Data Management and Deployment of Cloud Applications in Financial Institutions and its Adoption Challenges

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Abstract- The Cloud has become a new vehicle for delivering resources such as computing and storage to customers on demand. Rather than being a new technology in itself, the cloud is a new business model wrapped around new technologies such as server Virtualization that take advantage of economies of scale and multi-tenancy to reduce the cost of using information technology resources. From one perspective, cloud computing is nothing new because it uses approaches, concepts, and best practices that have already been established. From another perspective, everything is new because cloud computing changes how we invent, develop, deploy, scale, update, maintains, and pay for applications and the infrastructure on which they run. Nonetheless, there exist an increasing number of large companies that are offering cloud computing infrastructure products and services that do not entirely resemble the visions of these individual component topics. The challenge of building consistent, available, and scalable data management systems capable of serving petabytes of data for millions of users has confronted the data management research community as well as large internet enterprises. Financial institutions are not strangers to cloud computing adoption. One of the earlier cloud uses in banks and financial institutions were for SaaS deployments, which allowed for more social media banking. However, now FI's face the issue of security due to the increased number of data leaks. As a result, cloud within IT strategies and architecture for FIs will increase the risk of a security breach among servers and networks unless there is an adoption of a multiyear cloud strategy to keep data protected. This paper highlights the data management in cloud applications and deployments of various services of cloud computing in Financial Institutions with the study of risk factors in the deployment of transaction data of Financial Institutions on clouds.

Index Terms: ACID, AMAZON's EBS, cloud computing, Green IT, replication, SaaS, VPC

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1 INTRODUCTION

Cloud Computing can be best described as a highly automated, readily scalable, on-demand computing platform of virtually unlimited processing, storage and ubiquitous connectivity, always available to carry out a task of any size and charged based on usage1. While early in its evolution, Cloud computing is fast becoming as pervasive a platform as the internet.

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It is transforming the stand-alone IT infrastructures to closely resemble social public Infrastructures like electricity and water utility systems, and facilitating a shift to on-demand and pay-per-usage arrangements. For small to medium sized businesses, this is already simplifying IT functions, providing higher efficiencies while reducing overall IT infrastructure and management costs. Cloud computing will eventually reduce the captive IT footprint of businesses, simplify corporate IT management, and transform IT related expenses from large upfront capital outlays (and ongoing maintenance) to pay-as-you-use go arrangements. While businesses like Amazon, Google, IBM, Microsoft, HP and Dell are at the leading edge of providing components of the cloud computing platform (hardware, software, & services), a new crop of innovative businesses will emerge, as in the past, to capitalize on what the cloud has to offer. Amazon was an early mover, modernizing its data centers that were using as little as 10% of the capacity at any one time and allowing small, fast-moving groups to add new features fast and easy.

Cloud computing adoption continues to gain momentum across a broad range of industries including financial services. Once organizations manage to filter through the noise surrounding the cloud, there are actually some very pragmatic ways in which the IT organizations of banks, insurers and similar institutions can leverage cloud computing to directly benefit their daily operations and most significantly, have an impact on the business bottom line. These gains can be achieved without incurring large capital expenditure or exposing sensitive business data.

2 TYPES OF CLOUD MODEL

2.1 Public Clouds

Public or External cloud describes cloud computing in the traditional mainstream sense, whereby resources are dynamically provisioned on a fine-grained, self-service basis over the Internet, via web application/web services, from an off-site third-party provider who share resources and bills with a fine-grained utility computing basis. In this model, vendors dynamically allocate resources (hard drive space, RAM, and processor power) on a per-user basis through web applications.

A few public cloud offerings have already become such an ingrained part of the business community, such as Cisco's WebEx meeting space and Salesforce.com's Sales Cloud. Cisco and Salesforce.com aren't the only major vendors to jump in with a public cloud offering -- WebEx is joined by the Amazon Elastic Compute Cloud (EC2), Google Apps, and Microsoft Azure.

