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Network Security: Cloud Computing

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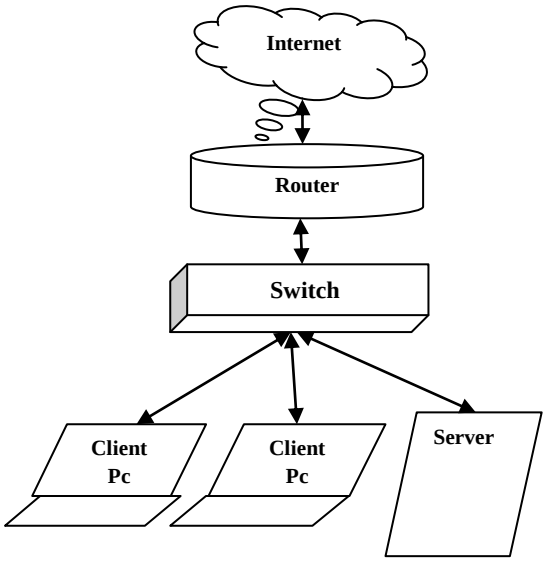
Abstract— Cloud computing has recently emerged as a new paradigm for hosting and delivering services over the Internet. Cloud computing is attractive to business owners as it eliminates the requirement for users to plan ahead for provisioning, and allows enterprises to start from the small and increase resources only when there is a rise in service demand. However, despite the fact that cloud computing offers huge opportunities to the IT industry, the development of cloud computing technology is currently at its infancy but there are many issues still to be addressed.
Keywords: cloud computing, Data centers, Virtualization

1) Introduction:

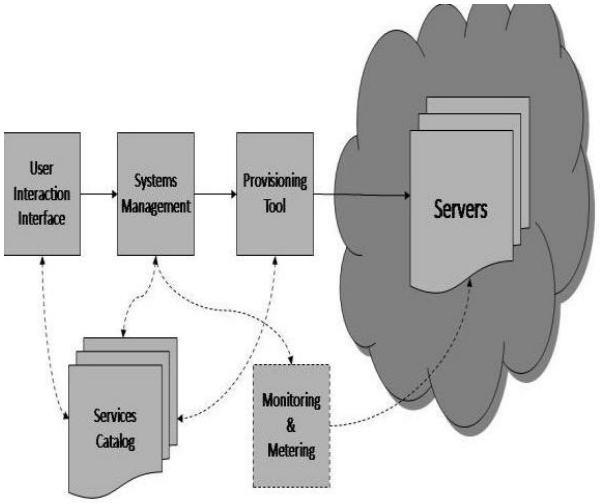
Cloud computing is a new computing model. It is based on grid computing. It is technology based on the storage of files, applications and infrastructure on internet. Cloud computing has been around for many years, but now a company may buy or rent space for their daily operations .The cost saving in implementing a cloud system is substantial, and the pricing for use of cloud can easily be scaled up or down as determining by necessity.

The Cloud computing, or something within the cloud, is an expression used to describe a variety of computing concepts in which there are large number of computers connected through a real communication network such as the Internet. In science, it is a synonym for distributed computing over a network, means the ability to run a program or application on many connected computers at the same time. Cloud compiting is network based services that is simulated by a software on one or more real machines which appear to be provide by real server hardware. Actually virtual servers do not physically exist and can therefore be moved around and scaled up (or down) on the fly without affecting the end user - arguably, rather like a cloud.

The popularity of the term can be attributed to its use in marketing to sell hosted services in the sense of application service provisioning that run client server software on a remote location.



A cloud is used in network to depict the internet.



Architecture of cloud computing

2) Advantage: Cloud computing based on sharing of resources to achieve coherence and economies of scale, similar to a utility (like the electricity grid) over a network. At the foundation of cloud computing is the broader concept of converged infrastructure and shared services. It also focuses on maximizing the effectiveness of the shared resources. Cloud resources are usually not only shared by multiple users but are also dynamically re-allocated per demand.This approach should maximize the use of computing powers and should reduce the environmental damage as well since less power, air conditioning, rackspace, etc.

