CSD343

DATA AND KNOWLEDGE ENGINEERING

Cloud Computing Report

Group 26

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1. Introduction to Cloud Computing

What is Cloud Computing?

Cloud Computing, in brief, is a new IT service delivery paradigm that works over the Internet. "Cloud" is used to represent the abstract nature of the network providing a service to a user. From the user's perspective, he is connected to a "black-box" via a "cloud" of network components. The purpose of cloud computing is to provide such an abstraction to make it much easier to develop and use services on the "web". The term was proposed for when the applications and services move into the internet "cloud".

The main idea is to provide delivery of as-and-when-required computing resources - that one need not own - be it some applications, servers, networking, analytics and even data centers - over the internet. These services are usually provided on a pay-per-use basis.

There are many players in the market today that provide cloud services. Some of the prevalent cloud providers include Google (Google Cloud Platform), Amazon (Amazon Web Services & Elastic Compute Cloud), Microsoft (Azure).

Why the switch to Cloud Computing?

Cloud computing has seen a large penetration into very many industries because of its following benefits:

1. **Cost reduction**: It eliminates the capital expense of purchasing expensive hardware and software and bootstrapping on-site data centers with server racks, electricity for power and cooling, staff for managing the infrastructure etc.

2. **Speed**: The as-and-when-required model allows large amount of computing power to be provisioned to a user's system, with a simple mouse click, in under a few minutes. And also provides reduction in computing power when there isn't much need thus saving resources and providing full flexibility.

3. **Scalability**: One of the most prized asset of cloud computing is the ability to scale elastically. Applications can be scaled very easily by deploying on cloud which manages load balancing, distribution of resources across geographies very easy.

4. **Productivity**: On-site data centers usually require a lot of hardware setup, software patching and continuous management of resources. Cloud computing removes the need for many of these tasks, so developer teams spend more time on targeting important business goals.

5. **Performance**: Large cloud services function on a global network of secure datacenters, which are regularly upgraded to the latest generation of fast and efficient computing hardware. This offers several benefits over a single corporate datacenter, including reduced network latency for applications and greater economies of scale.

6. **Reliability**: It makes redundancy backups and disaster recovery less demanding and more less expensive because data can be mirrored at multiple redundant sites on the provider's network.

Difference between Cloud and Grid/Distributed

Both computing types involve multitenancy and multitask, meaning that many customers can perform different tasks, accessing a single or multiple application instances.

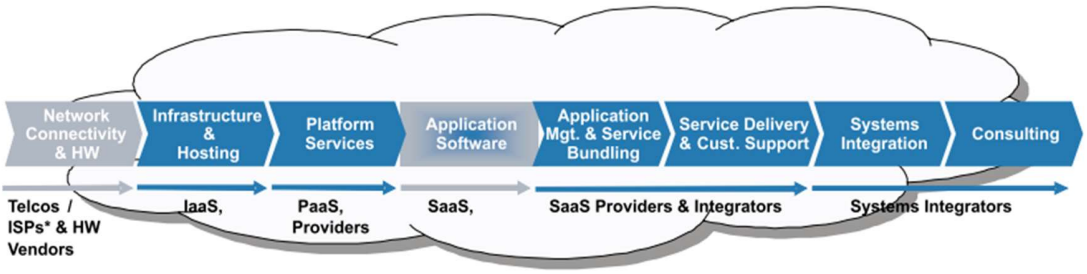
Grid computing links disparate computers to form one large infrastructure, harnessing unused resources. With grid computing, you can provision computing resources as a utility that can be turned on or off.

Cloud computing goes one step further with on-demand resource provisioning. This eliminates over-provisioning when used with utility pricing. It also removes the need to over-provision in order to meet the demands of millions of users.

Also, Grid computing may or may not be in the cloud depending on what type of users are using it. Grid computing requires the use of software that can divide and farm out pieces of a program as one large system image to several thousand computers.

Cloud Business Models

The conventional linear value chain for IT services ranging from consultation, design, implementation and operation of solutions and infrastructures is changing as a result of cloud computing concepts.



