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A COMPREHENSIVE STUDY AND OVERVIEW OF CLOUD COMPUTING ARCHITECTURE

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ABSTRACT
we often heard about cloud computing technology, benefits and related challenges specially related privacy and security, but not all really aware about how exactly cloud technology works and how security is still a big concern. Security is a big concern doesn't mean there is no security exists in cloud computing, it's all about to understand the gaps in existing implementations. One of the best approaches to understand the functionality of cloud computing and security gaps is, first understand the basic and high level architecture of cloud computing, and then how some of the leading cloud providers implemented the security functionalities. In this paper I am going to explain basic and high level architecture of cloud computing, and then overview of some of the leading cloud service providers cloud architecture like Amazon AWS and MS Azure

KEYWORDS: Cloud Computing, Cloud Architecture, Cloud Layers, Cloud Security, Cloud Management, Microsoft Azure, Amazon AWS

INTRODUCTION
Current increased level of competition and economic circumstances are demanding for more efficient model to deliver applications, services and infrastructure. Cloud computing architectures refers to all the fundamental components and sub components those required to create an elastic and scalable cloud environment. Elastic and scalable means an environment which you can expend dynamically at any time within a short period according to your growing business requirements. Cloud architecture defines how to create a cloud platform by arranging different infrastructure components which can satisfy the dynamic and scalable demand of the customers. As you know there is different level of cloud delivery models like SaaS, Paas and Iaas, but they all are specific components and part of cloud delivery structure and do not represent the architecture. They all are the service based cloud delivery models which customer chooses according to their requirements from the cloud.

CLOUD COMPUTING ARCHITECTURE
In terms of basic architecture of cloud, there are two important entities are there. First is the end customer who is going to use the services and second is the cloud service provider. There is only a carrier between both is internet. Architecture is basically completely resides within cloud service provider environment and since there is not standard cloud standards yet, so it's varies from cloud service vendors to vendors. Refer below Fig 1 to understand the basic architecture of cloud. A cloud user is who intended to use the cloud services via internet, and cloud service provider is the actual player who provides the services over internet. So whole architecture is resides inside the cloud service provider premises and as an end user, you don't have any visibility of the same, and this is area you have to under in terms to get clarity on cloud architecture.
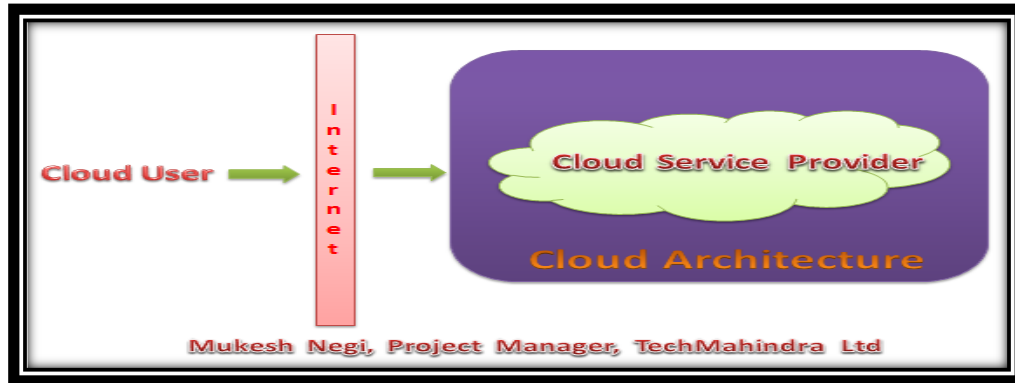
Fig 1 - Cloud Basic Level Architecture 1

Now if you got to the second level of understanding, cloud is a combination of all cloud service delivery models like SaaS, PaaS, IaaS etc as shown in below Fig 2. Each delivery model defines the set of services and responsibilities between a cloud consumer and cloud service provider. Depend on the services and cloud model has chosen by customer, they can connect to cloud model via internet and use the service and all service components like applications, software's, hardware's, database etc resides inside the cloud.