The term **"moving to cloud"** also refers to an organization moving away from a traditional model (buy the dedicated hardware and depreciate it over a period of time) to the model (use a shared cloud infrastructure and pay as you use it).

Proponents claim that cloud computing allows companies to avoid upfront infrastructure costs, and focus on projects that differentiate their businesses instead of infrastructure. Cloud computing allows enterprises to get their applications running faster, with improved manageability and less maintenance.

3) Characterstics: Cloud computing exhibits the following key characteristics:

- **Agility:** improves with users' ability to re-provision technological infrastructure resources.
- **Application programming interface (API):** Interface provide accessibility to software that enables machines to interact with cloud software like a traditional user interface(e.g., a computer desktop). Cloud computing systems uses Representational State Transfer (REST)-based APIs.
- **Cost**: Cloud providers claim that computing costs reduce. A public-cloud delivery model converts capital expenditure to operational expenditure. This purportedly lowers barriers to entry, because infrastructure is provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained, with usage-based options and fewer IT skills are required for implementation (in-house).
- The e-FISCAL project's state-of-the-art repository contains several articles looking into cost aspects in more detail, most of them concluding that costs savings depend on the type of activities supported and the type of infrastructure available in-house.
- **Device independence**: It enable users to access systems using a web browser regardless of their location or what device they use (e.g., PC, mobile phone). Because infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.
- **Virtualization:** This technology allows sharing of servers and storage devices and increased utilization. Applications are easily migrated from one physical server to another.
- **Reliability** : Its reliability improves with the use of multiple redundant sites, which makes well it a service suitable for business continuity and disaster recovery.
- **Scalability and elasticity** : By dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis near real-time,

without users having to engineer for peak loads.

- **Performance**:They are loosely coupled architectures that are monitored, and consistentare constructed using web services as the system interface.
- **Security**: It is improved due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels. We can say that security is good as or better than other traditional systems, because providers are able to solve the security issues that many customers cannot afford to tackle. But the complexity of security is greatly increased when data is distributed over a wide area or over a greater number of devices, as well as in multi-tenant systems shared by unrelated users. In addition, user access to security audit logs may be difficult or impossible.
- **Maintenance** :Maintenance of cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places.

4) Cloud components:-

Cloud computing is made up of many elements: clients, the data center and distributed server. These component are made up of three parts of a cloud computing solution. Every element has a purpose and plays a specific role in delivering a function

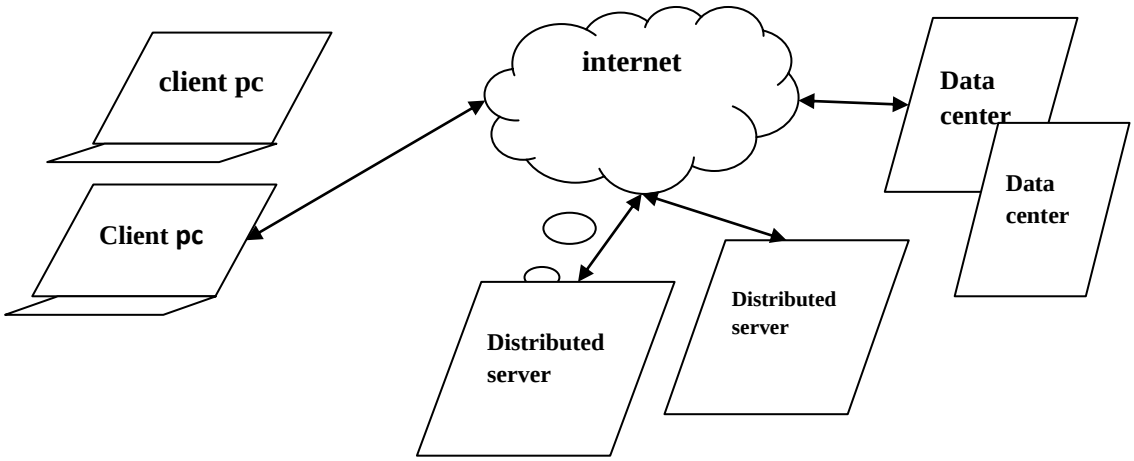
Computer based application. These three components are:

- Clients
- Datacenter
- Distributed servers

4.1) Clients : Clients in cloud computer architecture are the exact same things that they are in plain Local area network (LAN).