The much lower entry costs for using a professional infrastructure in the cloud, translates into a low entry barrier, giving rise to a large number of small and medium enterprises to use their creativity and launch new IT services on the market with minimal capital commitment and flexible operating costs. The result is a cloud computing eco system of IT service providers. This eco system, such as Amazon in particular promotes by providing easy-to-use basic IT services and middleware components as Web services, will necessitate new stages in the value chain, such as service brokering and aggregation, trust and reputation assessments.

2. Types of Cloud Computing

Cloud Computing is known for avoiding undifferentiated work (procurement, maintenance or capacity planning). Cloud Computing uses different models to provide services. Also, each cloud service provides levels of control, flexibility and management. Different models and deployment strategies have been made to decide what set of services are right for the needs of a user. So, typically cloud computing can be classified by two ways:

Location of the cloud

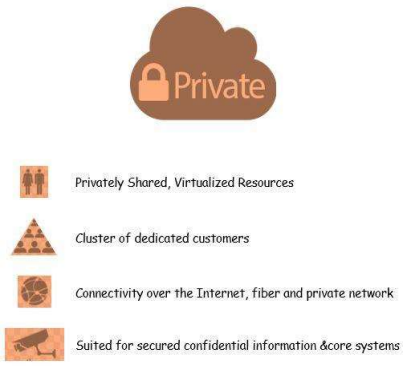
Based on the cloud location, cloud computing can be classified into three main deployment models.

Public Cloud

In Public Cloud, the computing infrastructure is located on the premises of a cloud computing company that offers cloud service. The location remains separate from the customer. Thus, he cannot see where the computing infrastructure is hosted and he does not have a physical control over it. The computing infrastructure is shared between organizations and as the resources are shared, public clouds excel in performance.

Private Cloud

Private cloud means that only one customer/organization uses a cloud infrastructure and is not shared with other organizations. Compared to public clouds, private clouds are more expensive but more secure. Private clouds are further divided into two types, On-Premises private clouds and Externally hosted private clouds. Externally hosted private clouds are hosted by a third party while with on-premises private clouds, the companies have a physical control over the infrastructure.



Hybrid Cloud

If both public and private clouds are used together then it is called Hybrid Cloud. Organizations may host applications with less security concerns on the public cloud and critical applications on the private

cloud. For example, public cloud can be used to interact with customers, while keeping their data secured through a private cloud.

Some other types of cloud computing based on location are:

Community Cloud

In Community Cloud, computing infrastructure is shared among organizations of the same community.

Distributed Cloud

Distributed set of machines in different locations can be assembled to make a platform, connected to single network.

Intercloud

Intercloud can also be termed as the “The Cloud of Clouds”.

Multicloud

Rather than multiple deployment modes, Multicloud refers to multiple cloud services, reduces reliance and increases flexibility.

Cloud Services

Based on the services offered, cloud computing can be classified in the following ways.

Infrastructure-as-a-Service (IaaS)

IaaS is the most basic cloud service model. IaaS provides from high level APIs to low level network infrastructure like data partitioning, security, backup etc. IaaS uses the principles of cloud computing and offers hardware related services. Such services include raw block storage, firewalls, load balancers, software bundles etc. Eg. Amazon, Rackspace, Flexiscale etc.

Platform as a Service (PaaS)

PaaS offers a development platform which includes operating system, programming-language execution environment, database, and web server, on the cloud. Without buying and managing the underlying hardware and software layers, software solutions can be developed and run on the cloud platform. Eg. Google App Engine, Microsoft Azure, Salesforce.com etc.

Software as a Service (SaaS)

SaaS is also known as “on-demand software”. In this model, users get the access to applications and databases. Infrastructure is managed by cloud providers. It includes a complete software offering on the cloud. Users can access a software application hosted by the cloud vendor on pay-per-use basis. Advantages include reduced time to benefit, lower costs, and easy to use. Eg. Salesforce.com, Google Gmail, Microsoft Hotmail, google docs etc.

Some other types of cloud services are as follows.

