Information Services Paradigm for Small and Medium Enterprises Based on Cloud Computing

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***Abstract*—Small and medium enterprises (SMEs) have played a vital role in technology innovation and development of national economy throughout the world. To be competitive and to react faster to the market demands, SMEs need new information processing techniques to analyze the increasing amount of produced data, and innovative solutions in order to manage the computational resources with better flexibility, scalability, efficiency and smaller costs. The emergence of Cloud Computing represents a valuable answer to these requirements to be satisfied with these information services. Combining the architecture, characteristics of Cloud Computing with the actual needs of the SMEs, this paper proposes the architecture, utilities and major challenges of information service paradigm for SMEs using Cloud Computing. This information service paradigm always responds to the SMEs typical requirements: quality of service, high-availability.**

***Index Terms*—Cloud Computing, SMEs, Information Services, Services Paradigm**

I. INTRODUCTION

SMEs play an important role in economic development of a country. Several theories elaborate on connection between information technology, economic development and social change. Almost all agree on the importance of information technology adoption in SMEs. Compared with traditional business, information technologies facilitate an increased interactivity, flexibility, cheap business transactions as well as improve interconnection with business partners and costumers. For example, information technology can provide effective interface between users and computer technology and provide information for the managers on the day-to-day operations of the enterprises, and it can provide the decision making in all levels of management in enterprises [1].

SMEs need spend more time in purchasing, installing, and upgrading applications in order to fit with business partners, costumers and their own management requirements. And they spend on more time and money on the latest computer technology with their faster processors as well as on internal and external storage devices. Traditionally, SMEs come by these resources through much time and effort and at great expense by building it out and managing it themselves.

Cloud Computing is the new trends of Internet. It is the development of parallel computing, distributed computing and grid computing, or is the business realization of these concepts. Based on the virtualization technology and powerful storage and computing capacity of the integration of PCs and servers. Cloud Computing can provide SMEs with applications which are in the "cloud" anytime, anywhere through different kinds of terminals. It eliminates the bound of limited physical resources and reduces development costs.

Cloud Computing is the new trends of Internet. It is the development of Parallel Computing, Distributed Computing and Grid Computing, or is the business realization of these concepts. Based on the virtualization technology and powerful storage and computing capacity of the collection of PCs and servers, Cloud Computing can provide Infrastructure as a service (IaaS), Platform as a service (PaaS) and Software as a service (SaaS), etc. Cloud Computing can provide SMEs with applications which are in the "cloud" anytime, anywhere through different kinds of terminals. It eliminate the bound of limited physical resources and reduce development costs. Therefore, SMEs should make full use of this variety of types of sharing services in order that they cannot spend more time in purchasing, installing, and upgrading information technology applications in order to fit with business partners, costumers and their own management requirements.

The main purpose of this paper is to research the information services paradigm for SMEs Combining the architecture, characteristics of Cloud Computing with the actual needs of the SMEs. It proposes the model, utilities and major challenges of information service for SMEs using Cloud Computing. Through this information services paradigm, SMEs can break tradition and avoid expensive build-outs. With it, it can help SMEs access high-performance IT services with lower cost, and also conducive to SMEs to access high-performance IT services like large enterprises. And enhance the SMEs' overall IT standards and competitiveness. At the same time, the reduction of IT burden can help SMEs to concentrate on their core business.

This paper is organized as follows: Section 2 gives the definition of Cloud Computing, Cloud Computing architecture and Cloud Computing characteristics. Our findings are discussed in section 3. Finally section 4 concludes the paper.

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II. PAIN POINT OF INFORMATION TECHNOLOGIES IN SMES

SMEs are important because of their potential contributions to improvement of income distribution, employment creation, poverty reduction, industrial development, rural development, and growth of export revenues. With the development of enterprises, SMEs information requirements are increasingly high. But, at this stage, SMEs' the level of development of SMEs information technology are not as large enterprises(LEs), Many SMBs have smaller IT staffs, limited IT infrastructure, limited budgets, etc. than LEs. As for SMEs, There are several main pain point of information technologies at present as follows(shown in figure 1).

