RECENT TRENDS IN CLOUD COMPUTING: A SURVEY

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ABSTRACT

Cloud computing that has become an increasingly important trend, is a virtualization technology that uses the internet and central remote servers to offer the sharing of resources that include infrastructures, software, applications and business processes to the market environment to fulfill the elastic demand. In today's competitive environment, the service vitality, elasticity, choices and flexibility offered by this scalable technology are too attractive that makes the cloud computing to increasingly becoming an integral part of the enterprise computing environment. According to Gartner, while the hype grew exponentially during 2008 and continued since, it is clear that there is a major shift towards the cloud computing model and that the benefits may be substantial. Many aspects are still in an experimental stage where the long-term impact on provisioning and usage is as yet unknown. Furthermore, plenty of as yet unforeseen challenges arise from exploiting the cloud capabilities to their full potential, involving in particular aspects deriving from the large degree of scalability and heterogeneity of the underlying resources.

Key Words - Cloud computing, Software as a Service, Platform as a Service, Infrastructure as a Service.

Introduction:

Cloud computing is a model for allocating compute and storage resources on demand. Cloud computing offers new ways to provide services while, significantly altering the cost structure underlying those services. These new technical and pricing opportunities drive changes in the way businesses operate. Cloud computing is a unique combination of capabilities which include:

- A massively scalable, dynamic infrastructure
- Universal access
- Fine-grained usage controls and pricing Standardized platforms
- Management support services

Though the concept of "clouds" is not new, it is undisputable that they have proven a major commercial success over recent years and will play a large part in the ICT domain over the next 10 years or more, as future systems will exploit the capabilities of managed services and resource provisioning further. Clouds are of particular commercial interest not only with the growing tendency to outsource IT so as to reduce management overhead and to extend existing, limited IT infrastructures, but even more importantly, they reduce the entrance barrier for new service providers to offer their respective capabilities to a wide market with a minimum of entry costs and infrastructure requirements – in fact, the special capabilities of cloud infrastructures allow providers to experiment with novel service types whilst reducing the risk of wasting resources.

Cloud systems are not to be misunderstood as just another form of resource provisioning infrastructure and in fact, multiple opportunities arise from the principles for cloud infrastructures that will enable further types of applications, reduced development and provisioning time of different services. Cloud computing has particular characteristics that distinguish it from classical resource and service provisioning environments: (1) it is (more-or-less) infinitely scalable; (2) it provides one or more of an infrastructure for platforms, a platform for applications or applications (via services) themselves; (3) thus clouds can be used for every purpose from disaster recovery/business continuity through to a fully outsourced ICT service for an organization; (4) clouds shift the costs for a business opportunity from CAPEX to OPEX which allows finer control of expenditure and avoids costly asset acquisition and maintenance reducing the entry threshold barrier; (5) currently the major cloud providers had already invested in large scale infrastructure and now offer a cloud service to exploit it; (6) as a consequence the cloud offerings are heterogeneous and without agreed interfaces; (7) cloud providers essentially provide datacenters for outsourcing; (8) there are concerns over security if a business places its valuable knowledge, information and data on an external service; (9) there are concerns over availability and business continuity ; (10) there are concerns over data shipping over anticipated broadband speeds.

Cloud computing was a buzz word for many years and it turned into reality in 2007 when IT giants Google and IBM announced a collaboration in this domain followed by "Blue Cloud" announcement by IBM. The prediction of IT advisory company Gartner says that cloud computing business will surpass $148 billion mark by 2014 while its competitor, Forrester, says it will reach $118 billion. Another Gartner's Survey says that the investment on services in public cloud is expected to increase 18.6% in 2012 to $110.3B that achieves a 17.7% Compound Annual Growth Rate (CAGR) from 2011 through 2016. In general, the total market is likely to increase to $210B in 2016 from $76.9B in 2010. Cloud computing area looks very promising for researchers and businesses. On the other hand, its realization brings many challenging issues that need to be carefully addressed.

