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Could Computing

Submitted to
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KRISHANT CHAUHAN

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Krishna Kumar
CEO

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This is certified that Mr. Krishant Chauhan has satisfactory completed Term Work in the laboratory of this university. The Seminar report of Cloud Computing in partial fulfilment of thus requirements at the 1st semester of MCA Degree course
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Faculty Head of Department

Examiner

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CLOUD COMPUTING

Abstract

Early literature on servitization was focused on the necessity and rationale for the need to create value by adding services to products. This approach regarded services as additional offerings to core (often physical) products. However, recent writings on the subject of servitization recognize that a service can also replace the main product itself. Other

ability to use its knowledge, skills and capabilities) or a combination of physical products and services (where services assume greater importance) is becoming increasingly popular.

New disruptive innovations such as cloud computing and Massive Open Online Courses (MOOCs) add an interesting dimension to the contemporary debate about servitization. In the case of cloud computing, its emergence represents a new paradigm of servitization where a

the potential to servitize education in a manner that is unprecedented in its history.

This paper will explore these two phenomena within the contemporary context of servitization and will highlight the implications of a more servitized Information Technology (IT) and educational world.

Keywords

Servitization; Cloud Computing; Massive Open Online Courses (MOOCs); Higher Education.

Introduction

Cloud computing is increasingly emerging as a new model for servitizing the IT industry. Many organizations, small and large, have embraced this new servitizing model for IT due to the advantages it promises in terms of flexible cost structure, scalability and efficiency. Furthermore, the MOOCs phenomenon is also predicted to do to higher education (HE) education what cloud computing did to IT by providing education as a service (EaaS) that can potentially be consumed on a pay-as-you-go basis (Sultan, 2014). But cloud computing and MOOCs are also disruptive innovations that are likely to require a fundamental and cultural shift in the way organizations (both cloud providers and consumers) view IT and in the way universities and society view education. Both the cloud and MOOCs paradigms represent an approach to providing services (e.g., IT and education) that is different from the traditional delivery of such services. This article will attempt to highlight this issue and reflect on the development of these emerging business and education models and their implications for organizations, universities and society.

To describe the cloud computing and MOOCs phenomenon within the context of the concept of servitization. This is important as it will provide some insights into the characteristics that make cloud computing and MOOCs fundamentally different from other servitized forms of business and educational activity. Furthermore, the disruptive nature of cloud computing and MOOCs requires further investigation of this phenomenon within the context of the theory of disruptive innovation as described by Clayton Christensen and his colleagues.

This approach will enable a greater understanding of the behavioural issues that disruptive innovations give rise to and will provide a basis for understanding the cultural implications of cloud computing and MOOCs. Moreover, a good understanding of the cloud
and MOOCs phenomena is required. This will be presented in the next few pages.

Description of Cloud Computing and its Services

Cloud computing can be defined as a modality that uses advances in IT technologies such as virtualization and grid computing for delivering a range of IT services through software, and virtual hardware (as opposed to physical) provisioned (by data centres owned and operated by cloud providers and/or end users) according to user demands and requirements and delivered remotely through public (e.g., Internet), private networks or a mix (i.e., hybrid) of the two delivery modes.

When it emerged in 2007 the cloud model attracted a great deal of attention from many quarters (e.g. authors, consultants, technology analysts, companies). Many people (including

Johnson, 2008). With time, the model began to gain currency and many of the big players in the IT world (e.g., Amazon, Microsoft, Google, IBM, Salesforce.com) threw their weight behind it. Concerned with being left behind (and with the KODAK experience still fresh in the cloud bandwagon. The IT services that can
be offered by cloud computing can be listed in the following three main areas (Sultan, 2011):

Infrastructure as a Service (IaaS): Products offered via this mode include the remote delivery (through the Internet) of a full computer infrastructure (e.g., virtual computers, servers, storage devices). Some of the most notable vendors under this

Platform as a Service (PaaS): Services provided by the traditional computing model which involves teams of network, database, and system management experts to keep everything up and running. (e.g., operating systems, databases, middleware, Web servers and other software) are now provided remotely by cloud providers under this Salesforce.com);

Software as a Service (SaaS): Under this layer applications are delivered through the medium of the Internet as a service. Instead of installing and maintaining software, one can simply access it via the Internet; thus freeing oneself from complex software and hardware management. This type of cloud service offers a complete application functionality that ranges from productivity applications (e.g., word processing, spreadsheets, etc.) to programs such as those for Customer Relationship Management (CRM) or Enterprise-Resource Management (ERM). Products under this category include Yahoo mail, Google Apps, Salesforec.com, WebEx and Microsoft Office Live.