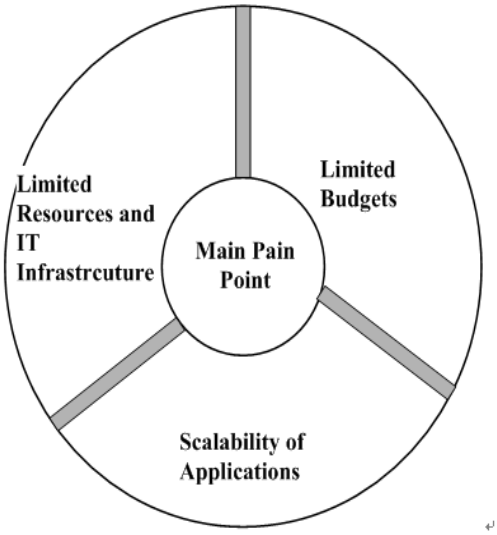

Figure 1. **M**ain pain point

(1) Limited Resources and IT Infrastrcuture

SMBs often have small IT departments with limited resources and are often hampered by lack of IT infrastrcuture to scale up their business with operational efficiency and better performance. The difficulties also lie in finding quality manpower in handling the respective departments, especially the IT. It would be impossible for these smaller enterprises to emulate the productivity of massive IT outfits with huge budgets. So they need a new technology that it can bring the same result used by LEs.

(2) Limited Budgets

SMBs have to work on limited budgets to invest on various technologies or update the existing IT infrastructure frequently, which is one of the major pain points of SMBs. With limited resources in place, it's a big challenge for SMBs to look for a better return on investment. These factors, often perceived as the major pain points of SMBs in adopting IT, results in the risk of falling behind in LEs and be tough to keep up with the LEs in any given market. Still, a new technology needs changing the way things, not only that is dynamic and customizable for each individual business, but they are also scalable. SMBs can set up a framework that suits your business perfectly, and SMBs can do it on a tight budget.

(3) Scalability of Applications

SMBs own little application system, they could not dream up available applications. Still, a new technology needs changing the way things, SMBs do not need an expensive IT department to keep their business rolling anymore. A new technology can take the load right off SMBs shoulders. Costs are reduced, and more capital is freed up. Barriers to entry in the market are being eliminated as third-party infrastructure providers make their mark. The IT world is changing, and SMBs are now able to compete like LEs before.

Generally, enterprise can scale a given application by adding more or larger resources when needed. Resources can be many things including servers, processors, storage, and networking bandwidth. Scalable applications are able to operate normally as they grow and can have more resources added at any time to service more customer demands. Applications that are not scalable may encounter performance and service availability problems as demand increases. These kinds of non-scalable applications may not be able to take advantage of more resources.

So, SMEs need new information service paradigm to provide superior value, better than competitors, when it comes to quality, price and services. Cloud Computing can help SMEs access high-performance IT services with lower cost, and also conducive to SMEs to access high-performance IT services like large enterprises. At the same time, Cloud Computing can help SMEs to reduce the IT burden and concentrate on its core business.

III. CLOUD COMPUTING

The following is the Cloud Computing definition, Cloud Computing architecture, Cloud Computing service and Cloud Computing characteristic.

A. Cloud Computing Definitions

Cloud computing is Internet-based computing, whereby shared resources, software and information are provided to computers and other devices on-demand, like a public utility, which require for you to pay for what you actually use[2,3].

B. Cloud Computing Architecture

Basically the whole architecture is three layers shown in figure 2: (1) resource (2) platform and (3) application. The resource layer is the infrastructure layer which is composed of physical and virtualized computing, storage and networking resources.

The platform layer is the most complex part which could be divided into many sub-layers. A computing framework manages the transaction dispatching and/or task scheduling. A storage sub-layer provides unlimited storage and caching capability. The application server and other components support the same general application logic as before with either on-demand capability or flexible management, such that no components will be the bottle neck of the whole system.

