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A Comprehensive Study on Cloud Computing Standardization

Dr. Mukesh Chandra Negi

Project Manager, Tech Mahindra Ltd, Noida, India

ABSTRACT: Standard is a trust between standardization body, buyers and sellers. Standardization body is a central governance body for any product or service, which ensures the minimum level of quality for similar kind of products or services. Cloud computing innovations has been accepted widely in last couple of years, but still struggling to get a common standard and standardization body. Lack of standards creating different kind of misconceptions between peoples, also it's not allowing large no of business entities to accept it as a trusted business solution for their IT infrastructures and operations. Many of the organizations like NIST, OCC, and SNIA etc. are working and coming up with their benchmarks and reference implementation studies to define cloud standards, but still it's like a black hole in cloud computing where nothing is clear and visible [1] [2]. It's very critical and important to build a platform with high standards and quality so that it will not hinder the adoption and development of cloud computing. In this paper I am going to consolidate a comprehensive study on cloud computing standardizations, its importance and progress so far.

KEYWORDS: Cloud Computing, Cloud Standards, Cloud Consumer, Cloud Vendor, Cloud Broker, Cloud Audit

I. INTRODUCTION

Despite of challenges, adoption of cloud computing is increasing consistently year by year. Most of the organizations are looking for hosted solutions to drive down their IT infrastructure cost. Although the growth of cloud computing is remarkable but still it's not according to the expectations, and many organizations are hesitating to opt for cloud solution due to lack of standards and governance model. Major problem arises when organizations wanted to select a cloud service provider but they don't have any option to do the proper assessments of same offerings from different service providers due to lack of standards [3]. From other side, cloud computing is not actually entirely without standards. It does use certain standard programming interface, protocols and internet standards however, the standard to govern, configure and management of all these aspects are still missing. One of the major concern is rapidly changing requirements and models of cloud computing. All cloud computing vendors are working on their own models and methods to enhance their existing capabilities as well as to implement consistently changing requirements of clients. Even though lots of independent standard development organizations are engaged in to create standards of cloud computing but this rapidly changing requirements of clients and cloud infrastructure model is creating a big barrier for the same [4].

In a cloud ecosystem, there are number of different participants worked in an integrated business process manner, share data, information and services where some common standards are required for the interoperability.

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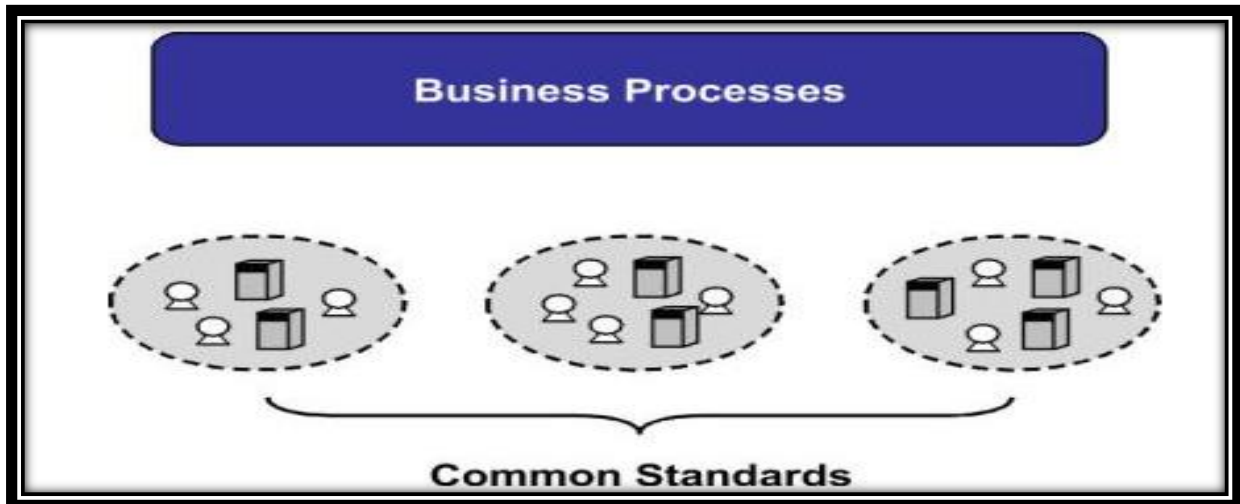


Fig 1: Cloud Ecosystem Model

As shown in fig below, there has to be some common standards in place when it comes to migration and sharing of data, services, and information across different cloud service providers, stakeholders and clients.

