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Simplifying Complex Tasks: Cloud Computing

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***Abstract*: In a remarkably short time, cloud computing has emerged as a hugely important evolution in the way that businesses and individuals consume and operate computing. It's a fundamental shift to an operational model in which applications don't live out their lives on a specific piece of hardware and in which resources are more flexibly deployed than was the historical norm. It's also a fundamental shift to a development and consumption model that replaces hard-wired, proprietary connections among software components and the consumers of those components with lightweight web services and web-based software access.**

In short, cloud computing refers to a convergence of technologies and trends that are making IT infrastructures and applications more dynamic, more modular, and more consumable. That's a big change that has implications that touch on just about every aspect of computing.

For end-user customers, cloud computing provides the means to ramp up new services or reallocate computing resources rapidly, based on business needs. It means having the ability to run an application either on-premises or off-premises (or a combination of the two) based on cost, capacity requirements, and other factors.

This paper strives to compare and contrast Cloud Computing with Grid Computing from various angles and give insights into the essential characteristics of cloud computing. And also to make sense of it all for readers that haven't been deeply involved in the details of cloud computing as it has rapidly evolved. It lays out the characteristics of a cloud computing infrastructure. It describes the forms that cloud computing can take and how different types of technology providers and consumers of technology relate to each other.

The paper aims to provide a means of understanding the model and exploring options available for complementing your technology and infrastructure needs.

I. INTRODUCTION

Cloud computing and Grid computing are two different realms of managing IT related work activities in the smoothest way possible. Where cloud computing is a branch of Information technology that invites businesses to become virtual, grid computing on the other hand calls for a shared environment on a common computer system from multiple administrative domains. Although, both of them function with a purpose to provide a good percentage of scalability levels to high-end computer networks, the cost of deploying these is equally high. Comparison between the two technologies is given below:

1.1 Grid Computing: As grid computing works on the fundamental principle of shared environment of computer systems from multiple administrative domains, it gives rise to certain advantages in terms of boosting daily operations of a business enterprise. The advantages related to grid computing are as follows:

- Foremost use of a grid computing network is to run an already running software application on a different as well as distant machine. Thus, it provides a flexible environment to run any application of different computer systems.
- As it works on the basic principle of shared environment, grid computing breaks a single large task into several smaller ones through a distributed system on multiple compute networks. This helps to ease down work burden. Let us explain this point with an example.

  Suppose, an IT organization is developing an application, which would help to run the daily attendance of all the employees. Now, because the company is huge, its employee strength is also quite large. Developing an application for their daily attendance is quite a painstaking task.

  Thus, the higher management working on the project decides to do it in a shared grid environment. Why they chose of grid computing is because of the fact that the work of this software application can be distributed or computed on different computer networks for convenience sake and making in-house IT work environment more efficient.

  When the application finishes its work on the distributed grids, it is sent back to the original computer network for final implementation.
- One feature that makes grid environment more flexible and viable than cloud is the fact that even if shared load collapses and fails at one server point, other distributed computer systems are there to pick up the load. This cannot be felt in cloud computing until or unless you are using Load Balancer on Cloud.
- Upgrading any software application while on grid is possible and convenient. This is because, the application is distributed evenly on several other servers out of which some can be taken on offline mode for doing so.

Thus, if a single compute network is making your work harder, simply add more servers and desktops by incorporating grid network software in it and see your task completing within no time.

1.2 Cloud Computing: The long-held dream of computing as a utility, has the potential to transform a large part of the IT industry, making software even more attractive as a service and shaping the way IT hardware is designed and purchased.

Resource sharing in a pure plug and play model that dramatically simplifies infrastructure planning is the promise of "cloud computing". The two key advantages of this model are *ease-of-use* and *cost-effectiveness*.

Developers with innovative ideas for new Internet services no longer require the large capital outlays in hardware to deploy their service or the human expense to operate it. They need not be concerned about over provisioning for a service whose popularity does not meet their predictions, thus wasting costly resources, or under provisioning for one that becomes wildly popular, thus missing potential customers and revenue. Moreover, companies with large batch-oriented tasks can get results as quickly as their programs can scale, since using 1,000 servers for one hour costs no more than using one server for 1,000.

Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage. With the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly.

Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data-center from a capital-intensive set up to a variable priced environment. The idea of cloud computing is based on a very fundamental principal of “reusability of IT capabilities”. The difference that cloud computing brings compared to traditional concepts of “grid computing”, “distributed computing”, “utility computing”, or “autonomic computing” is to *broaden horizons across organizational boundaries*.