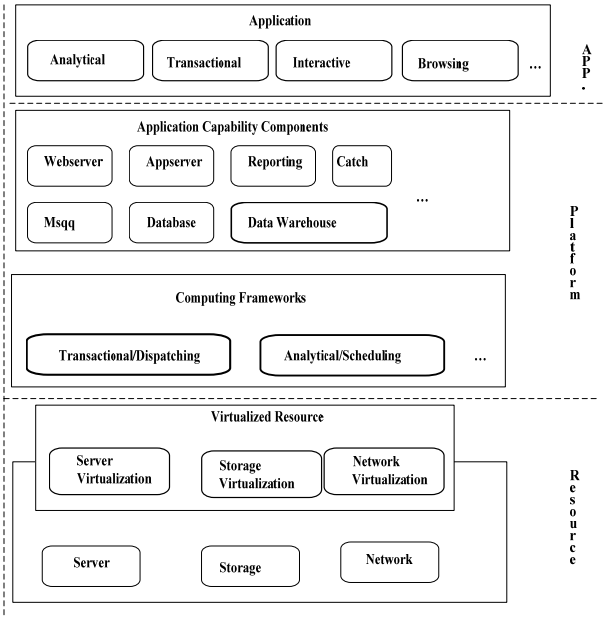

Figure 2. Cloud Computing Architecture

Based on the underlying resource and components, the application could support large and distributed transactions and management of huge volume of data. All the layers provide external service through web service or other open interfaces.

C. Cloud Computing Service

There are different categories of Cloud Computing services such as infrastructure, platform, application etc. These services are delivered and consumed in real-time over the Internet.

Software-as-a-Service (SaaS): SaaS [4] commonly referred to as the Application Service Provider model, is heralded by many as the new wave in application software distribution. Examples of the key providers are CRM/ERP/HR, industry application etc.

Platform-as-a-service(PaaS): Compared with conventional application development, this strategy can slash development time, offer hundreds of readily available tools and services, and quickly scale.

Hardware–as-a-Service(HaaS): As a result of rapid advances in hardware virtualization, IT automation, and usage metering and pricing, this model is advantageous to the enterprise users, since they do not need to invest in building and managing data centers .

Infrastructure-as-a-Service(IaaS): Customers can achieve a much faster service delivery and time to market. Key examples are Storage, Netware, Storage, etc.

D. Virtualization Technology

Virtualization technology refers to the abstraction of logical resources away from their underlying physical resources in order to improve agility, flexibility, reduce costs and thus enhance business value. It is the key delivery technology in Cloud Computing. In a Cloud Computing, virtualization refers primarily to platform virtualization, or the abstraction of physical IT resources from the users and applications using them. Virtualization allows servers, storage devices, and other hardware to be treated as a pool of resources rather than discrete systems, so that these resources can be allocated on demand. In a virtualized environment, computing environment can be dynamically created, expanded, shrunk or moved as demand varies. Virtualization is therefore extremely well suited to a dynamic cloud infrastructure, because it provides important advantages in sharing, Manageability and isolation.

Platform virtualization is performed on a given hardware platform by a control software, called a hypervisor or virtual machine monitor shown in figure 3. This software creates a simulated computer environment, called a virtual machine, for its guest software. The guest software, which is often itself a complete operating system, runs just as if it were installed on a stand-alone hardware platform. The current leading virtualization and software providers include VMware, Xen , KVM , Force.com and Microsoft Virtualization.

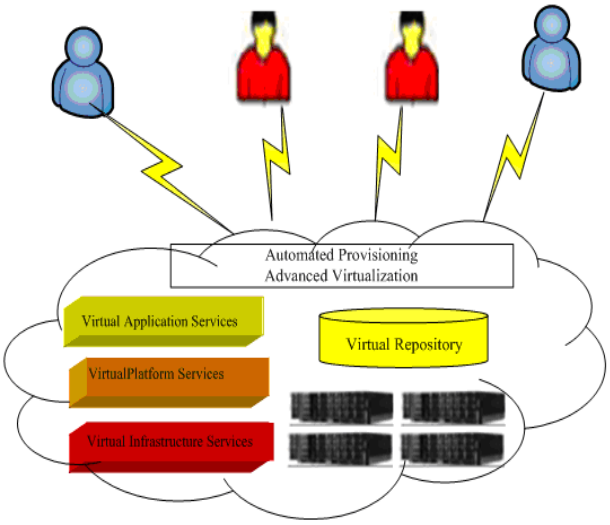

Figure 3. Virtualization Technology

As a means of encapsulation of physical resources, virtualization solves several core challenges of datacenter managers and delivers specific advantages, including:

(1) Higher Utilization Rates: Through virtualization, workloads can be encapsulated and transferred to idle or underused systems. This means that existing systems can be consolidated, so purchasing additional server capacity can be delayed or avoided.