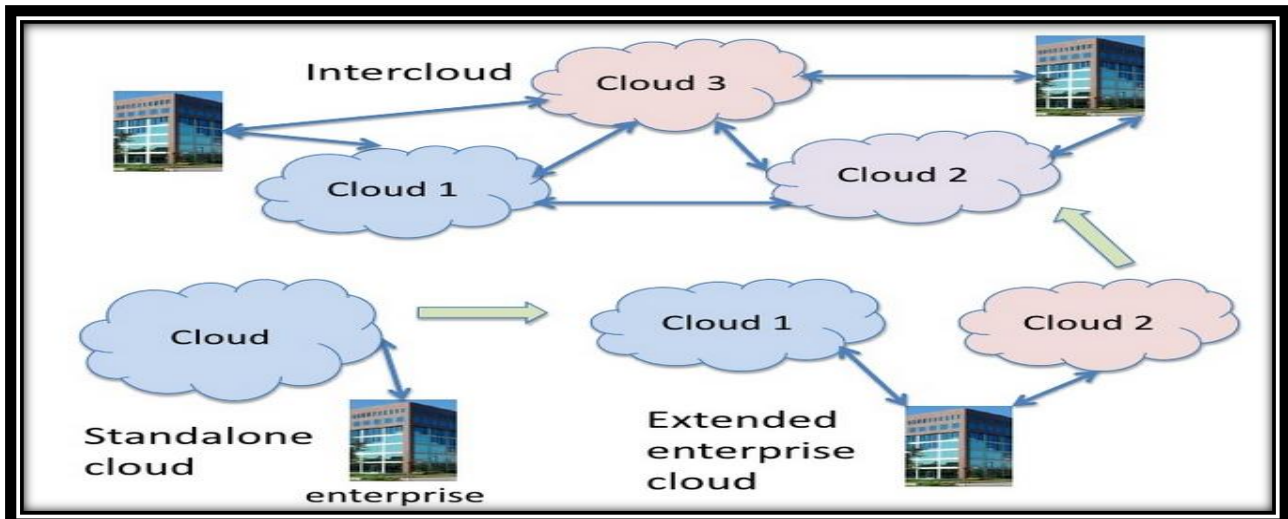


Fig 2: Interconnected cloud model

II. RELATED WORK

Reference [1][2][3][4] and [5] are reviews from some of the independent organizations and IT professional where they have described different potential ways and components to standardize the cloud computing. They have explained all of the critical areas where standards need to be implemented at least in initial phase of standardization. Cloud is a group of large services and it can't be possible to come with all standards all together so certain critical areas are highlighted by the authors. [6][15][16][17] are the research work of some independent organizations those are working independently to define and established standards for the cloud computing. All those organizations are working and helping lots of private and government organizations across the world and documenting and published the critical areas and different ways to implement standards based on their experience.



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III. MAPPING OF CLOUD COMPUTING STANDARDS

NIST was designated by the Federal CIO (Chief Information Officer) to accelerate and efficiently adoption of cloud computing services by the federal government. Wherever required, NIST worked closely with developers, different independent agencies, U.S industry and market leaders in the global community to design and develop standard for the cloud computing wherever needed [5] [6]. There was a cloud conceptual model presented by the NIST Cloud Computing Reference Architecture and Taxonomy Working Group in NIST Cloud Computing Standards Roadmap survey guide, and one of the approaches for mapping cloud standards was presented by relating it with that conceptual model.

NIST cloud computing definitions are widely accepted, and the reference architecture presented by NIST is just an extension to all the definitions. It's a high level architecture which represents the structure, requirements, operations and standards of the cloud computing [7].

