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Technologies of Cloud Computing - Architecture Concepts based on Security and its Challenges

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Abstract
Cloud computing is becoming a powerful network architecture to perform large-scale and complex computing. we present a survey of cloud computing, highlighting its key concepts, architectural principles, state-of-the-art implementation as well as research challenges. The aim of this paper is to provide a better understanding of the design challenges of cloud computing and identify important research directions in this increasingly important area. As Clouds are complex, large-scale, and heterogeneous distributed systems, management of their resources is a challenging task. They need automated and integrated intelligent strategies for provisioning of resources to offer services that are secure, reliable, and cost-efficient.

Keywords: Cloud Computing, security, challenges, Architecture

1 Introduction

Cloud Computing is a distributed computing model for enabling service-oriented, on-demand network access to rapidly scalable resources . Such resources include infrastructure as a service (IaaS), development and runtime platforms as a service (PaaS), and software and business applications as a service (SaaS).

Building a dynamic infrastructure(Service managemant)

- Business Resiliency – Maintaining continuous business and IT operations while rapidly adapting and responding to risks and opportunities.
- Information Infrastructure – Helping businesses achieve information compliance, availability, retention, and security objectives.
- Service Management – Provide visibility, control and automation across all the business and IT assets to deliver higher value services.
- Virtualization – Leadership virtualization and consolidation solutions that reduce cost, improve asset utilization, and speed provisioning of new services.
- Asset Management – Maximizing the value of critical business and IT assets over their lifecycle with industry tailored asset management solutions.
- Energy Efficiency – Address energy, environment, and sustainability challenges and opportunities across your infrastructure.
- Security – End to end industry customized governance, risk management and compliance solutions.

1.1 Value Proposition

The main value proposition of Cloud Computing is to provide the clients a cost-effective, convenient means to consume the amount of IT resources that is actually needed; for the service provider, better resource utilization of existing infrastructure is achieved through a multi-tenant architecture.

1.2 Challenges & Research Questions

Trade-off decisions have to be made between several (sometimes contradictory) goals, such as:

- increase availability & reliability
- increase performance (latency, throughput)
- increase security and ensure privacy

1.3 Virtualization

Virtualization technology provides the technical basis for Cloud Computing. Virtualization has already been in the focus of research in the early 1970s, but gained a lot of attention in the last years, as inexpensive servers and client machines became powerful enough in order to be used for virtualization. In general, virtualization deals with the creation of virtual resources, such as operating systems, servers, or storage devices.

1.4 Decision Support

When building new software applications or services that might potentially be deployed in the cloud, some decisions are inevitable in different stages of the software engineering process. For example, use of an in-house IT department may be compared to the use of third party service providers. In the context of cloud computing, this implies an important, principle business decision whether to own and maintain a data center or outsource operations to the cloud. The later stages of the decision process include the design, deployment and operations of applications and services.

Benefits of the Cloud

Cloud computing fundamentally changes the way that IT services are delivered to organizations. Instead of both owning and managing IT services for themselves, or using an outsourcing approach built around dedicated hardware, software, and support services, organizations can use cloud computing to meet their IT requirements using a flexible, on-demand, and rapidly scalable model that requires neither ownership on their part, nor provision of dedicated resources.

Some of the benefits that cloud computing brings are as follows:

- Reduced Cost:
- Flexibility
- Improved Automation:
- Focus on Core Competency:
- Sustainability:

2 Overview of cloud computing

overview of cloud computing,including its definition and a comparison with related concepts.

2.1 Definitions

The term “cloud” has also been used in various contexts such as describing large ATM networks in the 1990s. However, it was after Google’s CEO Eric Schmidt used the word to describe the business model of providing services across the Internet in 2006, that the term really started to gain popularity. Cloud computing is a new consumption and delivery model inspired by consumer internet services**.**

NIST definition of cloud computing *Cloud computing is a model for enabling 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.*

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2.2 Related technologies

Cloud computing is often compared to the following technologies, each of which shares certain aspects with cloud computing:

- *Grid Computing*: Grid computing is a distributed computing paradigm that coordinates networked resources to achieve a common computational objective. The development of Grid computing was originally driven by scientific applications which are usually computation-intensive.
- *Utility Computing*: Utility computing represents the model of providing resources on-demand and charging customers based on usage rather than a flat rate. Cloud computing can be perceived as a realization of utility computing

.