(2) Resource Consolidation: Virtualization allows for consolidation of multiple IT resources. Beyond server and storage consolidation, virtualization provides an opportunity to consolidate the systems architecture, application infrastructure, data and databases, interfaces, networks, desktops, and even business processes, resulting in cost savings and greater efficiency.

(3) Lower Power Usage/Costs: Using virtualization to consolidate makes it possible to cut total power consumption and save significant costs.

(4) Space Savings: Server sprawl remains a serious

problem in most datacenters, but datacenter expansion is not always an option, with expensive building costs and cooling costs. Virtualization can alleviate the strain by consolidating many virtual systems onto fewer physical systems.

E. Cloud Computing Characteristics

Cloud Computing are commonly associated with the following Characteristic:

(1) Cloud Services Model: In the Cloud Computing, computing and storage resources form variety of services to users and a number of functions of PC have been transferred to the clouds. All the complex calculation can be executed by clouds which further simplified the functions of terminals [5].

(2) Virtualization Technology: Virtualization technology is the key of Cloud Computing and is the foundation for building cloud services [6]. Cloud Computing provides virtualization to all of hardware, storage, network resources and establishes a resource pool. User requests the resources from the cloud rather than a fixed physical entity.

(3) High scalability, security and reliability: Cloud Computing has a good scalability, reliability and flexibility which meet the needs of the scale of growth of users. It is more effective to manage, control and use data which are centralized stored in the cloud. Data in the cloud can get unified management, load balancing, resource allocation, deployment of software, control security and the security of reliable real-time testing[7], so that the user's data security is guaranteed greatly.

(4) Resource outsourcing: Instead of a consumer providing their own hardware, the cloud vendor assumes responsibility for hardware acquisition and maintenance.

(5) Utility computing: The consumer requests additional resources as needed, and similarly releases these resources when they are not needed. Different clouds offer different sorts of resources, e.g., processing, storage, management software, or application services [8].

(6) Automated resource management: This feature encompasses a variety of configuration tasks typically handled by a system administrator.

IV. INFORMATION SERVICES PARADIGM USING CLOUD COMPUTING

Combining the architecture, virtualization technology, characteristics of Cloud Computing with the actual needs of the SMEs, in this part it proposes the architecture, utilities and major challenges of information service paradigm for SMEs using Cloud Computing. This information service paradigm can be dynamically provisioned with computing infrastructure, compute resources, storage resources, as well as applications on a pay per use basis.

A. The Architecture of Information Services Architecture for SMEs using Cloud Computing

It shows the architecture for supporting SMEs oriented computing infrastructure, Compute resources and storage resources allocations in Cloud Computing in Fig.4. There are basically four main entities involved:

(1) Users/SMEs: Users or SMEs acting on their behalf submit service requests from anywhere in the world to the Cloud Computing to be processed.

(2) SLA Resource Allocator: The SLA Resource Allocator acts as the interface between the Cloud service provider and external users/SMEs. It requires the interaction of the following mechanisms to support SLA-oriented resource management:

