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Research Article

Managing IT Operations in a Cloud-driven Enterprise: Case Studies

Rabi Prasad Padhy[1] and Manas Ranjan Patra[2]

[1]Oracle Corp., Bangalore, Karnataka, India

[2]Departement of Computer Science, Berhampur University, Odisha, India

Abstract

Enterprise IT needs a new approach to manage processes, applications and infrastructure which are distributed across a mix of environments. In an Enterprise traditionally a request to deliver an application to business could take weeks or months due to decision-making functions, multiple approval bodies and processes that exist within IT departments. These delays in delivering a requested service can lead to dissatisfaction, with the result that the line-of-business group may seek alternative sources of IT capabilities. Also the complex IT infrastructure of these enterprises cannot keep up with the demand of new applications and services from an increasingly dispersed and mobile workforce which results in slower rollout of critical applications and services, limited resources, poor operation visibility and control. In such scenarios, it's better to adopt cloud services to substitute for new application deployment otherwise most Enterprise IT organizations face the risk of losing 'market share' to the Public Cloud. Using Cloud Model the organizations should increase ROI, lower TCO and operate with seamless IT operations. It also helps to beat shadow IT and the practice of resource over-or under provisioning. In this research paper we have given two case studies where we migrated two Enterprise IT application to public clouds for the purpose of lower TCO and higher ROI. By migrating, the IT organizations improved IT agility, enterprise-class software for performance, security and control. In this paper, we also focus on the advantages and challenges while adopting cloud services.

Keywords: Enterprise Cloud; Cloud Architecture; Virtualization; Cloud Services; Cost Optimization

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*Correspondence to: Rabi Prasad Padhy, Oracle India Pvt Ltd, Bangalore, Karnataka, India

Email: rabi.padhy@gmail.com

1. Introduction

Moving to the cloud isn't just changing the way businesses work by adding more collaboration. It changes the consulting businesses that actually sell most of the software used by business. Cloud computing is evolving as an important IT service platform with its benefits of cost effectiveness, Simplify IT and global access [1]. To become

a widely adopted IT infrastructure and service platform, cloud computing has to be integrated with other systems in organizations. The cloud computing model is enabled by the ongoing standardization of underlying technologies like virtualization, service-oriented architecture (SOA), and Web 2.0. These technologies have made it possible to deliver IT services in a cost-effective and pervasive way. IT organizations to consider the variety of cloud models - public, private and hybrid - with different cost savings [2]. The ideal cloud model enables combining the benefits of both public and private clouds and offers portability between them according to the business requirements. Hybrid clouds provide the best of both worlds: improved IT agility together with enterprise-class software for performance, security and control. They allow delivering the right workload in the right environment, at the right cost. Consumer and large enterprises are increasingly utilizing cloud based applications for both every day and the business-critical applications. The needs of operating cloud computing systems are vastly different from general computing. Most of today's communication infrastructure is based on the advancement of information technology and business transformation, and to increase profits from its value chain, an enterprise should be able to rapidly modify and adapt its business process and collaboration infrastructure. Enterprise cloud computing represents a fundamental change in the automation of business functions and a sea of change in the planning, design, and architecture of the enterprise data center. Resources can be rapidly engaged, scaled, and terminated anywhere at any time, and in the public cloud, organizations pay only for the resources used. The struggle between pure Internet players like Amazon, Google, Salesforce and Success Factors and traditional enterprise vendors has only just begun [3]. Vendors such as SAP and Oracle are coming under particular pressure and making huge attempts to "transform" their on-premise offerings and provide them in the form of cloud computing. The desire by customers to break down monolithic IT structures and so reduce one-sided dependency on software vendors also furthers the chances of cloud computing. Virtualization is one of the key underlying technologies that make cloud computing possible [4]. Virtualization consists of a set of technologies that enable systems and applications to securely share IT resources such as servers, storage, and networking. It masks the complexity of the resources being shared and their location, which effectively simplifies the use of the IT environment. In the process, virtualization loosens the coupling between resources and removes the interdependencies among infrastructure layers, which ease the transition to cost-saving automation in the data center. Data center is the foremost ingredient of the cloud computing because it contains the collection of various hardware and software resources that are linked and incorporated for the IT application.

2. Cloud Models

There are four cloud types and delivery models namely private, public and hybrid cloud. The service or delivery model includes IaaS, PaaS and SaaS. Private Clouds managed on-premises by the IT Organization, usually behind a firewall, and access to cloud services is exclusive to Internal IT of the organization or a known set of users. Public Cloud managed by a cloud service provider, and multiple IT organizations have access. Services can be provided on a subscription or pay-as-you-go basis. Hybrid Cloud combines both public and private cloud deployment models. Community clouds infrastructure and computing resources are shared by several organizations that have the same mission, policy and security requirements [5]. An example of a community cloud is the educational cloud used by universities and institutes around the world to provide education and research services.

Figure 1 Effects of selecting different switching under dynamic condition

3. Cloud Enable IT Enterprise

In traditional enterprise computing, IT departments forecast demand for applications and capacity and invest time and money to develop those resources in-house or purchase them from others and operate them in-house [6]. In traditional, on-premise deployment models, enterprise applications and various IT solutions are commonly hosted on centralized servers and storage devices residing in the organization's own data center. Cloud users may be a single user or an entire organization which uses services from providers. Cloud users need not to deploy the computing resources at their site [7]. These resources are available at the cloud providers on utility basis and charged on uses basis. Cloud providers specialize in particular applications and services, and this expertise allows them to efficiently manage upgrades and maintenance, backups, disaster recovery, and failover functions. As a result, consumers of cloud services may see increased reliability, even as costs decline due to economies of scale and other production factors. In looking at enterprise cloud services from the perspective of applications, there are the front-office, mission critical task and the back office activities as well as supporting the domains for starting new business fields. Hybrid clouds use a combination of internal resources, which stay under the control of the customer, and external resources delivered by a cloud service provider [8]. Like the private model, a hybrid cloud lets an organization continue to use their existing data center equipment and keep sensitive data secured by the organization's own network. And like the public cloud, a hybrid model lets an organization take advantage of a cloud's almost unlimited scalability [9]. It's a way to solve some of the trust issues of the public cloud while getting the public cloud's benefits. Amazon's Virtual Private Cloud (VPC) is one of the leading examples of a hybrid cloud. With VPC, a company can also extend its security measures, such as firewalls and intrusion detection systems, to its AWS resources in the cloud. Because hybrid cloud would allow enterprises to seamlessly optimize their apps and services across clouds and facilities without modification, it would

allow IT teams to be even more nimble, efficient and strategic to business units.