Interestingly, the notion of providing software as a service (SaaS) is not a new ICT practice.

In fact, it predates the emergence of computers themselves. In the 1930s some companies (such as IBM) specialized in producing electric accounting machines based on punched cards and were able to offer data processing services (e.g. payrolls) to organizations. Providers of processing in return for a fee. Organizations that were unable to purchase the data processing equipment found it economically viable to pay for those services. Then came mainframe computers in the 1950s and 1960s which continued this practice that became known as to afford buying mainframe computers would rent the data processing functionality of those machines from a number of providers. Connection to mainframes was achieved through a normal telephone line connecting those

Types of Cloud

Cloud can be of three types [20].

- Private Cloud - This type of cloud is maintained within an organization and used solely for their internal purpose. So the utility model is not a big term in this scenario. Many companies are moving towards this setting and experts consider this is the 1st step for an organization to move into cloud. Security, network bandwidth are not critical issues for private cloud.

- Public Cloud - In this type an organization rents cloud services from cloud providers on-demand basis. Services provided to the users using utility com-puting model.

- Hybrid Cloud - This type of cloud is composed of multiple internal or exter-nal cloud. This is the scenario when an organization moves to public cloud computing domain from its internal private cloud.

Cloud Stakeholders

To know why cloud computing is used let's rst concentrate on who use it. And then we would discuss what advantages they get using cloud. There are three types of stakeholders cloud providers, cloud users and the end users [Figure 1]. Cloud providers provide cloud services to the cloud users. These cloud services are of the form of utility computing i.e. the cloud users uses these services pay-as-you-go model. The cloud users develop their product using these services and deliver the product to the end users.

Motivation towards Cloud in recent time

Cloud computing is not a new idea but it is an evolution of some old paradigm of distributed computing. The advent of the enthusiasm about cloud computing in recent past is due to some recent technology trend and business models

- High demand of interactive applications { Applications with real time response and with capability of providing information either by other users or by non-human sensors gaining more and more popularity today. These are generally attracted to cloud not only because of high availability but also because these services are generally data intensive and require analyzing data across di erent sources.

- Parallel batch processing { Cloud inherently supports batch-processing and analyzing tera-bytes of data very e ciently. Programming models like Google's map-reduce [18] and Yahoo!'s open source counter part Hadoop can be used to do these hiding operational complexity of parallel processing of hundreds of cloud computing servers.

- New trend in business world and scienti c community { In recent times the business enterprises are interested in discovering customers needs, buying pat-terns, supply chains to take top management decisions. These require analysis of very large amount of online data. This can be done with the help of cloud very easily. Yahoo! Homepage is a very good example of such thing. In the homepage they show the hottest news in the country. And according to the users' interest they change the ads and other sections in the page. Other than these many scienti c experiments need very time consuming data processing jobs like LHC (Large Hadron Collider). Those can be done by cloud.

- Extensive desktop application { Some desktop applications like Matlab, Math-ematica are becoming so compute intensive that a single desktop machine is no longer enough to run them. So they are developed to be capable of using cloud computing to perform extensive evaluations.

Popular Cloud Applications: A Case study

Applications using cloud computing are gaining popularity day by day for their high availability, reliability and utility service model. Today many cloud providers are in the IT market. Of those Google App-Engine, Windows Azure and Amazon EC2, S3 are prominent ones for their popularity and technical perspective.

Amazon EC2 and S3 Services

Amazon Elastic Computing (EC2) [13] is one of the biggest organizations to pro-vide Infrastructure as a Service. They provide the computer architecture with XEN virtual machine. Amazon EC2 is one of the biggest deployment of XEN architec-ture to date. The clients can install their suitable operating system on the virtual machine. EC2 uses Simple Storage Service (S3) for storage of data. Users can hire suitable amount CPU power, storage, and memory without any upfront com-mitment. Users can control the entire software stack from kernel upwards. The architecture has two components one is the EC2 for computing purposes and S3 is for storage purposes.

- Simple Storage Service: S3 can be thought as a globally available distributed hash table with high-level access control. Data is stored in name/value pairs. Names are like UNIX le names and the value can be object having size up-to 5 GB with up-to 4K of metadata for each object. All objects in Amazon's S3 must t into the global namespace. This namespace consists of a \bucket name" and an \object name". Bucket names are like user names in traditional email account and provided by Amazon on rst come rst serve basis. An AWS (Amazon Web Services) account can have maximum of 100 buckets.