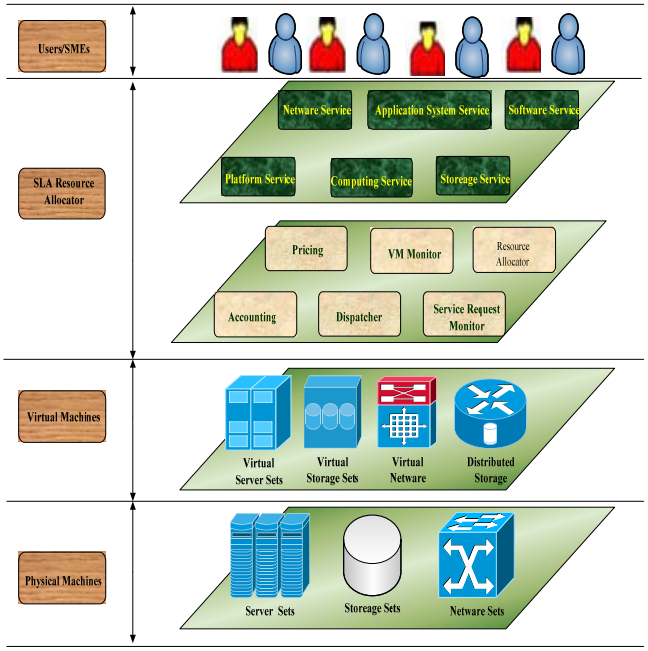

Figure 4. SMEs-Oriented Cloud Computing architecture

Pricing: The Pricing mechanism decides how service requests are charged. For instance, requests can be charged based on submission time (peak/off-peak), pricing rates (fixed/changing) or availability of resources (supply/demand). Pricing serves as a basis for managing the supply and demand of computing resources within the Data Center and facilitates in prioritizing resource allocations effectively.

Accounting: The Accounting mechanism maintains the actual usage of resources by requests so that the final cost can be computed and charged to the users. In addition, the maintained historical usage information can be utilized by the Service Request Examiner and Admission Control mechanism to improve resource allocation decisions.

VM Monitor: The VM Monitor mechanism keeps track of the availability of VMs and their resource entitlements.

Dispatcher: The Dispatcher mechanism starts the execution of accepted service requests on allocated VMs.

Service Request Monitor: The Service Request Monitor mechanism keeps track of the execution progress of service requests. When a service request is first submitted, the service request examiner and admission control mechanism interprets the submitted request for QoS requirements before determining whether to accept or reject the request. Thus, it ensures that there is no overloading of resources whereby many service requests cannot be fulfilled successfully due to limited resources available. It also needs the latest status information regarding resource availability (from the VM monitor mechanism) and workload processing (from the service request monitor mechanism) in order to make resource allocation decisions effectively. Then, it assigns requests to VMs and determines resource entitlements for allocated VMs.

VMs: Multiple VMs can be started and stopped on-demand on a single physical machine to meet accepted service requests, hence providing maximum flexibility to configure various partitions of resources on the same physical machine to different specific requirements of service requests. In addition, multiple VMs can concurrently run applications based on different operating system environments on a single physical machine since every VM is completely isolated from one another on the same physical machine.

Physical Machines: The Data Center comprises multiple computing servers that provide resources to meet service demands.

From the Cloud Computing architecture, it can provide SMEs with many information system services in order to fit the SMEs requirement that there are many information system development fashions in SMEs. And among SMEs, they can establish a long term partnership to share information, resource, benefit and risk with the business partner because VMs is the ability to host multiple operating system environments which are completely isolated from one another on the same physical machine and is the capability to configure VMs to utilize different partitions of resources on the same physical machine. At the same time, SMEs have scalable abilities of an application to expand to meet enterprise business needs. Furthermore, SMEs can use the existing information systems in Cloud Computing, such as operation system, network system, developing language and database environment etc., when the SMEs are different development time.

B. Utility of using Cloud Computing

With this information service of Cloud Computing, it can help SMEs to get information services with lower cost, and also conducive to SMEs to access high-performance IT services like large enterprises. At the same time, the reduction of IT burden can help SMEs to concentrate on its core business. The process optimization which based on Cloud Computing can achieve throughout a large-scale reconstruction of the SMEs informationization, and enhance the overall IT standards and competitiveness of SMEs. Following are some major utilities of implications shown in figure 5.

(1) Unrestricted data storage

Vertically limitless storage, Virtualized data access, Convenient data recovery and back up plans are some time not possible within in-house ability. Due to rapidly incremental data, present 200GB hard drive is nothing in compare to accessible million's of GB storage spaces in Cloud Computing environment. SMEs can store what ever you want to stock up.

(2) Enhanced data computation

The research of SMEs involving complex computation in many fields e.g. Chemistry, Physics, Mathematics, Computer vision. Where large computational data need to be solved and used to take several days or months with very expensive data processing environment, by grace of Cloud Computing now this is quite possible to achieve faster and more accurately with expensive work space for every research.