Five Essential Characteristics:

The cloud computing must have some characteristics in order to meet expected user requirements and to provide qualitative services. According to NIST [8], these five essential characteristics can be classified as:

i. On-demand self-service: A consumer can access different services viz. computing capabilities, storage services, software services etc. as needed automatically without service provider's intervention.

Broad network access: To avail cloud computing services, internet works as a backbone of cloud computing. All services are available over the network and are also accessible through standard protocols using web enabled devices viz. computers, laptops, mobile phones etc.

Resource pooling: The resources that can be assigned to users can be processing, software, storage, virtual machines and network bandwidth. The resources are pooled to serve the users at a single physical location and/or at different physical location according to the optimality conditions (e.g. security, performance, consumer demand). The cloud gives an impression of resource location independence at lower level (e.g. server, core) but not at the higher level (e.g. datacenter, city, country).

Rapid elasticity: The beauty of cloud computing is its elasticity. The resources appear to users as indefinite and are also accessible in any quantity at any time. The resources can be provisioned without service provider intervention and can be quickly scale in and scale out according to the user needs in a secure way to deliver high quality services.

i. Measured service: A metering capability is deployed in cloud system in order to charge users. The users can achieve the different quality of services at different charges in order to optimized resources at different level of abstraction suitable to the services (e.g. SaaS, PaaS and IaaS).

Cloud Computing Models:

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

1. **Software as a Service (SaaS):** In this model, a complete application is offered to the customer, as a service on demand. A single instance of the service runs on the cloud & multiple end users are serviced. On the customers‟ 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. Today SaaS is offered by companies such as Google, Salesforce, Microsoft, Zoho, etc.

2. **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.

3. **Infrastructure as a Service (Iaas):** IaaS provides basic storage and computing capabilities as standardized services over the network. Servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads. The customer would typically deploy his own software on the infrastructure. Some common examples are Amazon, GoGrid, 3Tera, etc.

Deployment 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:

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, "Pay-as-you-go" model. 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.

Advantages :

Reduce run time and response time

For applications that use the cloud essentially for running batch jobs, cloud computing makes it straightforward to use 1000 servers to accomplish a task in 1/1000 the time that a single server would require. For applications that need to offer good response time to their customers, refactoring applications so that any CPU-intensive tasks are farmed out to 'worker' virtual machines can help to optimize response time while scaling on demand to meet customer demands.

i. Increased pace of innovation

Cloud computing can help to increase the pace of innovation. The low cost of entry to new markets helps to level the playing field, allowing start-up companies to deploy new products quickly and at low cost. This allows small companies to compete more effectively with traditional organizations whose deployment process in enterprise datacenters can be significantly longer. Increased competition helps to increase the pace of innovation — and with many innovations being realized through the use of open source software, the entire industry serves to benefit from the increased pace of innovation that cloud computing promotes.

ii. Lower cost of entry

There are a number of attributes of cloud computing that help to reduce the cost to enter new markets: Because infrastructure is rented, not purchased, the cost is controlled, and the capital investment can be zero. In addition to the lower costs of purchasing compute cycles and storage "by the sip," the massive scale of cloud providers helps to minimize cost, helping to further reduce the cost of entry. Applications are developed more by assembly than programming. This rapid application development is the norm, helping to reduce the time to market, potentially giving organizations deploying applications in a cloud environment a head start against the competition.

iii. Minimize infrastructure risk

IT organizations can use the cloud to reduce the risk inherent in purchasing physical servers. When pushing an application out to the cloud, scalability and the risk of purchasing too much or too little infrastructure becomes the cloud provider's issue. In a growing number of cases, the cloud provider has such a massive amount of infrastructure that it can absorb the growth and workload spikes of individual customers, reducing the financial risk they face. Another way in which cloud computing minimizes infrastructure risk is by enabling surge computing, where an enterprise datacenter (perhaps one that implements a private cloud) augments its ability to handle workload spikes by a design that allows it to send overflow work to a public cloud. Application lifecycle management can be handled better in an environment where resources are no longer scarce, and where resources can be better matched to immediate needs, and at lower cost.