2.2 Private Clouds

Private clouds mitigate these concerns, with the security of an internal network. Because the customer owns all of the equipment powering the cloud environment (often a very large data center), the customer has complete control over the IT resources as well as the data and is responsible for securing it. In a private cloud, enterprise IT resources are consolidated and pooled so users across the company can have self-service access and increased scalability. Also like a public cloud, a private cloud also makes provision an automated service request rather than a manual task processed by IT.

Unlike a public cloud, setting up shop in a private cloud requires expertise with network integration as well as with sophisticated virtualization and cloud platform technologies. The organization will have to run own hardware, storage, networking, hypervisor, and cloud software. Cloud platforms for building a private cloud, includes Cisco and EMC, IBM, Microsoft, Oracle, and VMware, as well as services to help manage it. Public clouds may be the standard, but private clouds are taking hold in enterprises with surprising speed.

2.3 Hybrid Clouds

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. 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. 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.

3 DATA MANAGEMENT IN CLOUD

Data management has always been a challenge — for individuals, for small businesses, for big enterprises, and particularly for large, decentralized organizations like higher education institutions. The discipline of data management is not new — it started way back as records management, when paper files and folders were the data collection medium of choice. Unfortunately, legacy approaches based on paper often remain in place today for campus information, even when converted to electronic data formats and processes. Once data management structure is established and operating well, It is ready to take on the new frontier of data management in the cloud. For example if SAAS in clouds is being considered as how a typical mid-tier enterprise application move to a software as a service (SaaS) offered by cloud, for example, student information management that contains sensitive data. Today, most of the Institutions likely receive data files from third-party vendors containing profile information about prospective students, including contact data, regional demographic data, ethnicity or gender, and possibly high school or transfer.

Data is stored at an untrusted host. Although it may not seem to make business sense for a cloud computing host company to violate the privacy of its customers and access data without permission, such a possibility makes some potential customers nervous. In general, moving data off premises increases the number of potential security risks, and appropriate precautions must be made. Furthermore, although the name "cloud computing" gives the impression that the computing and storage resources are being delivered from a celestial location, the fact is, of course, that the data is physically located in a particular country and is subject to local rules and regulations [1]. Data is replicated, often across large geographic distances Data availability and durability is paramount for cloud storage providers. Unavailability can data management in Market-oriented Cloud Computing be damaging both to the bottom line by failing to hit targets set in service level agreements [2] and to business reputation [3]. Data availability and durability are typically achieved through under-the-covers replication (i.e., Data is automatically replicated without customer interference or requests). Large cloud computing providers with data centers spread throughout the world have the ability to provide high levels of fault tolerance by replicating data across large geographic distances. Amazon's S3 cloud storage service replicates data across "regions" and "availability zones" so that data and applications can persist even in the face of failures of an entire location. The customer should be careful to understand the details of the replication scheme however; for example, Amazon's EBS (elastic block store) will only replicate data within the same availability zone and is thus more prone to failures. It describes the suitability of moving the two largest components of the data management market into the cloud: transactional data management and analytical data management.

3.1 Transactional data management

Transactional data management refers to the databases that back banking, airline reservation, online e-commerce, and supply chain management applications. These applications typically rely on the ACID property. The transactional data management applications are not likely to be deployed in the cloud due to following reasons:

Transactional data management systems do not use a shared-nothing architecture. The transactional database market is dominated by Oracle, IBM DB2, Microsoft SQL Server, and Sybase [4]. Of these four products, neither Microsoft SQL Server nor Sybase can be deployed using a shared-nothing architecture. IBM released a shared nothing implementation of DB2 in the mid-1990s which is now available as a "Database Partitioning Feature" (DPF) add-on to their flagship product [5], but is designed to help scale analytical applications running on data warehouses, not transactional data management [6]. Oracle had no shared-nothing implementation, but again, this implementation is designed only to be used for data warehouses [7]. Implementing a transactional database system using a shared-nothing architecture is non-trivial, since data is partitioned across sites and, in general, transactions cannot be restricted to accessing data from a single site. This results in complex distributed locking and commit protocols, and in data being shipped over the network leading to increased latency and potential network bandwidth bottlenecks. Furthermore the main benefit of a shared-nothing architecture is its scalability [8]; however this advantage is less relevant for transactional data processing for which the overwhelming majority of deployments are less than 1 TB in size [9]. It is hard to maintain ACID security in the situation where data replication over large geographic distances. The CAP theorem [10] shows that a shared-data system can only choose at most two out of three properties: consistency, availability, and tolerance to partitions.

