Building Cloud Enterprise Resource Planning Systems from Traditional Enterprise Resource Planning System Based on Cloud Application Platform

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Abstract: *ERP is now facing serious challenges and difficulties under the networked and global manufacturing, to solve the complex development and application problems of Enterprise Resource Planning (ERP). There are some shortcomings raised due to the huge amount of resources required for the implementation and big risk of failure, it needs the cloud computing. ERP system based on cloud computing is put forward and several key technologies are discussed in this study. The concept and characteristics of cloud ERP are defined and the architecture of service-oriented ERP in sale force platform based on cloud computing is proposed. The aim in this paper, it established the theoretical and technological support for helping to construct the cloud ERP system from old ERP system under force.com platform.*

Keywords: *Enterprise Resource Planning; Cloud Computing; Cloud Enterprise Resource Planning*

1. INTRODUCTION

ERP provides businesses flow management and includes manufacturing, accounting, sales and customer relationship management. ERP systems are integrated software packages with a common database that support business processes in companies [1]. Hofmann [2] indicated that ERP systems are undergoing commoditization just like other mature technologies, and big changes of technology and business model are coming for ERP. ERP systems offer advantages introduced through an easy to use, real-time, decision support system, which integrates all organization's functions into one system with single database that can be accesses by suppliers and customers to get timely react regarding their needs [3].

However, despite the huge benefits of ERP systems, there are some shortcomings raised due to the huge amount of resources required for the implementation and big risk of failure, which introduced difficulties prevented small and mid-size organizations from setting up ERP systems [4]. ERP system is a costly and time-consuming system to implement, and enclose high risk of failure and disruption to the customer's business continuity process [5]. ERP systems emerged as a vital tool for many organization, these difficulties demanded the researchers to search for a new way to implement ERP applications [6]. Therefore, it needs a cloud computing ERP system.

Cloud computing is a new paradigm in which computing resources such as processing, memory, and storage are not physically present at the user's location [7]. Cloud computing can ensure the benefit of both vendor and the business user. The cloud is not only created for the ERP the total support and establishment of ERP will be from a cloud [8]. Cloud computing model arise as a new technology depending on providing application and systems services for clients without need to hardware, software, networks, but through using of the provider portal [9]. Cloud Computing refers to a model that deliver its offering and its special services over the Internet [10]. These services can be Software, Hardware, Platforms, Services, Networks, Storage Providers, Servers, Services and etc. There are different companies like Apple, Google and Amazon that provide cloud computing services.

1.1 Research Purpose and Method

This research is on theories and applications of ERP under the new networked state; especially in the cloud computing situation is meaning and practical in sale force (CRM) platform. The objective of this paper is to present a framework that can describe implications of integrating conventional ERP

with SaaS, PaaS and IaaS. This framework will also show the motivations and characteristics of integrating different types of cloud services with conventional ERP based on Sale force cloud services. Figure 1 is denoted as research framework.

The objectives include:

1. To discuss the theory of ERP systems based on cloud computing and the characteristics and key technologies of Cloud computing ERP.

2. To understand the cloud computing architecture and C-ERP architecture.

3. To discuss the construction of Saas service application in Salesforce.com.

4. Cloud computing ERP in cloud application platform

As an initial step, an inclusive review of existing literature on the ERP system and differences between conventional (traditional) and cloud computing ERP. Secondly, it explains cloud computing system. Using this definition, it introduces cloud deployment models and cloud computing architecture. Thirdly, cloud computing ERP is an important issue in organization, and point out the cloud computing ERP architecture. Finally, it presents the application instance with force platform and discusses cloud computing use Salesforce.com and kinds of businesses could benefit from switching to Sales Force.
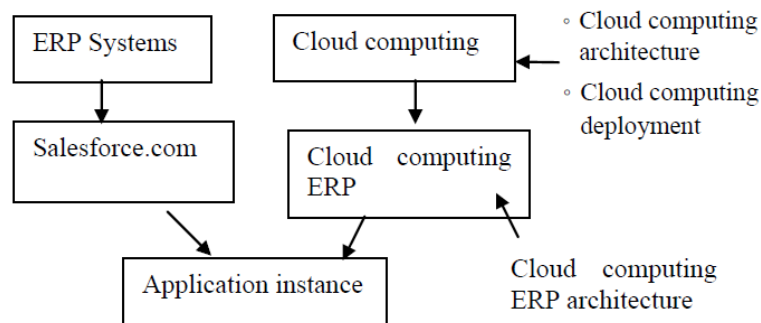

