Architectural Platform in Cloud Computing With Respect To Issues and Challenges

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Abstract

Cloud computing is a multifarious technological paradigm that is outgrowth of decades of research in parallel computing, virtualization, networking and communication, utility computing and Service-Oriented Architecture (SOA). It offers an on-demand and scalable access to a shared pool of resources hosted in a data centre at providers' site. It reduces the overheads of up-front investments and financial risks for the end-user. The qualitative services and lower cost of services are the key requirements of this technology. Regardless of the fact that cloud computing offers great advantages to the end users, there are several challenging issues that are mandatory to be addressed. Owing to the financial nature of use of the cloud services based on Service Level Agreements (SLA) makes these issues even more serious that needs to be taken care of. This work presents an overview, style and actuality of cloud computing with the objective of presenting challenging issues concerned with various aspects of cloud computing.

Keywords: *Cloud computing; Cloud security; Virtualization; Workflow scheduling; Data integrity, Public auditing.*

1. INTRODUCTION

In recent years, the popularity and rapid growth in processing and storage technologies and the success of the Internet, computing resources have become cheaper, more powerful and more ubiquitously available than ever before [1]. This technological trend is popularly known as cloud computing and has led to an evolutive way to provide a better answer to current and future information and communication technology (ICT) requirements. Cloud computing gives an adaptable online environment which encourages the capability to handle an expanded volume of work without affecting on the execution of the framework. With the advent of Cloud, the increasing numbers of cloud providers and the variety of service offerings have made it difficult for the researcher and pose numerous challenges to cope with. Over the years, researchers are working around the world to enable this technology towards wide business opportunity and in other areas of IT infrastructure, utilizing the cloud computing services and mechanism. Utilization of cloud services makes a developing relationship among both public and private sector substances and the people served by these elements. Cloud computing is attractive to business owners as it eliminates the requirement for users to plan ahead for provisioning, and allows enterprises to start from the small and increase resources only when there is a rise in service demand [2]. Promoting and expanded expansion of cloud offers made a vast build-up around the cloud that led to strong user expectation pressure, that partially couldn't be reasonably be satisfied - this is by and large the case for any promising technologies or concepts. Marketing tends to guarantee attributes that are effortlessly confounded with qualities with distinctive implications in different domains, possibly prompting the confusion towards cloud. Consequently, thorough characterization of cloud application features is an essential for the further improvement of cloud framework. Over the years, several technologies such as virtualization, grid computing, and service-oriented architecture (SOA) have matured and significantly contributed to making cloud computing viable [5]. On the other hand, cloud computing is still in infancy and experiences absence of institutionalization in many aspects. In current scenario, most new cloud providers propose their own solutions and proprietary interfaces for access to resources and services which lead to the heterogeneity problem and raises barriers to cloud realization. As users get more experienced in using cloud infrastructures, their capabilities, strengths and deficiencies become more and more apparent. The cloud providers are thus working under growing pressure to fulfil the promises, and provide better services to their users. As cloud infrastructure is being used throughout the globe, security is the major concern. This sharing of framework together to the way that the customers to the cloud have needed control over the cloud foundation raises huge security worries. The clouds have a different architecture based on the services they provide. The information is stored on to a concentrated area called server farms having a huge size of information store and those data process in the server. So, the customers need to

trust the cloud resource provider on the accessibility and additionally information security. The service level agreements (SLA) is the only legal agreement between the service provider and client. The only means the supplier can addition trust of the client is through the SLA, so it must be institutionalize. Looking at the current trends and overgrowing interest for this subject, this paper explores the current patterns in the space of Cloud computing and presents researching space for future improvements of this technology.

2. CLOUD COMPUTING

To properly understand cloud, it is important to know what it is, some essential characteristics that a system must possess to qualify as a cloud along with various services that can be offered using it through various deployment models.

A. The Definition

Cloud computing is in its infant form and numerous definitions have been proposed by many scientists. Some of the definitions are,

Buyya et al. defines, "A Cloud is a type of parallel and distributed system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resource(s) based on service-level agreements established through negotiation between the service provider and consumers" [6].

According to P. Gaw, "The way I understand it, 'cloud computing' refers to the bigger picture…basically the broad concept of using the internet to allow people to access technology-enabled services. According to Gartner, those services must be 'massively scalable' to qualify as true 'cloud computing' [1].