- Data to S3 can be sent by SOAP based API or with raw HTTP \PUT" com-mands. Data can be retrieved using SOAP HTTP or BitTorrent. While using BitTorrent the S3 system operates as both tracker and the initial seeder. There are also some tools available which enables the users to view S3 as a remote le system. Upload download rate from and to S3 is not that much exiting. One developer from Germany reported experiencing 10-100 KBps. This rate can go up-to 1-2 MBps on the higher side depending on the time of the day. Although the speed is not that much fascinating it is good enough for deliv-ering web objects and for backup purposes although for doing computation it is not suitable.

- Amazon S3 has a very impressive support for privacy, integrity and short term availability. Long term availability is unknown as this depends on the internal commitment of Amazon data centers. Data privacy can be obtained by encrypting the data to be stored. But this encryption is to be done by the user before storing the data in S3. One can use SSL with HTTPS to connect to S3 for more security but this usage of SSL increases upload/download time also. Data integrity can be achieved by checking end to end MD5 checking. When an object is stored into S3 then it returns MD5 of that object. One can easily check it with previously computed hash value to guarantee data integrity. Short term availability depends upon the Amazon's connectivity and load on its server at that instant. Once the data is actually in the S3 then it is Amazon's responsibility to take care of it's availability. They claim that the data is backed up on multiple hard drives in multiple data centers but doesn't guarantee this by any Service Level Agreement. There is no backup or recovery mechanism if the user accidentally deletes any data.

- Amazon has a very impressive scheme of authentication in comparison to other cloud services. Every AWS account has an Access Key ID and a Secret Key.
- The ID is of 20 characters and the Key is a 41 character string. When signing HMAC is rst computed for the sign request parameters using that Key. And in the Amazon server that HMAC is again computed and compared with the value previously computed in the client side. These requests also include timestamp to prevent replay attacks.

- Elastic Compute Cloud: As the name implies EC2 rents cloud of computers to the users with exibility of choosing the con guration of the virtual machine like RAM size, local disk size, processor speeds etc.

- Machines that deliver EC2 services are actually virtual machines running on top of XEN platform. Users can store a disk image inside S3 and create a virtual machine in EC2 using tools provided by Amazon. This virtual machine can be easily instantiated using a java program and can also be monitored. As EC2 is based on XEN it supports any linux distribution as well as other OSs. Amazon does not promise about reliability of the EC2 computers. Any machine can crash at any moment and they are not backed up. Although these machine generally don't crash according to the experience of the users but it is safe to use S3 to store information which is more reliable and replicated service. EC2 security model is similar to that of S3. The only di erence is that the commands are signed with an X 509 private key. But this key is downloaded from AWS account so the security depends fundamentally on the AWS username and password.

Google App-Engine

Google App-Engine [1] is a platform for developing and deploying web applications in Google's architecture. This provides Platform as a Service to the cloud users. In 2008 Google App-Engine was rst released as beta version. Languages supported by Google App-Engine are python, java and any extension of JVM languages. App-Engine requires developers to use only languages which are supported by it and this is also applied with APIs and frameworks. Now Google App-Engine allows storing and retrieving data from a BigTable non-relational database.

AppEngine applications are expected to be request-reply based. Google App-engine provides automatic scalability, persistent data storage service. Data store features a query engine and transaction capabilities. These applications are easy to scale as tra c and data storage need to grow so the cloud user doesn't have to worry about the spikes in the tra c or data. These applications are generally suitable for social networking start-ups, event-based websites catering to seasonal events or institutions (schools, colleges, universities, government agencies) etc .

Windows Azure

Windows Azure [9] is an intermediate in the spectrum of exibility vs programmer convenience. These systems use .NET libraries to facilitate language independent managed environment. This service falls under the category of Platform as a Ser-vice. Though it is actually in between complete application framework like Google App-Engine and hardware virtual machines like EC2. Azure applications run on machines in Microsoft data centers. By using this service customers can use it to run applications and store data on internet accessible machines owned by Microsoft. windows Azure platform provides three fundamental components - compute com-ponent, storage component and fabric component. Basic components of Windows Azure.

The Compute Service: The primary goal of this platform is to support a large number of simultaneous users. (Microsoft also said that they would use Azure to build their SaaS applications which motivated many potential users.) To allow applications to scale out Microsoft uses multiple instances of that appli-cations on virtual machines provided by Hypervisor. Developers use Windows Azure portal through Web browser, and use Windows live ID to sign in into his/her hosting account or storage account or both.

