IDRBT Community Cloud for Indian Banks

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Abstract— **Cloud computing is a promising technology that provides various services to the customers on demand over Internet. The ease of this technology is increasingly expanding in almost all the industries across the globe for its resulting benefits. Several organizations including BFSI Sector, want to adopt Public or Private Cloud services, but due to several security challenges posed by this emerging technology, these organizations hesitate to try Cloud services by external providers. A Community Cloud can possibly be a solution where the Cloud services are meant for organizations having common objectives and security controls. To furnish Cloud services to such like-minded organizations in India, IDRBT (Institute for Development & Research in Banking Technology, established by Reserve Bank of India) has setup a pilot approach in building Community Cloud for the Indian Banks to provide Infrastructure as a Service. In this paper, we present the IDRBT Community Cloud approach for Indian banks along with implementation details, High Level Architecture, Disaster Recovery Plan, Application Assessment before deploying on Cloud, Network Solutions and Future Work.**

Keywords—Cloud Computing, Community Cloud, Iinfrastructure as a Service, Megdhoot .

I. INTRODUCTION

Cloud computing is an emerging Internet-based computing technology where a large pool of systems are connected through private or public networks, to provide dynamically scalable infrastructure for applications, data and file storage. Cloud computing is one of the most exciting technologies used these days which delivers IT capabilities as service-on-demand. Its ability to reduce costs associated with services while increasing flexibility and scalability for computer processes are well prominent.

Cloud computing technology provides three fundamental services namely Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) which can be deployed on top of Public, Private and Hybrid cloud models.

1. Infrastructure as a Service: A pool of equipments including servers, storage systems, network, data centers etc., provided as a service to the customers where providers can handle customers' application workloads is referred as IaaS. The customer can host their own software on the cloud infrastructure. Some of the IaaS providers are Amazon, GoGrid, 3 Tera, etc. [1]

2. Platform as a Service: In PaaS, a computing environment is provided as a service to the customers to build their own applications that run on the provider's infrastructure. Google's App Engine, Force.com, etc are some of the PaaS providers [2].

3. Software as a service: SaaS is an "on-demand software" service where the required software is provided to the end users as an application to run on their systems through Internet. Today, SaaS is offered by companies such as Google Apps, Salesforce.com, Microsoft, Zoho, etc. [2].

A. CLOUD DEPLOYMENT MODELS

- Public Cloud: A public cloud provides services like applications or storage to the public including individuals, various organizations etc. Public cloud is essentially maintained by a third party vendor and is provided to the users on a pay-per-use basis only through Internet. Providers like Amazon AWS, Microsoft, Rackspace and Google own and operate the infrastructure and offer access only via Internet.

- Private Cloud: Private Cloud is built for clients to use it just within their organizations, thus resulting in more effective control of data, security and service quality [3]. It offers benefits like flexibility and scalability, cost effective, secure, easy management. Some of the providers are Nimbula, Eucalyptus, VMware etc.

- Hybrid cloud: A blend of both public and private clouds together is termed as Hybrid Cloud. In public or in private clouds, the issues of flexibility, scalability and criticality may differ for several scenarios, whereas in hybrid cloud, we can accommodate our applications as per the requirement of issues depending on their critical and non-critical standards [3]. Critical applications can be confined to the private cloud while allowing non-critical applications into the public cloud.

- Community cloud: A community cloud is a collaborative service where the infrastructure is shared between several organizations that are from a familiar society with common concerns like security, compliance, jurisdiction, etc. It can be managed internally or by a third-party. IDRBT provides community cloud services to the Indian banks.

