ISSN:0975-9646

On the Advancements in Cloud Computing Technology: An Overview

Majed Alhaisoni

College of Computer Science and Engineering
University of Ha'il
Saudi Arabia

***Abstract*— Cloud computing is the next killer of technology where people share pool of resources at same time. Hence, such evolution of technology has changed IT infrastructure. This has led most organization to join the cloud due to cost effectiveness and reliability. However, cloud computing concept involves large number of computers connected through a real-time communication network (typically the internet). This paper presents an overview on the basic concept and highlight advances of applications over Cloud. Architecture of cloud and industry adaptation of such trend are also briefly covered. Finally, cloud computing issues are presented and followed with some proposed mitigation steps to overcome such issues.**

***Keywords*— Cloud Computing, On-Demand, Real-time, Utility Computing.**

I. INTRODUCTION

Technology has grown rapidly over past years. Such movement of technology has shown various applications such as new devices, protocols, communication, cloud software, etc. However, cloud computing would be considered one of the attractive phenomena recently due to its ability to change the performance drastically. It takes the computation into another level in which old servers' utilization rate was very low [6].

The concept of virtualization has been shown clearly on such technology as Virtual Machines (VMs) supports a certain server to be fully utilized where different virtual machines could be enabled on the physical hardware of the server. Virtualization [7] is a framework or methodology of dividing the resources of a computer into multiple execution environments. This could be more effective by applying one or more concepts or technologies such as hardware, software partitioning, time-sharing, partial or complete machine simulation, emulation, quality of service, and others. It allows abstraction and isolation of lower-level functionalities and underlying hardware. Moreover, portability of higher-level functions and sharing and/or aggregation of the physical resources can be also gained. Therefore, VMs could be the key point behind the cloud computing where thousands of customers could be served by remote machines. Hence, through virtualization customers could adjust their own needs accordingly. On other hand, various companies has adapted such technology on their infrastructure such as Amazon, Microsoft, IBM and Rackspace and some of these services are Google Apps, Microsoft Office 365, Dropbox, Netflix, Flickr, Windows Azure and Rackspace [9] [10]

Cloud can save the world on getting everything on the cloud, It can be considered as a natural step in the evolution of on-demand information technology services. It is a metaphor for the Internet, based on how it is depicted in computer network diagrams, and is an abstraction for the complex infrastructure it conceals. It is a style of computing in which IT-related capabilities are provided "as a service", allowing users to access technology-enabled services from the Internet (i.e., the Cloud) without knowledge, expertise, or control of how service is delivered. However, it is worth mentioning that Email was probably the first service on the "cloud". Therefore, industry has already started to shift towards providing Platform as a Service (PaaS) and Software as a Service (SaaS) [11][12][13].

However, owing to the need of giving more insights of such technology, this paper presents an overview on the basic concept and highlight advances of applications over Cloud. Finally, architecture of cloud and industry adaptation of such trend are also briefly covered. Ultimately, some open issues on cloud adaptation are considered with some possible proposed solutions. Finally, discussion and conclusion are presented.

II. BACKGROUND

Cloud computing is a type of computing that has obvious advantages and disadvantages as any other technology. Consequently, it does not serve the needs of real business to hear only the hype about cloud computing [1]. Cloud computing provides the facility to access shared resources and common infrastructure, offering services on demand over the network to perform operations that meet changing business needs. However, location of physical resources and devices being accessed are typically not known to the end user. Therefore, users are allowed to develop, deploy and manage their applications 'on the cloud', which entails. Various organizations have deployed cloud such as Amazon's Elastic Computing Cloud (EC2) [14], as mentioned, offering computational services that enable people to use CPU cycles without buying more computers. On the other hand, cloud can also act as a Storage services such as those provided by Amazon's Simple Storage Service (S3) [15]. Furthermore, Companies like Nirvanix allowing organizations to store data and documents without the need of introducing new physical server. Furthermore, SaaS companies like Salesforce.com is delivering CRM services, so clients can manage customer information without installing specialized software. Table 1 shows clearly the growth of the cloud utilization.