Overall architecture was represented by five level diagrams where each entity has its own role with respect to the cloud service life cycle. Below are defines five levels –

- Cloud Consumer
- Cloud Provider
- Cloud Broker
- Cloud Carrier
- Cloud Auditor

All levels in whole playing a key role in preparation and defining the standards of cloud in terms of service usability, maintainability, operability, security etc. each entity has its own role and interacting with other entities wherever required and follow standard governance model [8].

- Cloud Consume is the end user who is intended to use the cloud computing services.
- Cloud Provider is the cloud service provider
- Cloud Broker is an intermediary consultant or organization between cloud consumer and cloud provider to help cloud consumer to understand complexity, advantages and disadvantages of cloud computing and add value added to the decisions to the cloud consumers.
- Cloud Auditor is another body to conduct auditing on governance, risk and compliance and should conduct independent security and performance monitoring of all of the cloud services.
- Cloud broker is an body which should governs with the migration or transferring of data either from cloud consumer to cloud provider or from one cloud provider to other cloud provider following the standard guidelines.

Below is the high level architecture diagram of same

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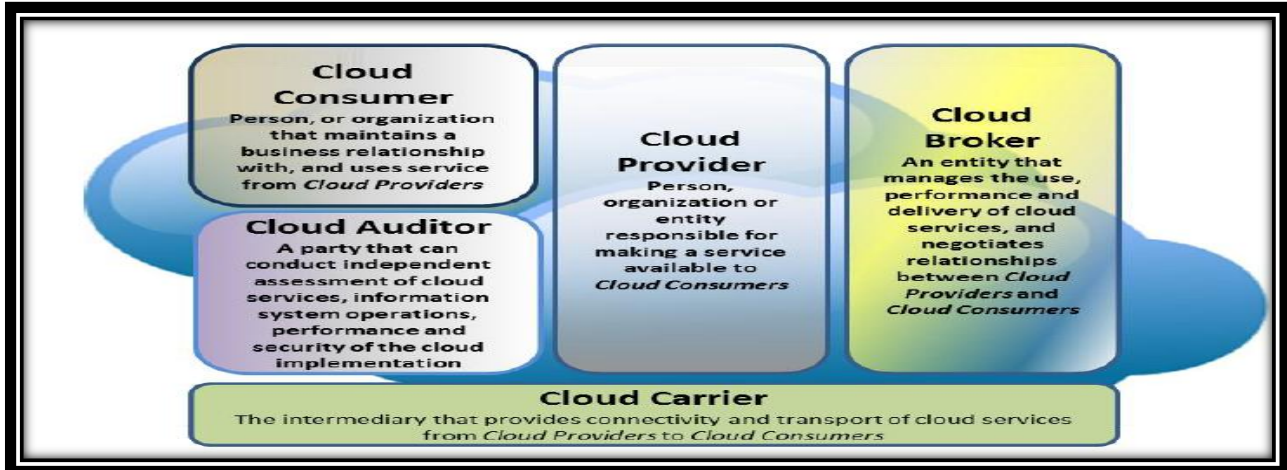


Fig 3 – NIST 5 entities level cloud architecture

Below fig shows the interaction path between different entities. A cloud consumer can directly interact with cloud provider or can go via a cloud broker. Cloud auditor can conduct an independent auditing of cloud provider and wherever required can interact with cloud consumer, cloud vendor or cloud broker.