3. Cloud Storage

How cloud storage works?

Cloud Storage can be defined as a structure in which data is stored, preserved and backed up in multiple servers so that a user can access data from anywhere around the world provided he/she has an internet connection.

At the most basic level, cloud storage can be one user with access to one server. The user will upload the data on server through the terminal to keep it safe. Suppose the server malfunctions, so it would not be possible retrieve the uploaded data. The core idea of the cloud storage is to provide reliability. This principle is implemented using redundancy.

So basically, as soon as user uploads data on the server, the server creates a copy and pass it to another server which in turn makes another one. Now even if the server fails, user can still retrieve data through another server.

Types of cloud storage

There are three types of cloud data storage.

Object Storage

It is a storage architecture where data is stored as objects. Each object includes data and the meta-data. It is ideal for building modern applications from scratch which require flexibility and scalability

File Storage

There are case where some applications need to access shared files which are stored in hierarchy. These types of storage require Network Attached Storage(NAS) server. This type of storage is best suited for maintaining large repositories, media stores etc.

Block Storage

Some applications require a dedicated, low latency storage for the host like the famous ERP systems. In this type of storage, one can detach a particular storage volume from one server and attach to another server. This pretty much acts like a hard disk. This is used where high-performance storage is needed for critical applications like ERP systems.

Using above data storage types, several types of cloud storage systems have been developed.

Personal File Hosting

It is the most basic for of cloud storage where individuals upload their files to central Internet server. This service allows HTTP and FTP access. This sometimes also helps to collaborate on document files.

Enterprise Storage

Software agents running inside the company network can securely transfer copies of files and database data to third-party cloud servers. Companies maintain repositories containing code of proprietary software. This is to ensure that they have several versions of software such that even if a developer did some mistake which resulted in failure, a different version of software can be deployed to avoid any losses.

4. Cloud Adoption

What is Cloud Adoption?

Cloud adoption is a strategic move made by organizations to leverage cloud and cloud-based technologies in their organizational workflow, usually with the objectives being mitigation of risk and increasing scalability.

More than 90% of the cloud security professionals surveyed in McAfee's report on cloud adoption (titled *Building Trust in a Cloudy Sky*) in 2017 say that they utilized some type of cloud service in their organization, and many were now operating under a *Cloud First* strategy.

Current Trends in Cloud Adoption

The following are some of the trends reflecting the state of industry-wide cloud adoption 2017 :

- Hybrid cloud adoption grew threefold in the last year, increasing from 19% to 57% of organizations surveyed. This sharp increase in the adoption of hybrid cloud indicates a rising maturity in enterprises. This indicates that many organizations are actively looking to create *Cloud First* apps internally that can replace legacy on-premise apps that no longer scale to their current and future business model needs.

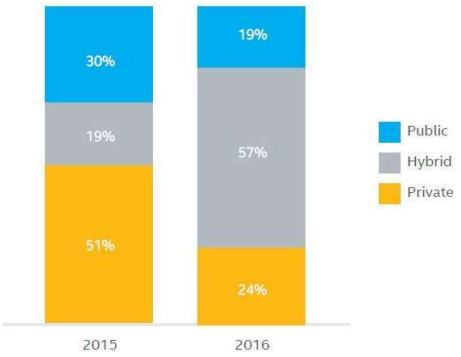
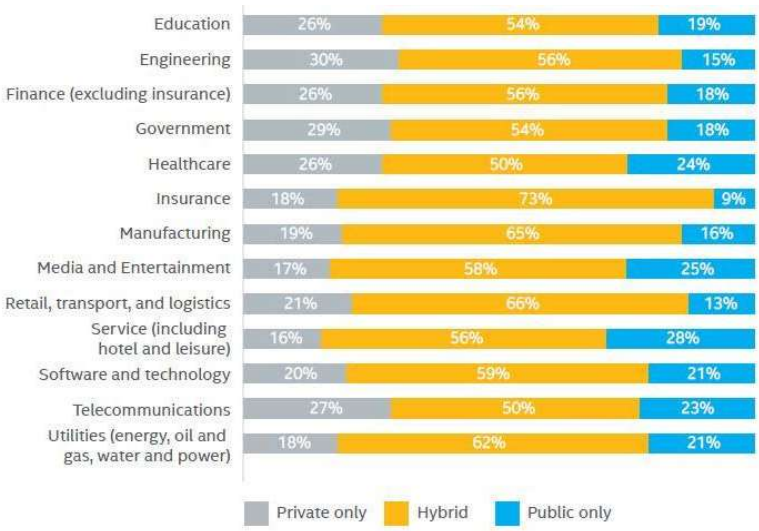