TABLE 1
CLOUD GROWTH FROM YEAR 2008 TO 2012 [4]

Year	2008	2012	Growth
Cloud IT spending	$ 16 B	$ 42 B	27%
Total IT spending	$ 383 B	$ 494 B	7%
Total-cloud spend	$ 367 B	$ 452 B	4%
Cloud total Spend	4 %	9%	

Cloud Computing is a new term given to a technological evolution of distributed computing and grid computing. However, development of ARPANET (Advance Research Projects Agency Network) is one of the key advances which has led to cloud computing. Cloud computing has introduced a new paradigm which changed the traditional interconnection of systems to a pool of shared resources that can be accessed through internet [3].

One of the areas that Service Oriented Architecture (SOA) principles can be applied is computing. Utility Computing is the paradigm in which computing is offered as a service rat her than a product. Utility Computing is the packaging of c omputing resources, such as computation, storage and servi ces, as a metered service.This model has the advantage of a low or no initial cost to acquire computer resources; instead, computational resources are essentially rented. Utility Computing has been widely named as Cloud Computing. Some authors use these terms interchangeably while others claim that their meaning is not exactly the same. NIST (2011) [8] defines Cloud Computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

The organization of this paper is as follows: the motivations towards cloud are explained in the next section; section 3 introduces different cloud services; cloud deployment models are introduced in section 4; the commercial clouds and their statistics are elaborated in section 5 while cloud computing issues are introduced in section 6; the discussion and conclusion are stated in sections 7 and 8 respectively**.**

III. MOTIVATION

There many reasons for using Cloud Computing; some of these reasons are as follows [1]:

High scalability: Cloud environments enable servicing of business requirements for larger audiences, through high scalability.

Agility: The cloud works in the 'distributed mode' environment. It shares resources among users and tasks, while improving efficiency and agility (responsiveness).

High availability and reliability: Availability of servers is high and more reliable as the chances of infrastructure failure are minimal.

Highly Automated: Cloud computing services are maintained by dedicated IT professionals of cloud service providers. As a result, universities' IT staff no longer need to worry about complex details behind the delivered computing services, such as hardware maintenance, constant software update, etc.

Economics: Traditional IT has multiple fixed and variable cost elements. In order to fulfill business requirements and sustain day-to-day business operations, universities must invest a large fixed amount for initial IT infrastructure establishment and continue to spend variably for software and hardware maintenance. By outsourcing IT functions to the cloud, universities can leverage the features of a lean IT structure to reduce the overall IT expenditures involved in software licensing, infrastructure development, on-going support and upgrades.

Cloud Computing is one of the vivid topics in IT as it fundamentally changes the ways institutions and companies are managing their computing needs. Cloud Computing is based on the concept of providing all of the needed software on the web. The basic service that provides such feature is the Software as a Service (SaaS). This feature allows companies to customize their needs from the clouds in terms of hardware and software. This concept of hardware and/or software customization to the company requirements fits under the term of Platform as a Service (PaaS). In fact, this PaaS is based in reality on what is called Infrastructure as a Service (IaaS).The three services [16][17][18] are shown in Figure 1.

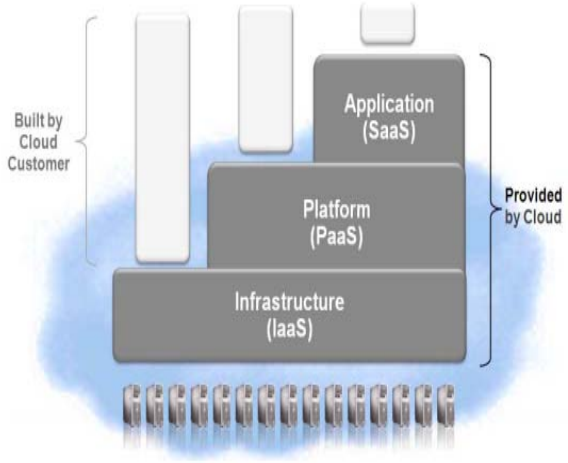

Fig. 1: Types of Cloud Service Models [19]