A brief representation of cloud models is shown in Fig. 1.
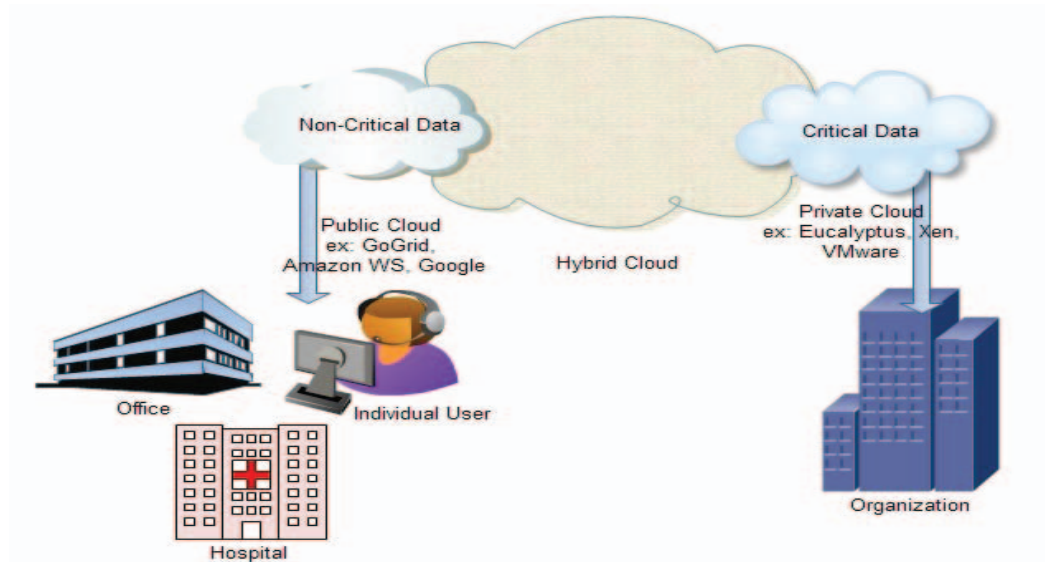
Fig. 1. Public, Private and Hybrid Cloud Services

II. CLOUD IN BANKING SECTOR

Cloud technology became a key focus for the financial sectors to rely their applications, storage capabilities, data centers etc over the cloud. The impact of cloud technology over banks is very high and beneficial too as it can provide flexibility for the banks and offers a way to measure and manage the services in a more efficient way. The following section talks about certain issues that banks faced in traditional systems.

A. General issues faced in traditional banking system

With the advancement in day-to-day life, the economy is becoming increasingly complex and banks are facing an enormous competition within the industry to uphold their customers from not getting influenced by the other banks. Some of the issues noted are:

- There is a need to develop attractive offers and services to attract customers for which banks require huge manual effort and physical infrastructure.

- With the increase in the capacity of data storage, banks need to incorporate huge infrastructures. For this purpose, they need to establish separate data centers that include appropriate real estates, setting up physical infrastructure like servers, power cables, cooling systems, network devices like switches and routers along with their cabling, etc is becoming a major trouble for the banks.

- The entire process leads to several challenges in the maintenance of the data centers with respect to electrical energy management, productive maintenance, environmental controls, safety measures, and security devices etc.

To ease from such issues, banks and financial firms can adopt this emerging technology for cost reduction, zero maintenance of infrastructure, better flexibility and agility, relieve from software licensing etc [4]. Banks have to adhere to a lot of regulatory and legal information in which customer account data is of highest importance. So banks need to be very cautious before moving their steps on to the cloud.

B. Benefits of Cloud Technology for the Banks

With cloud computing, banks can see a radical decrease in their costs of labor, real estates, infrastructure maintenance effort, as their majority of the expenses drain in setting up infrastructure, data center spaces and other IT resources. Instead of this, banks can develop new trade methods, grow their business aspects in new regions of both physical systems and technology updates for improvising banks' products and services.

Beyond cost savings, cloud provides banks with several opportunities to build customer centric and active business models to grow their brands more efficiently [5]. Banks can also provide customers with striking applications so that customers can experience an easy access to the banking services. For example, customers can use certain applications from Smartphone by which they can carry out the billing sort of services easily.

Studies now indicate that about 75% of banking organizations will use the Enterprise Cloud Computing, or hybrid solutions for cloud computing [6].

C. Cloud for Banks

Cloud computing provides a broad range of amenities that helps banks to inherit cloud services on a flexible approach. Most of the banks seek to rely on Private Cloud as it is the safest cloud service where data is not exposed to the external tenants.

In view of the fact that the cloud resources can be rented instead of being purchased, it also helps in reducing CAPEX to OPEX, reducing total cost of ownership. Apart from these benefits, private cloud comes with the advantages of affordability, rigorous protection to the applications safety and enables transition in banking technologies, hence banks should cautiously plan the development of new applications that can sustain for a long-term guarantee for the customers [7].

In the case of a public cloud, IT resources or software are provided by an external supplier via the Web. Users' data and applications are all located on the same physical infrastructure but with separate individual allocation. In this instance several users therefore share the cloud infrastructure. Whereas, hybrid cloud aims at combining the advantages of public and private cloud for their respective intended environments.

In this paper, we present some similar issues which were raised by banking communities while deploying their applications in the cloud.