Fig 2 - Cloud Basic Level Architecture 2

Further, in a higher model then earlier Basic Architecture Level 2, two more critical and important components, Management and Security added. Management is refer to the complete management and monitoring of cloud resources and Security represents the complete governance, risks and compliance of particular cloud vendor since there is no common cloud standards exists yet and all cloud providers configuring their cloud service model based on their own best governance, risks and compliance model to deal with legal and security issue of customer applications and data.
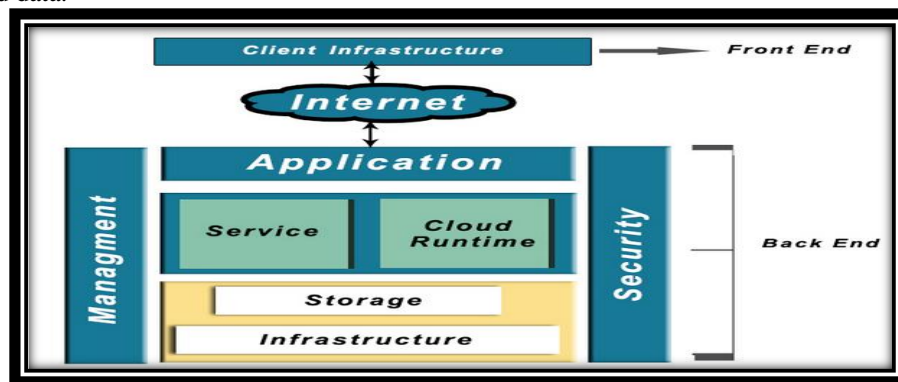

Fig 3 – Cloud Basic Level Architecture 3 [5]

Now you can divide cloud computing architecture in four different layers as shown in below Fig 4
- Cloud User Layer
- Cloud Orchestration Layer
- Virtual Layer
- Hardware Layer

All above Services have Cloud characteristics like Automation, Security and Manageability.
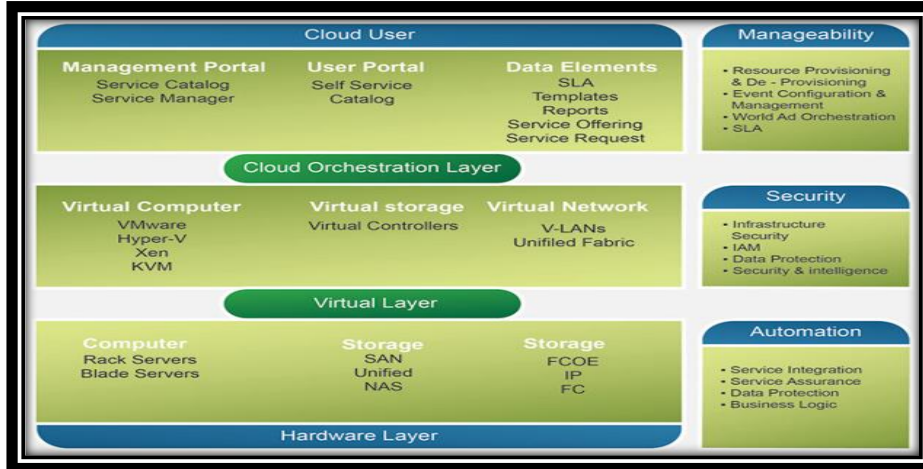

Fig 4 – Cloud Architecture Layers [6]