J. Kaplan says, "I view cloud computing as a broad array of web-based services aimed at allowing users to obtain a wide range of functional capabilities on a 'pay-as-you-go' basis that previously required tremendous hardware/software investments and professional skills to acquire. Cloud computing is the realization of the earlier ideals of utility computing without the technical complexities or complicated deployment worries"[7].

B. Five Essential Characteristics

The cloud computing must have some characteristics in order to meet expected user requirements and to provide qualitative services. According to NIST [8], these five essential characteristics can be classified as:

- **On-demand self-service:** A consumer can access different services viz. computing capabilities, storage services, software services etc. as needed automatically without service provider's intervention.

- **Broad network access:** To avail cloud computing services, internet works as a backbone of cloud computing. All services are available over the network and are also accessible through standard protocols using web enabled devices viz. computers, laptops, mobile phones etc.

- **Resource pooling:** The resources that can be assigned to users can be processing, software, storage, virtual machines and network bandwidth. The resources are pooled to serve the users at a single physical location and/or at different physical location according to the optimality conditions (e.g. security, performance, consumer demand). The cloud gives an impression of resource location independence at lower level (e.g. server, core) but not at the higher level (e.g. datacenter, city, country).

- **Rapid elasticity:** The beauty of cloud computing is its elasticity. The resources appear to users as indefinite and are also accessible in any quantity at any time. The resources can be provisioned without service provider intervention and can be quickly scale in and scale out according to the user needs in a secure way to deliver high quality services.

- **Measured service:** A metering capability is deployed in cloud system in order to charge users. The users can achieve the different quality of services at different charges in order to optimized resources at different level of abstraction suitable to the services (e.g. SaaS, PaaS and IaaS).

C. Service Models

The cloud services are delivered in three forms viz. Infrastructure-as-a-Service (IaaS), Software-as-a-Service (SaaS) and Platform-as-a-Service (PaaS). The services are delivered over the network by using Web browser, Web Based mail etc. The service models are as follows:

- **Software-as-a-Service (SaaS):** In this multitenant service model, the consumers use application running on a cloud infrastructure. The cloud infrastructure including (servers, OS, Network or application etc.) is managed and controlled by the service provider with the user not having any control over the infrastructure [8, 9]. Some of the popular examples are SalesForce.com, NetSuite, IBM, Microsoft and Oracle etc.

- **Platform-as-a-Service (PaaS):** With this model, the provider delivers to user a platform including all the systems and environments comprising software development life cycle viz. testing, deploying, required tools and applications. The user does not have any control over network, servers, operating system and storage but it can manage and control the deployed application and hosting environments configurations [8, 9]. Some popular PaaS providers are GAE, Microsoft's Azure etc.

- **Infrastructure-as-a-Service (IaaS):** In this service model, the provider delivers to user the infrastructure over the internet. With this model, the user is able to deploy and run various software's including system or application softwares. The user has the ability to provision computing power, storage, networks. The consumers have control over operating systems, deployed applications, storage and partial control over network. The consumer has no control over underlying infrastructure [8, 10]. Some important IaaS providers are GoGrid, Flexiscale, Joyent, Rackspace etc.

D. Deployment models:

Cloud systems can be deployed in four forms viz. private, public, community and hybrid cloud as per the access allowed to the users and are classified as follows:

- **Private cloud:** This deployment model is implemented solely for an organization and is exclusively used by their employees at organizational level and is managed and controlled by the organization or third party. The cloud infrastructure in this model is installed on premise or off premise. In this deployment model, management and maintenance are easier, security is very high and organization has more control over the infrastructure and accessibility [8, 10].

- **Public cloud:** This deployment model is implemented for general users. It is managed and controlled by an organization selling cloud services. The users can be charged for the time duration they use the services. Public clouds are more vulnerable to security threats than other cloud models because all the application and data remains publicly available to all users making it more prone to malicious attacks. The services on public cloud are provided by proper authentication [8, 10].

- **Community cloud:** This cloud model is implemented jointly by many organizations with shared concerns viz. security requirements, mission, and policy considerations. This cloud is managed by one or more involved organizations and can be managed by third party. The infrastructure may exist on premise to one of the involved organization or it may exist off premise to all organizations [8, 10].