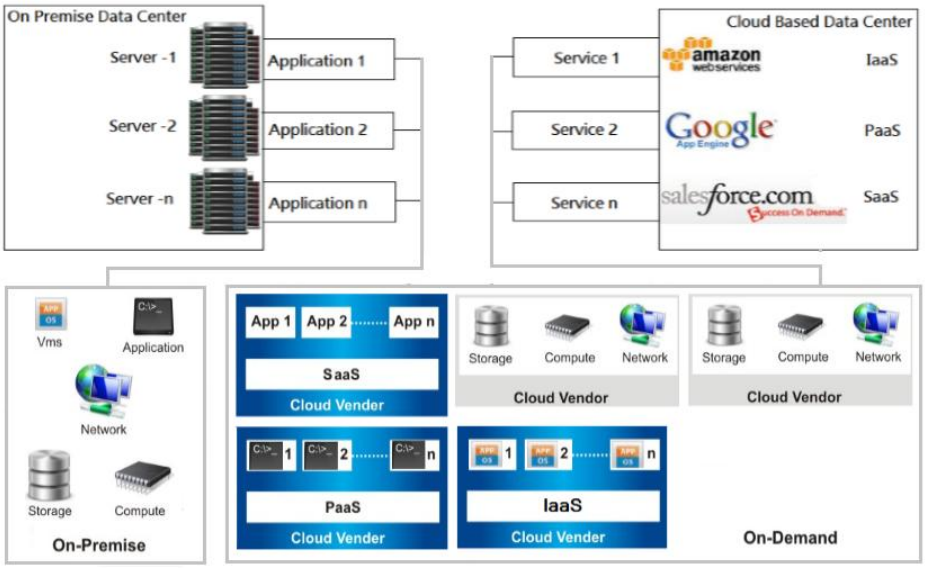

Figure 2. On Premise vs. Cloud enable Enterprise IT architecture

3.1 Characteristics of Enterprise Applications

Enterprises run a number of applications to support their day-today business. For instance, a company may run applications to support payroll, travel and expense reimbursement, customer relationship management, and supply chain management [10]. Similarly, a university may run applications corresponding to student registration, employee payroll, class management, and alumni relations. Such applications are implemented using multi-tier architectures. Typically, applications can be decomposed into three functional tiers: (i) a front-end tier, containing web servers that handle user requests and application presentation; (ii) a business-logic tier, containing servers that perform specialized application logic such as sales analysis; and (iii) a back-end tier that comprises of various database servers. While a 3-tiered design is the conventional architecture used in most applications, in practice applications are much more complex [11]. Each of these tiers may have multiple functional components; each component may have multiple servers performing the same role and executing the same code while load-balancers are employed to spread the requests across each server [12].

An enterprise application could be accessed by two types of users: (i) users internal to the enterprise; and (ii) users external to the enterprise. For instance, in a university campus setting, current employees and students correspond to internal users, but alumni, and prospective students correspond to external users. Many enterprise applications (e.g., employee payroll) are extremely sensitive, and access to servers corresponding to these applications is highly restricted. For instance, following the tiered application architecture, typical security policies may only allow front-end servers to access business logic and back-end servers [13]. The security policies are carefully crafted reflecting the complex application interdependencies so only application components that need to talk to each other are permitted to do so. Servers corresponding to various enterprise applications are logically partitioned into Virtual LANs (VLANs) [14]. Each VLAN is protected by a firewall context. Each firewall context is associated with one or more access control lists (ACLs). Enterprise Applications comes under two categories namely Internal IT Applications (Example SCM Oracle Apps, CRM Oracle Apps, ERP SAP etc.) and Cloud Applications (Private/Public/Hybrid): Example Google Apps, Amazon EC2 and Salesforce.com etc [15].

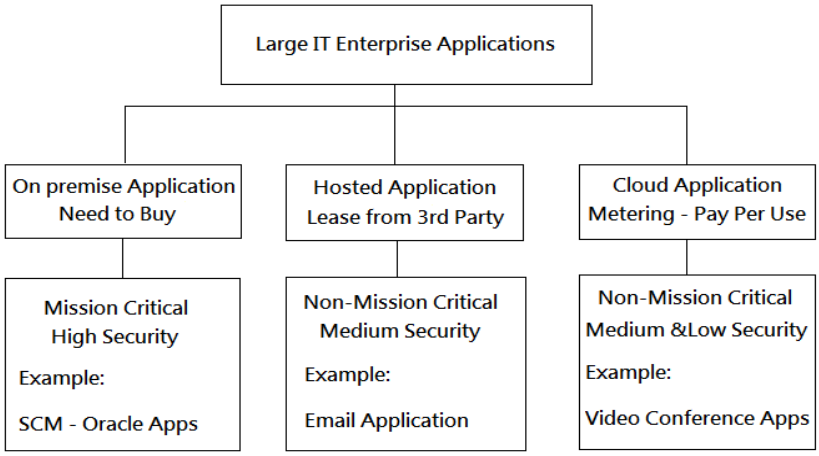

Figure 3. Various Types of Applications used by an IT Organization

3.2 Things to consider before migrating an Enterprise IT System to Cloud Environment

There are various factors need to consider and analyze before migrating a IT system to cloud. The main factors related to business, technology and implementation which should be consider while evaluating the suitability of an application and infrastructure for Cloud migration. We also discuss here the minimum requirement for an IT system to consider for migration [16].

Security: The application will need to provide security at the data storage, processing and transmission stages. Three critical components namely a) Data in transit needs to be protected either at the application or the transmission level. b) Data at rest must be protected by the application. The application must provide a mechanism to protect the data stored in the cloud. Encrypting data at rest is the best option at this time, and a future technical tip will delve into the specifics of this area. c) Servers to server communications are typically forgotten because they currently exist within the data center [17].

Regulations: Geopolitical issues especially for Governments and financial institutions should be carefully evaluated before making the transition to the Cloud. In the Indian context this is especially relevant as most Cloud data centers are not located within the country [18]. It is also important to ensure that local regulations relevant to each organization should be adhered to before deciding to move to the Cloud [19].

Communication Protocol: The cloud is based on the Internet Protocol (IP), so for an application to be considered, it must use IP as its communication mechanism. While there are many protocols that can be run over IP, the use of Transport Control Protocol (TCP) is preferred [20].

Resource Provisioning: One of the key benefits of the Cloud is the quick provisioning of resources. Applications that need to be quickly available and scaled up rapidly based on demand are ideal candidates for the Cloud for e.g. an organization running a limited period online marketing campaign. Several applications are seasonal in nature as well for example HR and Payroll applications, which need resources to be processed only during certain periods [21]. These sorts of applications can make use of the ability of the Cloud to quickly provision resources.

Licensing: Application is made up of many components which are associated with some license agreements. Analysis should be made about the effects of those license agreements on the deployment of application on cloud. Applications which are designed licensed for CPU, when we deploy it on the cloud increases the load by exciding the CPU license limit [22].