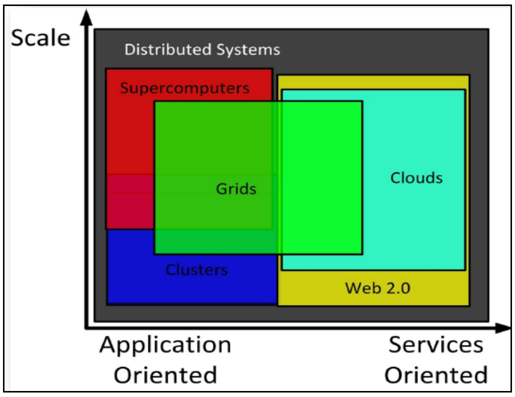

Figure.1 Comparison of Cloud and Grid Computing

1.2.1 History of Cloud Computing: Cloud Computing has become another buzzword now-a-days. Cloud Computing is not a completely new concept; it has intricate connection to the relatively new but thirteen-year established Grid Computing paradigm, and other relevant technologies such as utility computing, cluster computing, and distributed systems in general.

Cloud computing has evolved through a number of phases which include grid and utility computing. But the overarching concept of delivering computing resources through a global network is rooted in the sixties.

The idea of an "intergalactic computer network" was introduced in the sixties by ***J.C.R. Licklider***, who was responsible for enabling the development of ARPANET (Advanced Research Projects Agency Network) in 1969. His vision was for everyone on the globe to be interconnected and accessing programs and data at any site, from anywhere. "It is a vision that sounds a lot like what we are calling cloud computing."

Then after the cloud concept is attributed by computer scientist ***John McCarthy*** who proposed the idea of computation being delivered as a public utility.

Since the sixties, cloud computing has developed along a number of lines, with Web 2.0 being the most recent evolution.

One of the *first milestones* for cloud computing was the arrival of Salesforce.com in 1999, which pioneered the concept of delivering enterprise applications via a simple website. The services firm paved the way for both specialist and mainstream software firms to deliver applications over the internet.

The next development was Amazon Web Services in 2002, which provided a suite of cloud-based services including storage, computation and even human intelligence through the Amazon Mechanical Turk. Then in 2006, Amazon launched its Elastic Compute cloud (EC2) as a commercial web service that allows small companies and individuals to rent computers on which to run their own computer applications.

Another big milestone came in 2009, as Web 2.0 hit its stride, and Google and others started to offer browser-based enterprise applications, though services such as Google Apps. The advantages related to cloud computing are as follows:

- Cloud and cloud managed services are designed in such a manner so that businesses get rid of the hardware and software mess, which kills their quality time as well as money.
- Cloud, as per several researchers has provided a platform where three elements of IT Infrastructure, Platform and Software cater to the requirements of the customers in the most flexible manner possible.
- Characteristics features like managed and monitored cloud environment, load balancing, SRC (Security, Risk Management and Compliance Management), high scalability, a complete secured environment, cost-effective and extremely reliable.
- For all IT organizations, that lack storage space and their servers hardly entertain any new data can opt for managed cloud services from reputed cloud providers. The role of these cloud providers is not till the time you avail services from them but they manage your entire in-house IT operations in the efficient way possible.
- Apart from all these factors, disaster recovery and data backup plan in cloud technology helps to restore data at the time a server or data crashes. Incorporating disaster recovery and data backup plan is one of the essential parts of cloud computing and to make it run effectively and efficiently is the utmost priority of cloud providers.

1.2.2 Characteristics of Cloud Computing: Cloud computing has a variety of characteristics, with the main ones being:

- **Shared Infrastructure:** Uses a virtualized software model, enabling the sharing of physical services, storage, and networking capabilities. The cloud infrastructure, regardless of deployment model, seeks to make the most of the available infrastructure across a number of users.
- **Dynamic Provisioning:** Allows for the provision of services based on current demand requirements. This is done automatically using software automation, enabling

the expansion and contraction of service capability, as needed. This dynamic scaling needs to be done while maintaining high levels of reliability and security.

- **Network Access:** Needs to be accessed across the internet from a broad range of devices such as PCs, laptops, and mobile devices, using standards-based. Deployments of services in the cloud include everything from using business applications to the latest application on the newest Smartphone's.
- **Managed Metering:** Uses metering for managing and optimizing the service and to provide reporting and billing information. In this way, consumers are billed for services according to how much they have actually used during the billing period.

In short, cloud computing allows for the sharing and scalable deployment of services, as needed, from almost any location, and for which the customer can be billed based on actual usage.