A. *Software-as-a-Service (SaaS)*

This is the top layer of the cloud services model. It allows business owner to run any required software in the cloud where all other portions are managed by the cloud vendor. This idea is inspired from the concept of "on-demand" software which originally provided by IBM in 2003. With this concept in mind, the IT engineers have started to move their focus from the software deployment and maintenance to the results of the used applications. Therefore, is E-mail service is such a good example of SaaS, for instance Gmail and Hotmail services were originally server based. Furthermore, the cloud offered users to work in a multi-tenant environment where different applications can merge their results together. This is an advantage of the cloud over the single- tenant restriction that had been an obstacle for many applications on the cloud. Accordingly, business sell the software for customer with onetime fee and the user is responsible for handling the software. Now, with cloud computing, users pay only for the usage time of

the software and customer does not care about the maintenance of such software. However, one issue that raised on cloud is the security of the business information. This makes many of the businesses resist using the cloud. However, with the new auditing system on SAS 70, it seems that businesses begin to trust using the cloud.

There are many of the architectures/modeling for SaaS; one of the conceptual models of SaaS is introduced by Intel [20] shown in Figure 2. As can be seen in the Figure, the architecture consists of five components which are presentation, security, application, operations, and infrastructure. The presentation component is responsible of items display, display and reporting while the security component is responsible of all issues of security including authentication, encryption and regulatory control. The infrastructure is also part of the SaaS architecture where different issues need to handle for SaaS such as the computers' hardware, networking and communication bandwidth and databases. Applications and operations are also important components of SaaS where the task monitoring, backup, configuration and provisioning are considered. In addition, data workflow and user profiling, data synchronization and many other tasks are considered at the application component.

Another more detailed architecture is provided by open group [21] is shown in Figure 3. The multi-tenant is clearly considered in the open group architecture where the virtualization resources and virtual images as well as the metadata are taken into consideration as separate components

Some of the disadvantages of the SaaS are that: 1) some of the organizations find it is hard to trust a third party on their work, 2) some of the vertical markets cannot find their required business solutions, 3) the bandwidth required to run certain applications could be one of the challenges in SaaS, 4) some businesses require customer relationship management system which it is not completely available on SaaS.

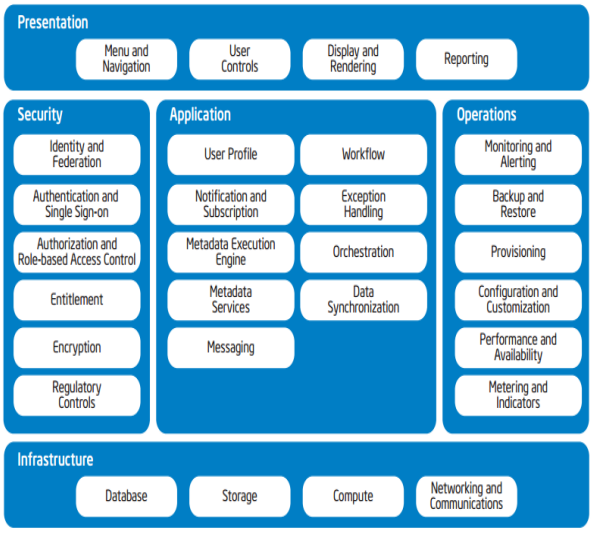

Fig. 2: Intel conceptual model for SaaS [20]

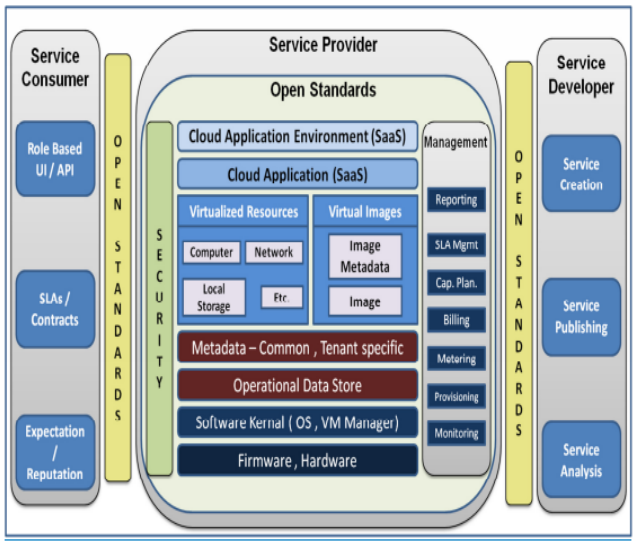

Fig. 3: Open group architecture of SaaS [21]