III.   IDRBT'S PROPOSAL

IDRBT is a Research and Development Institution, established by RBI in 1996. For more than a decade, IDRBT has been in the progress of developing and implementing new technology trends for the Indian Banks and financial industries to smoothen their progress towards implicating customer satisfying products and services. Some important technology infrastructures introduced in IDRBT are INFINIT in 1999, the implementation of PKI based electronic data transfer and the Structured Financial Messaging System (SFMS), National Financial Switch etc, which facilitated the development of secured payment system practice in India.

In accordance, IDRBT has started a project that provides community cloud services to the Indian Banks, in October 2012 and initially a Lab level infrastructure had been set up. The objective of this project is to set up a Community Cloud for Indian Banks to cater their critical and non-critical applications by providing Infrastructure-as-a service (IaaS) as a Proof of Concept (PoC).

IDRBT's community cloud for banks has been deployed using C-DAC, Chennai's Cloud Stack "Meghdoot 1.0" which s built up on Eucalyptus 2.0.3. The proposal is to set up a pilot with 5-6 banks hosting two-three non-customer facing applications with high cyclicality (varying load) and low criticality from each bank.

A. Eucalyptus Cloud Architecture

The Eucalyptus cloud platform is an open source, Linux based software for building scalable private and hybrid clouds. It draws together the existing virtualized infrastructure to create cloud resources for compute, network and storage. The Eucalyptus Cloud can dynamically scale up or down depending on application workloads and is uniquely suited for enterprise clouds, delivering production-ready software that supports the industry-standard Amazon Web Services APIs. The benefits are highly efficient scalability, organizational agility, and increased trust and control for IT.

B. High Level Architecture of IDRBT Cloud

The IDRBT cloud stack as shown in Fig. 4 can be briefly explained as follows:

The lowermost layer includes hardware infrastructure where the data and applications are stored. Above physical infrastructure lies virtual machines which uses several kinds of hypervisors that are supported by the applications and the NCs' that act together with VMs. Above virtualization and hardware layer is the place for virtual interface management which holds the eucalyptus component Cluster Controller.

The above next layer consists of several components each with specific functionalities. Provisioning and Configuration is the capability of cloud providers in providing priority services to the customers in terms of virtual machines, data access, infrastructure resources etc. In general, this phase is connected to the bottom most layer where the physical resources are available [8]. Orchestration layer is the automated arrangement and management of services provided by the service providers. That means it can dynamically attach the services to the clients based on the norms of the cloud service providers and specifications of the clients.

OSS/BSS/ISTM is the various management services that can be adopted to manage the operational and business related functionalities in cloud computing [9]. Service catalog is the list of services provided by the cloud providers to their customers. It helps the customers to decide what sort of services can be utilized for their applications.SLA manager takes care of the service level agreements between the providers and the clients while defining the services.

CMDB (Configuration Management Database) is a collection of information about the various resources related to the IT Infrastructure within an organization. It contains data regarding managed resources like computers and application software, process records etc [10]. Monitoring is a special task used to verify the performances and functionalities of every computing resource in the cloud in order to keep away the chances of failure events [11].

Metering is another important task for ensuring proper functioning of the utilities like disk space, network and memory usage in the machines. [11]. A refined metering plan grants cloud providers an ability to monitor actual usage of resources by the clients and then charge them accordingly. The accurate usage information resulted from metering offers exact pay per use model to the clients. Resource provisioning is a system of dynamically allocating data and computing resources to the users as per applications or services requirements.

Above these components level is the level of services provided to the customers like IaaS, PaaS and SaaS. IDRBT is providing IaaS services to the clients to deploy their applications. On top of all these layers is the clients' level, where they can avail cloud services through Web Interface/API depending on their requirements.

C. Disaster Recovery (DR) plan in IDRBT Cloud

With a well planned Disaster Recovery in set, the retrieval of lost data smoothly and easily without any unpredictable

failures can be achieved. Cloud computing takes a very different approach to disaster recovery. With virtualization, the entire server, including the operating system, data and applications are encapsulated into a single software bundle. This entire bundle can be copied or backed up at an offsite data center and built up on a virtual host. This virtual server being hardware independent, the operating system, data and applications can be safely and accurately transferred from the original data center to the DR mapped data center without the problem of reloading every component on to it again. This sort of mapping allows very less time in capturing data and applications between the two centers.