- **Hybrid cloud:** This deployment model is an amalgamation of two or more clouds (private, community, public or hybrid). The participating clouds are bound together by some standard protocols. It enables the involved organization to serve its needs in their own private cloud and if some critical needs (cloud bursting for load-balancing) occur they can avail public cloud services [8, 10].

3. SECURITY ISSUES IN CLOUD

Here in this section we described several cloud computing security issues based on different service layer. The Fig. 1 shows the overlay architecture of security issues and trust requirement in a top-down service model. Trust basically works in a top-down design, as every layer needs to trust the layer instantly beneath it, and obliges a security ensure at an operational, specialized, procedural and lawful level to empower secure correspondences. But

the security is treated as individually in each service layer. Trust could be seen as a sequence from the end client to the application holder, who thusly believes the provider.

A. Security issues in SaaS

In SaaS, the client needs to rely on upon the supplier for fitting efforts to establish safety. The supplier must do the work to keep numerous clients' from seeing one another's information. So it gets to be hard to the client to guarantee that right efforts to establish safety are set up furthermore hard to get confirmation that the application will be accessible when required. Based on SaaS, client can substitute net program or software applications over old one. Hence, the center is not upon portability of uses, yet on safeguarding or upgrading the security usefulness gave by the legacy application and attaining effective information relocation.

B. Security issues in PaaS

In PaaS, the administration supplier may give some control to the customer to manufacture applications on top of the stage. However any securities beneath the application level, for example, have and system interruption anticipation will at present be in the extent of the supplier and the supplier brings to the table solid affirmations that the information stays distant between applications. Paas is proposed to empower designers to assemble their own particular applications on top of the platform. As a result, it tends to be more extensible than SaaS, at the expense of customer-ready features. This exchange off stretches out to security gimmicks and abilities, where the implicit capacities are less finish, however there is more adaptability to layer on extra security. Applications sufficiently perplexing to influence an Enterprise Service Bus(ESB) need to secure the ESB straightforwardly, leveraging a convention, for example, Web Service (WS) Security.

The capability to portion ESBs is not accessible in PaaS situations. Measurements ought to be set up to survey the viability of the application security programs. Among the immediate application, security particular measurements accessible are defencelessness scores and patch scope. These measurements can show the quality of application coding. Consideration ought to be paid to how malignant on-screen characters respond to new cloud application architectures that the darkened application parts from their examination. Programmers are liable to the assault noticeable code, including but not constrained to code running in the client connection. They are prone to assault the foundation and perform extensive black box testing. The vulnerabilities of cloud are connected with the web applications as well as vulnerabilities connected with the machine-to-machine Service- Oriented Architecture (SOA) applications, which are progressively being conveyed in the cloud.

C. Security issues in IaaS

In IaaS, the developer has better control over the security the length of there should not any security gap in the virtualization director. Likewise, however in principle virtual machines may have the capacity to address these issues yet in practice there are a lot of security issues. The other element is the unwavering quality of the information that is put away inside the supplier's equipment. Because of the developing virtualization of "everything" in data society, holding a definitive control over information to the holder of information paying little respect to its physical area will turn into a subject of most extreme investment. To accomplish most extreme trust and security on a cloud asset, a few procedures would need to be connected. The security obligations of both the supplier and the client incredible contrast between cloud administration models. Amazons Elastic Compute Cloud (EC2) (Amazon, 2010) IaaS offering, as a case, incorporates merchant obligation regarding security up to the hypervisor, importance they can just address security controls, for example, physical security, natural security, and virtualization security. The client, thus, is in charge of the security controls that identify with the IT framework including the OS, applications and information.