B. *Platform-as-a-Service (PaaS)*

This cloud service model could be considered the second layer. You manage your applications and data and the cloud vendor manages everything else. Benefits for using Platform-as-a-Service include streamlined version deployment and the ability to change or upgrade and minimize expenses. One popular Platform-as-a-Service is the Google app engine. In fact, PaaS allows the user to enable and deploy his/her applications in a seamless manner through software without caring about the underlying servers operating systems, storage, or network. Figure 4 shows one of the PaaS architectures, as a case study, provided by Oracle [22] . The lowest layer, as shown in the Figure is the OS virtualization which is the basic component of any cloud. The middleware consists of many services such as service-oriented architecture (SOA), business process management (BPM), user interface (UI) technologies, and identity management. The top layer is designated to the Information Technology to fit their requirements.

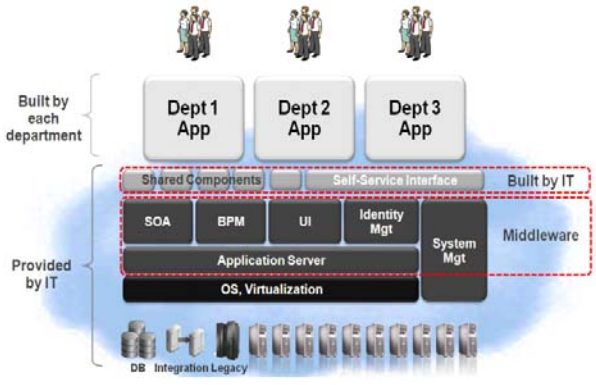

Fig. 4: PaaS architecture provided by Oracle [22]

C. *Infrastructure-as-a-Service (IaaS)*

Infrastructure-as-a-Service is the layer and foundation of cloud computing. Using this service model, you manage your applications, data, operating system, middleware and runtime. The service provider manages your virtualization,

servers, networking and storage. This allows you to avoid expenditure on hardware and human capital; reduce your ROI risk; and streamline and automate scaling. According to a 2011 article released by Venture Beat [23], some of the biggest names in IaaS include Amazon, Microsoft, VMWare, Rackspace and Red Hat. An example of a typical need for this model is someone who needs extra data space for processing power on occasion. Infrastructure-as-a-Service allows you to easily scale based on your needs and you only pay for the resources used. This means that the extra data processing space is available to you whenever you need it, and when you not paying for it, saving you money and providing your business exactly what it needs. There are main services that are managed by the IaaS such as the cloud uptime, dynamic scaling, policy based services, load balancing, machine imaging, security control, and preconfigured templates.

The previous three main layers of the cloud, SaaS, PaaS, and IaaS, have been utilized with many services from different vendors; Table 2 lists some of these services and their references for the benefit of the readers.

TABLE 2
SOME OF THE SERVICE IN THE CLOUD

SaaS	PaaS	IaaS
Salesforce.com (http://www.salesforce.com)	Simple Cloud API (http://simplecloud.org/).	VMWare http:// www.vmware.com/appliances/directory/)
Dropbox (https://www.dropbox.com)	Java	Amazon Web Services (http://aws.amazon.com/)
Google Services (http://www.google.com/services/)	Google App Engine (http://golang.org/) http://myApp.appspot.com .	Amazon Elastic Compute Cloud (EC2) (http://aws.amazon.com/ec2/)
Prezi (http://prezi.com/)	Google Web Toolkit (http://www.gwtproject.org/)	Amazon Storage Services (http://aws.amazon.com/s3/)
	Microsoft Azure (http://azure.microsoft.com/en-gb/)	Amazon Elastic Beanstalk (http://aws.amazon.com/elasticbeanstalk/
	Force.com (http://force.com)	FlexiScale (http://www. fl exiscale.com/)
	VMForce (https://na11.salesforce.com/)	GoGrid (http://www.gogrid.com/)
	Heroku (https://www.heroku.com/)	Eucalyptus (http://www.eucalyptus.com/)
	Cloud Foundry (http://www.cloudfoundry.org/index .html)	Rackspace (http://www.rackspace.com/)

IV. CLOUD DEPLOYMET MODELS

The cloud deployment model is a description to the way the cloud services are deployed depending on the customer as well the organization. The cloud deployment model is classified as public, private, hybrid, and community clouds as shown in Figure 5.