A simplified approach of proposed IDRBT DR Plan between Hyderabad and Mumbai is shown in Fig. 2.
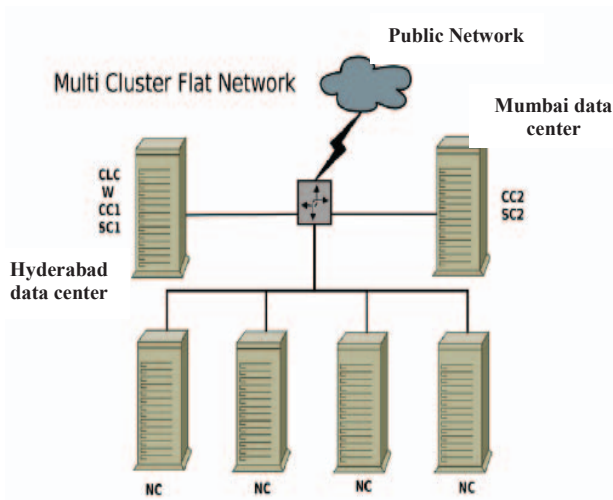

Fig. 2. IDRBT DR Plan between Hyderabad and Mumbai data centers

This picture describes the connection of NCs between the two data centers of IDRBT placed in Hyderabad and Mumbai data cneters. Both these centers are connected over a restricted public network as shown in the diagram. At both the centers, the CCs and SCs have been replicated with each other where information of NCs, VMs scheduling and executions, volumes and volume snapshots etc are stored.

IV. IDRBT'S COMMUNITY CLOUD ARCHITECHTURE

The IDRBT's Cloud PoC at lab level has been setup with the following initial and current configurations as shown in Table I and TABLE II respectively, using C-DAC, Chennai's Cloud Stack "Meghdoot 1.0" which is built up on Free Open Source Software "Eucalyptus 2.0.3".

- Initial Configuration: The initial configurations of Node Controller (NC), Cloud Controller (CLC), Storage Controller (SC), Cluster Controller (CC) and Walrus machines are shown in TABLE. I.

- Current Configuration: At present, the configurations have been escalated with the increase in applications

requirements. The new configuration details of NC, CLC, SC, CC and Walrus are shown in TABLE II.

TABLE I. INITIAL CONFIGURATIONS

Components	Configuration
NC + SC	16 Core, 2 TB HDD, 32 GB RAM, 3.10 GHz, i5 (HP Server)
CLC+CC+ Walrus	4 Core, 500 GB HDD, 8 GB RAM, 3.10 GHz

TABLE II. CURRENT CONFIGURATIONS

Components	Configuration
NC + SC	1. 64 Core, 256 GB RAM, 5 TB HDD, 2.44 GHz, DELL R910 Server. 2. 16 Core, 1.8 TB HDD, 32 GB RAM, 3.10 GHz, DELL R710 Server. 3. 16 Core, 1.8 TB HDD, 32 GB RAM, 3.10 GHz, DELL R710 Server.
CLC+CC+ Walrus	16 Core, 1.8 TB HDD, 32 GB RAM, 3.10 GHz, HP DL380 Server

Following section describes our experiences with some of the banks in deploying their applications on IDRBT's community cloud.

A. Bank Applications on IDRBT Cloud

IDRBT's cloud solutions have successfully deployed two banks' applications on IDRBT's Cloud in PoC phase as shown in TABLE III. A few more banks have come forward to host their applications onto IDRBT's cloud.

TABLE III. DETAILS OF APPLICATIONS HOSTED ON IDRBT'S CLOUD

Name of Bank	Application	Specification
Bank A*	Information portal	OS: WIN 2K3 Server, CPU: 2 * Xenon 2.4 GHZ (32 bit), RAM:8 GB, HDD:80 GB, Webserver: Pramati Server 5.0
Bank B*	Document Management Portal	OS: Windows 2008 Server Enterprise Edition (64 Bit), CPU- 2 * Xenon 2.4 GHZ, RAM- 4 GB, HDD-100GB

We are in progress to launch these applications as per the banks' requirements at the earliest. While working with these bank applications, we have   encountered a few challenges. To hamper these issues from further arising, we have taken up certain measures which are discussed in the next section.

B. Challenges encountered while deploying some applications

Following are some of the issues raised while deploying some applications on cloud.

- Eucalyptus cloud software is supported on all Linux based OS. In case of Windows based OS, Eucalyptus is supported only on Windows 2003 server and its above

versions. Any application which is reliant to lower versions in Windows cannot run on Eucalyptus cloud. Therefore, applications that are running on older versions of OS needs to get migrated to deploy on eucalyptus cloud.