Figure 6. Which type of cloud architecture is your organization currently using? (grouped by year)

- The services industry is the largest consumer of public cloud platforms(28%), while Engineering and Government sectors remain the largest adopters of private clouds, with 30% and 29% rates of adoption respectively.



- The trust in clouds from a security based perspective remains low since only 23% of organizations today completely trust public clouds to keep their data secure. However, the

general trust in cloud is on the rise as it has seen a 73% increase in the last year.

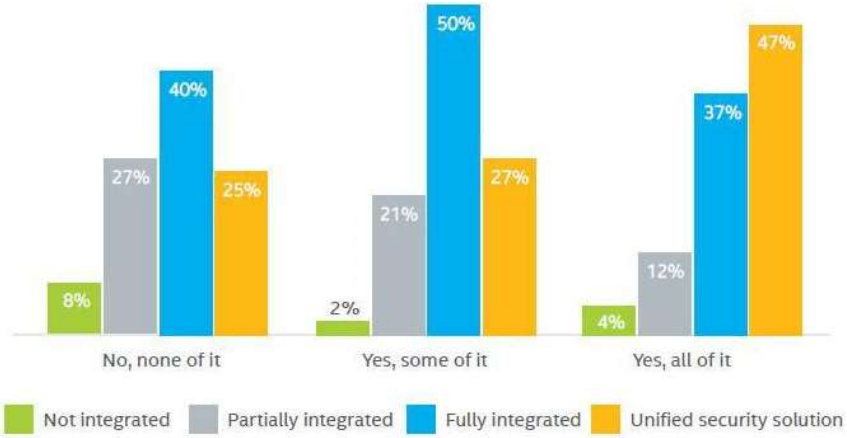


Figure 15. Does your organization's public cloud service store your organization's sensitive data? (split by level of integration of security solutions)

- The increase in trust regarding the security provided by public clouds can be attributed to an increase in utilization of fully integrated and unified security solutions across the industry. Organizations with integrated security solutions across multiple cloud environments are significantly more likely to store some or all of their sensitive data in a public cloud service.

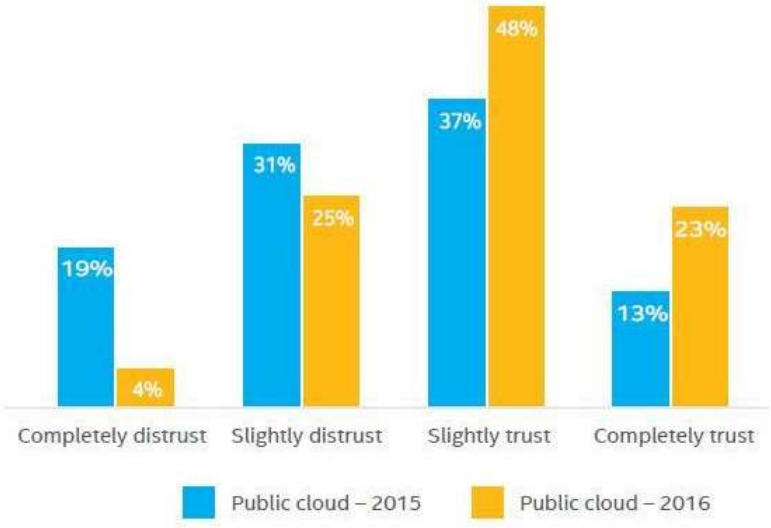


Figure 12. To what extent do you trust the following to keep your organizations' sensitive data secure?