They are like the computer that sits on your desk. But they could be mobile phones, laptops, tablet computers or PDA's. Thin clients are becoming an increasingly popular solution. Clients are the device that the end user interact with to manage their information in the cloud. Clients are mainly of three types:-

1) Mobile
2) Thick
3) Thin



Three component make up cloud component solution

4)

- **Mobile:** Mobile device include PDA's and smart phone like blackberry, Window Mobile Smartphone or an iphone.

- **Thin:** this type of clients are the computers that do not have internal hard drive but they allow the server to do the work and they just display the information.
- **Thick:** This type of client are the regular computer using a web browser like Firefox or Internet explorer to connect to cloud.

Thin clients are becoming popular because because of their price and effect on environment. Some benefits of using **thin clients** include:

- **Lower hardware costs:** Thin clients are cheaper than the thick clients because they do not contain as much hardware. They also last longer before they need to be upgrade
- **Lower IT costs:** These are managed at server and there are few points of failure.
- **Security:** There is no hard drive and processing take place on server so there is less chance of malware attack on device. Also since the client don't work without the server, there is less chance of being physically stolen.
- **Data security:** data is stored on server so less chance of data to be lost if computer crashes
- **Less power consumption:** Thin client consume less power than thick client.
- **Ease of repair or replacement:** If a thin client dies, it is easy to replace..
- **Less noise:** There is no spinning hard drive and due to quieter fans less noise is generated.

4.2) Data center: The data center is a collection of server from where application you have to subscribe is stored which could be accessed via internet. A growing trend in IT world is virtualizing server. Software can be installed allowing multiple instances of server to be used. So you have a half of dozen server running on the physical server.

4.3) Distributed server: The server don't have to be housed in the same location. Often servers are in geographically disparate location .but to the cloud subscriber these server act as they are humming away right to next each other. This gives more flexibility to the service provider.

5)Cloud computing architecture:

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

Layered model of cloud computing:

the architecture of a cloud computing environment can be divided into 4 layers:

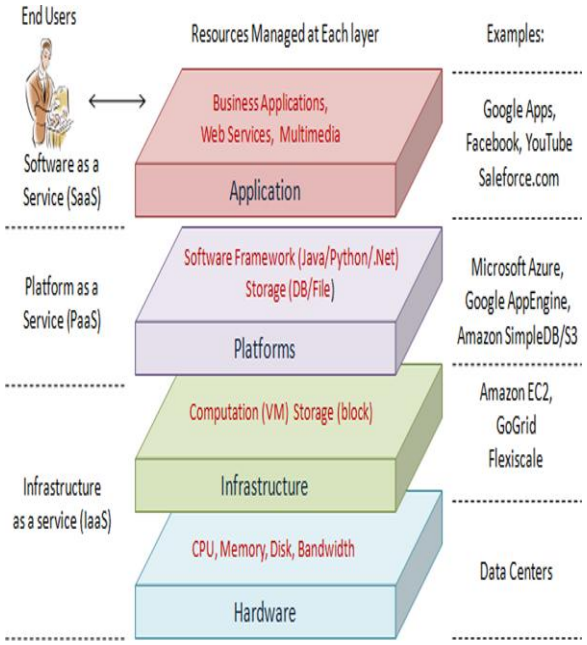
The hardware layer: This layer is responsible for managing the physical resources of the cloud, including physical servers, routers, switches, power and cooling systems. In practice , the hardware layer is typically implemented in data centers. A data center usually contains thousands of servers that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

The infrastructure layer: It is 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 such as Xen ,KVM and VMware . 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. For example, Google App Engine operates at the

platform layer to provide API support for implementing storage, database and business logic of typical web applications.