Application Complexity: Simple applications can be easily migrated to the Cloud and the amount of effort required to move such applications may not be not too significant. These applications can be directly migrated to Software as a Service (SaaS) applications already available from various vendors. E.g. e-Mail applications can be directly ported onto Cloud offerings like Office365, Google Apps or Lotus Live. Similarly, moving a simple web server to an Infrastructure as Service (IaaS) platform may not require as much effort. Migration of complex applications

however, needs elaborate planning and testing prior to implementation [23].

Processing requirements and memory locks: Application should be designed to work on the parallel architectures, because of the dynamic scalability of cloud. Multi-threaded code which allows process to split in to small chunks suits for the cloud environment. A single threaded application cannot take the real advantage of clouds distributed nature.

4. Case Study 1: Migrating an Enterprise IT System to AMAZON Cloud

Objective: The objective of this case study is to demonstrate migrating an e-business application to Amazon Cloud [24]. The case study organization is a Large Enterprise that provides IT solutions. It has an organizational structure based on functional divisions: Administration; Engineering; IT Support; product and Sales Support; Employee needs access to the company e-business system for effective management their day to day activities. The main challenges for hosting a E-business application for internal employees using a traditional datacenter is much expensive. Procuring a new server or upgrading an existing one took more than months as there will always need to update the software as well as the hardware to successful business run [25].

Management observed that the entire process of hosting and managing this e business service was smooth and easy if they can migrate to public cloud. Also developers, testers to focus on building apps and test it based on their business needs [26]. This was not possible in the older model where developers were spending time making changes to the apps to accommodate the traditional datacenter's limited capabilities. The cloud solution helps easily manage access to servers through security groups, easy-to-use self-service management console, the concept of Elastic IPs, and superior support [27].

A Gentle introduction to Amazon AWS

Amazon Web Services (AWS) represents a set of online services that form together a cloud computing platform. Amazon has built large-scale, reliable and efficient IT infrastructure where customers can host their applications. Currently Amazon has data centers in five regions: US East (Northern Virginia), US West (Northern California), EU (Ireland), Asia Pacific (Singapore), and Asia Pacific (Tokyo). Besides REST based APIs, AWS has recently released a set of direct language-integrated APIs to access the cloud services.

Compute services: Amazon Elastic Compute Cloud (EC2) service allows renting virtual machines to run custom applications on Amazon's data centers. Virtual machines or "instances" function as virtual private servers. Instances have different CPU resources, available memory, local storage space, and I/O performance, depending on the instance size. The consumers are free to choose any size and deployment region for their virtual machines. In order to instantiate a virtual machine, a user should boot Amazon Machine Image (AMI) that contains operating system with required middleware and configuration settings [28]. It is possible to create custom AMIs or choose available preconfigured images. EC2 is very flexible and supports many operating systems, a lot of middleware, and any development platform or programming framework.

EC2 does not have built-in scaling. The users can manually change the number of instances through administration console or provided APIs. Another possibility is to use Auto Scaling service. Auto Scaling can scale applications up or down dynamically without an extra management effort. Locations in the area served by an instance of more than one infrastructure for all services. For example, memory and cache server and Tomcat application servers, web applications and services for mobile API-house back office and integrated deployment server [29].

Storage services: AWS offers various durable and scalable storages for different purposes. Simple Storage Service (S3) provides primary data storage for any type and amount of data. Data is stored in special "buckets" that can be located in a specified region to reduce latencies or cost. Moreover, AWS has a content delivery service for even better data distribution. The provided authentication mechanism allows the protection of sensitive information. Also, S3 has built-in redundancy support, but there is an optional Reduced Redundancy Storage (RRS) service at a lower price [30].

Amazon SimpleDB is another service used for storing

and querying over non-relational semi structured data. This storage service has a built-in replication, indexing and performance tuning features. Https endpoints ensure a secure, encrypted communication with this service. Developers can take advantage of Amazon Relational Database Service (RDS) to set up and operate a relational database in the Cloud. RDS provides capabilities similar to ordinary databases. In addition to that, it has an automatic replication and backup support. However, developers can still install standard Oracle Database or Microsoft SQL Server on EC2 instances [31].

Simple Queue Service (SQS) and Simple Notification Service (SNS): These are examples of messaging services. They offer reliable communication capabilities among application components and end-users, enabling message-driven and event-driven workflows for large distributed systems. SQS offers a reliable and scalable hosted queue for storing messages that are "polled" by application components [32]. SQS has built-in redundancy support and a special delivery mechanism to achieve high reliability and availability. It fits well to organize communication across EC2 instances. SNS delivers notifications to clients using a "push" mechanism. Potential uses for this service include time-sensitive information updates, applications for monitoring, workflow systems or mobile applications [33].

Elastic Load Balancer (ELB) is another useful service. It can balance a load for EC2 instances even when the application dynamically scales up or down. ELB can be configured in many ways including sticky load balancing, which means the user is stick to a particular EC2 instance.

CloudWatch is a very powerful monitoring service provided by Amazon. Besides a possibility to track applications, developers and system administrators can configure systems behavior using CloudWatch. For example, applications can be scaled in a scheduled manner or according to certain metrics like CPU utilization. Moreover, CloudWatch can monitor application health and boot new instances in case a failure is detected.

Pricing model and Service Level Agreements

The pricing model for AWS is quite complex. EC2 compute is billed per active instance hours. The price depends on the type and configuration. The users can optionally reserve instances. In this case they get a reduced hourly rate but have to pay in advance. Data storage is charged per GB per month. Data transfer is charged per GB in and GB out. Usually the price is lower within the same region and free within the same Availability Zone. Also, there are additional costs per transaction for some services. Prices vary across different regions. AWS service level agreements guarantee 99.95% availability of EC2 service, 99.999999999% durability and 99.99% availability of S3 storage, and 99.99% durability and 99.99% availability of RRS. Availability time is calculated for one year period. More detailed information about the pricing model and SLAs is available on the official web site [34].

Cloud-based Architecture & Design: Below Figure provides an overview of the traditional & Cloud based Model

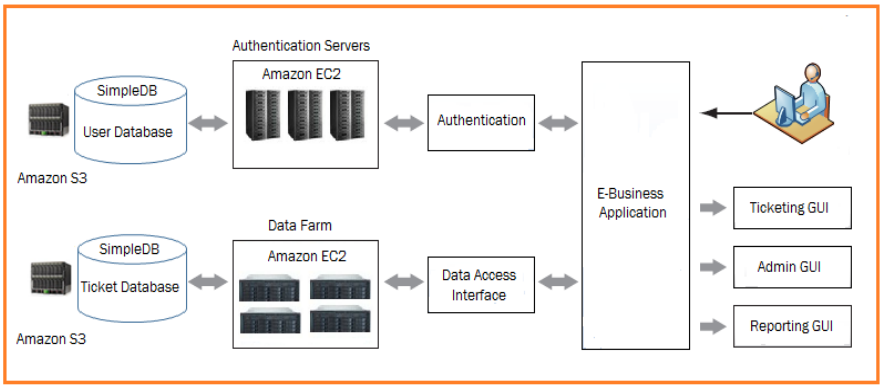

Figure (a)