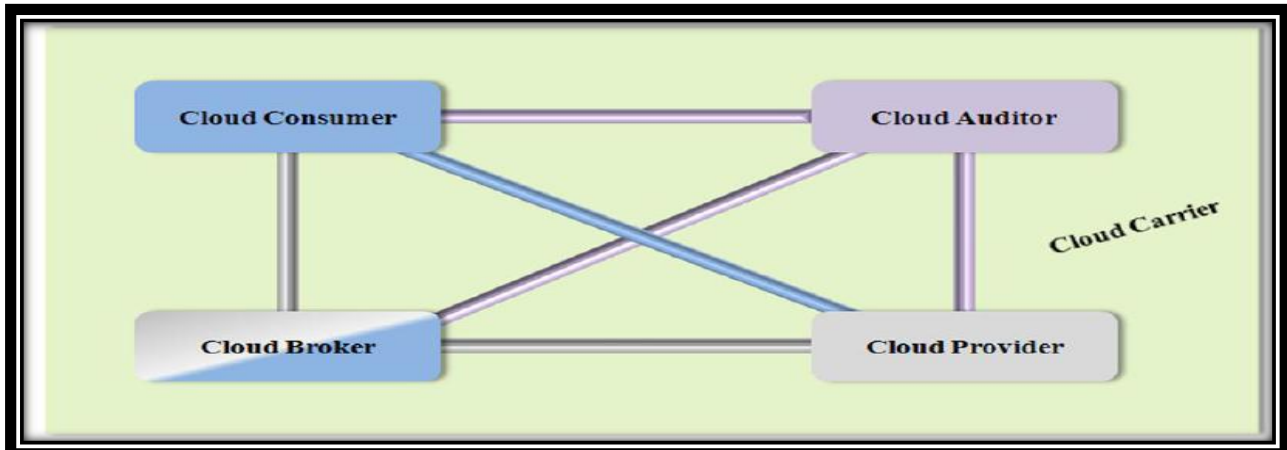


Fig 4 – Interactions between different cloud entities

Despite of all, Cloud Consumer and Consumer Vendors are the two important entities where standards need to be defined in terms of the responsibilities and activities. A cloud consumer is the only stakeholder going to use all cloud services, and it's a person or organization that is going to use the services provided by the cloud service provider. Cloud consumer browse for the services provided by the cloud provider, opt or subscribe for the required services and pay as on use basis but an standard is required to properly governs and set the responsibilities between a cloud consumer and clod provider [9] [10].

Below are some generic and high level responsibilities segregation between cloud provider and cloud consumer



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Service Models	Consumer Activities	Provider Activities
SaaS	Uses application/service for business process operations.	Installs, manages, maintains, and supports the software application on a cloud infrastructure.
PaaS	Develops, tests, deploys, and manages applications hosted in a cloud system.	Provisions and manages cloud infrastructure and middleware for the platform consumers; provides development, deployment, and administration tools to platform consumers
IaaS	Creates/installs, manages, and monitors services for IT infrastructure operations.	Provisions and manages the physical processing, storage, networking, and the hosting environment and cloud infrastructure for IaaS consumers.

Mukesh Negi, Project Manager, TechMahindra Ltd.

Fig 5 – Consumer and Vendor Activities Chart

IV. CLOUD FUNCTIONS AND STANDARDS

Everybody aware that still there are lot's more open challenges exist related with cloud computing, especially in the area of security, service level agreements, privacy and interoperability. If we address all those challenges and makes some standards then it's definitely going to help in the functionality of the cloud computing, which directly going to benefit all cloud service providers, partners as well as customers. NIST cloud computing group has done lots of surveys on existing standards on different aspects of cloud computing like security, privacy, accessibility, interoperability, performance and monitoring etc. and presented an enhanced version of all standards [12] [13].

A. STANDARDS ON PRIVACY AND SECURITY

Privacy and security is one the big challenge in the area of cloud computing as customer's complete data resides on the third party service provider premises. Due to this, there always concerns about Governance, Risks and Compliance (Legal and Regulatory, Standards). In most of the countries regulations to control the security and privacy of data is controlled by some authority and which varies from country to country, and due to abundance of cloud standards as well as awareness gaps decreasing the confidence of customers in the area of cloud computing. Though it's secure as it's in your premises, but since you don't have any control over it and there is no cloud standard in terms of data integrity and security, so there is always a fear in customers mind [13] [14]. There has to be some standards where customer and service providers should take the join responsibilities in terms of security and privacy.