- *Virtualization*: Virtualization forms the foundation of cloud computing, as it provides the capability of pooling computing resources from clusters of servers and dynamically assigning or

reassigning virtual resources to applications on-demand.

- *Autonomic Computing*: autonomic computing aims at building computing systems capable of self-management, i.e. reacting to internal and external observations without human intervention. The goal of autonomic computing is to overcome the management complexity of today's computer systems.

3 Cloud computing architecture

This section describes the architectural, business and various operation models of cloud computing.

3.1 A layered model of cloud computing

Generally speaking, the architecture of a cloud computing environment can be divided into 4 layers: the hardware/ datacenter layer, the infrastructure layer, the platform layer and the application layer.

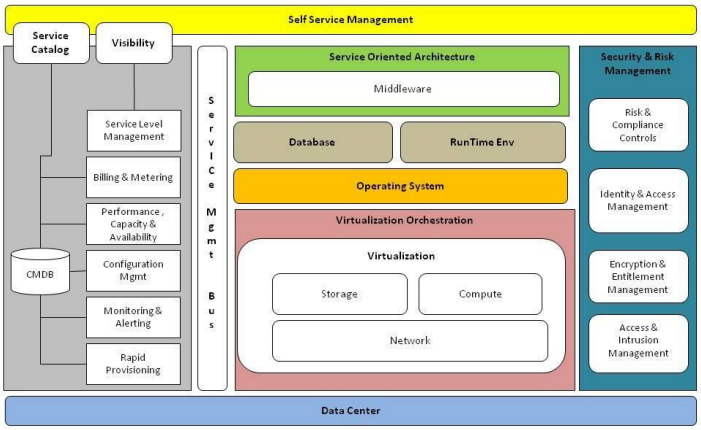
- *The hardware layer*: This layer is responsible for managing the physical resources of the cloud, including physical servers, routers, switches, power and cooling systems. In practice, the hardware layer is typically implemented in data centers. A data center usually contains thousands of servers that are organized in racks and interconnected through switches, routers or other fabrics. Typical issues at hardware layer include hardware configuration, faulttolerance, traffic management, power and cooling resource management.

- *The infrastructure layer*: Also known as the virtualization layer, the infrastructure layer creates a pool of storage and computing resources by partitioning the physical resources using virtualization technologies. The infrastructure layer is an essential component of cloud computing, since many key features, such as dynamic resource assignment, are only made available through virtualization technologies.

- *The platform layer*: Built on top of the infrastructure layer, the platform layer consists of operating systems and application frameworks. The purpose of the platform layer is to minimize the burden of deploying applications directly into VM containers.

- *The application layer*: At the highest level of the hierarchy, the application layer consists of the actual cloud applications. Different from traditional applications, cloud applications can leverage the automatic-scaling feature to achieve better performance, availability and lower operating cost.

Fig. 1 Cloud computing Architecture



3.2 Business model

Cloud computing employs a service-driven business model. In other words, hardware and platform-level resources are provided as services on an on-demand basis. Conceptually, every layer of the architecture described in the previous section can be implemented as a service to the layer above. clouds offer services that can be grouped into three categories: software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS).

- *Infrastructure as a Service*: IaaS refers to on-demand provisioning of

infrastructural resources, usually in terms of VMs. The cloud owner who offers IaaS is called an IaaS provider.