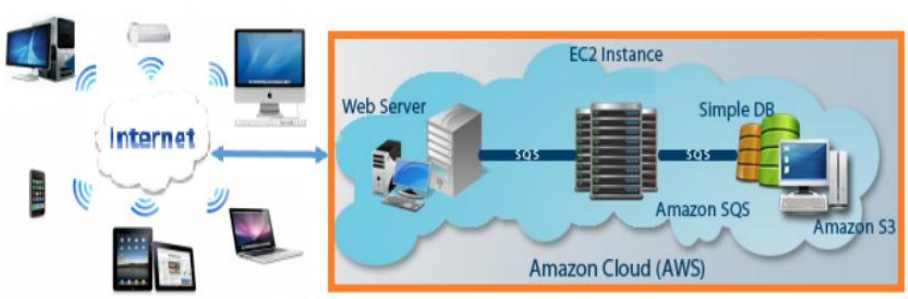

Figure (b)

Figure 4 Overall Architecture & Design of Cloud-based Application

5. Case Study 2: Migrating an IT System to MICROSOFT SAAS Cloud

Objective: The case study organization is a Large Enterprise that provides IT solutions. It has an organizational structure based on functional divisions: Administration; Engineering; IT Support; Sales Support; Employee needs access to the company email system, and the ability to work on documents using Microsoft Office applications such as Word and Excel. The organization decided to switch from on-premises Microsoft exchange infrastructure to Microsoft Office 365 to provide email for its staff mainly address two key business issues: the ability to scale computing resources to support as many new users as needed, and to create a common, easy-to-manage user platform based on the Microsoft Office system that would include up-to-date Microsoft Office applications. The organization also wanted to enhance teamwork by making it easier and faster for employees to find and share files and conduct meetings, while still controlling files centrally.

Challenges: The Organization migrated its on-premises Exchange Server 2003 system to cloud due to limited user mailbox sizes, as the email databases that had grown to more than a terabyte in size, which meant that recovery times for any type of disaster were greater than 24 hours, so sometimes couldn't meet the service agreements with the business and frequent performance issues. As the system grew in scale, it was harder and harder for the organization to deliver an exceptional level of service to employees at all locations. Not only the geographic diversity of the organization provide operational challenges but also the nature of its mission also places tremendous importance on using secure and reliable communication and collaboration tools for their day to day operations. To address these issues the organization selected Office 365 cloud service is the best solution [35].

Office 365: There are various SaaS cloud Solutions for Enterprise e-mail hosting namely Google Apps, LotusLive iNotes, Yahoo Zimbra and Office 365. The organization selected Office 365 due to flexibility and interoperability with the existing system and new solution. As compare to other SaaS cloud solutions, Office 365 advantages includes data portability, admin accessing and No advertising etc. Office 365 consists of Exchange Online which offers business-class e-mail, scheduling, and mobility. SharePoint Online offers document storage and application integration. Lync Online providing presence availability, instant messaging, and desktop sharing. Being Microsoft solution, it delivers enterprise-class security and availability with multiple data centers, best practice security, and a 99.9 per cent uptime guarantee [36].

Migration Process: The migration from a series of legacy platforms to Office 365 was the subject of a very thorough review and planning process. After the six-month implementation plan was complete, a two-day migration converted 2,200 internal and external users to the cloud. Five days after the move, the new tools were integrated, and users were functioning on the standardized Office 365

platform.

The organization has executed below steps during migration process

Step 1: Conducted technical pre-planning and discovery, which included reviewing the existing environment (servers, operating system, bandwidth, Active Directory, hardware, and software) and cutover to Exchange Cloud.

Step 2: Changed all DNS mail related settings, and mentored and oriented the IT staff to Office 365's web-based management console to enable them to automate tasks and centrally manage accounts.

Step 3: Deployed Active Directory Services to enable single sign-on so employees only need to maintain one user name and password. A part of AD Services is Office 365 Directory Sync, which updates the Office 365 user and configuration information automatically any time changes are made in AD.

Step 4: Migrated a small number of test mailboxes to evaluate the process and mail flow, and the client did the full migration.

Step 5: Move all users mailbox to cloud.

There is a server-side utility called the Microsoft Online Migration Console that need to install on a server in organizations environment. This console shows each user current Exchange mailboxes and whether these are reside on-premise or in the cloud, allowing to granularly move users individually or in small groups.

Migrate the user's mailbox to the cloud using the Online Migration Console.

Install and run the client-side Microsoft Online Services Sign In utility on the user's PC. (As per below figure)

Select all the Options in the Sign In Preferences section for the most transparent operation.

After successfully signing in, a wizard will launch that automatically configures the PC's Office 365 applications such as Outlook to work with the cloud.

User's Active-Sync devices such as iPhone, iPad, Android, or Windows Phone are configured by selecting to create a new Email account. If auto discover record is available in public DNS, this is an automatic procedure. Microsoft also provides Office 365 customers with instructions to manually configure Active-Sync devices with a server name an auto discover DNS record.

Step 6: Enable email for network devices

- Microsoft, like most cloud email service providers, does not allow direct SMTP (TCP port 25) connection from customers. They do make available a secure SMTP receiver on TCP port 587 specifically to support the requirement for email-enabled devices in your office. If the organization devices allows SMTP to be set up with a non-standard port, SSL/TLS encryption, and apply a username and password, then it can point the device directly to the cloud.
- If the organization various devices only supports SMTP on port 25, or can't support SSL/TLS encryption and/or secure login, then a tip is to provision a server-level SMTP postoffice on-premise for relaying to the cloud. Any Windows 2003, Windows 2008, or Windows 2008 R2 server can host an SMTP postoffice that is configured to relay messages to the Office 365 cloud. So on-premise SMTP devices to the on-premise SMTP relay postoffice, which in turn sends everything to the Office 365 cloud for onward delivery [37].

System Architecture: Below Figure provides an overview of the exsiting traditional E-mail system and new cloud based solution. The traditional email system which consists of several standalone servers namely AD server, Microsoft exchange server. The new cloud solution only required the security firewall configuration to connect to the head office of the organization.