Two di erent types of Azure instance is available: Web role instance and Worker role instances.

Web role instance: As the name implies this type of instance can accept HTTP or HTTPS requests. For this facility Microsoft uses IIS (Internet Information Services) as a web server inside the VM provided. Developers can build applications using ASP.NET, Windows Communication Foun-dation (WCF) or any other .NET technology or native codes also like C++. PHP or java based technologies also supported in Azure. Azure scales applications by running multiple instances without any a nity with a particular Web role instance. So it is perfectly natural for an Azure application to serve multiple requests from a single user by multiple in-stances. So this requires to write the client state in the Azure storage after each client request.

Worker role instance: This type of instances are very similar to that of Web role instances. But unlike the Web role instances these don’t have

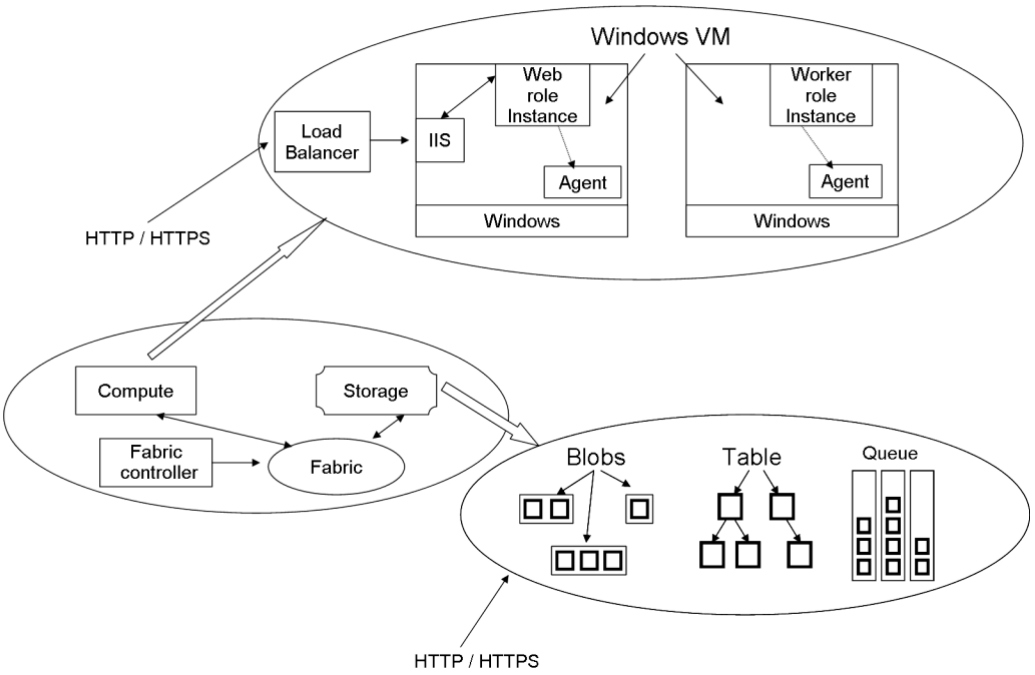

Figure 5: Windows Azure component architecture

IIS con gured. They can be con gured to run executable of users' right. Worker role instance is more likely to function like a background job. Web role instances can be used to accept request from the users and then they can be processed by Worker role instances in a later point of time. For a compute intensive work many Worker role instances can run in parallel.

Loging and monitoring of Azure applications is made easy by provision of application wide log. a developer can collect performance related information like measure of CPU usage, store crash dumps in the storage. Azure doesn't give the developer the freedom to use his/her own VM image for Windows Azure. The platform maintains its own Windows. Applications in Azure run only in user mode - no administrative access isn't allowed here. So Windows Azure can update the operating system in each VM without any concern of a ecting the applications running on it. This approach separates administrative work from the user domain.

The Storage Service: Applications running in Azure uses storage of di erent types

- Blobs: This is used for storing binary data in a simple hierarchy. Blobs can have associated metadata with them. A user account can have one or more containers and these containers have one or more blobs.

- Storage tables: Blobs provide mechanisms for unstructured data but for more structured purposes tables are more suitable. These tables are nothing like tables in a traditional database. They are actually stored in a group of entities. These tables can be accessed by using ADO.NET Data Services. SQL is not preferable for scale out issues.