(3) Improves data redundancy

Cloud storage systems commonly based on a large number of servers. Because computers seldom involve in safeguarding or repair, it's crucial to pile up the information on several server machines (called redundancy). In absence of redundancy a cloud storage space system couldn't guarantee user's accessibility to their data at any time.

(4) Increased data dependability

The crash of personal machine or a terminal doesn't affect the storage of data .because all your data reside in cloud you can easily access where every whenever through other terminal or mobile device, just having internet connection.

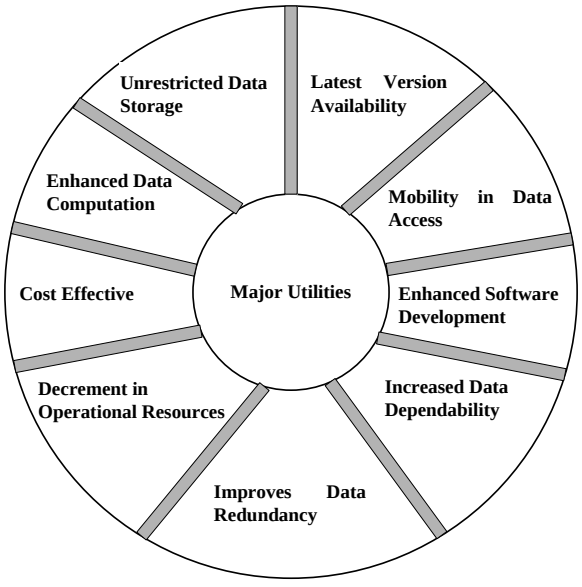

Figure 5. Major utilities of Cloud Computing implication

(5) Decrement in operational resources

Scalability of organization in short period of time or reduction in operational resources(e.g. data storing staff. IT Staff. Environmental resources including continues

power supply. Security cost. Maintenance cost and limited location) are easily manageable under clouds cost effectively and efficiently.

(6) Latest version availability

When user change a document at one place, that changed in version is what user have other place (e.g. at work).The cloud always entertained with the latest version of users documents: as long as user have internet connection, SMEs never are in danger of having an outmoded edition.

(7) Enhanced software development

By Cloud Computing environment, now it is much easier to solve large software development in pieces and then recombine those without limiting the work spaces and then recombine those without limiting the work space location foe developers to access there development data and on top considerably in shorten period of time with high accuracy rate.

(8) Mobility in data access

The centric attribute of services and data storage environment make SMEs machine interdependent, Applications for accessing data its self reside in cloud. SMEs can access their data, where ever when ever they need.

(9) Cost effective

Pay as SMEs go nature of the services, in cloud environment makes possible to start with services having cheaper devices and data storage. With this information services, having cheaper devices and data storage, Instead of buying expensive software application(e.g. Microsoft office desktop application).

Through the unrestricted data storage, enhanced data computation provided with Cloud Computing. The transfer of business information of SMEs into the cloud is very straightforward. There is no need to install new hardware or software as everything is run by the cloud provider. And the resources provided with Cloud Computing are on-demand for many of the typical scaling points. The on-demand nature of cloud computing means that as an SME demand grows, Cloud Computing can more easily match your capacity to your demand.

Cloud Computing provides with built-in data protection, fault tolerance, self-healing and disaster recovery. With this improved data redundancy, increased data dependability, disaster recovery is estimated to use fewer time to recover. Additionally, because cloud service providers replicate their data, even the loss of one or two data centers will not result in lost data. Cloud computing provides a high level of redundancy at a point traditional managed solutions cannot match.

In contrast to traditional IT models which can involve expensive software licenses and long lock-in contracts, cloud computing allows developers and IT operations to develop, deploy and run applications that can easily grow capacity, work fast and never- or at least rarely -fail. Most cloud providers employ infrastructure software that can easily add, move, or change an application with very little, if any, intervention by cloud provider personnel. This dynamic, elastic nature of cloud computing is what gives it a big advantage over an in-house data centre. Cloud Computing allows SMEs to react more quickly to market conditions and to scale up and down as needed. New applications can be quickly released with lower up-front costs. The flexibility offered by cloud computing enables innovative ideas of SMEs to be rapidly tried and tested without the need to divert existing IT staff from their daily routine.