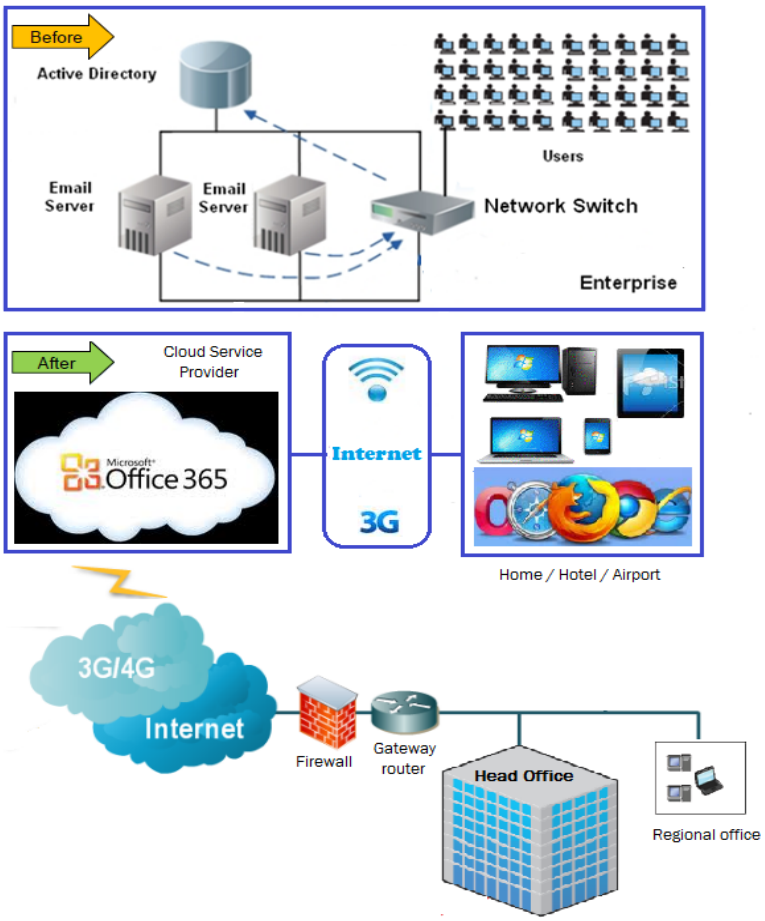

Figure 5 Migrating an On-Premises E-mail System to Microsoft SaaS Cloud

Benefits:

Simplified IT Enterprise Infrastructure: The single sign-on (SSO) technology made possible by the Active Directory migration and supported by Office 365 means that the IT department maintains only one user ID and password per employee. Employees can usually reset the password themselves, saving time for both IT staff and users. By using Office 365, it can pay for the online services and Office Professional Plus in one easy, per-user subscription [38].

Reduced IT Costs & Enterprise-Class IT Capabilities: Using Office 365 to reduce its IT costs in several ways. First the company transitions from on-premises to Office 365, it will avoid hardware costs for future deployments. Also, the third-party licensing costs of some IT management tools, such as antivirus and anti spam software, are avoided because they're now built into Office 365.

Reduce IT Admin tasks: The amount of time IT staff spent on administrative tasks supporting the desktop and server environments has been reduced. This time savings equals to at least two full-time employee in yearly operation costs.

Strengthen Security & Reliability: By using office 365 there will be a big benefit for support from service provider for twenty-four hour a day, seven days a week IT-level phone support, and a financially backed, 99.9 percent uptime service level agreement [39].

Flexible Mobile Access: Office 365 has quality tools at a great value, robust reliability and security, and an extensible platform that add communication and collaboration services.

Easy Integration: Cloud mail allows for easy integration of tablets and mobile devices to the business scene.

Ongoing upgrades: Cloud systems are continuously

upgraded in the background, which keeps your systems at the cutting edge. You are saved the costs and effort of disruptive upgrade cycles of legacy software.

Mobility: In an age of distributed and mobile workforces, cloud systems are ideal for workers who want to access data and tools outside the company firewalls on a variety of devices like desktops, tablets and mobile phones [40].

Disadvantages

It's harder to enforce company email standards.

Composing emails offline can be difficult if not using email client software.

Limited emails per day, for example each Google email account is currently limited to 2,000 emails a day.

6. Advantages and Challenges While Adopting Cloud Services

6.1 Advantages

Upgrade/update protection: No annual maintenance, hardware/software obsolescence and upgrade etc.,

Agility: one of the significant factor of cloud computing is requisition i.e. addition of on-demand resources can be done very rapidly, which makes

Human Resources: Maintenance of the system is done by the service provider. Hence no additional skilled man power needs to be employed by the organization.

Cost Saving: as the cloud computing brings all the fundamental computing resource under one cloud, it becomes very easy for the user to access these resource and pay as you go.

Infrastructure cost savings - Corporate servers are estimated to run below 15% capacity. An Enterprise Cloud Solution promises to dramatically increase infrastructure utilization rates especially where load is variable, eliminating the need for hardware purchases that tackle only peak demand and avoiding over-provisioning of resources.

Operational cost savings - By automating manual processes, Enterprise Cloud Solutions reduce the demand for administration and support.

Scalability: It is one of the important aspects of cloud computing, where it provides the various resources on-demand to the user. It is also referred as 'elasticity'.

Dynamic Workload Allocation: Efficient dynamic workload allocation is a key requirement for a utility grade Enterprise Cloud Solution and replaces the hands-on resource provisioning of the static data center paradigm. Intelligent placement should efficiently allocate resources to instances based on user specified parameters, such as number of CPUs and amount of RAM required. Ideally you want to be able to dynamically place any instance shape on any node, according to policy, instead of having to hard configure nodes for particular instance types or shapes. Hard configuring nodes makes it very difficult to accommodate shifts in demand from one shape to another.

Disaster Recovery and Back-ups: it is the responsibility of cloud computing to manage all the resources and the technology placed and to provide data protection, fault tolerance, self-healing and disaster recovery. Normally, disaster recovery is very expensive, but with cloud computing the service providers replicate their data, so even the data is lost from the data centers it will not lose the data.

Customization: The customer has got the freedom to choose from among the modules and the services offered by the cloud service provider.

Group Organization: All the different branches of an organization can access the same cloud based system in real time through the web.

It's Greener: most data centers and the servers are oversized and will not run to their full capacity. Since in cloud computing environment all the fundamental computing resources are shared, this decreases in the usage of energy and reduces the power consumption.

Low barrier to entry: Because hardware and software does not have to be acquired, installed, provisioned for every need and resources can be tapped on-demand, often in real-time, cloud computing can be as easy as moving existing applications into a hosted data center, although this depends entirely on the architectural model of the cloud computing provider.

6.2 Challenges

Security: it is one of the major concerns in cloud computing.

Organization has to think very seriously before putting their critical data in the hands of the external service provider. They must evaluate the risk and then adopt it. Since the hackers are around, hacking the Internet, intranet serious security challenges have created worries for the cloud vendors for the physical and logical security of data, authenticating users across firewalls by relying on vendor's authentication schemes. Organizations like Cloud Security Alliance are at the forefront of addressing these issues. Customers also are worried about the attacks which are vulnerable, when information and other important resources are kept outside the firewall. Standard security practices should be done to overcome this problem [41].

Latency: means the amount of time taken or delay for a packet of data to get from source to the destination. Just by running an application on the cloud does not mean it has latency. The cloud computing if done properly has opportunities to reduce latency based on its architectural advantage such as massively parallel processing capabilities and distributed computing.