II. CLOUD COMPUTING TAXONOMY

2.1 Architectural Differences:

Grids started off in the mid-90s to address large-scale computation problems using a network of resource-sharing commodity machines that deliver the computation power affordable only by supercomputers and large dedicated clusters at that time. Grids focused on integrating existing resources with their hardware, operating systems, local resource management, and security infrastructure. In order to support the creation of the so called "Virtual Organizations"—a logical entity within which distributed resources can be discovered and shared as if they were from the same organization. Grids provide protocols and services at five different layers as identified in the Grid protocol architecture (see Figure 2).

At the ***fabric layer***, Grids provide access to different resource types such as compute, storage and network resource, code repository, etc. Grids usually rely on existing fabric components, for instance, local resource managers (i.e. PBS [14], Condor [24], etc). General-purpose components such as GARA (general architecture for advanced reservation) [17], and specialized resource management services such as Falkon[22].

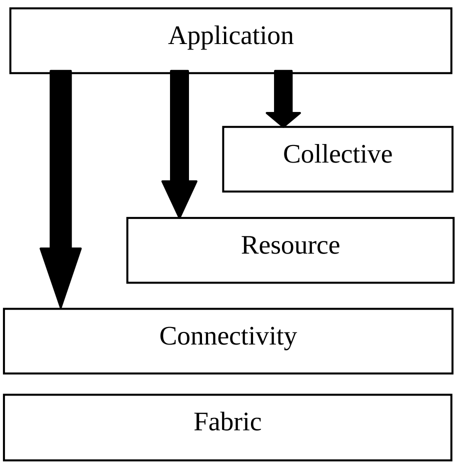

Figure.2 Grid Protocol Architecture

The ***connectivity layer*** defines core communication and authentication protocols for easy and secure network transactions. The GSI (Grid Security Infrastructure) [20] protocol underlies every Grid transaction.

The ***resource layer*** defines protocols for the publication, discovery, negotiation, monitoring, accounting and payment of sharing operations on individual resources. The GRAM (Grid Resource Access and Management) [16] protocol is used for allocation of computational resources and for monitoring and control of computation on those resources, and GridFTP [13] for data access and high-speed data transfer.

The ***collective layer*** captures interactions across collections of resources, directory services such as MDS (Monitoring and
Discovery Service) [23] allows for the monitoring and discovery of VO resources, Condor-G [18] and Nimrod-G [15] are examples of co-allocating, scheduling and brokering services, and MPICH [21] for Grid enabled programming systems, and CAS (community authorization service) [19] for global resource policies.

The ***application layer*** comprises whatever user applications built on top of the above protocols and APIs and operate in VO environments. Two examples are Grid workflow systems, and Grid portals (i.e. QuarkNet e-learning environment [25],
National Virtual Observatory, TeraGrid Science gateway).

Clouds are developed to address Internet-scale computing problems where some assumptions are different from those of the Grids. Clouds are usually referred to as a large pool of computing and/or storage resources, which can be accessed via standard protocols via an abstract interface. Clouds can be built on top of many existing protocols such as Web Services (WSDL, SOAP), and some advanced Web 2.0 technologies such as REST, RSS, AJAX, etc. In fact, behind the cover, it is possible for Clouds to be implemented over existing Grid technologies leveraging more than a decade of community efforts in standardization, security, resource management, and virtualization support.

There are also multiple versions of definition for Cloud architecture, we define a four-layer architecture for Cloud Computing in comparison to the Grid architecture, composed of *fabric, unified resource, platform, and application Layers.*

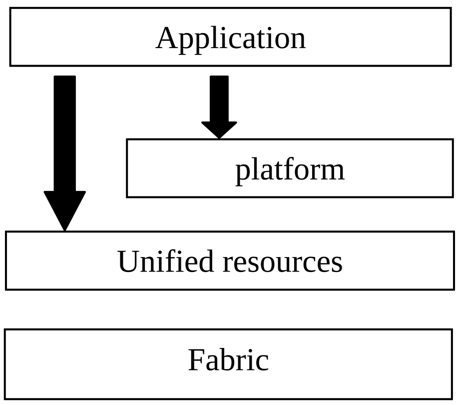

Figure.3 Cloud Protocol Architecture

The *fabric layer* contains the raw hardware level resources, such as computer resources, storage resources, and network resources. The *unified resource layer* contains resources that have been abstracted/encapsulated (usually by virtualization) so that they can be exposed to upper layer and end users as integrated resources, for instance, a virtual computer/cluster, a logical file system, a database system, etc. The *platform layer* adds on a collection of specialized tools, middleware and services on top of the unified resources to provide a development and/or deployment platform. For instance, a Web hosting environment, a scheduling service, etc. Finally, the *application layer* contains the applications that would run in the Clouds.