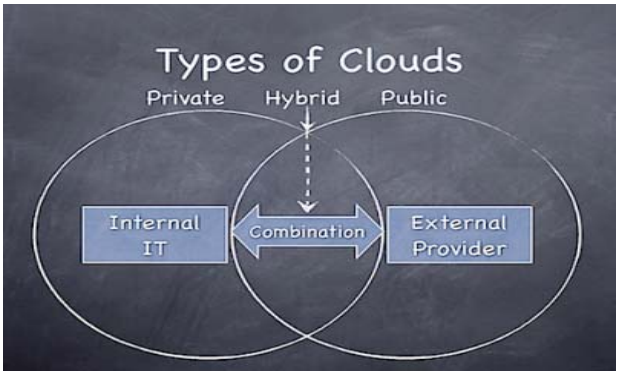

Fig. 5: Types of Cloud Computing [10]

Public cloud: A public cloud is a cloud computing model in which services, such as applications and storage, are available for general use over the Internet. Public cloud services may be offered on a pay-per-usage mode or other purchasing models. The major concern of the public cloud is the security where multi-tenant is hosted on the same servers using the virtualization concept.

Private cloud: The computing infrastructure is dedicated to a particular organization and not shared with other organizations. The concept of private cloud provides some form of ownership. Some experts consider that private clouds are not real examples of cloud computing. Private clouds are more expensive and more secure when compared to public clouds. Examples of the hosted private cloud providers are Amazon EC2 Dedicated, IBM Smart Cloud Enterprise, and Rackspace Cloud.

Hybrid cloud: Organizations may host critical applications on private clouds and applications with relatively less security concerns on the public cloud. The usage of both private and public clouds together is called hybrid cloud. A related term is Cloud Bursting. This ensures that a sudden increase in computing requirement is handled gracefully.

Community cloud: involves sharing of computing infrastructure in between organizations of the same community. For example all Government organizations within the state may share computing infrastructure on the cloud to manage data related to citizens residing in any state [3]. Figure 6 shows a simple architecture of the Community Cloud.

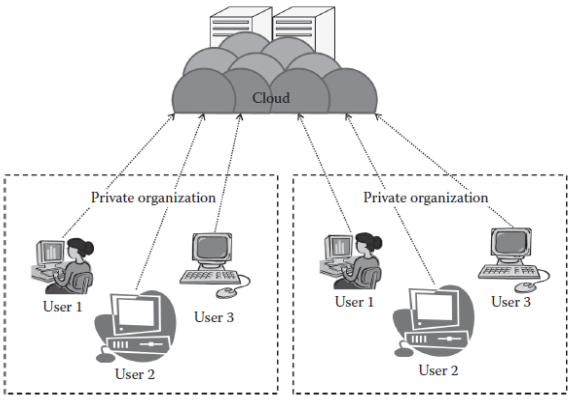

Fig. 7: Community Cloud [24]

V. COMMERCIAL CLOUDS

This section is designated to the commercial cloud providers around the world. This will give an indicator to the development and the current market of the Cloud Computing. First, let us look at the type of business in 2013 that are using the clouds and in what scale. As can be seen in Figure 8, the most business that are using the cloud are the banking/financial services with 55% of the overall banking/financial services followed by the residential/Customers. However and unfortunately, the education is the last organizations that are utilizing clouds. Therefore, for the education community needs to pay some

efforts towards utilizing the clouds and its benefits. I believe that this paper is an effort in this regard. The future plan is to have another articles focusing on the could features and benefits for education.