Figure 1. *A research framework*

2. ERP SYSTEMS

ERP refers to the developed technologies that assist managers and employees in meeting the demands of reduced product cost and elevated efficiency [9]. ERP systems integrate the various firms' departments through different business functions to manage the internal resources such as finance, human resources (HR), manufacturing and logistics, and link the firm with the customers and vendors through Supply Chain Management (SCM) and Customer Relationship Management (CRM) [11]. Figure 2 is denoted as ERP system concept.
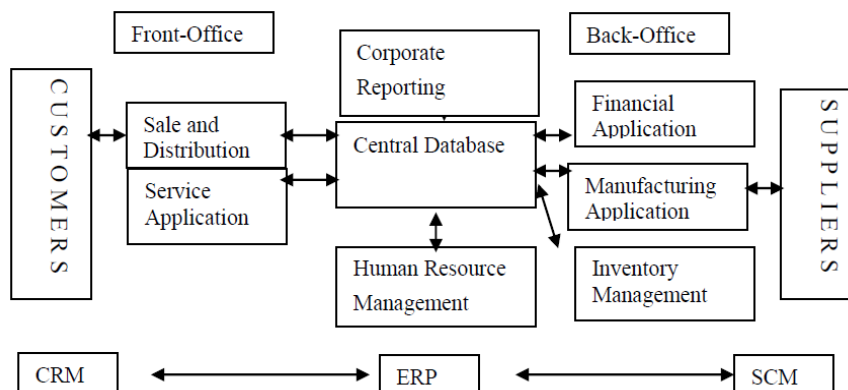

Figure 2. *ERP System Concept*

Source: modify from Rashid et al.(2002)[12]

An ERP system generally includes all the IT systems that enable ERP software to execute and operate efficiently. An ERP system allows an organization to design, execute, operate and maintain an enterprise information system. This system includes the software that provides business functions and processes, computing hardware for hosting and executing software applications, and back-end

network architecture for data communication across and within information systems [11]. ERP system may provide services and solutions such as accounting information systems, financial information systems, production information systems, marketing information systems and human resource information systems [13]. ERP systems are being utilized by enterprises or organizations to increase their profits as well as growth. ERM aims to bring more benefit and less cost to enterprises. But in the process of the ERP using, the effect of ERP is disquieting.

Trunick [14] identified that 40% of all ERP installations only achieve partial completion, and 20% of ERP adoptions are scrapped as total failures. The reported that between 60% and 90% of ERP implementations failed to attain the return on investment (ROI) identified during project and challenging, with significant risk.

In order to solve these problems, the architecture and the ERP operating way have been important embranchments in the field of ERP studies. Cloud computing means to provide services just what customers need. It can be described as an abstraction of the underlying platform which can save customers from the troubles of designing, programming and maintaining, meanwhile, a distinct advantage of cloud computing that can help improve the ERP performance is cloud computing can adjust the services dynamically [13]. The adjustments can be automated from the cloud computing data centers standing by the defined strategies just as the customers' demands. Cloud Computing ERP will be the perfect solution to enterprises [13]. Table 1 is denoted as the differences between conventional (traditional) ERP and cloud computing ERP.