- Queue : This is not a structure like tables or blobs to store data but these queues are used to store messages about tasks to be performed by Worker role instance. These tasks are written by Web role instances on receiving request from clients. A Worker role instance waiting on that queue can read the message and perform the task it species.

All data in the Windows Azure storage is replicated three times for providing fault tolerance. Azure also keeps backups in geographically distributed data centers. Windows Azure storage can be accessed by any Windows Azure application as well as any application hosted at another cloud platform. All the blobs, tables, queues are named using URIs and can be accessed by HTTP methods calls.

Some applications have inherent need for relational databases. This is provided in the form of SQL Azure. This is build on Microsoft SQL Server. This data can be accessed via ADO.NET or by other Windows data access interfaces.

The Fabric: All Windows Azure application and all of the data stored in Azure Storage live are physically happen inside some of the data centers handled by Microsoft. In the data centers the set of machines dedicated to Azure are organized into a fabric. These machines are managed by fabric controller. These are replicated in ve to seven machines. These controllers are aware of every Windows Azure application running in that fabric and also owns all the resources like computers, switches, load balancers etc. Controllers monitors, decides which resources to allocate to new applications looking at the con guration le with the application. They also monitor the running applications.

Advantages of Cloud Computing

The servitized nature of cloud computing has the potential to bring a number of advantages to the consumers (and the wider community) of this service model. Cost, efficiency and the environment are the most important ones.

Cost and EfficienCJCloud computing services could provide many organizations that use them with the opportunity to continue to take advantage of new developments in IT technologies at affordable costs. Organizations that adopt this service model will be able to access the latest technology in terms of software and hardware (onasay basis) without having to spend great sums of money on software licences and upgrades and expensive hardware. One of the characteristics of disruptive innovations, as indicated above,

is that they tend to occur when characteristics of existing products and services (e.g., size, price, complexity) limit the number of potential consumers or force consumption to take place in inconvenient or centralized settings. On that basis, cloud computing is likely to be particularly attractive (from an economic viewpoint) to startup, small to medium enterprises (SMEs) and educational establishments which have demonstrated increasing interest in this computing service (Sultan, 201 Oa; Sultan, 201 Ob; Sultan, 2011).

However, dontrary conventional wisdom, there is also evidence to suggest that even large companies are actually embracing the cloud. A report by Forrester (the independent technology and market research company), a survey of small and large enterprises located in North America and Europe revealed that large firms were more interested than small firms in leveraging laaS (Infrastructure as a Service) external cloud capability (Golden, 2009).

Environmental Factors:

clients (and indeed society) in other no less important ways. It has the potential to reduce 000 MW of electric power, which is about 10 per cent of global consumption (see Lefevre and Pierson, 2009). Subscription to public clouds will enable organizations to spend less money on electricity for powering and cooling their computing hardware. It will also enable those organizations to devote less space to house their IT infrastructures and resources (an advantage where square foot rent is at a premium). There is increasing government pressure on companies in the UK and elsewhere to reduce their carbo.

Commitment (recently renamed the Energy Efficiency Scheme) is aimed at reducing carbon emissions within the UK by 60 per cent by 2050, in comparison to 1990 levels. On a regional level, the EU Energy Using Products Directive is aiming to reduce the environmental impact caused during the manufacture, use and disposal of a very wide range of products (excep1 vehicles for transport). Consumers of cloud services will find themselves in an advantageous position with regard to this issue in a more environmentally friendly and greener future with more ethically conscious consumers.

Cloud Problems

Cloud computing, as indicated earlier, is an emerging paradigm for servitizing the IT industry and a disruptive innovation. And, as is the case with new disruptive innovations, there are likely to be some issues associated with it. Loss of control, vendor lock-in, security, privacy and reliability are examples of some of those issues.

A 2008 survey of 244 chief information officers and IT executives by IDC (International Data Corporation), the market research firm, revealed that 75 per cent of the respondents rated security as their main cloud computing concern while performance and availability were the next two concerns for 63 per cent of the respondents (Cisco, 2009). Moreover, various governments, such as those in the European Union (EU), have privacy regulations that prohibit the transmission of some types of personal data outside the EU. This issue, however, is no longer a problem as many cloud vendors now (such as Amazon, Microsoft and others) are able to establish some of their cloud data centres in various locations across

the EU region and elsewhere in the world and can offer their cloud clients the option of where they want to store their data.