Disadvantages of Cloud Computing:

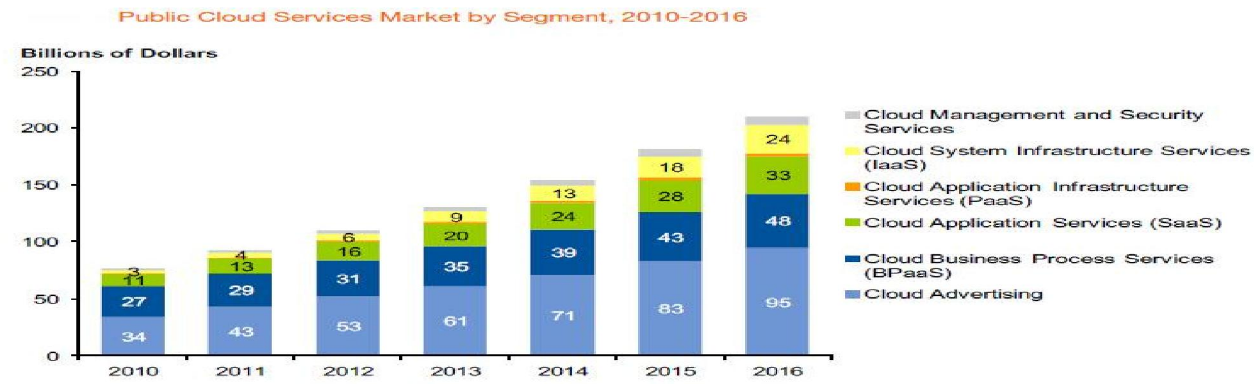
Some of the disadvantages while using a cloud can be summarized as [9]:

- Requires high speed network and connectivity constantly.
- Privacy and security is not good. The data and application on a public cloud might not be very secure.
- Disastrous situation are unavoidable and recovery is not possible always. If the cloud loses one's data, the user and the service provider both gets into serious problems.
- Users have external dependency for mission critical applications.
- Requires constantly monitoring and enforcement of service level agreements (SLAs).

The Future:

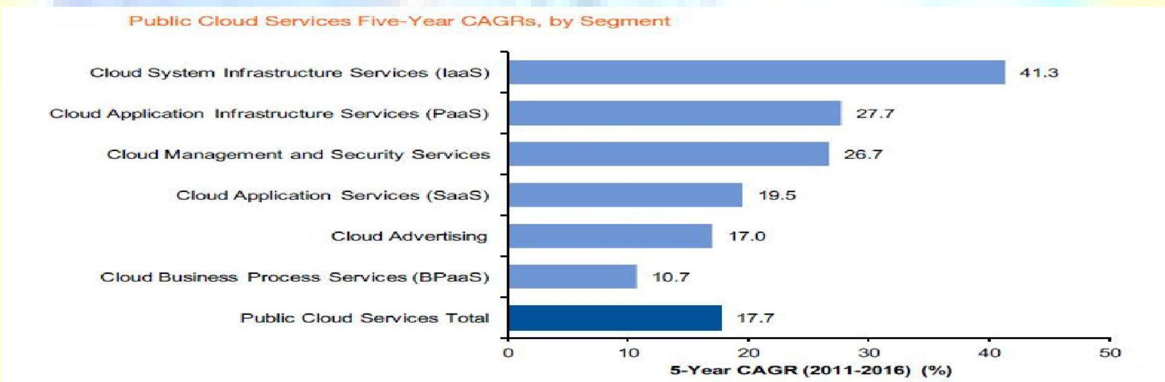
As public cloud computing gains greater adoption across enterprises, there's an increased level of spending occurring on infrastructure-related services including Infrastructure-as-a-Service(IaaS). Enterprises are prioritizing how to get cloud platforms integrated with legacy systems to make use of the years of data they have accumulated. From legacy Enterprise Resource Planning (ERP) to Customer Relationship Management (CRM) systems, integrating legacy systems of record to cloud-based platforms will accelerate in the coming years. Gartner's cloud computing predictions shed light on the evolution of the concept as it continues its path toward becoming more and more integral to IT. IT organizations will need to monitor developments in order to adapt their cloud strategies to the realities of tomorrow.