Table 1. *Differences between conventional (traditional) and cloud computing ERP*

Conventional Computing	Cloud computing
Applications	End user cloud services
◦ Client-side apps	◦ Rich internet application
◦ Client/server apps	◦ Web 2.0 technologies
◦ Web interface to local sever apps	◦ Software-as-a-services
◦ Data and process reside on PC or on local sever	◦ Data and process resides at services provider
Developer tools and techniques	App-components-as- a- services
◦ Client-side development tool	◦ Internet-hosted software services
◦ Service-oriented architecture	◦ Web-hosted development tools
◦ Composite application	◦ Community development tools for shared templates and code
◦ Proprietary APIs, such win 32	◦ Proprietary service provider APIs and schema
Middleware	Software-platform-as-service
◦ App sever	◦ Hosted app platform
◦ File and object storage	◦ Hosted data, file, and object stores
◦ Database	◦ Hosted database
◦ Integration sever	◦ Software-integration-as-a-services
Physical infrastructure	Virtual-infrastructure as-a-service
◦ Sever	◦ Virtual sever
◦ Disks	◦ Storage shares
◦ Networks	◦ Virtual LAN configurations
◦ System management	◦ Management-as-a-sever
Cost	Cost
◦ High cost in implementation	◦ Low cost in implementation
◦ High cost in ongoing	◦ Low cost in ongoing
◦ High cost in support cost	◦ Low cost in support cost
◦ High cost in licensing	◦ High cost in licensing
◦ High cost in ERP update and modification	◦ Low cost in ERP update and modification
Others	Others
◦ Independency on internet	◦ Dependency on interne
◦ Audit and trial is easy	◦ Audit and trial is complex
◦ Not open for business organization	◦ Open for business organization

Source : Okezie, et al.[15] and Motalab and Shohag [16].

3. CLOUD COMPUTING TRANSFORM MODEL

Cloud computing has a profound impact on the entire IT industry as a new business model. It can help enterprises to access high-performance IT services with low cost, and also conductive to small and medium-size enterprise to access high-performance IT services like large enterprises ([7].

3.1 Analysis of Cloud Computing System

Cloud computing is the operation of infrastructure, platforms and software in a virtualized environment whose components can be accessed and used over the Internet. Cloud computing systems are classified as public cloud, private cloud, community cloud and hybrid cloud.

- **Public Cloud Computing**: In this model the infrastructure of cloud computing (applications, storage, and other resources) is owned by an organization selling cloud services and it is made available to the public. For example, Amazon AWS, Microsoft and Google are public cloud service providers. They own and operate the infrastructure and offer access only via Internet users can access this service by web browsers. Many popular cloud services are public including Amazon EC2, Google App Engine and Salesforce.com [17].

- **Private Cloud Computing**: The cloud infrastructure (hardware and other IT resources) are operated for a single organization. It may be managed internally by the organization or by a third party. Private clouds are considered to be more secure than public clouds since their users are trusted individuals inside the organization. Hardware and IT infrastructures located in an organization or these infrastructure used with physical separation from other infrastructures, no hardware and software will be shared among users.

- **Hybrid Cloud Computing:** The cloud infrastructure is a composition of two or other clouds computing structures (private, public). Hybrid clouds allow organizations to optimize their resources, so the critical core activities can be run under the control of the private component of the hybrid cloud while other auxiliary tasks many be outsourced to the public component [18]. Hybrid Cloud Computing managed and provisioned as a single unit and circumscribed by a secure network.

- **Community cloud:** The provision of a cloud computing environment that is shared by several organizations and which is managed by either a participating organization or a third party. An example of a community cloud is the educational cloud used by universities and institutes around the world to provide education and research services [17].

Figure 3 is showed as cloud deployment models and Table 2 compared these models with each other [19].

Table 2. *Comparison of cloud deployment models*

Deployment model	Scope of services	Owned by	Managed by	Security level	Location
Public	General public and large industry groups	CSP	CSP	Low	Off premise
Private	Single organization	Single organization	Single organization or CSP	High	Off or on premise
Community	Organizations that share the same mission, policy and security requirements	Several organizations	Several organization or CSP	High	Off or on premise
Hybrid	Organization and public	Organizations and CSP	organization or CSP	medium	Off and on premise