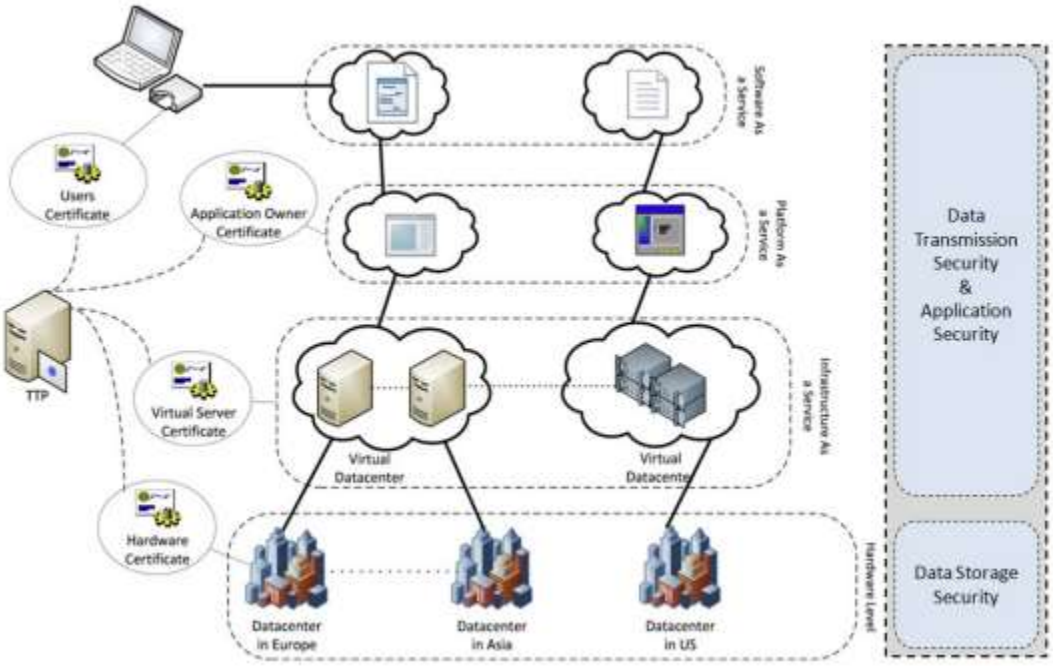

Fig. 1. Overlay architecture of security issues and trust requirement in a top-down service model

4. ADVANTAGES AND DISADVANTAGES OF CLOUD COMPUTING

The degree of acceptance for any computing paradigm is measured by its strengths and weaknesses. If advantages owing to computing paradigm are fair enough and the overheads are bearable to some extent, the degree of acceptance is very high and that computing paradigm will be accepted by users. Following are some important advantages and disadvantages offered by the cloud can be written as:

A. Advantages

Cloud computing offers many benefits and flexibility to its users. User can operate from anywhere at any time in a secure way. With the increasing number of web-enabled devices used now-a-days (e.g. tablets, smart phones etc.), access to one's information and data must be quick and easier. Some of these relevant benefits in respect to the usage of a cloud can be as follows [9, 10]:

- Reduces up-front investment, Total Cost of Ownership (TCO), Total Operational Cost (TOC) and minimizes business risks.
- Provides a dynamic infrastructure that provides reduced cost and improved services with less development and maintenance cost.
- Provides on-demand, flexible, scalable, improved and adaptable services on pay-as-you go model.
- Provides consistent availability and performance with automatically provisioned peak loads.
- Can recover rapidly and has improved restore capabilities for improved business resiliency.
- Provides unlimited processing, storage, networking etc. in an elastic way.
- Offers automatic software updates, Improved Document Format Compatibility and improved compatibility between different operating systems.
- Offers easy group collaboration i.e. flexibility to its users on global scale to work on the same project.
- Offers increased return on investment of existing assets, freeing capital to deploy strategically.
- Provides environment friendly computing as it only uses the server space required by the application which in turn reduces the carbon footprints.

B. Disadvantages of Cloud Computing

Every coin has two faces. That's not to say, of course, cloud computing is without disadvantages. Some of the disadvantages while using a cloud can be summarized as [9]:

- Requires high speed network and connectivity constantly.
- Privacy and security is not good. The data and application on a public cloud might not be very secure.
- Disastrous situation are unavoidable and recovery is not possible always. If the cloud loses one's data, the user and the service provider both gets into serious problems.
- Users have external dependency for mission critical applications.
- Requires constantly monitoring and enforcement of service level agreements (SLAs).