- Gartner predicts that Infrastructure-as-a-Service (IaaS) will achieve a compound annual growth rate (CAGR) of 41.3% through 2016, the fastest growing area of public cloud computing the research firm tracks. The following graphic provides insights into relative market size by each public cloud services market segment:



Source: Gartner (February 2013)

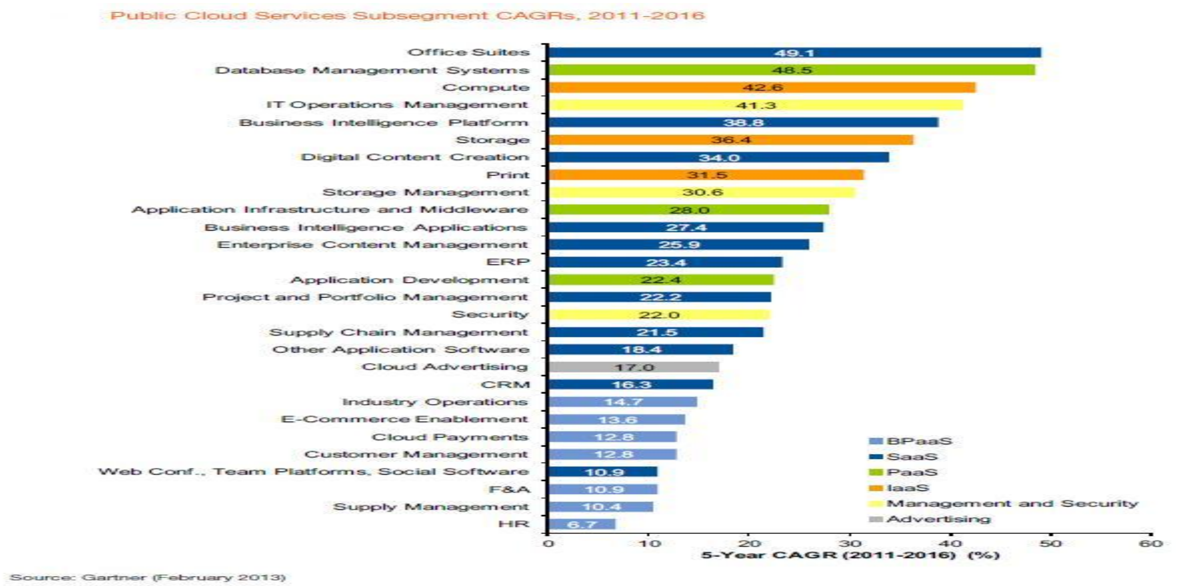
- Gartner also predicts that Platform-as-a-Service (PaaS) will achieve a 27.7% CAGR through 2016, with Cloud Management and Security Services attaining 26.7% in the same forecast period. Software-as-a-Service's CAGR through 2016 is projected to be 19.5%. The following graphic illustrates the differences in CAGR in the forecast period of 2011 – 2016:



Source: Gartner (February 2013)

- According to Gartner, CRM will continue to be the largest global market within SaaS, forecast to grow beyond $5B in 2012 to $9B in 2016, achieving a 16.3% CAGR through 2016. The highest growth segments of the SaaS market continue to be office suites (49.1%), followed by digital content creation (34.0%). The following graphic rank orders CAGRs across all public cloud services segments from the forecast period:

July 2015
IJMIE
Volume 5, Issue 7
ISSN: 2249-0558



Challenges:

Although much progress has already been made in cloud computing, there are a number of research areas that still need to be explored. Issues of security, reliability, and performance should be addressed to meet the specific requirements of different organizations, infrastructures, and functions.