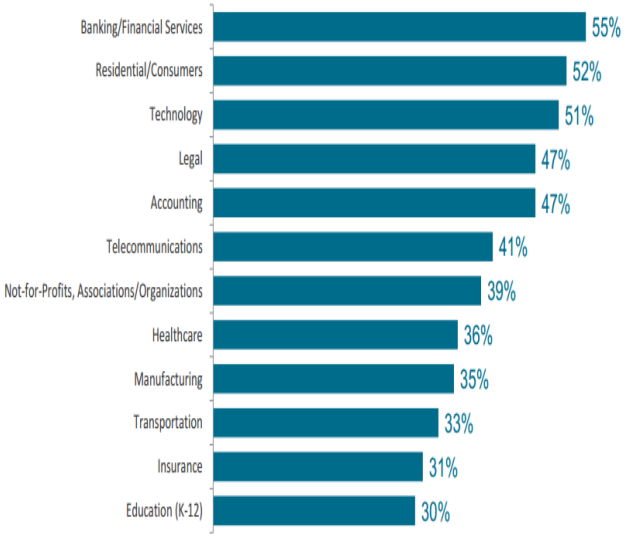

Fig. 8: Businesses using cloud [25]

Figure 9 shows the types of services using the cloud in 2013 compared to the same services in 2012. As can be seen, the backup service is the most used in 2012 and 2013. However, the backup service is decreased in 2013 than in 2012. Other services are growing on the could in 2013 such as Mobile devices/applications, VoIP, File sharing and Security. Such services indicate the users increasing trust of using the clouds. Based on this statistics, It can be concluded that the trust percentage in the cloud is increasing within the youth category; however, there is still the large companies need to be encouraged to do so.

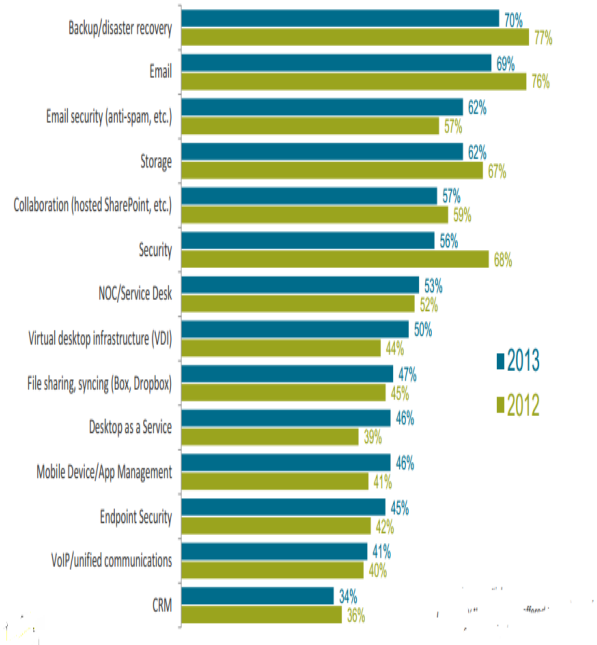

Fig. 9: Services on cloud [25]

VI. CLOUD COMPUTING CHALLENGES AND SOLUTIONS

Although cloud computing is widely accepted, there are many issues that hinder the utilization of it. These issues are briefly described in this section as follows:

Data Integrity: When a data is on a cloud, anyone from any location can access those data's from the cloud. Cloud does not differentiate between a sensitive data from a common data thus enabling anyone to access those sensitive data's. Thus there is a lack of data integrity in cloud computing.

Data Theft: Most of the cloud Vendors instead of acquiring a server tries to lease a server from other service providers because they are cost affective and flexible for operation. The customer doesn't know about those things, there is a high possibility that the data can be stolen from the external server by a malicious user.

Privacy Issues: The Vendor must make sure that the Customer Personal information is well secured from other operators. As most of the servers are external, the vendor should make sure who is accessing the data and who is maintaining the server thus enabling the vendor to protect the customer's personal information.

Infected Application: Vendor should have the complete access to the server for monitoring and maintenance, thus preventing any malicious user from uploading any infected application onto the Cloud which will severely affect the customer.

Data Loss: Data loss is a very serious problem in Cloud computing. If the vendor closes due to financial or legal problems there will be a loss of data for the customers. The customers won't be able to access those data's because data is no more available for the customer as the vendor shut down.