Now refer below Fig 5 to understand detailed cloud computing architecture with detailed component level wise. Each component is representing required high level of sub components. Self Service Management is the cloud end user layer where users can maintain their profiles and manage their subscriptions. Left side components representing the Monitoring and Manageability of different cloud resources and services. Right side representing the security components likes Governance, Risk, Compliance, Identity and Access Management, Encryption etc. Mid layer representing the base of cloud computing which includes middleware applications, virtualized networking and compute resources and actual server, storage, networks etc.
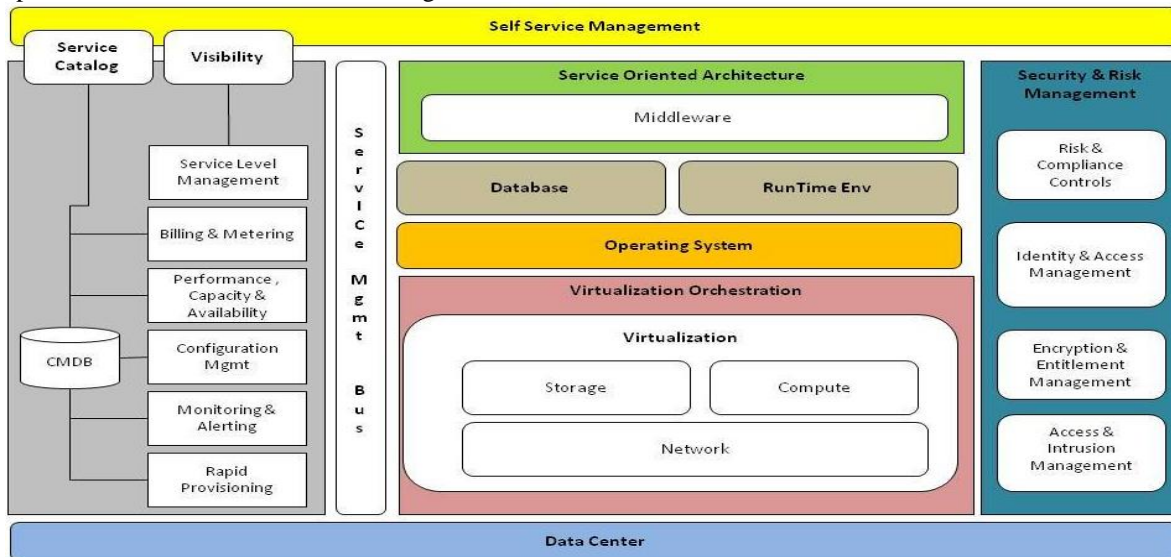

Fig 5 – Cloud High Level Architecture [7]

MICROSOFT AZURE AND AMAZON AWS CLOUD COMPUTING ARCHITECTURE

There is a differentiation in architectures and implementations of different cloud service providers cloud model due to lack to standards in cloud computing. Despite of no cloud business standard it's growing consistently because benefits are high and certain things are moving with mutual agreements between cloud consumer and cloud service provider. Certain standard terms are same in all cloud models like security, management etc but they all are different in terms of the implementations. One of the examples is, how data is flowing and getting secure during outer and inner communications between different application, internet service providers, machines, database. Some cloud provider has implemented IPsec's and someone using certified certificates using public and private keys implementation. All have their own way to make secure communications internally between different systems.

MICROSOFT AZURE CLOUD SERVICES ARCHITECTURE

Microsoft Azure is one of fastest growing public cloud model. Its own by the Microsoft so you can say it was mainly developed for the .NET developers and support all .NET technologies and many more like ADO.NET EF, WWF, ASP.NET MVC, Java, PHP, node.js, API's etc. as of today it's a very strong and flexible platform which allow developers to use any language, framework or tools to build, deploy and manage applications. All azure services and features are exposed to outer world using REST protocol and different azure client libraries are exist to support multiple programming languages under open source licensing agreements [12].

Below Fig 6 is the high level architecture of Microsoft Azure. Left and right side bars representing different tools and management platform used for development and management of the cloud services and resources like, visual studio is used to build applications with database connections with MS SQL Azure to perform data binding operations [13]. Load balancer is the initial entry gate for external customer where based on different configuration factors of load balancer, requests diverted to internal sub components like web servers, applications etc and based on your application and service configurations, they further connects with different other sub components and external services like database, queues, CDN (Content Delivery Network), on premises applications etc[14].