Security:

As different users store more of their own data in a cloud, being able to ensure that one user's private data is not accessible to other users who are not authorized to see it becomes more important. While virtualization technology offers one approach for improving security, a more fine-grained approach would be useful for many applications.

Reliability:

As more users come to depend on the services offered by a cloud, reliability becomes increasingly important, especially for long-running or mission-critical applications. A cloud should be able to continue to run in the presence of hardware and software faults. Google has developed an approach that works well using commodity hardware and their own software. Other applications might require more stringent reliability that would be better served by a combination of more robust hardware and/or software-based fault-tolerance techniques.

Vulnerability to Attacks:

If a cloud is providing compute and storage services over the Internet such as the Amazon approach, security and reliability capabilities must be extended to deal with malicious attempts to access other users' files and/or to deny service to legitimate users. Being able to prevent, detect, and recover from such attacks will become increasingly important as more people and organizations use cloud computing for critical applications.

Cluster Distribution:

Most of today's approaches to cloud computing are built on clusters running in a single data center. Some organizations have multiple clusters in multiple data centers, but these clusters typically operate as isolated systems. A cloud software architecture that could make multiple geographically distributed clusters appear to users as a single large cloud would provide opportunities to share data and perform even more complex computations than possible today. Such a cloud, which would share many of the same characteristics as a grid, could be much easier to program, use, and manage than today's grids.

Network Optimization:

Whether clouds consist of thousands of nodes in a computer room or hundreds of thousands of nodes across a continent, optimizing the underlying network to maximize cloud performance is critical. With the right kinds of routing algorithms and Layer 2 protocol optimizations, it may become possible for a network to adapt to the specific needs of the cloud application(s) running on it. If application-level concepts such as locality of reference could be coupled with network-level concepts such as multicast or routing algorithms, clouds may be able to run applications substantially faster than they do today. By understanding how running cloud applications affects the underlying network, networks could be engineered to minimize or eliminate congestion and reduce latency that would degrade the performance of cloud-applications and non-cloud applications sharing the same network

Interoperability:

Interoperability among different approaches to cloud computing is an equally important area to be studied. There are many cloud approaches being pursued right now and none of them are suitable for all applications. If every application were run on the most appropriate type of cloud, it would be useful to share data with other applications running on other types of clouds. Addressing this problem may require the development of interoperability standards. While standards may not be critical during the early evolution of cloud computing, they will become increasingly important as the field matures.

Applications:

Even if all of these research areas could be addressed satisfactorily, one important challenge remains. No information technology will be useful unless it enables new applications, or dramatically improves the way existing applications are built or run. Although the effectiveness of cloud computing has already been demonstrated for some applications, more work should be done on identifying new classes of novel applications that can only be realized using cloud computing technology. With proper instrumentation of potential applications and the underlying cloud infrastructure, it should be possible to quantitatively evaluate how well these application classes perform in a cloud environment. Along these same lines, experimental software engineering research should be conducted to measure how easily new cloud-based applications can be constructed relative to non-cloud applications that perform similar functions. This research should also compare the dependability of similar cloud and non-cloud based applications running in production environments. Application-focused research will help organizations make well-informed business decisions on where to apply cloud technology, and give cloud technology developers guidance on what kinds of improvements to the technology will provide the greatest benefits to application developers and end users

Conclusion:

Cloud computing has been showing its impact on the industry for the past few years and it has heralded a revolutionary change giving new directions to how information technology resources can be best utilized and by reducing the cost and complexity for customers**.** Cloud computing is providing the technological underpinnings for new ways to collect, process, and store massive amounts of information. Based on the ongoing research efforts, and the continuing advancements of computing and networking technology, one can believe that cloud computing is poised to have a major impact on society's data-centric commercial and scientific endeavors.

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