Bandwidth costs: With cloud computing, companies can save money on hardware and software; however they could incur higher network bandwidth charges. Bandwidth cost may be low for smaller Internet-based applications, which are not data intensive, but could significantly grow for data-intensive applications.

Control: Some IT departments are concerned because cloud computing providers have a full control of the platforms. Cloud computing providers typically do not design platforms for specific companies and their business practices [42].

SLA: (Service Level Agreement) is one of the most common concerns regarding cloud computing is the potential for downtime. This is a critical issue in business since every minute is important. SLA is an agreement between the organization and the cloud service providers. They are used as a part of commitments and outsource agreements with companies, where the company selects an external provider to operate its IT systems. Organizations have to take all the necessary steps before making the agreement.

Migrating Applications: current enterprise application cannot be migrated easily as each cloud service provider imposes architecture dissimilar to the common architecture of enterprise application. Amazon web service provides an 'empty image' of which anything can be put into it, but migrating the application is not possible due to storage framework. Microsoft Azure is a .Net based architecture that offers services based on the existing Microsoft development framework, but it does not offer regular storage thereby requiring different application architecture, thus making migration of enterprise application difficult.

Performance: Cloud may lack performance in some intensive transaction oriented and other intensive applications. High latency delays may be observed by the users who are at far long distance from cloud.

Internet Dependency and Performance: availability, quality and performance of Internet connection is one of the major concerns of cloud computing which organization always think for. Before running the application and software on cloud computing organization has to improve the network infrastructure and update the software so as to obtain the maximum performance. These may also leads to re-design the infrastructure [43].

Reliability: Cloud computing still does not always offer round-the-clock reliability. There were cases where cloud computing services suffered few-hours outages. In the future, we can expect more cloud computing providers, richer services, established standards, and best practices. IBM has launched the Research Computing Cloud, which is an on-demand, globally accessible set of computing resources that support business processes.

7. Cloud Data Encryption Methods

Cloud storage encryption is a service offered by cloud storage providers whereby data, or text, is transformed using encryption algorithms and is then placed on a storage cloud. These encryption algorithms create ciphertext, a coded form that cannot be understood by anyone unfamiliar with the data set or the way the data was converted. A data key is created for each set of data, and that key is used to both encrypt and decrypt that data. Encryption to the cloud is almost identical to storage encryption, with one major difference. In a cloud environment, it is sometimes debated whether the customer or cloud storage provider should hold the data key. Encryption is a well known technology for protecting sensitive data. Use of the combination of Public and Private Key encryption to hide the sensitive data of

users, and cipher text retrieval. I have referred various research papers and analyze the feasibility of the applying encryption algorithm for data security and privacy in cloud Storage [44].

Implementing DES Algorithm in Cloud for Data Security Neha Jain and Gurpreet Kaur described Data security system implemented into cloud computing using DES algorithm. This Cipher Block Chaining system is to be secure for clients and server. The security architecture of the system is designed by using DES cipher block chaining, which eliminates the fraud that occurs today with stolen data. There is no danger of any data sent within the system being intercepted, and replaced. The system with encryption is acceptably secure, but that the level of encryption has to be stepped up, as computing power increases. The algorithm steps are follows.

Get the Plaintext.

Get the Password.

Convert the Characters into binary form.

Derive the Leaders (L1 to L16) from the Password.

Apply the Formula to get the encrypted and decrypted message.

In order to secure the system the communication between modules is encrypted using symmetric key. Though many solutions have been proposed earlier many of them only consider one side of security; the author proposed that the cloud data security must be considered to analyze the data security risk, the data security requirements, deployment of security functions and the data security process through encryption. The main contribution of this paper is the new view of data security solution with encryption, which is the important and can be used as reference for designing the complete security solution.

Data Security in Cloud computing using RSA Algorithm Parsi Kalpana, Sudha Singaraju have proposed a method by implementing RSA algorithm to ensure the security of data in cloud computing. RSA algorithm to encrypt the data to provide security so that only the concerned user can access it. The purpose of securing data, unauthorized access does not allow. User data is encrypted first and then it is stored in the Cloud. When required, user places a request for the data for the Cloud provider; Cloud provider authenticates the user and delivers the data. RSA is a block cipher, in which every message is mapped to an integer. RSA consists of Public-Key and Private-Key. In the proposed Cloud environment, Pubic-Key is known to all, whereas Private-Key is known only to the user who originally owns the data. Thus, encryption is done by the Cloud service provider and decryption is done by the Cloud user or consumer. Once the data is encrypted with the Public-Key, it can be decrypted with the corresponding Private-Key only.

Homomorphic Encryption Applied to the Cloud Computing Security Maha TEBAA *et al* have proposed an application of a method to execute operations on encrypted data without decrypting them which will provide the same results after calculations as if the authors have worked directly on the raw data. Homomorphic Encryption systems are used to perform operations on encrypted data without knowing the private key (without decryption), the client is the only holder of the secret key. When the author decrypts the result of any operation, it is the same as if they had carried out the calculation on the raw data. In this paper cloud computing security based on fully Homomorphic encryption, is a new concept of security which enables providing results of calculations on encrypted data without knowing the raw data on which the calculation was carried out, with respect of the data confidentiality [45]. The author work is based on the application of fully Homomorphic encryption to the Cloud Computing security considering: The analyze and the improvement of the existing cryptosystems to allow servers to perform various operations requested by the client. The improvement of the complexity of the Homomorphic encryption algorithms and compare the response time of the requests to the length of the public key.

When organizations look to protect sensitive data at rest in the cloud or in transit on the way to it, there are two primary obfuscation strategies most consider – tokenization or encryption. When considering placing data in the cloud, regardless of whether it is a public or private cloud, it is important that organizations ask what type of in flight and rest encryption the service is using, and who will hold the key to those encryptions.The cloud is a convenient place to back up and store files, but user should hesitate before uploading that sensitive data, user files may be encrypted in transit and on the cloud provider's servers, but the cloud storage company can decrypt them — and anyone that gets access to your account can view the files. Client-side encryption is an essential way to protect your important data without giving up on cloud storage. Encryption does add

some complexity, however. User can't view the files in the cloud storage service's web interface or easily share them. You'll need your encryption tool to decrypt and access user files [46].

8. Discussion and Open Issues

The future of cloud computing also shows that the burden of maintaining software in client's computer will be negligible since there is no need to install the software application on their computer so there will no need for the person to take stress for maintenance or troubleshooting issues if any arises. The applications can be operated on by using an interface designed especially for cloud computing which will make it easier for the person to access the software which is installed on one specific computer in a network. If the software can be accessed over web browser, then there will be minimal need to store data on the computer which indirectly points to another advantage offered by the future of cloud computing where the end user will not have to invest large amounts of money to buy hard disks which can store loads of information in various formats and types [47]. All the data is stored safely on internet along with ready backup all the time.