When data is replicated over a wide area, this essentially leaves just consistency and availability for a system to choose between. Thus, the 'C' (consistency) part of ACID is typically compromised to yield reasonable system availability. Amazon's SimpleDB [11] and Yahoo's PNUTS [12] both implement shared nothing databases over a wide-area network, but overcome the difficulties of distributed replication by relaxing the ACID guarantees of the system. In particular, they weaken the consistency model by implementing various forms of eventual/timeline consistency so that all replicas do not have to agree on the current value of a stored value. Google's Bigtable implements a replicated shared-nothing database, but does not offer a complete relational API and weakens the 'A' (atomicity) guarantee from ACID. There are enormous risks in storing transactional data on an untrusted host. Transactional databases typically contain the complete set of operational data needed to power mission-critical business processes. This data includes detail at the lowest granularity, and often include sensitive information such as customer data or credit card numbers. Any increase in potential security breaches or privacy violations is typically unacceptable.

4 FINANCIAL INSTITUTION'S DATA ON CLOUD

Cloud services have challenged the traditional nature of Financial Institutions. Touted as one of the most important technology shifts in recent times, cloud services claim to provide solutions for a majority of IT requirements ranging from e-mail and Web hosting to fully managed applications as well as vast on-demand computing resources. Cloud computing offers FIs the capability to create a highly mobile and virtual structure and provides flexibility to scale up/ down based on demand. Several IT organizations within FIs are organized either based on businesses or with a combination of businesses and technologies. Cloud computing services enable FIs to overcome silos by creating a single hub. The technology supports scaling up with just an internet connection & browser while all the IT assets (data and applications) are hosted in the Cloud Service Provider's data center. Work is platform independent due to the centralized nature of data, processing and services. Whosoever wants to upgrade or avail of a service can do so from the Cloud. The centralized enterprise level network administration is also made possible where updates and patches can be applied once and will be valid for all those connecting to the resources. Superior computing power can be brought within reach of FIs, who will be able to hire systems on a need basis per-user. This prevents expenditure on temporary needs or expenditure on infrastructure in case of scaling up of operations. The system management component controls the provision of the tools for accessing the servers. Charges are applied based on the usage of services.

Cloud computing can help financial institutions improve performance in a number of ways.

4.1 Cost Savings and Usage-based Billing

With cloud computing, financial institutions can turn a large up-front capital expenditure into a smaller, ongoing operational cost. There is no need for heavy investments in new hardware and software. In addition, the unique nature of cloud computing allows financial institutions to pick and choose the services required on a pay-as-you-go basis.

4.2 Business Continuity

With cloud computing, the provider is responsible for managing the technology. Financial firms can gain a higher level of data protection, fault tolerance, and disaster recovery. Cloud computing also provides a higher level of redundancy and back-up at lower prices than traditional managed solutions.

4.3 Business Agility and Focus

The flexibility of cloud-based operating models let financial institutions experience shorter development cycles for new products. This supports a faster and more efficient response to the needs of banking customers. Since the cloud is available on-demand, less infrastructure investment is required, saving initial set-up time. Cloud computing also allows new product development to move forward without capital investment. Cloud computing also allows businesses to move non-critical services to the cloud, including software patches, maintenance, and other computing issues. As a result, firms can focus more on the business of financial services, not IT.