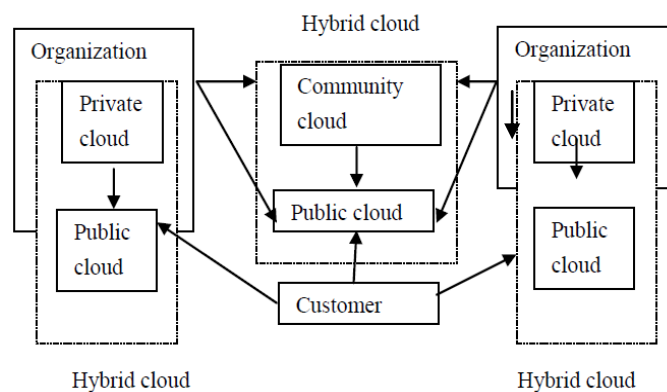CSP: Cloud Service Providers   Source: Singh [20]

Figure 3. *Cloud deployment models*

Source: Singh [20]

3.2 Cloud Computing Services

Cloud service is any provision of access to computing devices or human resources including hardware, software, networks or staff which are based on a cloud computing delivery model. Virtualization is the configuration of a physical server that allows installing multiple instances of virtual servers on a single machine [21]. Cloud services are provided in three services:

◦ Software as a Service (SaaS) is the provision of an application which is hosted (off premise) by a provider as a service to customers, SaaS is based on a multi tenant model where many customers are using the same program code but have their own private data spaces [22]. SaaS is only suited for software "out of the box" that does not require much customization or integration with other applications ([21], [23]). For example, the Google APP and Apple Cloud can be accessed by browsers or client software.

◦ Platform as a Service (PaaS) is the provision of resources required to build applications and services (software development environment) to a customer by an outsourcing provider. Typical use scenarios are application design, development, testing and deployment [21]. Platform as a Service is the use of cloud computing to provide platforms for the development and use of customer applications [24].

◦ Infrastructure as a Service (also called hardware as a service) (IaaS) is the provision of computing resources (CPU cycles, memory, storage, network equipment) to a customer by an outsourcing provider. In this service model it is possible to share a server among multi tenants. The service is typically billed on a utility computing basis (resource consumption) [21].

4. CLOUD ERP

4.1 Cloud Computing ERP

The Cloud ERP offers an easy way and low cost on implementing. Cloud Computing ERP is a new, dynamic ERP System that supply custom-made enterprise information management services to customers by organizing appropriate resources in Cloud Service Center (CSC) of the Cloud Computing Platform on the Internet. There is a difference between Cloud ERP and SaaS ERP (EaaS): Cloud ERP is hosted service delivered over the Internet. The ERP system in the EaaS model resides in the cloud, which provides computing power to run the ERP system [25].

SaaS is not a required component of ERP software but organizations can purchase the more flexible Cloud ERP system when it is offered in a SaaS model. An organization can have Cloud ERP without SaaS (cloud infrastructure or cloud platform), SaaS ERP without cloud (web-based ERP) or SaaS ERP enabled by cloud (cloud application) [25].

Customers can purchase services with different amounts of "cloud" in the service delivery stack. Assume that we have four distinct layers of delivery: cloud infrastructure (hardware resources for the cloud), cloud platform (operating system resources for the cloud), cloud applications (application resources built for the cloud), and client resources (user interface to the cloud).

Different types of Cloud ERP are illustrated on Fig. 4. In this study, cloud ERP is a general term and referred as three of them.
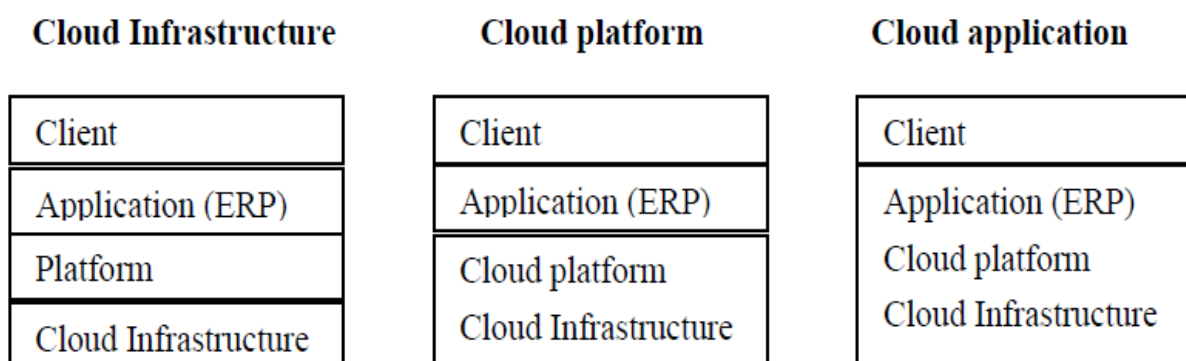