For people who are a lot into gaming, future of cloud computing assures them that with the reduced usage of hardware, there will be no chance of virus entering the system since everything will be operated over the network and using web browser. The future of cloud computing shows scope for many areas of fields like medicine, education and space where there is need for larger storage spaces and which requires high bandwidth internet which might seem difficult if the system does not use cloud computing. Cloud computing reduces the cost and risks of having storage area. It can have the data stored readily with backup without the need to do it manually.

As companies evaluate internal and external cloud solutions, portability becomes a major concern. Can customers efficiently move production workloads from their data center to the cloud and from their private IaaS to their own physical infrastructure? As with virtualization, DEV and QA environments are the first workloads to be migrated to cloud infrastructure. Unlike virtualization, even basic IaaS solutions provide network topographies, storage, firewalls and content routing. Moving workloads means migration of far more than just the compute needs. In today's technology environment, many cloud providers are available, such as Google, Microsoft, Amazon and users have a choice of selecting a best cloud environment which satisfies his requirement [48].

Every cloud environment provides the different services to its users at the same time using single sign on. Every cloud provider provides the different services to its authenticate user, so the main thing is that every user has to first subscribe or register to a respected cloud environment and then the user can access the services provides by that cloud. This is the procedure for every cloud provider to authenticate user and give the privileges to access its services. Now issue is generated that what happen if a same user wants to access the different services provides by the different cloud provider? For example, if a user is using the Google docs service from Google and user have to maintain the database using another service which is provide by the other cloud provider say Oracle cloud [49]. So how user can use both the services from the different cloud provider? The simple solution for this issue is that user has to first subscribe in the entire cloud provider environment and then the user can access the services from different cloud provider.

Figure 6 Various Cloud Service Providers in Current Market

Network Bandwidth and Latency Issues: The target applications and IT solutions need to be assessed against business requirements that are affected by network bandwidth and latency, which are inherent to cloud interconnection. Bandwidth is critical for applications that require substantial amounts of data to be transferred to and from the cloud, while latency is critical for applications with a business requirement for swift response time. ISPs need to use broadband network technology to implement the core network required to guarantee end-to-end broadband connectivity. This type of bandwidth is constantly increasing; Web acceleration technologies, such as dynamic caching, compression, and pre-fetching continue to improve end-user connectivity. Also latency which is defined as the amount of time it takes a packet to travel from one data node to another. Latency increases with every intermediary node on the data packet's path. Transmission queues in the network infrastructure can result in heavy load conditions that also increase network latency. Networks are dependent on traffic conditions in shared nodes, making Internet latency highly variable and often unpredictable. This unpredictability makes latency an issue that needs to be mitigated through the judicious usage of Web acceleration technologies and network infrastructure provisioning [50].

9. Conclusion

In today's modern world where innovations of new technologies are expected to satisfy the customers need and demand, businesses or organization has to keep an eye on the worldwide innovations, collaborations and productivity which is very necessary for the IT organizations to compete with other IT organizations. Enterprises will continue to move to the cloud, increasingly virtualizing their infrastructure, using more hosted computing capacity and making cloud services as their mainstream use. In the current economic climate where the expectations of efficiencies and cost savings are growing from IT organizations, enterprise clouds provide a good opportunity to get started with cloud computing and reap the associated benefits of agility, cost savings and on-demand services while meeting the stringent enterprise security, performance and reliability requirements. In feature we will investigate the extent of different types of Enterprise Cloud deployment methods. Cloud computing represents the next evolutionary step toward elastic IT. It will transform the way your IT infrastructure is constituted and managed, through consumable services for infrastructure, platform, and applications. This will convert your IT infrastructure from a factory into a supply chain.

References

1. Foster *et al*. Cloud Computing and Grid Computing 360-Degree Compared. Proceedings of IEEE Grid Computing Environments Workshop, ***IEEE Press***, 2008, 1-10
2. Gong CY, Liu J, Zhang Q, Chen HT and Gong ZF. The Characteristics of Cloud Computing. ***IEEE Computer Society***, 39th International Conference on Parallel Processing Workshops, 2010
3. Choudhary V. Software as a Service: Implications for Investment in Software Development. Proceedings of 40th Hawaii International Conference on System Science, 2007
4. Wu JY, Ping LD, Ge XP, Wang Y and Fu JQ. Cloud Storage as the Infrastructure of Cloud Computing. International Conference on Intelligent Computing and Cognitive Informatics, ***IEEE***, 2010
5. Keahey K and Freeman T. Science Clouds: Early Experiences in Cloud Computing for Scientific Applications. Proceedings of Cloud Computing and Its Applications 2008, Chicago, IL. 2008
6. Nurmi D and Wolski R. The Eucalyptus Open-Source Cloud Computing System. Proceedings of 9th IEEE/ACM International Symposium on Cluster Computing and the Grid, Shanghai, 2009, 124-131
7. Rains G. Cloud Computing and SOA, MITRE, white paper, Oct. 2009
8. Shivaji P, Mirashe and Kalyankar NV. Cloud Computing, ***Journal of Computing***. 2, Issue 3, March 2010
9. Zhang SF, Zhang S, Chen XB and Wu SZ. Analysis and Research of Cloud Computing System Instance. ***IEEE Computer Society***, Second International Conference on Future Networks, 2010
10. Zhang S, Zhang SF, Chen XB and Huo XZ. The Comparison Between Cloud Computing and Grid Computing. International Conference on Computer Application and System Modeling, ***IEEE***. 2010
11. Almorsy *et al*. Collaboration-Based cloud Computing Security Management Framework. Conference proceedings of IEEE International conference on Cloud computing (CLOUD 2011), Washington DC, USA 99, 2011
12. Bhadauria *et al*. A survey on Security Issues in Cloud Computing. arXiv:1109.5388v1
13. Bingi P *et al*. Critical issues affecting an ERP implementation. ***Information Systems Management***. 1999, 16:7
14. Goel *et al*. Impact of cloud Computing on ERP implementations in Higher Education. International ***Journal of Advanced Computer Science and Applications***. 2011, 2, No.6
15. Gulla, JA. Introduction to Enterprise Systems. Norwegian University of Science and Technology Trondheim, Norway,white paper, 2004
16. Buyya R, Yeo CS, and Venugopal S. Market-Oriented Cloud Computing: Vision, Hype and Reality for Delivering IT Services as Computing Utilities. ***Future Generation Computer Systems.*** 2009, 25: 599-616
17. Inmon WH. Building the Data Warehouse. ***John Wiley Sons, Inc.***, New York (NY, USA), 2005
18. Dibbern J, Goles T, Hirschheim R, and Jayatilaka B. Information Systems Outsourcing. A Survey and Analysis of the Literature. 2004
19. Relan P and Sibbingz. Business intelligence for the cloud software stack helps gaming sites quickly adapt to evolving customer needs. 2009
20. Linthicum DS. Cloud Computing and SOA Convergence in Your Enterprise. ***Addison-Wesley Professional***, New York, 2009
21. Howie N. Computing on a Cloud. ***Canadian Manager***. 2010, 35: 9-10
22. Marston S, Li Z, Bandyopadhyay S, Zhang J, Ghalsasi A. Cloud Computing - The Business Perspective. ***Decision Support Systems***. 2011, 51:176-189
23. Orakwue E. Private Clouds: Secure Managed Services. ***Information Security Journal***. 2010, 19:295-298
24. Hofmann P, and Woods D. Cloud Computing: The Limits of Public Clouds for Business Applications. ***IEEE Internet Computing***. 2010, 14: 90-95
25. Anthes G. Security in the Cloud: Cloud Computing Offers Many Advantages, but Also Involves Security Risks. ***Communications of ACM***. 2010, 53:16-18
26. Subashini S, Kavitha V. A Survey of Security Issues in Service Delivery Models of Cloud Computing. ***Journal of Network and Computer Applications***. 2011, 34:1-11

