONOMY		Addressable Market	Early Adoption	Demand Drivers	Affordability	Support	OVERALL SCORE
1.	Japan	101.4	57.7	71.0	64.7	56.6	70.2
2.	Singapore	25.7	78.0	68.7	73.0	73.8	63.8
2.	Hong Kong	29.3	75.7	66.7	75.3	72.3	63.8
4.	South Korea	40.3	67.7	78.0	70.7	58.8	63.1
5.	China	141.9	37.3	36.3	29.3	59.0	60.8
6.	Taiwan	27.6	73.3	62.7	66.7	73.0	60.6
7.	Australia	44.3	56.7	72.0	80.3	46.0	59.9
8.	New Zealand	28.3	72.3	71.3	77.7	48.8	59.7
9.	Philippines	17.8	66.0	52.7	54.3	52.8	48.7
10.	Indonesia	76.8	39.7	39.3	31.3	52.0	47.8
11.	Malaysia	20.6	57.3	41.0	53.0	60.8	46.5
12.	Thailand	22.4	50.0	47.0	48.7	56.8	45.0
13.	India	39.3	39.3	24.3	43.7	42.0	37.7
14.	Vietnam	6.2	41.0	26.0	34.7	35.5	28.7

Source: Asia Cloud Computing Association 2015 http://www.asiacloudcomputing.org/research/smecloud2015

2016 (cloud computing predictions and survey)

Informationweek expected to see from cloud computing in 2016 [[8]]:

- Current-generation cloud environments to be improved with offerings completely new technologies for application developers to take full advantages.
- Mismanagement also needs to be sorted out with more flexibility, scalability, and lower expenditures.
- There will be no more burdens of deployment of different apps into the cloud. And this will be a big step for many companies or organizations that yet to take advantage of cloud benefits.
- Containerization and hyper-convergence will become much more common in 2016 which will be due to changes in application designs, IoT growth, and the speed as cloud providers need to address customer requirements.

Cloud computing trend did the largest survey on cloud infrastructure focusing on cloud buyers and users. The result of survey shows a comprehensive perspective on the state of the cloud today [[21]]:

- Hybrid cloud adoption hits its stride.
- The security concern is no longer top cloud challenge for both end (users and service providers) maturities.

- More enterprise workloads shift to cloud environment where a private cloud is more popular.
- Cloud users are running applications more on private clouds than public clouds but public clouds are using more for experimental purposes.
- Cloud bills and cost concerns are increasing as adoption grows since most organization doing little to improve cost management and optimization strategies.
- The use of DevOps practices and tools continues to increase while Docker spreading like wildfire.
- Amazon Web Services (AWS) continues to lead public cloud adoption, and Azura (Iaas, Paas) grows strongly.
- The rate of private cloud adoption grows across all providers.

Summery

Cloud computing is a new paradigm of computing utilities that promises to provide more flexibility, less expense, and more efficiency in IT services to end users. This paper tried to analyze definitions of cloud computing from different authentic sources and came up with new definition to describe cloud computing. Essential characteristics of cloud computing with four service models is being reviewed including relatively new service (BpaaS) to benefits enterprises by

assisting business objectives. This paper also discussed about four deployment models including community cloud. A historical background and development is being discussed to understand the needs of this new technology over the period which led to present situation and predictions of cloud computing. There will be a time when our lives will depend on cloud computing entirely for daily and basic needs for standard, safe, more environment friendly lifestyle.

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