4.4 Green IT

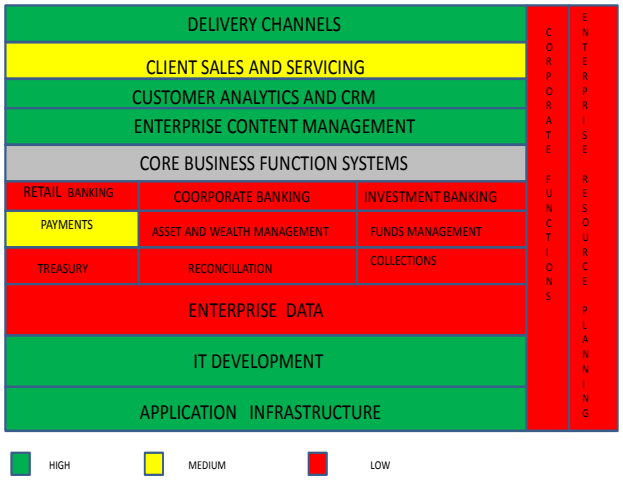
Organizations can use cloud computing to transfer their services to a virtual environment that reduces the energy consumption and carbon footprint that comes from setting up a physical infrastructure. It also leads to more efficient utilization of computing power and less idle time.

5 CLOUD APPLICATION CONSIDERATION BY FI

The non-core business applications to the cloud have been more deployed by financial institutions. Many software providers such as Oracle, IBM, and Pegasystems have cloud solutions available for their leading financial services applications. Areas that can profit from cloud computing include:

- Customer analytics and customer relationship management. Vendors with cloud solutions include Salesforce.com and Pegasystems.
- Browser-based technologies such as enterprise content management. Vendors with cloud solutions include IBM and EMC.

- IT development and application infrastructure. Since these functions are highly outsourced, banks can achieve cost savings through the cloud.



Cloud Computing Adoption Propensity

Figure1: Source: Copgemini Analysis 2010

As institutions evolve into a cloud based model, some internal business operations would get organized into following specific categories –

5.1 Customer Services of FI

Customer Services of FI include all aspects of customer engagement, sales, servicing and interactions. This also includes internal employee enablement functions to perform the customer focused activities. There is a clear maturity in terms of channels, operating activities on the channel, customer / product / pricing information requirements to support sales and servicing, architecture and technology to deploy these services. Mobile based service delivery is currently being envisaged in most financial institutions; this will be greatly enhanced by cloud based solutions.

Components	Potential Cloud solution	Comments
ATM, Kiosk, Call Center	Private Cloud delivering services across the global enterprise	• SaaS delivery model • Service standardization across these channels • Differentiation is delivered by product features than channel capabilities
Branch, Online Functions	Private cloud supporting standard functional suite	• SaaS delivery model • Potential for Core Banking providers to offer Community cloud solutions product features than channel capabilities
Mobile based functions	Private cloud supporting standard functional suite	• SaaS delivery model • Diversity of devices, carriers & technologies will enable common solutions rather than individual investments
Content Management	Private cloud delivering enterprise wide services	• SaaS delivery model • Potential for Technology vendors to deliver Public cloud solutions
Business Partner delivered functions	Public cloud delivering software applications	• SaaS based delivery model • Functionally and usage rich applications • Seamlessly integrated with internal services

Figure 2: Customer Service of FI using Cloud Solution

Currently, financial transactions are predominantly done using credit cards. While the credit card processing system is both wide-spread and well-used, it is not a public network, nor is the system wireless. A POS (point-of-sale) processing device is required in order to access the credit card validation and processing system. One example is Square, which is a small credit card reading device that attaches to the USB port of a Smartphone. IPhones, iPads, and Android devices are supported. This implementation allows anyone to accept credit cards as payment. No merchant account setup is required, no monthly fees are imposed, and no minimum monthly levels are required.

5.2 Business Enabling Services of FI

Business enabling services will increase as financial institutions re-consider aspects of differentiation. These services provide real, rich and practical opportunities for leveraging the benefits of Cloud based solutions. As this evolves, service providers will begin to offer extended business services leveraging their internal innovation ability, abstracting best practices from across the industry at significantly lower operating costs; this will further force financial institutions to replace their internal service platforms with partner services.