Data Location: When it comes to location of the data nothing is transparent even the customer doesn't know where his own data's are located. The Vendor does not reveal where all the data's are stored. The Data's won't even be in the same country of the Customer, it might be located anywhere in the world [1]

1) To overcome these challenges, mitigation steps following guidelines offer companies a possible cloud approach to help them make proper strategy before implementing cloud services These include :
2) Building up an iterative policy for relocation from traditional environment to Cloud environment. Vendors in around the world should follow proper strategy moving from their existing system to this new evolution.
3) As this upcoming trend reduces cost, it is essential to be careful selecting possible solutions to avoid problems in this computing and calculate the effect on the system just not consider the outlay.
4) Providers should be aware regarding new changes and assure that customers access privileges are limited.
5) Cloud is a shared pool of resource. Discover the linked service providers that wants to connected to particular

Cloud service provider to query, which provider has right to use facts and data .

6) System for monitoring should be request for exclusion.

7) Service provider should tell customer for managing polices for security beside provider's owned policies, with in the duration of services.

8) Make it sure, that the data being transferred is protected and secured by standard security techniques and managed by appropriate professionals. [15].

VII. DISCUSSION

When it comes to cloud computing, the security and privacy of personal information is extremely important. Given that personal information is being turned over to another organization, often in another country, it is vital to ensure that the information is safe and that only the people who need to access it are able to do so. There is the risk that personal information sent to a cloud provider might be kept indefinitely or used for other purposes. Such information could also be accessed by government agencies, domestic or for businesses that are considering using a cloud service. It is important to understand the security and privacy policies and practices of the provider. The terms of service that govern the relationship with the provider sometimes allow for rather liberal usage and retention practices.

The Personal Information Protection and Electronic Documents Act (PIPEDA) does not prohibit cloud computing, even when the cloud provider is in another country. Under PIPEDA, organizations must ensure that they collect personal information for appropriate purposes and that these purposes be made clear to individuals; they obtain consent; they limit collection of personal information to those purposes; they protect the information; and that they be transparent about their privacy practices. PIPEDA also requires that when an organization transfers personal information to a third-party for processing, it remains accountable for that information.

At the same time, for businesses that are considering using a cloud service, cloud computing could offer better protection of personal information compared with current security and privacy practices. Through economies of scale, large cloud providers may be able to use better security technologies than individuals or small companies can, and have better backup and disaster-recovery capabilities. Cloud providers may also be motivated to build privacy protections into new technology, and to support better audit trails [1].

Cloud computing can significantly reduce the cost and complexity of owning and operating computers and networks. If an organization uses a cloud provider, it does not need to spend money on information technology infrastructure, or buy hardware or software licensees. Cloud services can often be customized and flexible to use, and providers can offer advanced services that an individual company might not have the money or expertise to develop.

VIII. CONCLUSION

Number of approaches have been described on cloud computing in this article and pointed out some of their strengths and limitations. Cloud computing is a powerful new abstraction for large scale data processing systems which is scalable, reliable and available. In cloud computing, there are large self-managed server pools available which reduces the overhead and eliminates management nuisance. Cloud computing is particularly valuable to small and medium businesses, where effective and affordable IT tools are critical. This would be helping them to be more productive without spending lots of money in-house resources and technical equipment. Also it is a new emerging architecture needed to expand the Internet to become the computing platform of the future. Though cloud computing is still in its infancy but it's clearly gaining momentum. Organizations like Google, Yahoo, Amazon are already providing cloud services. The products like GoogleApp-Engine, Amazon EC2, and Windows Azure are capturing the market with their ease of use, availability aspects and utility computing model.

The future work which is in-progress now is to conduct a raw case study; an experimental testbed work shall be conducted on a large scale of university of hail datacenter where cloud is considered as trend of innovating the university with this style of technology. Such case study would depict and gauge the performance of running whole university business on a cloud versus a traditional heterogeneous environment of collection of different types of servers and storage

REFERENCES

[1] Ahmed Mohamed Gamaleldin , "An Introduction to Cloud Computing Concepts" , Software Engineering Competence Center, 2013 ,page 2.