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. Compared to traditional service hosting environments such as dedicated server farms, the architecture of cloud computing is more modular. Each layer is loosely coupled with the layers above and below, allowing each layer to evolve separately. This is similar to the design of the OSI model for network protocols. The architectural modularity allows cloud computing to support a wide range of application requirements while reducing management and maintenance overhead



Layered architecture

6) Business model:

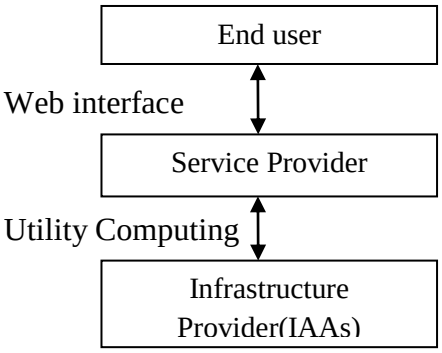
Cloud computing employs a service-driven business model. In other words, hardware and platform-level resources are provided as services on an on-demand basis. Conceptually, every layer of the architecture described in the previous section can be implemented as a service to the layer above. Conversely, every layer can be perceived as a customer of the layer below. However in practice, clouds offer services that can be grouped into three categories:

a) software as a service (SaaS),
b) platform as a service (PaaS),
c) infrastructure as a service (IaaS).

Infrastructure as a Service (IAAS): 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. Examples of IaaS providers include Amazon EC2 , GoGrid and Flexiscale .

Platform as a Service (PAAS): PaaS refers to providing platform layer resources, including operating system support and software development frameworks. Examples of PaaS providers include Google App Engine, Microsoft Windows Azure and Force.com

Software as a Service (SAAS): SaaS refers to providing on demand applications over the Internet. Examples of SaaS providers include Salesforce.com, Rackspace and SAP Business By Design



Business Model Of Cloud Computing

7) 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. However, public clouds lack fine-grained control over data, network and security settings, which hampers their effectiveness in many business scenarios.

Private clouds: It is 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. However, they are often criticized for being similar to traditional proprietary server farms and do not provide benefits such as no up-front capital costs.

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. Specifically, they provide tighter control and security over application data compared to public clouds, while still facilitating on-demand service expansion and contraction. On the down side, designing a hybrid cloud requires carefully determining the best split between public and private cloud components.

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.

VPC is essentially a more holistic design since it not only virtualizes servers and applications, but also the underlying communication network as well. Additionally, for most companies, VPC provides seamless transition from a proprietary service infrastructure to a cloud-based infrastructure, owing to the virtualized network layer.

For most service providers, selecting the right cloud model is dependent on the business scenario.

8) Related technologies:

There are some technologies which are same as cloud computing they are given below:

Grid computing:

Grid computing is often confused with cloud computing, but they are little bit different. Grid computing applies the resources of numerous computer on a network to work on a single problem at the same time. This is usually done to address a scientific or a technical problem. The well known example of this is the search for extraterrestrial intelligence(SETI)@Homeproject. In this project people, all over the world allow the SETI project to share the unused cycle of their computers to search for sign of intelligence in thousands of hours of recorded radio data .Grid computing necessitates the use of the software that can be divided and send out pieces of program to thousand of computers. It can be done throughout the computers of an organization or it can be done as a form of public collaboration.

Sun Microsystems offers Grid engine software that allows engineers at companies to pool the computer cycle on up to 80 workstations at a time. Grid computing is appealing for several reasons:

- It is a cost effective way to use a given amount of computer resources.
- It a way to solve problem that need a tremendous amount of computing power.
- The resources of several computers can be shared cooperatively, without one computer managing the other.

So what do grid computing and cloud computing have to do with one another? They always work in different manner. A large project is divided to among many computer to make use their of resources in Grid Computing but the cloud

computing allow several applications run at the same time.

Full virtualization: It is a technique in which complete installation of one machine runs on another machine. This result a system in which all software running on server is within virtual machine. This sort of deployment allow not only unique application to run but, also different operating systems.

Virtualization is relevant to cloud computing because it is one of the ways in which you will access services on cloud. In order for full virtualization to be possible, it was necessary for specific hardware combinations to be used.