- There has been a widespread demand for containers and 83% of organizations are actively using containers today. A container image is a lightweight, stand-alone, executable package of a piece of software that includes everything needed to run it: code, runtime, system tools, system libraries, settings. The number of containers used per host machine tends to be much higher than virtual machines, which makes it more challenging to protect containers. There is currently

a strong demand for cloud security vendors to integrate advanced security solutions for containers into their cloud service strategies.

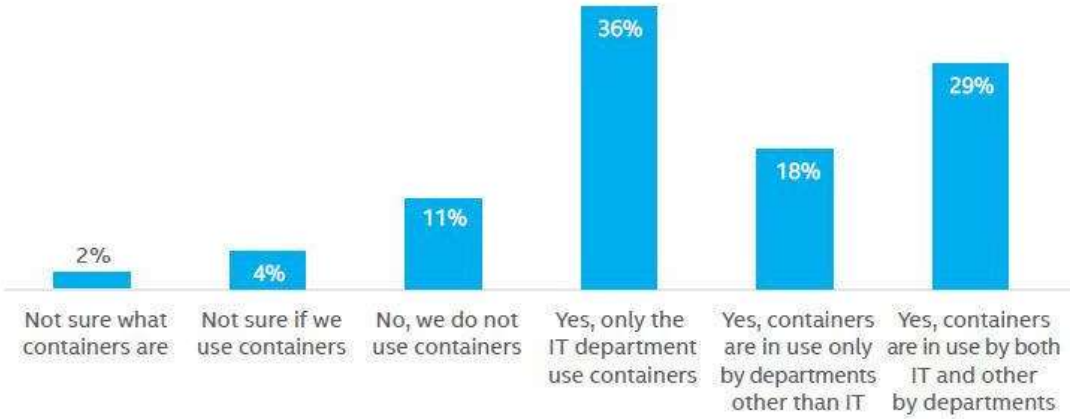


Figure 28. Does your organization use containers (e.g. Docker or Lynx)?

5. Challenges and Future Trends

Attacks targeting shared-tenancy environment

The VMs (Virtual machines) are used as software implementation which has its own operating system. We can also use multi- VMs to run different software applications on the single system. Each gets its own disk space and are independent of each other. One VMs is not affected by the other and does not interfere. It's good for flexibility and reducing cost. But in a recent study from university of California, team of scientists observed that you can actually map the address of VMs working on a system, their internal cloud structure. Their address, where they are going to reside next. Hence, it was concluded from this research that if their addresses can be mapped then it should not be very difficult to monitor the cache in order to retrieve the data information. This attack is also termed as side- channel attack.

This research raises the concerns of cloud computing being central point of vulnerability which can be easily exploited. Hence, cyber security is a great challenge for cloud computing yet. Attackers usually target shared technology inside cloud computing like Disk partitions, CPU caches and other such sources.

VM based Malware

Rootkits are the technologies generally designed by the malware programs to abuse systems by hiding files, register keys from anti-virus and security programs. These rootkits can be used to exploit the vulnerabilities in VMs to affect both client and server machines in cloud services. According to a security researcher, this vulnerability of the VM can be exploited to allow the attacker to read and write memory

on the host operating system. They can completely control the host OS without it knowing it. Also, they can control hardware interfaces which is quite dangerous.

Botnet hosting

Bot malware usually occurs due to system vulnerability and software bugs that allow these malware codes to be installed into the system without the owner's knowledge. Then these infected machines are exploited to carry out cybercrimes like exploiting any service provided by the server or neglecting the services by the customer, repeated messages and other crimes.

Cyber criminals could abuse cloud services to operate C&C servers (command and control) to carry out distributed denial-of-service(DDoS) attacks.

Data availability

As all the business and companies are dependent on data these days. One major challenge is the availability of internet. If internet is unavailable, companies will undergo huge trouble. One more thing is the vulnerability of the data available, if it is detected in the particular service provided by the cloud service provider, business may have decline all the services till it is assured that those vulnerabilities are rectified.

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