Figure 4. *Different types of Cloud ERP*

- **Cloud Infrastructure** (for example: Amazon, GoGrid) delivers a cloud infrastructure where you install and maintain a platform and an application.
- **Cloud Platform** (for example: Windows Azure) delivers a cloud platform where you install and maintain your applications without worrying about the operating environment.
- **Cloud Application** (for example: Salesforce.com) delivers a complete application, all you maintain is your client access program which is frequently a browser

Vendors can offer SaaS utilizing all three cloud infrastructures above. Some vendors such as Acumatica offer all three types of services

- Offering SaaS using a cloud application is straightforward. In this case the vendor builds an application which is tightly integrated with infrastructure and hardware so that the three components cannot be separated.

- Offering SaaS using a cloud platform means that the vendor must manage the application layer separately from the platform layer. This architecture gives the vendor the flexibility to move the application to a separate cloud platform provider.

- Offering SaaS using a cloud infrastructure is similar to a managed hosting scenario. In this case the vendor installs and manages both an operating system and their application on top of a multi-tenant hardware infrastructure. This technique provides maximum flexibility, but may increase overhead slightly

4.2 Cloud computing ERP

The cloud ERP architecture included seven layers; every layer will be introduced as follows: [10].

(1) User layer.

This layer provides the ERP cloud service requester for the application portal. The users connect the ERP system through their personal computers or handhelds.

(2) Application ERP layer.

This layer is ERP packaged to achieve separated management. This package includes inventory, sale, manufacturing and logistics, production, financial, human resources.

(3) Application workflow layer

This layer is designed to analyze the workflow of the enterprise. It is the basis of workflow extraction and service definition.

(4) Application cloud service layer

The end-user applies the requirement of service according to the process of the enterprise and receives the final service through this layer. This layer provides the interface between the enterprise ERP system and the cloud service. Another important function of this layer is the dispatcher and organization work in the internal system.

(5) Cloud manage layer

This layer is the core part of the whole architecture. In order to organize the clouds belong to different data centers, it needs the dispatching work with the Virtual Machine Monitor (VMM) under the standard service and programming APIs. The cloud service management of this laver determines the success or failure of the ERP system.

(6) Virtual resource layer

This layer is a collection of virtual resources. The virtual resource is packed as the cloud service resources and published to the data centers.

(7) Physical resource layer

This layer is the foundation of the whole system. It provides the hardware such as servers that cloud resource can run on. This layer supports the other layers by connecting the physical resources to a global network.

5. SALEFACE.COM [24]

Salesforce.com is an enterprise cloud computing company headquartered in San Francisco that distributes business software on a subscription basis. Salesforce.com hosts the applications off-site. It is best known for its Customer Relationship Management (CRM) products and, through acquisition, has expanded into the "social enterprise arena.

5.1 Cloud Computing use Salesforce.com

∘ Salesforce.com provides customer relationship management and other software applications using the software-as-a-service business model over the Internet.

∘ Cloud computing, also known as on-demand computing, eliminates the need for a business to make large up-front hardware and software investments and reduces the time to implement new programs.

∘ Salesforce.com don't have to purchase or maintain any hardware (albeit personal computing devices) nor do they have to install any special operating systems, database servers, or application servers.

∘ Users access the Salesforce.com cloud through a standard Web browser or a mobile handheld device.