5. ISSUES AND CHALLENGES OF CLOUD COMPUTING

The existing computing paradigms viz. distributed computing, SOA, networking etc. are building blocks of cloud computing. There are numerous issues associated with theses computing paradigms and some new challenges emerged from cloud computing are required to be addressed properly in order to realize the cloud to its full extent. Current cloud adoption is associated with numerous challenges as shown in Figure 2 and 3 depicting the specific business risk of adopting cloud services and biggest barriers. Therefore, these issues must be addressed in order to provide high quality services to the users while complying with the service provider's needs. The issues can be organized into several different categories varying from security, protection, identity management, resource management, power and energy management, data isolation, availability of resources, heterogeneity of resources. Although, there are several issues that demand attention but the following could be treated as of prime concern [11-14]:

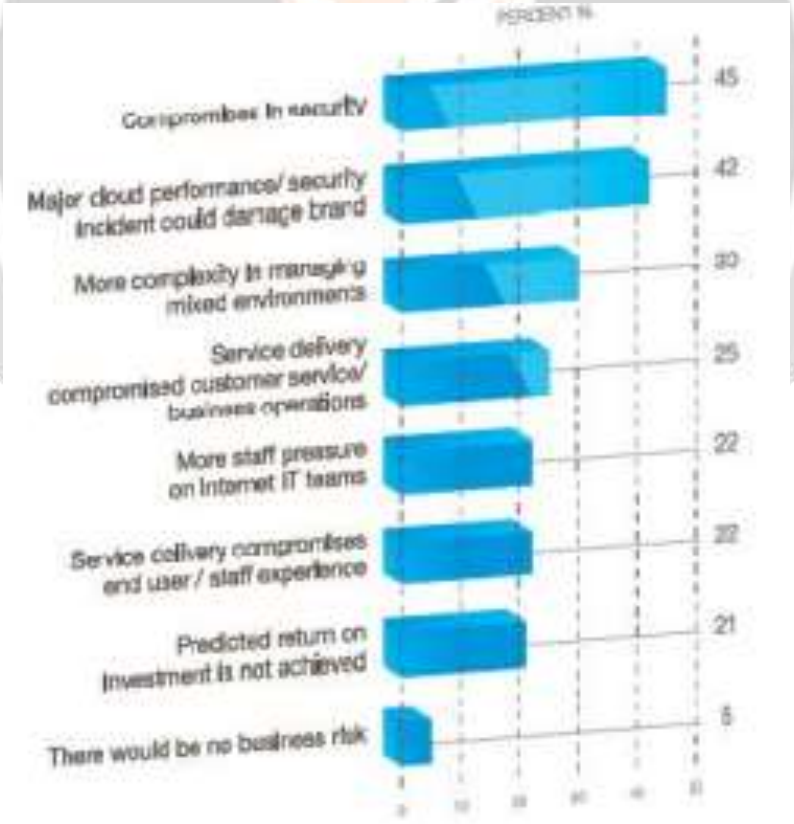

Fig. 2. Specific Business Risk of adopting cloud services [14]

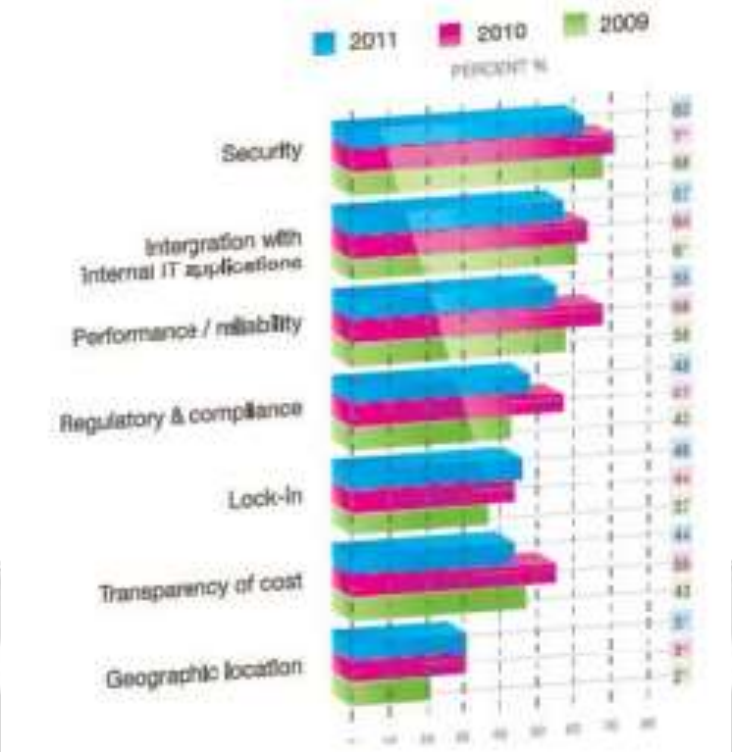

Fig. 3. Biggest Barriers to adoption of cloud services [14]