.As you see below, compute layer has been divided into three different layers –

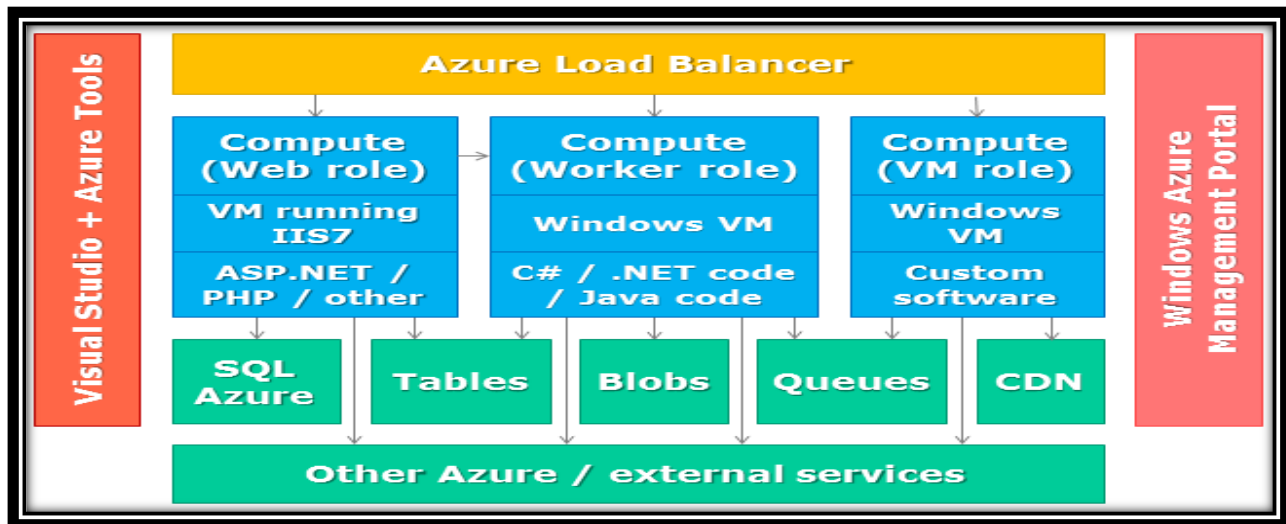* Web Role
* Worker Role
* VM Role

Fig 6– Microsoft Azure Cloud Architecture [14]

Window Azure Compute is computing instances running window O.S and applications (Memory, HDD, CPU etc.). Web Role is the machine running MS IIS web server for programming web applications and WCF services. Worker's role is for any type of processes or computations running in the background having a front end interface. VM's role is a Windows Virtual Machine. This virtual image is created in your environment and network and later uploaded to windows azure, and it can be customized according to whatever applications you wanted to use. So VM

role is basically a migration unit as well which you can use to migrate your on premise enterprise world to azure by just moving VM image.

AMAZON AWS CLOUD SERVICE ARCHITECTURE
Amazon AWS also called Amazon Web Service is one of the pioneer public cloud service providers almost since 2006. It's provides all three cloud delivery model services i.e. IaaS, Paas and SaaS. It's a collection of different cloud services access by web services makes cloud computing environment offered by amazon.com, also known as Amazon EC (Elastic Cloud) and Amazon S3(Amazon Simple Storage Service). Their servers located almost in 11 different geographical locations.