2.2 Available Cloud Service Levels:

Cloud Providers offer services that can be grouped into three categories.

Software as a Service (SaaS):

SaaS is a new model of how software is delivered. SaaS refers to software that is accessed via a web browser. In this model, a complete application is offered to the customer, as a service on demand and is paid on a subscription basis (monthly or yearly). A single instance of the service runs on the cloud & multiple end users are serviced.

On the customer's side, there is no need for upfront investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted & maintained. SaaS is faster and a cost effective way to getting implemented. It's the responsibility of the SaaS vendor to manage and run the application with utmost security, performance and reliability.

The SaaS model is a way of providing the same software to different customers via a network, usually the Internet. In other words, the software is not hosted on the customer's individual computers. Under the SaaS model, a vendor is responsible for the creation, updating, and maintenance of software. Customers buy a subscription to access it, which includes a separate license, or seat, for each person that will use the software.

The SaaS model can add efficiency and cost savings for the both the vendor and customer. Customers save time and money since they do not have to install and maintain programs. The customers do not have to hire staff, or use existing staff to maintain the software. They also generally do not have to buy any new hardware. This allows a customer to focus more resources on growing the business.

Shifting the burden of software hosting and development to the vendor can also speed up the time it takes for the customer to see a return on the software investment. Using the SaaS model, the number of seats can be increased as the business grows. This is usually faster and cheaper than purchasing another license and adding to another computer, as with traditional software.

Vendors usually only have to update and maintain the software on the network, versus updating different copies of the software on different computers. This allows the vendor to provide the latest updates and technology to each customer in a timely manner. The drawback for the customer is that they do not control the software, and customization of programs may be limited.

If an update is requested by a customer, it will most likely need to benefit other customers who are also using the same software. If the customer completely outgrows the software, however, the company can simply discontinue its subscription at the end of the current contract. In such a cancellation, applications typically do not have to be removed from the customer's computers. Generally, the canceling customer maintains ownership of any proprietary data entered into the SaaS application.

SaaS model contracts may be terminated early with sufficient cause. The vendor not delivering the software in a timely manner — or not at all — or the software not working as specified by the consumer requirement, are all typically grounds for termination of the contract. With broadband technology more commonplace throughout the workforce, however, customers have many choices when it comes to software delivered under the SaaS model. Customers can research SaaS vendors thoroughly, and request current references, to help avoid any non-delivery issues. Today SaaS is offered by companies such as Google, Salesforce, Microsoft, Zoho, etc.

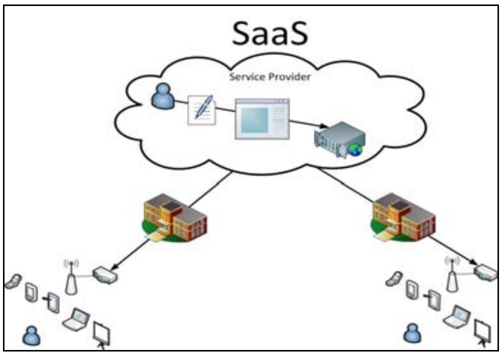

Figure.4 Software as a Service (SaaS) Model

Platform as a Service (PaaS):

Here, a layer of software or development environment is encapsulated & offered as a service, upon which other higher levels of service can be built. The customer has the freedom to build his own applications, which run on the provider's infrastructure. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers, such as LAMP platform (Linux, Apache, MySql and PHP), restricted J2EE, Ruby etc. *Google's App Engine, Force.com*...etc are some of the popular PaaS examples.

Benefits for Users: Platform as a Service (PaaS) helps users to minimize operational costs and increase their productivity.

The following are the benefits of PaaS

- Requires no up-front investments
- Minimize operational costs
- Centralized information management
- Enhanced productivity, Easy collaboration
- Access to information anywhere, anytime
- Secured and customized access
- Zero Infrastructure
- Lower Risk, cost and improved profitability
- Easy and quick development
- Monetize quickly
- Reusable code and business logics
- Integration with other web services

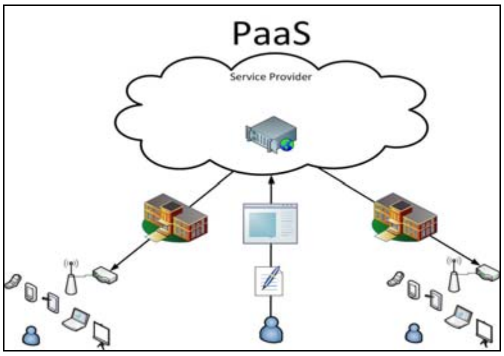

Figure.5 Platform as a Service (PaaS) Model

Infrastructure as a Service (IaaS):