A. Security and Privacy

According to the survey of International Data Corporation (IDC), Security, Performance and Availability are the three biggest issues in cloud adoption. The critical challenge is how it addresses security and privacy issues which occur due to movement of data and application on networks, loss of control on data, heterogeneous nature of resources and various security policies. Data stored, processing and movement of data outside the controls of an organization poses an inherent risk and making it vulnerable to various attacks. The security threats can be of two types viz. internal and external. The external risk is posed by various persons and organizations e.g. enemies or hackers that do not have direct access to the cloud. The internal security risk is a well-known issue which can be posed by organizational affiliates, contractors, current or former employees and other parties that have received access to an organization's servers, networks and data to facilitate operations. Cloud computing poses privacy concerns because the service providers may access the data that is on the cloud that could accidentally or deliberately be changed or even removed posing serious business trust and legal consequences [8, 11-14].

B. Performance

According to IDC's survey, performance is the second biggest issue in cloud adoption. The cloud must provide improved performance when a user moves to cloud computing infrastructure. Performance is generally measured by capabilities of applications running on the cloud system. Poor performance can be caused by lack of proper resources viz. disk space, limited bandwidth, lower CPU speed, memory, network connections etc. Many times users prefer to use services from more than one cloud where some applications are located on private clouds while some other data or applications being on public and/or community cloud. The data intensive applications are more challenging to provide proper resources. Poor performance can results in end of service delivery, loss of customers, reduce bottom line revenues etc. [2, 11, 13].

C. Reliability and Availability

Any technology's strength is measured by its degree of reliability and availability. Reliability denotes how often resources are available without disruption (loss of data, code reset during execution) and how often they fail. One of

the important aspect that creates serious problems for the reliability of cloud computing is down time. One way to achieve reliability is redundant resource utilization. Availability can be understood as the possibility of obtaining the resources whenever they are needed with the consideration to the time it takes for these resources to be provisioned. Regardless of employing architectures having attributes for high reliability and availability, the services in cloud computing can experience denial of service attacks, performance slowdowns, equipment outages and natural disasters. Data shows that some of the current cloud computing providers have some frequent outages last year. e.g Amazon EC2 outage. In order to remove FUDD (fear, uncertainty, doubt, and disinformation), probably the reliability, availability and security are the important and prime concern to an organization. Therefore, the level of reliability and availability of cloud resources must be considered as a serious issue into the organization's planning to set up the cloud infrastructure in order to provide effective services to consumers.

D. Scalability and Elasticity

Scalability and elasticity are the most amazing and unique features of the cloud computing. These features provide users to use cloud resources being provisioned as per their need in unlimited amount as required. Scalability can be defined as the ability of the system to perform well even when the resources have been scaled up. Elasticity, on the other hand, is the ability to scale resources both up and down as and when required. Elasticity goes one step further, though, and does also allow the dynamic integration and extraction of physical resources to the infrastructure. The elastic cloud computing means that allocation of resources can get bigger or smaller depending on the requirement. Elasticity enables scalability—which means the system can easily scale up or down the level of services to which the user has subscribed. Scalability can be provided in two ways- horizontally and vertically whereby horizontal scalability (Scale Out) refers to addition of more nodes to the system such as adding a new computer to an existing service provider system while vertical scalability (scale up) refers to addition of resources to a single node in the system, typically involving the addition of memory or processors to a single computer.

6. CONCLUSION

Cloud computing can be considered as an integral component of almost all businesses in near future and it is expected to change the landscape of IT industry. It is based on the model of delivering services on internet with pay-as-yougo model with advantages like no up-front cost, lower IT staff, lower cost of operation to name a few. Although cloud computing has bright prospects both for business and researchers certain challenging issues including security, performance, reliability, scalability, interoperability, virtualization etc. needs to be addressed carefully. The improvement in bandwidth technology, corresponding service models and security models can really revolutionize this area along with the IT industry. The paper has discussed the concept of cloud computing and shades some lights on various issues and challenges that needs to be addressed in order to realize the implementation of the cloud and making it a dominant part of our life in order to thrive.

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