27. Vaquero LM, Rodero-Merino L, Caceres J, and Lindner M. A Break in the Clouds: Towards a Cloud Definition. ***ACM SIGCOMM Computer Communication Review***. 2009, 39:50-55
28. Keahey K, Tsugawa M, Matsunaga A, and Fortes J. Sky Computing. ***Internet Computing***, IEEE. 2009, 13:43-51
29. Sotomayor B, Montero RS, Llorente IM, and Foster I. Virtual Infrastructure Management in Private and Hybrid Clouds. ***Internet Computing, IEEE***. 2009, 13:14-22
30. Lawton G. Developing Software Online with Platform-as-a-Service Technology. ***Computer, IEEE***. 2008, 41:13-15
31. Parveen T, Tilley S. When to Migrate Software Testing to the Cloud? In Third International Conference on Software Testing, Verification, and Validation Workshops (***ICSTW***). 2010, 424-427
32. Chan W K, Mei LJ, Zhang ZY. Modeling and Testing of Cloud Applications. In 2009 IEEE Asia-Pacific Service Computing Conference (***APSCC 2009***), Singapore; Dec 7-11, 2009
33. Dibbern J, Goles T, Hirschheim R, and Jayatilaka B. Information Systems Outsourcing. A Survey and Analysis of the Literature. 2004
34. Relan P, and Sibbingz. Business intelligence for the cloud software stack helps gaming sites quickly adapt to evolving customer needs. 2009
35. Miller HG and Veiga J. Cloud Computing: Will Commodity Services Benefit Users Log Term? Published by the IEEE Computer Society. 2009, 11:57-59
36. Chang F, Dean J, Ghemawats S, *et al*. Bigtable: a distributed storage system for structured data Proc of the 7th USENIX Symposium on Operating Systems Design and Implementation. 2006, 205-218
37. Peng B, Cui B, Li XM. Implementation issues of A cloud computing platform. ***IEEE Data Engineering Bulletin***. 2009, 32:59-66
38. Collins H. Enterprise Knowledge Portals: Next Generation Portal Solutions for Dynamic Information Access, Better Decision Marketing, and Maximum Results. Am. Management Assoc. 2003
39. Buyya R. *et al*. Cloud Computing and Emerging IT Platforms: Vision, Hype, and Reality for Delivering Computing as the 5th Utility. Future Generation Computer Systems, 2009
40. Fallenbeck N *et al*. Xen and the Art of Cluster Scheduling. In The 1st International Workshop on Virtualisation Technology in Distributed Computing (VTDC2006), 2006
41. Barham P *et al*. Xen and the art of virtualisation. In Ottawa Linux Symposium, 2004
42. Rochwerger B *et al*. The Reservoir Model and Architecture for Open Federated Cloud Computing. IBM Journal of Research and Development, 2009
43. Metzler J and A M *et al*. Virtualisation, Cloud Computing and Optimisation and Securing the Internet. The 2011 Application and Service Delivery Handbook, 2011
44. Nadgowda S. Cloud performance benchmark series. In Cloud Computing Centre - NSAC, 2011
45. Nordheimand S, Paivarinta T. Implementing enterprise content management: from evolution through strategy to contradictions out-of-the-box. ***European Journal of Information Systems***.2006, 15:648
46. Smith H and McKeen J. Developments in Practice VIII: Enterprise Content Management. Comm. ***Assoc. of Information Systems.*** 2003, 11: 647-659
47. B. Sotomayor, R. S. Montero, I. M. Llorente, and I. Foster. Virtual Infrastructure Management in Private and Hybrid Clouds. IEEE Internet Computing, 2009
48. Kumar RS and Saxena A. Data integrity proofs in cloud storage. Third International Conference on Communication Systems and Networks (COMSNETS), 2011
49. Ramgovind S, Eloff MM and Smith E. "The Management of Security in Cloud Computing" Information Security for South Africa (ISSA), Sandton, Johannesburg, 2-4 Aug, 2010
50. Chuang I, Li S, Huang K, and Kuo Y, An effective privacy protection scheme for cloud computing. In Proceeding of the 13th International Conference on Advanced Communication Technology (ICACT), 2011
51. Wang C, Wang Q, Ren K, and Lou W. Towards Secure and Dependable Storage Services in Cloud Computing. ***IEEE Transactions on Services Computing***, Issue:99 , 2011
52. Wang Q, Wang C, Ren K, Lou W, and Li J. Enabling

Public Auditability and Data Dynamics for Storage Security in Cloud Computing. ***IEEE Transactions on Parallel and Distributed Systems.*** 2011, 22, Issue 5

Bibliography of the Authors

Rabi Prasad Padhy is currently working as a Senior Software Engineer - Oracle India Private Ltd. Bangalore, Karnataka, India. He has achieved his MCA degree from Berhampur University. He carries more than 8 years of extensive IT Experience with MNC's like EDS, Dell, IBM and Oracle. His area of interests includes IT Infrastructure Optimization, Virtualization, Enterprise Grid Computing, Cloud Computing and Cloud Databases. He has published several research papers in national and international journals. He is a certified professional for Oracle & Microsoft Database, Oracle Apps, Linux & Solaris System Admin and also ITIL Certified.

Dr. **Manas Ranjan Patra** holds a Ph.D. Degree in Computer Science from the Central University of Hyderabad, India. Currently he is an Associate Professor in the Post Graduate Department of Computer Science, Berhampur University, India. He has about 24 years of experience in teaching and research in different areas of Computer Science. He had visiting assignment to International Institute for Software Technology, Macao as a United Nations Fellow and for sometime worked as assistant professor in the Institute for Development and Research in Banking Technology, Hyderabad. He has about 90 publications to his credit. His research interests include Service Oriented Computing, Software Engineering, Applications of Data mining and E-Governance. He has presented papers, chaired technical sessions and served in the technical committees of many International conferences.