Below is the high level architecture of Amazon Web Service. Left and right side bars represent the tools and software's for the development of applications as well as management platform for monitoring and management of Amazon cloud resources. ELB (Elastic Load Balancer) of the entry gate for external world or you can say it's the first entry point where you reach once you access any cloud application. Next, Amazon EC2 (Elastic Compute Cloud) is a web service from Amazon which is developed to make web scale cloud computing much easy for developers. EC2 is a web service which allows you easily manage, monitor, and scale up and down your cloud service environment anytime. Amazon S3 (Amazon Simple Storage Service) provides secure, scalable and durable object storage service to different developers and IT teams. It's a simple web service you can use to store and retrieve your data anytime from anywhere and you have to pay only for the storage you are using. Further you have different layers of O.S virtual machine, Networking, Security, collaboration, analytics, Database, different frameworks or language to build and implement applications.
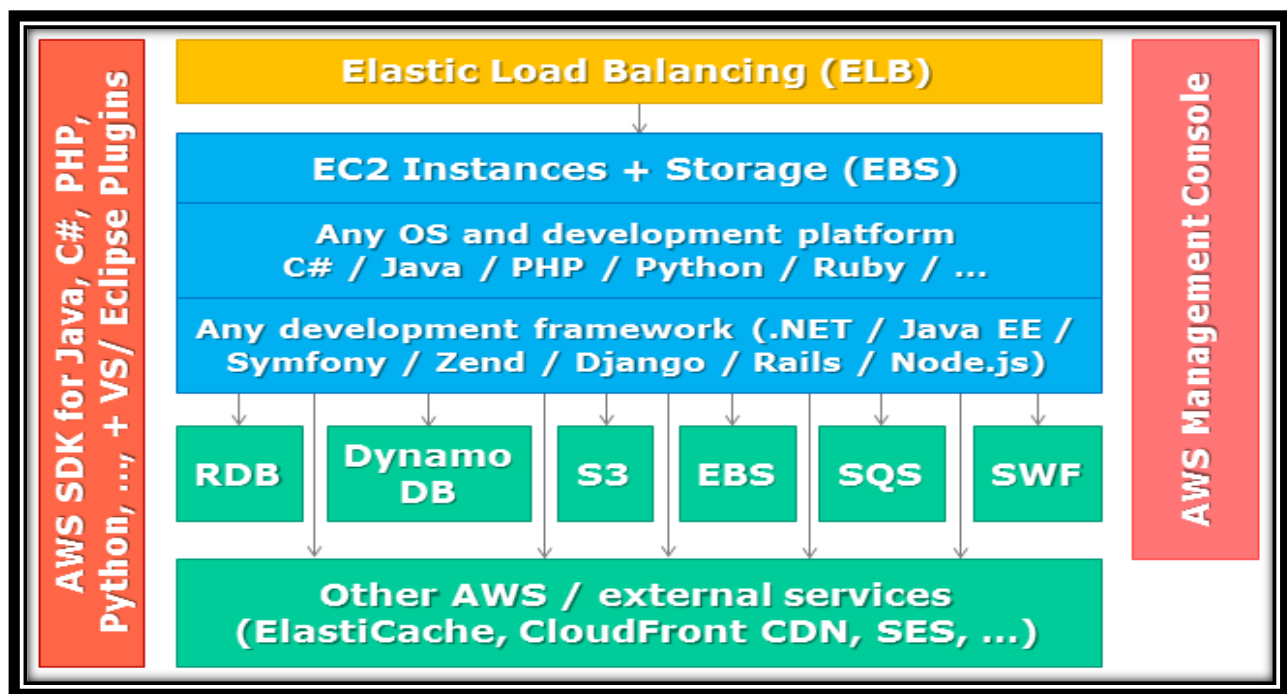

Fig 7– Amazon AWS Cloud Architecture [14]

CONCLUSION
This paper has highlighted and provided a thorough guidance and understanding on cloud architecture by comparing two leading cloud service providers, MS Azure & Amazon ASW. Students, research scholars and cloud architects would able to understand all necessary considerations required to design and implement an cloud architecture by focusing on some best practices and concepts of cloud architecture like different components and subcomponents, scalability, different layers including management and security etc. All ready to use and scalable cloud service provider architectures are designed using almost same concepts and after reading this paper you would able to

understand all other cloud architectures easily. To explorer and invent cloud architecture further, I would recommend all students and researchers to first understand the basic architecture of cloud by reading few more published articles, on top of that you can recommend your views and ideas. You would not able to understand cloud technology properly unless you have clarity on base architecture of the cloud computing environment.

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