- Certain applications could not prove to be compatible on to cloud due to the legacy code being unfeasible to implement on new environments. Also, there was mismatch of database and other technical version adaptations on the cloud environment when compared to previous environment. These conflicts were interrupting the applications from executing on the cloud environment.

- There was no support from the vendors in terms of documentation of the project or man power to debug the arising issues in case of implementing the unfeasible code.

- The requirements of storage and/or physical resources for some applications rise/drop suddenly at certain intervals of time. Rendering resources at such peak times could be risky. Such an issue can wipe out the data if it is not considered seriously.

- Justifying the heights of security and risk vulnerabilities, data storage capacities, extra resources allocation on demand, etc remain unpredictable at certain intervals of time.

- Apart from X86 architecture based applications, no other applications are supported in the present cloud environment.

C. Cloud Application Assessment Approach

To assess the bank's applications, IDRBT has designed and developed a Cloud Application Assessment Tool (CAT). The objective of this tool is to find out the software and hardware performance, security and risk estimations of applications. The tool evaluates various characteristic of the applications like its business value, technology readiness, operational risk readiness and technical requirements details etc. Assessing an application in this approach gives the cloud service providers a broad view regarding the pros and cons of the applications, how safe it is, how risky it is etc. Service providers can evaluate the conditions of the application and can thus conclude the application can be deployed in cloud or not.

A brief explanation of IDRBT's Cloud Assessment Tool course of action in the case of Bank A is given below:

- Business Value: This section evaluates the business level priorities of an application. The highest priority, which is indicated in red color, specifies that the application is bright enough for deploying in the cloud environment. While the low priority, indicated in green color is not good enough for deploying in the cloud.

- Technology Readiness: This section ensures whether the application is ready in trust of technology precedence.

- Operational Risk Readiness: This section verifies the operational level risks and vulnerabilities of the application before deploying into the cloud.

Once the assessment is filled in by the clients, it is evaluated with the benchmark values as per the standards allowed in our cloud environment. TABLE IV given below is the estimation revealed for the application of Bank A in business, technology and operational levels.

TABLE IV.   BANK A'S APPLICATION ASSESSMENT VALUES COMPARED TO THE BENCHMARK VALUES OF IDRBT

Category	Bank A	Benchmark
Business Value	15	12
Technology readiness	15	8
Operational Risk readiness	19	8

Here, the benchmark values depict the average values for an application to be suitable to host on cloud.
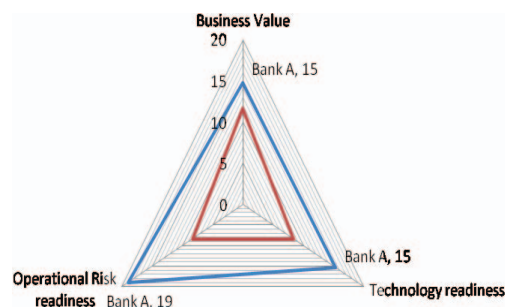

Fig. 3. Radar graph depicting Bank A's application assessment values and IDRBT's Benchmark values

It has been observed that assessment conducted for Bank A's application has raised above the average benchmark values and hence it can be deployed in the cloud without any trouble. Fig. 3 is a graph which gives a clear picture regarding the comparisons between IDRBT's Benchmarks and the application's assessment values.

The red lines in the graph represent benchmark values set by IDRBT while the blue lines represent the assessment values drawn by Bank A application in various prospects. Here, the graph gives a clear-cut expression that Bank A's application can be deployed on cloud with no dilemma.

V.   CONCLUSION AND FUTURE WORK

In this paper, we have discussed about various challenges banks are facing with the traditional methods of banking. Banks are in search of new practices to renovate their traditional approaches so that they can focus more on customer related values. Cloud computing has proven to be the best

result in fixing such issues. This is an emerging technology which delivers hosted services over Internet on demand basis.