Organizations are likely to adopt a careful approach to cloud computing. Another previous survey by EDUCAUSE (a US-based non-profit organization) involving 372 of its member institutions revealed that a great proportion of the respondents with use cases that involved cloud-based services reported that data privacy and data security risks were among their top barriers to overcome (Goldstein, 2009).

Another concern is vendor-lock and failures. Currently, many cloud providers offer their services through proprietary APIs (Application Programming Interfaces). Portability is likely to be increasingly important as the number of cloud providers increases. One solution would be to base those APIs on open source message standards such as SOAP or REST. SOA (Simple Object Access Protocol) and REST (Representational State Transfer) are open source methodologies for sending requests and receiving responses by client applications accessing Web-hosted

applications. In some situations this is already happening. For example, Amazon

protocols. The need for inter-cloud interoperability was highlighted by Vint Cerf, a co-d the current lack of cloud communication standards to that of computer networks in the early 1970s (Krill, 2010). However, there are currently efforts by some organizations such as the Cloud Computing Interoperability Forum to address this issue (Grossman, 2009), IEEE, the Open Data Center Alliance (ODCA) and the Distributed Management Task Force (DMTF) (the latter two working in partnership).

Furthermore, failure of a cloud provider that hosts client data in its data centres can have serious repercussions for those clients who entrusted their data to such providers. This issue could force potential cloud users to go for large and well established companies that are more likely to be around for many years to come.

Lastly, reliability can also be a serious problem for cloud users. Outages dating from 2008 to 2011 disrupted the services of many of the big cloud providers such as Salesforce.com, Amazon, Google and Microsoft. For more information on those and other outages in that period see (Raphael, 2011). In keeping with previous years, the year 2012 also had its fair share of high profile cloud outages. For example, on 28 February, a so-called leap-year bug lasted for more than 24 hours. Azure customers in Western Europe had also endured a loss of

-region. On 15 June,na Amazon Web Services (AWS) power outage cut services to customers for about six hours,affecting its Elastic Compute Cloud (EC2) service, Amazon Relational Database Service and rginia.

Google-managed data centres, went down on 26 October for about four hours due to slowness and errors causing 50 per cent of requests to the App Engine to fail (McCarthy, 2012).

Cloud computing may not be suitable for all organizations. For example, for large companies (especially those who use the Web for selling most of their products), the loss of service as a result of cloud glitches would be a major concern, particularly if it impacts on their customers and results in

substantial loss of sale opportunities and customer dissatisfaction. The issue of reliability with relation to cloud services will continue to be a problem. Similar glitches that befell the aforementioned cloud services of Amazon, Google, Microsoft and Salesforce.com are likely to surface again as the number of cloud providers and users increases. However, for small companies struggling to survive the current global economic downturn and cash strapped educational establishments, often used to similar glitches caused by their old in house systems, cloud computing is likely to remain an attractive option due to its cost structure and flexibility.

For organizations involved in scientific and medical research, for example, most of the aforementioned concerns may not be as important to them as they might be to those who provide products and services to consumers, e.g. e-commerce companies. The loss of a few hours of services may not be as dramatic for an organization conducting a research experiment as it would be for online auctions or online retailers. Furthermore, issues of privacy and data protection are likely to be of less concern or indeed relevance, especially if research organizations only use an laaS cloud for high speed compute operations. So, while

the aforementioned cloud drawbacks will remain of concern to many organizations contemplating using cloud computing, their current advantages are likely to outweigh their potential disadvantages for SMEs and the educational and scientific communities.

Conclusion

Cloud Computing is a vast topic and the above report does not give a high level introduction to it. It is certainly not possible in the limited space of a report to do justice to these technologies. What is in store for this technology in the near future? Well, Cloud Computing is leading the industry's endeavour to bank on this revolutionary technology.
Today, with such cloud-based interconnection seldom in evidence, cloud computing might be more accurately described as "sky computing," with many isolated clouds of services which IT customers must plug into individually.
Cloudloud Computing is a technology which took
the software and business world by storm. The much deserved hype over it will continue for years to come.

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 headache.
Cloud computing services can also grow and shrink according to need. Cloud computing is particularly valuable to small and medium businesses, where effective and affordable IT tools are critical to helping them become more productive without spending lots of money on 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.
Cloud Computing is the next big thing in the arena of computing and storage. There are some concerns about security and its availability. However, different service providers are coming up with various solutions and suggestions in response to customers' concerns. In any case, cloud is getting bigger and better, and as long as they are available through web services, without capital infrastructure investment at reasonable price, it is for sure going to proliferate and create robust demand in times to come.