∘ Businesses using the Salesforce.com's cloud have an easier time scaling their system as they increase or decrease their workforce – they adjust the number of subscriptions to the cloud.

∘ Service cloud is a platform for customer services that allows for thousands of conversation tools that help empower CRM around the world such as online communities, social network, phone, email and chat, partners and search.

∘ Sale cloud provides a comprehensive and easy to customize tools that delivery information to users in real time, at anytime and from anywhere. These tools include chatter, mobile, file and libraries, app exchange and marketing and leads.

∘ Salesforce.com offers some customization of its software so a business can adjust the software to unique business processes. It offers three types of clouds: Sales cloud, service cloud, and the custom cloud. The sales and service clouds help businesses improve sales and customer service. The custom cloud provides a venue for customers to develop their own applications for use within the broader Sales force network.

5.2 Kinds of Businesses Could Benefit from Switching to Sales Force

Small to medium-size businesses are probably the most likely ones to switch to Salesforce.com because of cost factors and the lack of having in-house resources to provide the same level of computing capacity. Businesses that are trying to increase the sophistication of their computing capabilities could also benefit from switching to Sales force as long as the two are compatible.

Businesses that rely on smart customer management would benefit greatly from using the tools available at Salesforce.com. Also companies that have small sales and marketing teams can benefit from the software-as-a-service business model.

5.3 An Application Instance of Cloud Computing ERP in Force Platform

C Company was founded in June of 1969 and signed a technical collaboration with Mitsubishi Motors Corporation the following year. Beginning with producing commercial vehicles, C Company is the leader of Taiwan's commercial vehicles manufactures. While the company's Yang-Mei plant produced less than 3000 vehicles per month through 1975, by the year 1983, total output had surpassed the 100, 000 unit mark. Under enterprise operation, C Company builds the ERP system in 2006.

An organization business processes must often be modified. It says that organizational ERP implementation is both complex and challenging, with significant risk. If C Company chose a cloud provider (such as Force.com) who had extensive experience dealing with human resource services and opted for applications that the vender has already developed for other clients. It is estimated that the cost of implementing cloud ERP were 15% lower than the traditional approach and that opting for SaaS solution reduced implementation time by 50% to 70% [26].

The steps of construction of cloud computing ERP are proposed as follows:

Step 1: Disassemble the old version ERP system. According the service requirement of production plan (such as supply the backward scheduling and forward scheduling, meet the delivery and the production capability etc.) build the ontology model and describe as the unified standard.

Step 2: Package the model and some other systems such as CRM and forging CAPP as service and storage in the cloud service center (CSC).

Step 3: Publish the requirement with the purpose of building the cloud computing ERP system in the CSC. The process is shown in Figure5 and Saas application framework for ERP is shown in Figure 6.

In order to make full used of cloud CRM services and ensure the system security, the cloud ERP platform must have the features as follows:

(1) Dynamic: The cloud ERP platform's functions must be satisfied customer requirement, such as Cloud ERP services and it configuration.

(2) Integration: The standard connector must be integrating the distributed services. The cloud ERP must hide the heterogeneity of returning services so that these distributed services can process under a unified frame.

(3) Stability: Under the dynamic of cloud services, it controls the service updating just at the right time. Continually update must avoid, if not, the services may not match the customer's requirements.

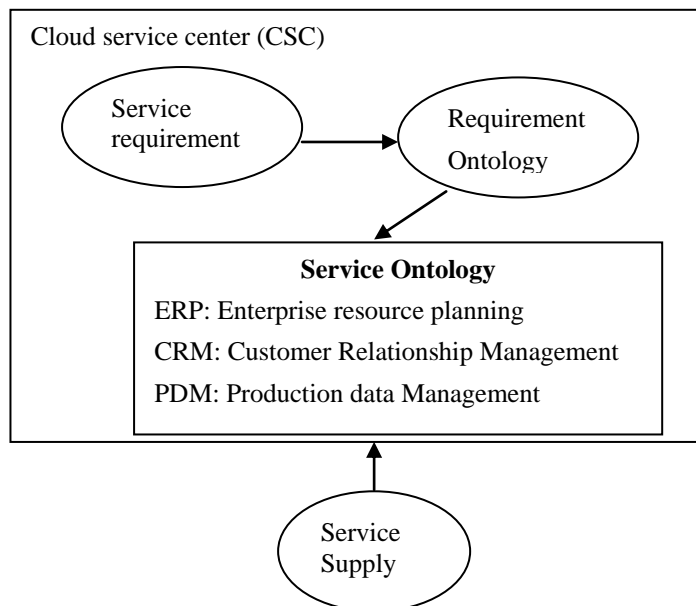(4) Security: All data security and integrity in the system updating and use processing, must be protected.