IDRBT provides a community cloud with IaaS services to the Indian Banks to execute their critical and/or non-critical applications. CDAC cloud stack "Meghdoot 1.0" which is built on Eucalyptus 2.0.3 has been deployed on the cloud. In PoC phase, two banks' applications have been successfully deployed on IDRBT cloud. A few challenges have encountered while executing these applications on cloud like applications being incompatible on Eucalyptus environment due to lack of OS support or other technical issues. Allocating resources to the applications in case of sudden rise/fall of their requirements etc. In order to sustain from such issues, IDRBT has developed a Cloud Application Assessment Tool to figure out the hardware and software performances, security and risk estimations of the applications. This tool estimates the application's characteristics in business, technology and operational levels. With the help of such estimations, cloud providers can categorize the applications in all aspects and decide if they are appropriate to deploy on their services or not.

IDRBT has even established a secure network channel for cloud access through MPLS network. MPLS is a packet forwarding network which attaches labels to the packets instead of IP addresses while forwarding them through the network. IDRBT has also a plan to setup DR Site at Mumbai as a replication to Hyderabad's data center in order to retrieve lost data smoothly without any interruptions. Both the centers are connected over a public network.

Banks can choose any of these services depending on their applications' requirements. The resultant of this technology in banking industry reflects in various areas like cost reduction in maintain technology and infrastructure, the concern of building data centers, procuring infrastructures, cables etc can be reduced thus reducing expenditures. Many of such issues can be relaxed by accomplishing cloud technology. Apart from cost savings, cloud technology provides banks with customer centric and active business models to grow their brands more effectively.

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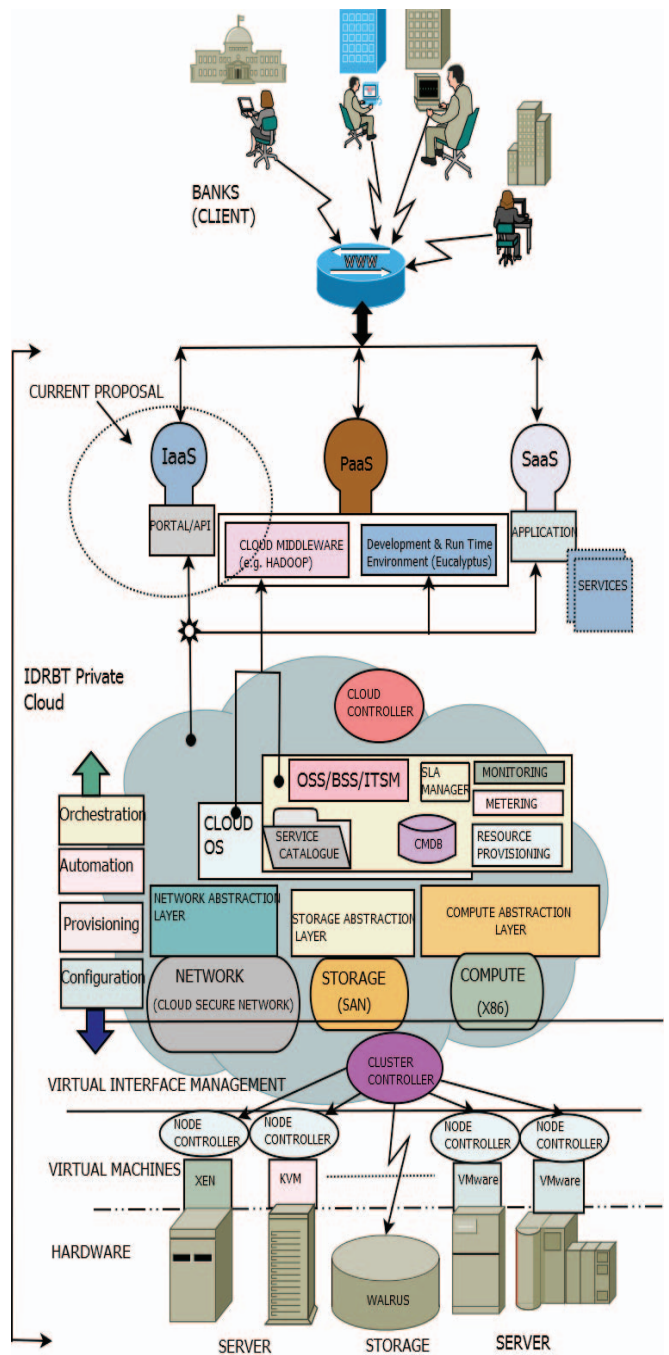[11] Eduardo Oliveros, Tommaso Cucinotta, Stephen C. Phillips, Xiaoyu Yang, Stuart Middleton, Thomas Voith. "Monitoring and Metering in the Cloud". Chapter 6.

Fig. 4. IDRBT Cloud Stack