Infrastructure as a service (IaaS) cloud computing is the delivery of computing on demand as a shared service, avoiding the cost of investing in, operating and maintaining the hardware. In order to be fully functional, the infrastructure must be reliable and flexible to allow easy implementation and operation of applications running within the cloud. The customer would typically deploy his own software on the infrastructure. Other characteristics of infrastructure as a service include:

- Delivery of resources such as servers, storage and network components as a service
- Lower total cost of ownership, Full scalability
- Eliminate the need for administration and maintenance of hardware
- Enterprise grade infrastructure for all subscribers

Infrastructure as a service offered in a dedicated cloud computing environment allows developers to entirely control the provisioning, configuration and deployment of virtual machines. The IaaS cloud is used for everything from building and validating new applications to operating production environments that require scalability.

IaaS computing services enable our customers to run their workloads on our infrastructure rather than their own. This is a great advantage to many organizations because it helps drive down IT costs and increase efficiencies of the organization.

Some common examples are Amazon, GoGrid, 3Tera, etc.

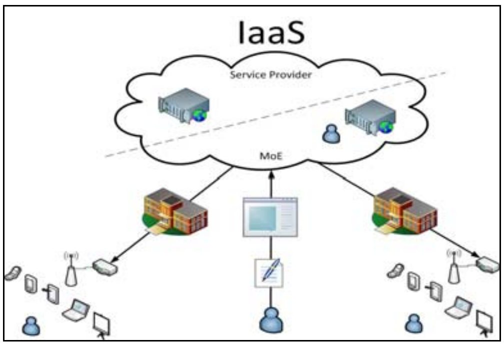

Figure.6 Infrastructure as a Service (IaaS) Model

III. DEPLOYMENT MODELS

3.1 CLOUD MODELS:

Enterprises can choose to deploy applications on Public, Private or Hybrid clouds. Cloud Integrators can play a vital part in determining the right cloud path for each organization.

Public Cloud**:** A P*ublic Cloud* is one based on the standard cloud computing model, in which a service provider makes resources, such as applications and storage, available to the general public over the Internet. Public cloud services may be free or offered on a pay-per-usage model.

Public clouds are owned and operated by third parties; they deliver superior economies of scale to customers, as the infrastructure costs are spread among a mix of users, giving each individual client an attractive low-cost. All customers share the same infrastructure pool with limited configuration, security protections, and availability variances. These are managed and supported by the cloud provider. One of the advantages of a Public cloud is that they may be larger than an enterprises cloud, thus providing the ability to scale seamlessly, on demand.

Private Cloud: Private clouds are built exclusively for a single enterprise. They aim to address concerns on data security and offer greater control, which is typically lacking in a public cloud. There are two variations to a private cloud:

- **On-premise Private Cloud:** On-premise private clouds, also known as internal clouds are hosted within one's own data center. This model provides a more standardized process and protection, but is limited in aspects of size and scalability. IT departments would also need to incur the capital and operational costs for the physical resources. This is best suited for applications which require complete control and configurability of the infrastructure and security.
- **Externally hosted Private Cloud:** This type of private cloud is hosted externally with a cloud provider, where the provider facilitates an exclusive cloud environment with full guarantee of privacy. This is best suited for enterprises that don't prefer a public cloud due to sharing of physical resources.

Hybrid Cloud: Hybrid Clouds combine both public and private cloud models. With a Hybrid Cloud, service providers can utilize 3rd party Cloud Providers in a full or partial manner thus increasing the flexibility of computing. The Hybrid cloud environment is capable of providing on-demand, externally provisioned scale. The ability to augment a private cloud with the resources of a public cloud can be used to manage any unexpected surges in workload.

3.2 PROPERTIES OF PUBLIC / PRIVATE CLOUDS:

Public clouds are defined as having the following properties:

- Computing resources available to subscribing users upon request
- Virtualization over a physical layer, thus maximizing hardware utilization
- Elastic scaling of computer resources without CAPEX
- Automated management of virtual machines
- Resource usage billed only as used

Computing Resources Availability: Cloud computing utilizes pooled computing assets. These assets are available to any subscriber who is willing to pay for them. This is similar to the consumption of electricity. Any subscriber is allowed to consume or pool electric power as long as electric power is available.

Virtualization: Virtualization of data centers in not a new concept. Most enterprises have been shifting much of their physical infrastructure to virtual infrastructure. The shift to virtualization makes economic sense as utilization rate grows significantly with a relatively minor added cost. This growth is achieved by the ability to partition a single physical server into many virtual servers. Each server acts like a real server that can run an operating system and a complete set of applications. Virtualization is a huge catalyzer for technology companies that wish to offer cloud computing services as it introduces a profitable business model, one that is based on billing per usage of computing resources over a virtualized environment.