[2] Nariman Mirzaei, "Cloud Computing", Independent Study Report January 9, 2009, pp. 2-4.

[3] Jangareddy gudem ,Vijayawada "Cloud computing : an overview" Journal of Theoretical and Applied Information Technology ,page 71-76.

[4] Mathur, P; Nishchal, N.; (2010), "Cloud Computing: New challenge to the entire computer industry", 2010 1st International Conference on Parallel, Distributed and Grid Computing (PDGC - 2010), pp 223.

[5] Shuai Z; Shufen Z; Xuebin C; Xiuzhen H; (2010), "Cloud Computing Research and Development Trend", 2nd International conference on Future Networks, 2010. ICFN ' 10. pp 23, 22-24 Jan 2010

[6] Zaigham Mahmood, Cloud Computing: Methods and practical approaches, Computer Communications and Networks, Springer publisher , ISBN: 978-1-4471-5106-7, 2013.

[7] Yuping Xing, Yongzhao Zhan, " Virtualization and Cloud Computing," Future Wireless Networks and Information Systems Lecture Notes in Electrical Engineering Volume 143, pp 305-312, 2012

[8] Hogan, M., Liu, F., Sokol, A., Tong, J.: Nist Cloud computing standards roadmap-version 1.0, Special Publication 500–291, December 2011. http://collaborate.nist.gov/twiki-cloudcomputing/pub/CloudComputing/StandardsRoadmap/NIST_SP_500-291_Jul5A.pdf (2011). Accessed 2015 .

[9] Ciurana, E.: Developing with Google App Engine. Firstpress, Berkeley (2009)

[10] Top 15 Consumer Cloud services/applications. http://www.devx.com/architect/Article/46190 , , 2010, accesses in 2015

[11] Mell, P., Grance, T.: The NIST definition of cloud computing. Technical Report Version 15, Information Technology Laboratory Newsletter, NIST (2009).
[12] Zhu J,Wen Q (2012, November) SaaS Access Control Research Based on UCON. In: Fourth international conference on digital home (ICDH), IEEE, 2012, pp 331–334
[13] G M Siddesh and K G Srinivasa, "Realization of Open Cloud Computing Standards, Forums and Platforms," Continued Rise of the Cloud Computer Communications and Networks , pp 103-117, 2014.
[14] Amazon: Amazon Elastic Compute Cloud. http://aws.amazon.com/ec2 (2009)
[15] Garfi nkel, S.: An evaluation of Amazon's grid computing services: EC2, S3 and SQS. Tech. Rep. TR-08-07, Harvard University, August 2007.
[16] Höfer, C.N., Karagiannis, G.: Cloud computing services: taxonomy and comparison. J. Internet Serv. Appl. 2 (2), 81–94 (2011). doi: 10.1007/s13174-011-0027-x
[17] L. Youseff, M. Butrico, and D. Da Silva, Toward a unified ontology of cloud computing, in Proceedings of the 2008 Grid Computing Environments Workshop, 2008, pp. 1-10.
[18] B. Hayes, "Cloud computing", Communications of the ACM, 51:9_11, 2008.
[19] Oracle, Platform-as-a-Service Private Cloud with Oracle Fusion Middleware, http://www.oracle.com/us/technologies/cloud/036500.pdf (2009), Accessed 2015
[20] Intel , Architecting Software as a Service for the Enterprise , http://www.intel.co.uk/content/dam/doc/white-paper/cloud-computing-intel-it-architecting-software-as-a-service-paper.pdf, (2009) accesses 2015.
[21] Open group , http://www.opengroup.org , accessed 2015
[22] Oracle, Platform-as-a-Service Private Cloud with Oracle Fusion Middleware, (2009) http://www.oracle.com/us/technologies/cloud/036500.pdf, accessed 2015 .
[23] Venture Beat , http://venturebeat.com/ , accessed 2015.
[24] K. Chandrasekaran, Essentials of Cloud Computing, CRC Press, SBN 9781482205435 , 2014.
[25] Talkin' Cloud 100 Report, (2014), http://talkincloud.com/TC100/datasheet/2014-talkin-cloud-100-report, accessed 2015.