Below are some of the areas in security and policies those should be addressed through proper standardization -

- Addressing the concerns with respect to location and controlling of data
- Audits, Testing, Certifications and Conformance
- Exit strategies and procedures
- Data protection regulations and legalities surrounding countries where data resides
- Multi tenancy related Risks and Concerns
- Transparency and Visibility of data and process
- Preventions solutions, Access control and intrusion detection
- Identity and access management related concerns for protecting the customer's data from unauthorized access.
- Define rule, regulations and responsibilities of each stakeholder to get confidence of customers

And security and privacy standards need to be developed in below areas specific for cloud computing –

- Security Controls
- Policy Implementation & Management
- Identity and Access Management (Authentication & Authorization)
- Data Integrity



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- Confidentiality
- Monitoring & Management

It's not like cloud providers are not using the cloud standards. Some global ISO standards are used by the cloud service providers but they all are related to some specific technology like networking, servers, software's etc. and in combine they are not specific to the cloud computing [15 [16].

B. STANDARDS ON SERVICE LEVEL AGREEMENTS

Service level agreement is a legal binding agreement document between service provider and customer where service provider is agreed to provide minimum service levels for almost all offered services like server and applications uptime and availability, performance level, response time, resolution time, bug fixes and security updates etc. it's a very critical area and plays a very important in all service level agreements between a customer and service provider. By defining the standards with respect to SLA in cloud computing will ensure all areas are covered equally and efficiently and customer can do an efficient comparison between services from the different cloud service providers. Main objective is to define a formal standard common objective document so that it can be reviewed and compared easily to take decision [17]. All objectives should be designed and created considering from implementation till support.

C. STANDARDS ON INTEROPERABILITY

Interoperability is also one of the major challenges in cloud computing, and one of the major barriers to cloud computing adoption. As of now there are no standards for communication, data sharing as and integrations between different cloud service providers. It's related to many aspects of the cloud computing. Some of them are as below –

- Migration portability standards should be there to migrate, data and service from one service provider to other.
- Standards on ability to use multiple service provides services efficiently they should work in conjunction with each other.
- All cloud service should operate according to the agreed standards and specifications

D. STANDARDS ON PERFORMANCE

Performance is one of the major factor which is directly related with cost. All consumers moving to the cloud should have some way to validate the claims made by cloud service providers. They should have some standards in place where they can compare all performance parameters with respect to all cloud service providers to get most suitable provider according to their needs. **Performance standard means to prepare a set of matrices to give a clear picture and understanding on how a cloud service performs.** Definitely it's not easy as its look like and bit complex because in conjunction with service category it need to be categorized based in domain as well. Some of the different performance metrics for cloud computing based on different metrics are as below –

- Performance Testing
 - Performance Monitoring
 - Performance Auditing
- Cloud Computing Service Life Cycle Entities
 - Negotiation Performance
 - Instantiation Performance
 - Termination Performance
- Benchmark Performance
- Management Performance

Finally all performance standards will help all involved cloud computing stakeholders. It will work as Service Level Agreement on performance measurements between cloud consumer and consumer vendor. Cloud auditors will able perform performance auditing's based on same. Cloud brokers will ensure cloys customer expectations are met.



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E. STANDARDS ON MONITORING

Due to lack of a well defined monitoring and metric term and multiplicity of underlying product, this is one of the area which is less developed in comparison with other areas. NIST and Taxonomy groups are working to develop a set of terms related with monitoring to include in service level agreements. The International Telecommunication Union's Telecommunication Standardization Sector (ITU-T) establishment of a cloud computing resource management area of study is already started addressing and closure of some of the standard gaps in cloud computing monitoring. ITU-T's roadmap outlines the standards required to monitor the Health, Quality of Service, Availability, and Reliability of cloud services based on the aggregations of services from different cloud service providers.

V. CONCLUSION

Although cloud services are in use by many small, medium and large scale organizations, it's still an emerging technology, and especially in terms of standards those are still under development, and till today there is no clarity on the cloud services standardization. There are certain entity specific standards exists those are always being accepted and maintained, but complexity increased when it comes to the legalities and jurisdiction of cloud computing service providers that accommodate national as well as international legal requirements. Standards are necessary and necessity to increase the trust of different organizations and customers in cloud computing specially to protect the customer's personal and critical data in accordance with the regulatory body. It will not reach to its full potential until contextual and management standards are fully defined, developed and implemented, till then all customers and organizations would chose and continue taking service from provider those appropriately satisfy their requirements.

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