Elasticity: Today's business world is very dynamic. A given company might need to grow (or reduce) its business over a short period of time. Changing business requirements have a direct impact on IT needs. Hence an efficient business is constantly looking for "dynamic scaling," the ability to grow or reduce computing power in a matter of minutes and pay only for actual usage. This is what elasticity is all about. In a non-cloud world, you would have to build sufficient capacity to not only perform well under everyday load conditions, but also handle peak load levels. This constraint has a direct impact on CAPEX. You would have to purchase hardware to cover for peak load levels when in all other times you will be underutilizing and over paying for your IT environment.

Automation: Automation is about efficiency. A virtualized IT environment has to be automated in order to be effective. Automation provides speed of execution and billing options that are easy to implement. A cloud-deployed application is expected to provision and deploy new server instances in minutes or de-provision and shutdown existing instances in minutes. This can only be done with automation and API interaction.

Billing per Usage: Cloud computing turns CAPEX to OPEX. The meaning is that computing costs become variable rather than fixed and are based on usage. Billing is applied on CPU cycles, storage and bandwidth. A cloud computing billing application has to count CPU cycles, GB of storage and GB of bandwidth consumed within a given period, usually a month. Then it needs to multiply these measurements by a configurable rate and output the bill. The ability to bill by usage is an integral part of public clouds.

Private clouds are a **subset** of the above properties. They are virtualized, elastic and automated.

The other two – pooled resources and billing per usage are less applicable to private clouds. Pooled resources are not private by definition. There is no logic in providing anyone who is willing to pay with access to a private cloud environment. The resources in private clouds are reserved for exclusive use of the organization hence billing per usage is not a logical business scenario – organizations will not bill their employees for using resources in a private cloud datacenter.

Security: Public clouds are extremely secured. With that organizations might require or be forced to place an additional layer of security. By managing and authorizing access to a cloud computing environment organizations place an additional layer of security. Virtual instances are not shared by heterogeneous users but rather by a single group that is constantly monitored.

Availability: Cloud computing farms have a finite pool of computing resources. Even with virtualization computing resources might exhaust. IT organizations that require massive computing processing in a short notice might find that a cloud hosting company cannot provide this requirement because it doesn't have enough resources. Hence these organizations might consider starting private cloud computing datacenters that will guarantee the availability of computing power at all times.

3.3 Cloud Computing Benefits:

Enterprises would need to align their applications, so as to exploit the architecture models that Cloud Computing offers. Some of the typical benefits are listed below:

1. Reduced Cost: There are a number of reasons to attribute Cloud technology with lower costs. The billing model is pay as per usage; the infrastructure is not purchased thus lowering maintenance. Initial expense and recurring expenses are much lower than traditional computing.

2. Increased Storage: With the massive Infrastructure that is offered by Cloud providers today, storage & maintenance of large volumes of data is a reality. Sudden workload spikes are also managed effectively & efficiently, since the cloud can scale dynamically.

3. Flexibility: This is an extremely important characteristic. With enterprises having to adapt, even more rapidly, to changing business conditions, speed to deliver is critical. Cloud computing stresses on getting applications to market very quickly, by using the most appropriate building blocks necessary for deployment.

IV. Cloud Computing Challenges

Despite its growing influence, concerns regarding cloud computing still remain. In our opinion, the benefits outweigh the drawbacks and the model is worth exploring. Some common challenges are:

1. Data Protection: Data Security is a crucial element that warrants scrutiny. Enterprises are reluctant to buy an assurance of business data security from vendors. They fear losing data to competition and the data confidentiality of consumers. In many instances, the actual storage location is not disclosed, adding onto the security concerns of enterprises. In the existing models, firewalls across data-centres (owned by enterprises) protect this sensitive information. In the cloud model, Service providers are responsible for maintaining data security and enterprises would have to rely on them.

2. *Data Recovery and Availability*: All business applications have Service level agreements that are stringently followed. Operational teams play a key role in management of service level agreements and runtime governance of applications. In production environments, operational teams support

- Appropriate clustering and Fail over
- Data Replication
- System monitoring (Transactions monitoring, logs monitoring and others)
- Maintenance (Runtime Governance)
- Disaster recovery

- Capacity and performance management

If, any of the above mentioned services is under-served by a cloud provider, the damage & impact could be severe.

3. Management Capabilities: Despite there being multiple cloud providers, the management of platform and infrastructure is still in its infancy. Features like "Auto-scaling" for example, are a crucial requirement for many enterprises. There is huge potential to improve on the scalability and load balancing features provided today.