- *Platform as a Service*: PaaS refers to providing platform layer resources, including operating systems support and software development frameworks. Examples of PaaS providers include Google App Engine .
- *Software as a Service*: SaaS refers to providing ondemand applications over the Internet. According to the layered architecture of cloud computing, it is entirely possible that a PaaS provider runs its cloud on top of an IaaS provider's cloud. However, in thecurrent practice, IaaS and PaaS providers are often parts of the same organization (e.g., Google and Salesforce).

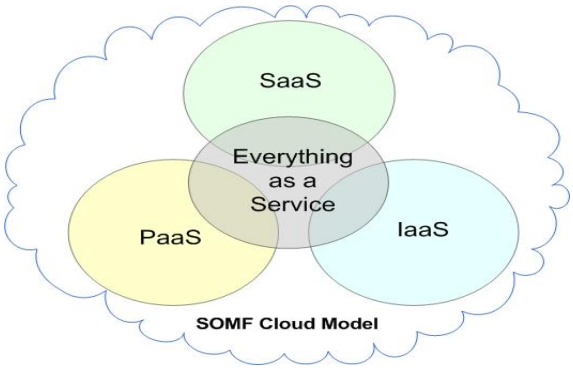


Fig. 2 Business model of cloud computing

3.3 Types of clouds

There are many issues to consider when moving an enterprise application to the cloud environment. For example, some service providers are mostly interested in lowering operation cost, while others may prefer high reliability and security. Accordingly, there are different types of clouds, each with its own benefits and drawbacks:

- *Public clouds*: A cloud in which service providers offer their resources as services to the general public. Public clouds offer several key benefits to service providers, including no initial capital investment on infrastructure and shifting of risks to infrastructure providers.
- *Private clouds*: Also known as internal clouds, private clouds are designed for exclusive use by a single organization. A private cloud may be built and managed by the organization or by external providers. A private cloud offers the highest degree of control over performance, reliability and security.
- *Hybrid clouds*: A hybrid cloud is a combination of public and private cloud models that tries to address the limitations of each approach. In a hybrid cloud, part of the service infrastructure runs in private clouds while the remaining part runs in public clouds. Hybrid clouds offer more flexibility than both public and private clouds
- *Virtual Private Cloud*: An alternative solution to addressing the limitations of both public and private clouds is called Virtual Private Cloud (VPC). A VPC is essentially a platform running on top of public clouds. The main difference is that a VPC leverages virtual private network (VPN) technology that allows service providers to design their own topology and security settings such as firewall rules.

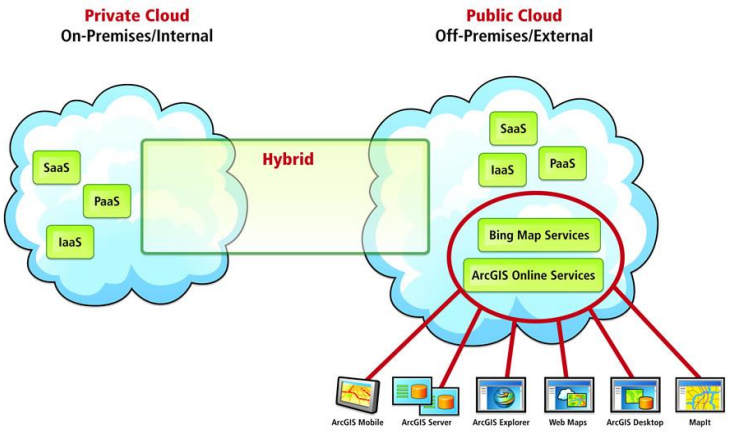


Fig.3 Types of clouds

4. Cloud Computing Security

4.1. Why Security in Cloud Computing?

By using offloading data and cloud computing, a lot of companies can greatly reduce their IT cost. However, despite tons of merits of cloud computing, many companies owners began to worry about the security treats. Because in the cloud-based computing environment, the employees can easily access, falsify and divulge the data. Sometime such behavior is a disaster for a big and famous company. Encryption is a kind of ideal way to solve such problem, whereas for the customers who are using the cloud computing system cannot use such encrypted data.