With cloud computing you move from a capital investment to an operational expense. Businesses of SMEs that move to the cloud can make savings on many different levels - IT hardware and software expenditure is cut dramatically and fewer staff or support resources are needed for IT maintenance. The cloud model offers a much cheaper way for businesses to acquire and use IT. In an economic downturn the appeal of that cost advantage will be greatly magnified.

In conclusion, the Cloud Computing is a useful strategy for SMEs. It can Satisfy business requirements on demand by resizing the resource occupied by application to fulfill the changing the customer requirements, lower cost and energy-saving by making use of low cost PC, low power consuming hardware and server virtualization, improve the efficiency of resource management through dynamic resource scheduling.

C. Major Challenges

However, with the use of Cloud Computing, there are growing concerns over the control ceded to large Cloud vendors, including the lack of information privacy. Also, the Cloud Computing centers required are growing exponentially, creating an ever-increasing carbon footprint, raising environmental concerns. There are also some major challenges to be studied shown in figure 6.

(1) privacy and security: SMEs have concerns on their privacy and data security than traditional hosting service.

(2) continuity of service: It refers to the factors that may negatively affect the continuity of Cloud Computing such as Internet problems, power cut-off, service disruption and system bugs.

(3) service migration: Currently, no regularity organizations have reached the agreement on the standardization of Cloud Computing external interface. As a result, once a SME started to use the service of a Cloud Computing provider, the SME is most likely to be locked by the provider, which lay the SMEs in unfavorable conditions.

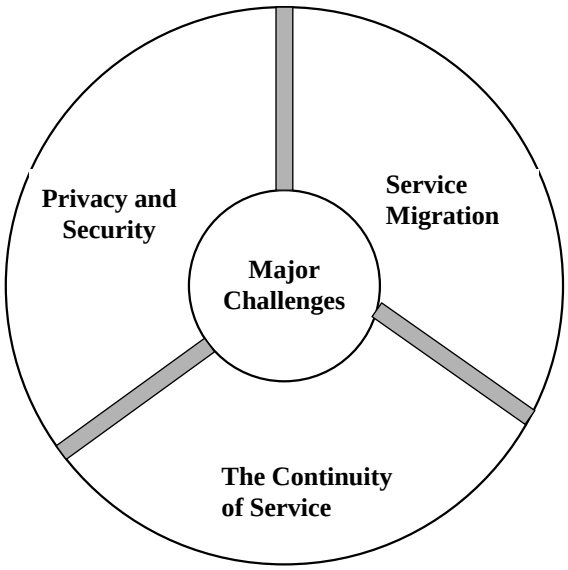

Figure 6. Major challenges

V. CONCLUSION

The main purpose of this paper is to research the information services paradigm for SMEs Combining the architecture, virtualization technology, characteristics of Cloud Computing with the actual needs of the SMEs. It proposes the model, utilities and major challenges of information service for SMEs using Cloud Computing. Through information services paradigm, it can provide SMEs with many information services in order to fit the SMEs requirement and SMEs can establish a long term partnership to share information, resource, benefit and risk with the business partner and have scalable abilities of an application to expand to meet enterprise business needs, and can use the existing information systems in Cloud Computing, such as operation system, network system, developing language and database environment etc.

Furthermore, it proposes some major utilities of implications by Cloud Computing and also some major challenges to be studied. However, Cloud Computing is the best way for SMEs adopting advanced technology enterprises, because it eliminates the cost of buying, building and maintaining of the IT infrastructure and applications. The research on application of Cloud Computing in SMEs will accelerate the realization of Cloud Computing in the SMEs, and improve the IT quality of SMEs.

Cloud Computing isn't yet at the center of most SMEs' attention. The odds are good, though, that this won't be true before more years. The attraction of cloud-based computing, including scalability and lower cost, are very real. So, it's expected the cloud to play an increasing role in the future. The next generation of computing is here.

In the future, we will continue along the direction of the information service paradigms of Cloud Computing, and identify other emerging research issues. We also plan to reason and analyze Cloud Computing and explore technical practices using our models.

ACKNOWLEDGMENT

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