



Key Challenges in Cloud Research

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Abstract

Nowadays cloud computing environments play an important role in our daily lives and day by day our dependence on them will grow. Delivering on demand, elastic and cost effective services to the consumers is only part of the benefits that a cloud system provides. However, despite all its benefits this innovative information system contains a variety of research challenges from different points of view. As a matter of fact, the variety of technologies used in a cloud computing system leads to various existing challenges that show the complexity of this environment. In this work first we have introduced a cloud architecture and its specifications with the benefits and drawbacks, and after that the challenges that researchers face in this context. To be able to deliver services in a manner that both the provider and the consumer are satisfied, it is essential to consider the issues mentioned in this paper.

Keywords: Cloud computing, data, challenge, service.

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Introduction

Due to limited resources and the expense of developing a secure computing environment, organizations might turn to cloud computing to defect cybersecurity concerns. Not all providers have the infrastructure to detect and survive a cyber attack but two of the exceptions are Google and Amazon. Clouds contain multiple components, and in such a configuration, cloud is as secure as its weakest link. If a cybercriminal identifies the provider's vulnerabilities, then this component becomes a very good target which threatens the entire cloud environment in which it resides on [1]. This is only part of the challenges that will be introduced in this paper.

The remainder of this paper is as follows: the architecture of cloud is given and after that its characteristics are introduced. Since cloud computing is still on the way of development, research challenges do exist therefore, in the next section we have introduced the issues that need careful consideration. After that finally in the last section the conclusions are given.

Cloud Architecture

Cloud computing is a type of computing in which scalable services are provided virtually through the internet and consumers need not have knowledge of, or control over the technology infrastructure of the cloud [2].

As illustrated in Figure 1 [3] Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) are three types of services that a cloud computing environment provides for costumers based on their demands. These abstractions of cloud computing are similar to the design of the Open Systems Interconnection (OSI) model for network protocols. Therefore, each upper layer is served by the lower layer in this model which makes the management and maintenance easier. Furthermore, the relation between these layers and the roles inside a cloud system named vendor, developer and end user is also illustrated that indicates whether they provide the service or consume it.

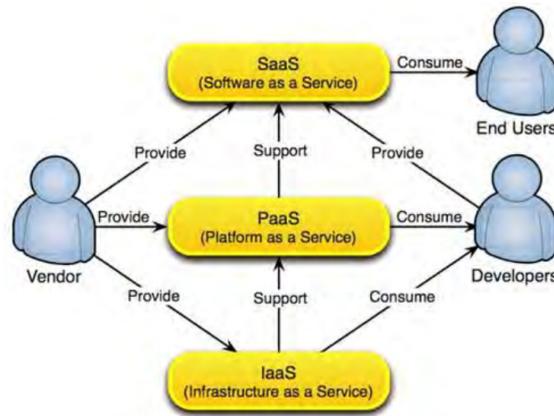


Fig 1: Abstractions of cloud computing

Characteristics of Cloud

According to the definition and architecture of cloud computing we can summarize the characteristics of a cloud computing environment into the advantages and disadvantages mentioned below.

A brief list of advantages:

- security centralization
- redundancy
- availability
- ubiquity
- reliability
- scalability
- simplicity
- flexibility
- resource management efficiency due to dynamic resource scheduling [4]
- cost efficiency which means reduction of all Capital Expenditures (CapEx) and reductions of the Operational Expenditures (OpEx) [5]
- no maintenance overhead [6].

On the other hand, the disadvantages are:

- latency
- service interruption such as internet problems, power cut-off, service disruption and system bugs [4]
- problematic service migration due to the fact that no agreement exists on the standardization of cloud computing external interface [4]
- data communication cost [7]
- elastic resource pooling makes cost analysis a lot more complicated than regular data centers [7]
- significant cost in developing multi-tenancy because it includes redesign and re-development of the original single-tenant software and also the cost of providing new features for intensive customization, performance and security enhancement for concurrent user access [7].

Research Challenges in Cloud

Due to the variety of technologies used in a cloud computing system different research challenges exist that shows the complexity of this environment. According to [8] these challenges are mentioned in detail in this section.

A. Data Management

Data is a vital component in any system specially cloud that is multi-tenant and distributed. Managing the data with its high capacity in a way that its availability and durability is preserved is an important research factor. On the other hand, one of the important factors in a cloud system is elasticity therefore, novel data management approaches are needed to cope with the increased demands of consumers. Besides this, storing the data at a third-party cloud that could be untrusted will be a great risk for its privacy.

B. Software/Hardware Architecture

The specifications of a cloud computing system require special software and hardware. These components in the cloud should provide a high degree of parallelism, data-intensive computing and reliable and high-performance data storage. Therefore, producing software and hardware with the needed requirements is an issue that even after production selecting them would need careful considerations in various aspects such as price, capability, capacity and adaption with other components of the cloud environment.

C. Cloud Interoperability

Whenever services from various providers are integrated in order to provide consumer's demanded service, interoperability between them is crucial. For this purpose, new standards and interfaces need to be created for interaction between different platforms. However, progress in standardization will be very difficult when big players such as Microsoft and Amazon do not come forward to reach consensus [7].

D. Security and Privacy

Security and privacy are one of those challenges that exist in different parts of a cloud computing environment. When consumer's data is outsourced the service provider is responsible for preserving its confidentiality and integrity against any intruder. In addition to untrusted service providers other consumers can also be a threat to the security and privacy of the cloud specially the data. By enhancing the interoperability of service providers, new protection mechanisms are required to secure data privacy, resource security, and content copyrights.

E. Automated Service Provisioning

Any agreement between the service provider and the consumer is determined by the Service-Level Agreement (SLA). Thereby, estimating the amount of resources without underestimating and overestimating is a concern due to the fact that each of these conditions has its own consequences. Underestimating would lead to broken SLAs and penalties while overestimating would lead to resource underutilization and, consequently, a decrease in the revenue for the provider.

F. Energy Management

Efficient energy consumption can be viewed in different aspects such as designing data centers, hardware architecture, job scheduling, network protocols and infrastructures. An issue in all the above methods is to achieve a good trade-off between energy savings and application performance [9].

G. Traffic Management and Analysis

Analysis of data traffic is important for today's data centers due to optimization and making management and planning decisions. However, there are some challenges that Internet Service Providers (ISPs) networks and enterprise face in order to extend traffic analysis methods to data centers. Two of these issues are: having a high density of links which is the worst case for existing methods and having several thousand servers in a modular data center while most existing methods could be used for traffic computation of a few hundred end hosts [9].

Other open issues include data transfer bottlenecks, performance unpredictability, scalable storage, software licensing [10], performance, latency, bandwidth costs and transparency [11].

Conclusions

A cloud computing system delivers applications as services through the internet to consumers based on their demands on a pay-per-use basis. Due to the benefits of this evolving paradigm the number

of organizations switching to a cloud environment is increasing. As a result, the amount of data, the complexity of required services and also the complexity of energy management increases which would require more effort in this area. Furthermore, this complexity would lead to a variety of challenges that are introduced in this paper. Based on this work we conclude that vendors and developers would need a thorough knowledge of the introduced challenges in order to develop and deliver a broad range of on demand services.

For future we would focus on the main presented challenges which are security, privacy and energy management and try to perform a thorough and technological study in this context to be able to address the drawbacks.

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