4. Regulatory and Compliance Restrictions: In some of the European countries, Government regulations do not allow customer's personal information and other sensitive information to be physically located outside the state or country. In order to meet such requirements, cloud providers need to setup a data-center or a storage site exclusively within the country to comply with regulations. Having such an infrastructure may not always be feasible and is a big challenge for cloud providers.

With cloud computing, the action moves to the interface that is, to the interface between service suppliers and multiple groups of service consumers. Cloud services will demand expertise in distributed services, procurement, risk assessment and service negotiation — areas that many enterprises are only modestly equipped to handle.

5. Continuously Evolving: User requirements are continuously evolving, as are the requirements for interfaces, networking, and storage. This means that a "cloud," especially a public one, does not remain static and is also continuously evolving.

V. CLOUDS COMPARISON

5.1 Comparisons between Cloud Models

Comparison between *private* and *public*_cloud is often done on the basis of how each one of them is accessible, provides scalability, cost-effective or secure.

Now, whether it is private or public cloud, how well a cloud is functioning or how well will it perform depends on certain factors necessary to maintain its stability.

Activities such as disaster recovery, data backup plan, increasing uptime and reducing down time, offering a secured, scalable, reliable and green environment is all managed by managed cloud service providers.

Public Cloud Vs Private Cloud

- Public cloud is used as a service via Internet by the users, whereas a private cloud, as the name conveys is deployed within certain boundaries like firewall settings and is completely managed and monitored by the users working on it in an organization.
- Users have to pay a monthly bill for public cloud services, but in private cloud money is charged on the basis of per Gb usage along with bandwidth transfer fees.
- Public cloud functions on the prime principle of storage demand scalability, which means it requires no hardware device. On the contrary, no hardware is required even in private cloud, but the data stored in the private cloud can only be shared amongst users of an organization and third party sharing depends upon trust they build with them. It is also entirely monitored by the business entity where it is running.

5.2 Which one is Better- Private or Public?

Although, cloud technology has come up as a boon for IT organizations, it still holds several questions unanswered as to what is its scope for businesses in future.

Nevertheless, when it comes to comparing both cloud services in terms of performance, they share almost similar nature, but differentiate only in their architecture. However, as per several researches, a public cloud rules over the private one. Let us ponder upon some points related to it.

Private Cloud, because it functions independently for an organization and that too behind firewall settings does prove to be accessible. By stating this, we mean that a private cloud cannot be accessed from anywhere and at any point of time. It is completely managed by the users working for an organization.

As far as the scalability factor is concerned, private cloud gives scalable business environment. It also offers flexibility to expand as per user's requirement. Public is more viable than private cloud, let us check on few points:

- *Data security risks are less as compared to the one stored in public cloud. The geographical location of the data stored in private cloud is visible than that in public cloud.*
- *Initial cost is expensive, but gets minimal at later stages of using it as a service.*

Public Cloud architecture is built with the view to create an accessible business environment that can be shared and accessed from anywhere and at any time of the hour. Even though, it poses security risks, public cloud is considered more useful than its counterpart because of several reasons:

- *Initial cost is minimal, but if data is stored for a long period of time, it proves to be expensive. However, the cloud acts as an excellent source for different types of data than a particular type of it.*
- *More accessible than the private cloud as it can be accessed from anywhere round the globe.*
- *Availability and reliability are the two factors that make public cloud computing service more popular. The reason being, it is available to users via web installed at a given server off-premises.*

Apart from the technical in and outs of the cloud technology, there have been a number of researches and conferences on cloud theory that have given rise to a number of conclusions from a number of IT researchers, analysts and professionals. One of them listed below will give an overview of what industry thinks on cloud computing and its managed services.

In two statements on public as well as private cloud architecture, Vanessa Alvarez, a Frost & Sullivan analyst on cloud computing said that: "Private clouds will make the most money and drive the most revenue," whereas "Public clouds can offer some level of security and reliability, but private gives you that comfy feeling."

Thus, despite being different from each other on so many factors, it is difficult to say which cloud service stands out. Both have equal pros and cons. Nonetheless, factors concerning access patterns, security, confidentiality, service level agreements and professional work force in public and private cloud computing are yet to be enhanced so that the technology proves to be beneficial for establishing as well as established businesses.

VI. COMMUNICATIONS IN THE CLOUD

For service developers, making services available in the cloud depends on the type of service and the device(s) being used to access it. The process may be as simple as a user clicking on the required web page, or could involve an application using an API accessing the services in the cloud.

6.1 Using the Communications Services

When in the cloud, communications services can extend their capabilities, or stand alone as service offerings, or provide new interactivity capabilities to current services.