Figure 5. *An example of cloud computing platform*

Under the proposed cloud computing platform, the advantages of cloud computing is:

◦ Using a cloud based solution negate the need to purchase hardware, software licenses and annual hardware and software maintenance support contracts for company owned assets.

◦ ERP enables Cloud companies to have greater control over marketing, production and inventory.

◦ The benefits of implementing a solution include rapid deployment, minimal configuration and the capability to support standard processes.

◦ Implement ERP Cloud SaaS solution on force.com platform to support finance, payroll, procurement, and human resource function.
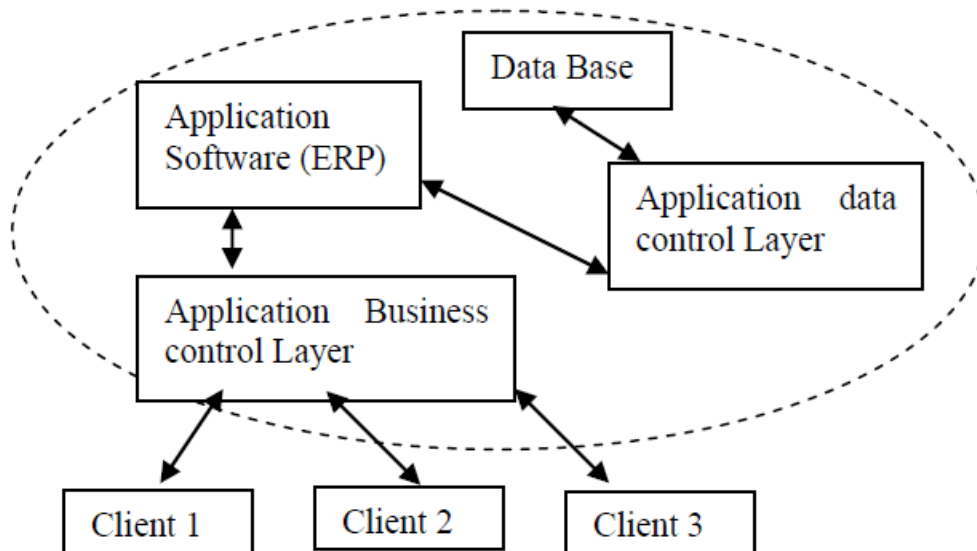
Figure 6. *Saas application framework for ERP*

6. DISCUSSION AND CONCLUSIONS

Traditional ERP is very much controllable by the business organizations, because it is under their supervision. Failed ERP implementations may have gone over time or over budget or are operation but not delivering full functionality [26]. The cloud computing provides new solution to help the ERP system change to the service-oriented style. The aim of this paper seeks to establish a systematic, collaborative and agile Cloud computing ERP system from the old ERP system. Under the objectives of this paper, the architecture of cloud ERP system in force.com platform has been built, and Saas application framework for ERP has been developed on it.

It finished the following work: (1) an inclusive review of existing literature on the ERP system and differences between conventional (traditional) and cloud computing ERP, (2) explains cloud computing system and introduces cloud deployment models and cloud computing architecture. (3) Cloud Computing ERP is an important issue in organization, and point out the Cloud Computing ERP architecture. In next phase, the construction and description of cloud ERP resources and the management of Cloud ERP platform will be studied in depth in order to realize the industrialization of Cloud ERP platform in the future

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