4.2. Encryption-on-Demand

The basic idea for encryption-on-demand is that they try to use the encryption-on-demand server which can provide some kind of encryption service. For example, when the server gets a request from user, the website or server will make a unique encryption program, the socalled 'client' program, send a package including such program to the client.

4.3. Security for the Cloud Infrastructure:

For managing the hardware or resources in the same physical system, the VMM (virtual machinemonitor) can createmultipleVMs(virtual machines). For the server, this infrastructure provides a very convenient way to create, migrate, and delete the VMs. The cloud computing concept can easily achieve the big scale and cheap services. However, using one physical machine to execute all the workloads of all the users, it will make some serious security issues. Because this infrastructure needs many likelihood components, it will easily lead to the misconfiguration problems. The so-called trusted virtual data center has different VMs and associated hardware resources.

4.4. Towards Trusted Cloud Computing

A traditional trusted computing architecture can provide some-degree security for the customers. Such system can forbid the owner of a host to interfere all the computation. The customer can also run the remote testing program which can let the customer know if the procedure of the host is secure or not. If the users or customers detect any kind of abnormal behavior from the host, they can immediately terminate their VMmachines. Unfortunately, such apparent perfect platforms also have some fatal flaws. For example, as we know, the service providers always provide a list of available machines to the customers. Afterwards, the customer will be automatically assigned a machine.

4.5. Privacy Model

Privacy is a fundamental human right; security schemes in cloud computing services must meet many government regulations and abide by many laws . These laws and regulations are primarily aimed toward protecting information which can be used to identify a person (such as a bank account number or social security number). Of course, these stipulations make cloud computing security even more difficult to implement. Many security schemes have been proposed, but the factor of accountability must be included in all systems, regardless of specific components.

Fig.4 cloud security

5. Research challenges

Many existing issues have not been fully addressed, while new challenges keep emerging from industry applications.

5.1 Automated service provisioning- One of the key features of cloud computing is the capability of acquiring and releasing resources on-demand. The objective of a service provider in this case is to allocate and de-allocate resources from the cloud to satisfy its service level objectives (SLOs), while minimizing its operational cost.

5.2 Virtual machine migration -Virtualization can provide significant benefits in cloud computing by enabling virtual machine migration to balance load across the data center. In addition, virtual machine migration enables robust and highly responsive provisioning in data centers.

5.3 Server consolidation- Server consolidation is an effective approach to maximize resource utilization

while minimizing energy consumption in a cloud computing environment.

5.4 Energy management- Improving energy efficiency is another major issue in cloud computing. The goal is not only to cut down energy cost in data centers, but also to meet government regulations and environmental standards.

Designing energy-efficient data centers has recently received considerable attention. This problem can be approached from several directions.

5.5 Traffic management and analysis- Analysis of data traffic is important for today's data centers. For example, many web applications rely on analysis of traffic data to optimize customer experiences. Network operators also need to know how traffic flows through the network in order to make many of themanagement and planning decisions.

5.6 Data security -Data security is another important research topic in cloud computing. Since service providers typically do not have access to the physical security system of data centers, they must rely on the infrastructure provider to achieve full data security.

6. Conclusions

Cloud computing will be a major power of the large-scale and complex computing in the feature.

In this paper, we present a comprehensive survey on the concepts, architectures, and challenges of cloud computing. We provide introduction in details for architectures of cloud computing in every level, followed by a summary of challenges in cloud computing, in the aspects of security, virtualization, and cost efficiency. Among them, Security issues are the most important challenge in the cloud computing. We survey comprehensively the security and the current methods addressing the security challenges. This survey provides useful introduction on cloud computing to the researchers with interest in cloud computing. However, despite the significant benefits offered by cloud computing, the current technologies are not matured enough to realize its full potential. Many key challenges in this domain, including automatic resource provisioning, power management and security management, are only starting to receive attention from the research community. Therefore, we believe there is still tremendous opportunity for researchers to make groundbreaking contributions in this field, and bring significant impact to their development in the industry.

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