Cloud-based communications services enable businesses to embed communications capabilities into business applications, such as Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems. For "on the move" business people, these can be accessed through a smartphone, supporting increased productivity while away from the office.

These services are over and above the support of service deployments of VoIP systems, collaboration systems, and conferencing systems for both voice and video. They can be accessed from any location and linked into current services to extend their capabilities, as well as stand alone as service offerings.

In terms of social networking, using cloud-based communications provides click-to-call capabilities from social networking sites, access to Instant Messaging systems and video communications, broadening the interlinking of people within the social circle.

6.2 Accessing through Web APIs

Accessing communications capabilities in a cloud-based environment is achieved through APIs, primarily Web 2.0 RESTful APIs, allowing application development outside the cloud to take advantage of the communication infrastructure within it (see Figure 7)

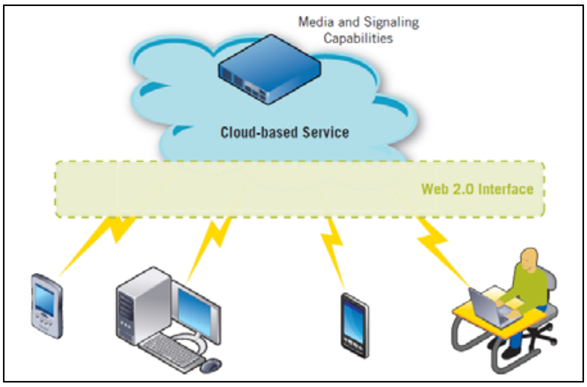

Figure.7 Web 2.0 Interfaces to the cloud

These APIs open up a range of communications possibilities for cloud-based services, only limited by the media and signaling capabilities within the cloud. Today's media services allow for communications and management of voice and video across a complex range of codecs and transport types. By using the Web APIs, these complexities can be simplified and the media can be delivered to the remote device more easily. APIs also enable communication of other services, providing new opportunities and helping to drive Average Revenue per User (ARPU) and attachment rates.

6.3 Practical Applications:

6.3.1 Google Docs & Google Apps Engine

Google Docs, a master creation by Google invites businesses to work on its virtual *Software-as-a-Service platform* where they can;

- Share and access spreadsheets, presentations and upload files etc among others.
- The cloud application works in this fashion that users can register themselves at the Google Docs and get started with promotion of tasks.

Yet another cloud platform by Google is the **Apps Engine**. It is one of the Google's *PaaS* arenas where developers build and construct software applications on the existing systems for scalable and flexible results.

Both the cloud models from Google work towards creating a flexible and reliable business environment.

6.3.2 Microsoft's Windows Azure

This particular cloud form by Microsoft has been a consistent performer for businesses that face problems while managing and deploying enterprise applications. The application is compatible with almost all the popular computer languages like *.net, Java and PHP* etc among others.

6.3.3 Amazon EC 2 (Elastic Cloud Compute) and SSE S3

With the advent of **Amazon's EC2**, cloud industry boomed tremendously inviting more and more organizations to work on this platform. Prime purpose of using this platform is the fact that it offers developers a re-sizable compute capacity in the cloud. Not only this, the task of web scale computing becomes easier.

On the contrary, Amazon's Server Side Encryption in its Simple Storage Server cloud platform encourages users to encrypt their confidential data stored at rest in Amazon S3.

VII. CONCLUSION

In moving to the cloud or building new opportunities using a cloud infrastructure, the ownership, control, cost visibility, and decisions are moving to the domain expert (owner of the application). Cloud infrastructure allows for better operational efficiency and lower TCO for the creation and lifecycle of cloud application by enabling the domain expert.

This paper provided a high-level overview of Cloud technologies. As part of this overview several concepts were covered, such as a review of the NIST definition standards, cloud strategy and a description.

The advantages of cloud computing heavily outweigh the disadvantages. As better cloud computing technologies are developed and redundancy is fine tuned, the disadvantages will slowly become obsolete. As mentioned, cloud computing is in its infancy and new cloud technologies are growing exponentially

After so many discussions on cloud and grid computing, one thing that is similar in both is that both the technologies work or function with a view to enhance and improve the existing resources. The basic differentiating point between the two is the fact that in cloud computing users can operate their daily activities on a virtual environment that is free of hardware and software stuff, whereas grid computing works on the shared environment of the distributed administrative domains.

As Clouds mature, and more sophisticated applications and services emerge that require the use of multiple Clouds, there will be growing incentives to adopt standard interfaces that facilitate interoperability in order to capture emerging and growing markets in a saturated Cloud market

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