Full virtualization has been successful for these purpose:

- Sharing a computer system among multiple users.
- Isolating users from each other and from the control program.
- Emulating hardware on other machine.

Paravirtualization:

It allow multiple operating system to run on single hardware device at the same time by more efficiently using system resources, like processor and memory.

In full virtualization, the entire system is emulated (BIOS drive and so on), but in paravirtualization, its management module operates with an operating system that has been adjusted to work in virtual machine. Paravirtualization typically better than the full virtualization model, simply because in a full virtualized deployment, all elements must be emulated.

The trade-off is reduced security and flexibility. For instance flexibility is reduced because a particular OS or distribution may not work. For example a new window deployment may not be able as a guest OS for the solution. Security can be at risk because guest OS has more control of underlying hardware, and there is a risk of impacting and all the guest systems on the host. Paravirtualization also allow for better scaling.

Paravirtualization works best in these sort of deployments:

- **Disaster recovery:** in the event of catastrophe, guest instances can be moved to other hardware until the equipment can be repaired.
- **Migration:** moving to a new system is easier and faster because guest instances can be removed from underlying hardware.
- **Capacity management:** because of easier migrations, capacity management is very simpler to implement. It is easier to add more processing power or hard drive capacity in a virtualized environment.

9) Need of cloud computing:

Cloud computing is now becoming a business standard. It simplifies the user's accessibility. It provides a virtual storage space to the user which could be used without bothering about the details of the entire mechanism. Here are some other reasons why every enterprise might need cloud computing for their business:

- **Cost savings** - Cloud computing removes the requirement of a company to invest in storage hardware and servers.
- **Focusing on the business** -Since all the services will execute over the internet, a company does not have to bother about technical issues and other problems associated with physical storage and backup. A company can thus focus more on their core business.
- **Performance** - It delivers reliable performance irrespective to the geographical location of the user. Another key feature could be the automatic updating of services and applications.
- **Security** - Cloud Computing offers optimum security which protects you against any unauthorized access, modification and loss of data.
- **Flexibility** - Even if part of the cloud environment fails or stops working, the other resources continue to work until the problem

is fixed. That will become a great advantage of this computing.

so we can say this computing is robust in nature.

10) Future scope of cloud computing:

The Future of Cloud Computing With arrival of cloud computing the conventional way of computing has gone for a sea change. As per some expert opinions, it is going to be the face of future cloud computing. And hence, the future of cloud computing seems very promising.

Let us have a look on what is makes the future of cloud computing so bright.

- Presence of Internet will boost its future.
- No more software updates.
- Hardware optional.
- Entertainment unlimited.
- Medical treatments simplified.
- Weather Forecasting.
- Freedom from Wallets.
- We can get our location easily.
- A boon to Digital media
- The New Age lifesaver
- An efficient tool in disaster management

11) Research challenges:

a) Efficiency of service provisioning:

- Usage of development tools and component
- Creation of scalable architectures
- Resource management and flexibility
- Availability of services

b) Effectiveness of service usage and control:

- Contracts including questions of liability
- Control of services by users
- Governance/ escalation mechanisms

c) Transparency of service delivery and billing:

- Billing include license management
- Quality assurance and monitoring SLA
- Type and location of data processing

d) Information security:

- Identity and right management
- Privacy and integrity
- Access control logging and attack prevention
- Verification and certification

e) Data privacy

f) Interoperability:

- Migration into /out of the cloud
- Ability to integrate into on-promise IT
- Cloud federation

g) Portability between providers:

- Service portability
- Data portability

h) Ensuring fair competition in market:

i) Compliance between regulatory requirements

12) Conclusion:

"Cloud" computing builds on decades of research in virtualization, distributed computing, utility computing, and, more recently, networking, web and software services. It implies a service-oriented architecture, reduced information technology overhead for the end-user, great

flexibility, reduced total cost of ownership, on demand services and many other things. This paper discusses the concept of "cloud" computing, the issues it tries to address, related research topics, and a "cloud" implementation based on VCL technology. Our experience with VCL technology is excellent and we are working on additional functionalities and features that will make it even more suitable for cloud framework construction.

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