Components	Potential Cloud solution	Comments
Origination	Private and/or Community cloud	• SaaS delivery model • Covering A/c Management, Documentation, Collateral, Validation, Underwriting & Fulfillment, Fraud Management and AML
Transaction Processing	Initiating as Private Clouds, with potential to become Public based on the commodity nature of the functional services	• SaaS delivery model • Funds Management, Cheque processing, Payments, Chargeback, Authorization & Interchange Settlement
		• Corporate Actions, Custody operations, Treasury operations & Portfolio Management
Customer Servicing	Private cloud	• Enquiries, Exception Management & Informational service delivery, Fraud Management and AML
	Private cloud	• Organization specific services that enable differentiation like Cross Sell / Up Sell, Product / Service reconfiguration, etc
Reference Data Management	Private cloud	• SaaS model • Private services managing internal enterprise reference information, seamlessly integrated with the external reference information including market data, price, corporate actions and ratings
Collections	Initiating as Private Clouds, with potential to become Public based on the commodity nature of the functional services	• Full range of services with technology, applications and operations delivered on SaaS model internally • Covering standard reporting & analytics requirements
Reconciliation		
Analytics & Reporting	Private cloud	• Covering Performance analytics, competitive analytics, predictive analytics, segmentation & behavior analytics, etc that enable differentiation

Figure 3: Business Enabling Services of FI using Cloud Solution

But before moving to the cloud, financial institutions must consider issues around data confidentiality, security, regulatory compliance, interoperability of standards, and quality of services.

6 FINANCIAL INSTITUTIONS RISK FACTORS IN ADOPTION OF CLOUD COMPUTING

Financial institutions and their customers may face significant risk where periodic risk assessments and appropriate control enhancements have not routinely occurred. The board, executive management, back-office and front-line personnel, and is customers must engender a new understanding of these risks. Everyone needs to become aware of his and her responsibilities for adopting daily security practices and controls to help protect sensitive data in the event of unauthorized disclosure or breach.

There are some key concerns that need to be addressed before FIs decide to adopt Cloud Computing.

6.1 Portability & Preservation

A FI might lose visibility of the computation being performed. Moving applications and data across providers might create problems especially if it is not a smooth transition. How and when a backup is taken is not in the hands of the FIs but that of the provider.

6.2 Legal issues/Privacy

In case a government agency wants to access the data for surveillance or antiterrorism purposes or a court orders the disclosure of data which users had considered private hitherto, there arises a host of legal concerns, the latest example being a US court ruling involving a Leading Swiss Bank. Also, the regulations demand that historical data be preserved for certain periods, and there have to be mechanisms for ensuring this. Finally, several countries have laws around the location of data, which may take away some of the flexibilities of the cloud model.

6.3 Dependence on constant connectivity

FIs need uninterrupted and high bandwidth for seamless connection to the cloud. Interruption in connectivity would result in a severe outage for the entire FI. This concern is accentuated with the recent catastrophic data loss event that 'Magnolia' experienced not surprisingly large FIs tread carefully when it comes to the adoption of cloud services. One of the reasons why FIs have been skeptical to explore cloud computing based services is that the potential cost savings are not worth the trade-offs in terms of control, management and integration.

6.4 Account or Service Hijacking

Financial information about transactions and customers are critical to a FI, and the protection of data from intentional or accidental loss or leakage is vital both for operational and reputational reasons [13]. Account or service hijacking is not new. Attack methods such as fishing, fraud, and exploitation of software vulnerabilities still achieve results. Credentials and passwords are often reused, which amplifies the impact of such attacks. Cloud solutions add a new threat to the landscape. If an attacker gains access to your credentials, they can eavesdrop on your activities and transactions, manipulate data, return falsified information, and redirect clients to illegitimate sites. The account or service instances may become a new base for the attacker. From here, they may leverage the power of your reputation to launch subsequent attacks.

CONCLUSION

It is concluded that transactional data management applications are not well suited for cloud deployment. The characteristics of the data and workloads of typical analytical data management applications are well-suited for cloud deployment. The elastic compute and storage resource availability of the cloud is easily leveraged by a shared-nothing architecture, while the security risks can be somewhat alleviated. Further this paper highlighted the type of services and operations of Financial Institutions deployed with a specific cloud solution. However, security concerns continue to be an important factor for banks and

other financial institutions that are considering cloud computing. While there are many benefits, such as reduced infrastructure costs and pay-for-service savings, there are important security issues, such as increased dependency on a third-party service provider and uncertainty as to who owns the information that is stored and processed.

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