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Distributed Environment of Cloud for Supply Chain Management

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Abstract-Cloud computing can give the ability of flexibly outsourcing software for supply chain collaboration and infrastructure needs in a better way. Instead of maintaining and paying for maximum use this technology puts forward the method that provides flexibility to add on the way, depending upon the overall business process and network model of supply chain. Ahead of the usual technology publicity, the worth of cloud computing is that it can be a right technology for supporting and managing a constantly changing and dynamic network and thus for supply chain management. Because now a day these are the exact visibility and supply chain collaboration needs. All storage and computing resources are managed centrally in the cloud computing. Even if there exist load balancing, there are chances of network congestion. In current scenario almost all existing cloud computing architectures have centralized resources at the location of cloud provider .it leads to increment in latencies. So this is the reason to move towards the cloud environment that is distributed. Here supply chain management software will be provided to the client of cloud, so it will be considered as example of software as a service (SaaS). Instances of this SCM software and required data will be available at master data center as well as at slave data centers of cloud located at different geographical locations.

I. INTRODUCTION

A. Cloud computing

Cloud computing is a computing paradigm in which tasks are assigned to a combination of connections, software and services accessed over a network. This network of servers and connections is collectively known as "the cloud". Computing at the scale of the cloud allows users to access supercomputer-level power. Users can access resources as they need them [1]. The underlying cloud architecture includes a pool of virtualized computers, storage and networking resources that get aggregated and launched as platforms to run workloads and satisfy their Service-Level Agreement (SLA). Cloud architectures also include provisions to best guarantee service delivery for clients and at the same time optimize the efficiency of resources for providers [2].“Cloud” is a virtualized pool of computing resources. It can:

- Manage a variety of different workloads, including the batch of back-end operations and user oriented interactive applications.
- Rapidly deploy and increase workload by speedy providing physical machines or virtual machines.
- Support for redundancy, self-healing and highly scalable programming model, so that workload can be recover from a variety of inevitable hardware/software failure
- Real-time monitor resources usage, rebalance the allocation of resources when needed.

The core concept of cloud computing is reducing the processing burden on the users’ terminal by constantly improving the handling ability of the “cloud”, eventually simplify the users’ terminal to a simple input and output devices, and providing the powerful computing capacity of the cloud on-demand. All of this is available through a simple Internet connection using a standard browser or other connection [3].

1. Cloud services

The service provider provides the following main services to the service user. These are as follows:

- Software as a Service [SaaS]
- Platform as a Service [PaaS]
- Infrastructure as a Service [IaaS] [4].

(i) SaaS (Software as a service)

It features a complete application offered as a service on demand. A single instance of the software runs on the cloud and services multiple end users or client organizations. The most widely known example of SaaS is salesforce.com, though many other examples have come to market, including the Google Apps offering of basic business services including email and word processing.

(ii) PaaS (Platform as a service)

It encapsulates a layer of software and provides it as a service that can be used to build higher-level services. There are at least two perspectives on PaaS depending on the perspective of the producer or consumer of the services: Someone producing PaaS might produce a platform by integrating an OS, middleware, application software, and even a development environment that is then provided to a customer as a service. Someone using PaaS would see an encapsulated service that is presented to them through an API. The customer interacts with the platform through the API, and the platform does what is necessary to manage and scale it to provide a given level of service.

(iii) IaaS (Infrastructure as a service)

It delivers basic storage and compute capabilities as standardized services over the network. Servers, storage systems, switches, routers, and other systems are pooled and made available to handle workloads that range from application components to high-performance computing applications [1].

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2. Characteristics of Cloud Computing

Cloud computing has following essential characteristics:

(i) On demand service

Cloud computing can automatically provide computing capabilities as needed. The main purpose of cloud computing is that the public can use computing power just like the way they use water, electricity, gas and telephone. Cloud will be available in a pay-as-you-go model that users can pay for only what they use.

(ii) Elastic Scalability

Cloud computing solutions give clients the ability to choose the IT resources they need in a way that can grow over time or instantaneously as needs change.

(iii) Sharing information and group collaboration

Data and applications are easily accessible from the cloud, and information can be shared to the maximum, which facilitates group collaboration on projects.

The main feature of cloud computing is reliable services delivered through data centers and built on servers. Cloud often appears as a single point of access for all consumers' computing needs [5].

3. Virtualization technique:

Using virtualization technique, several operating systems can run at the same time on a single physical system. A user can pick the operating system and hardware configuration of his own choice to run his application. This selected combination is known as virtual machine (VM). In this approach the user share the underlying hardware resources. To centrally manage several virtual machines on a particular physical system, software is used known as "virtual infrastructure management software (VIMS)". According to user's point of view each virtual machine is a single, logical group of resources. Virtualization technique offers efficient and cost effective utilization of IT infrastructure.

Xen and VMWare are the examples of virtualization technology provider.

B. SCM (Supply Chain Management):

Hand field & Nichols define supply chain as: a supply chain includes all the activities relevant to the flow of goods and information from the raw material stage to that in which the goods are delivered to the end user [6].

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations, although the complexity of the chain may vary greatly from industry to industry and firm to firm. Traditionally, marketing, distribution, planning, manufacturing, and the purchasing organizations along the supply chain operated independently. These organizations have their own objectives and these are often conflicting. Marketing objective of high customer service and maximum sales conflict with manufacturing and distribution goals. Many manufacturing operations are designed to maximize throughput and lower costs with little consideration for the impact on inventory levels and distribution capabilities. Purchasing contracts are often negotiated with very little information beyond historical buying patterns. The result of these factors is that there is not a single, integrated plan for the organization---there were as many plans as businesses. Clearly, there is a need for a mechanism through which these different functions can be integrated together. Supply chain management is a strategy through which such integration can be achieved [7].

Supply chain management (SCM) is the oversight of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer. Supply chain management involves coordinating and integrating these flows both within and among companies. It is said that the ultimate goal of any effective supply chain management system is to reduce inventory (with the assumption that products are available when needed).As a solution for successful supply chain management, sophisticated software systems with Web interfaces are available, who promise to provide part or all of the SCM service for companies who rent their service. Supply chain management flows can be divided into three main flows:

- The product flow
- The information flow
- The finances flow

The product flow includes the movement of goods from a supplier to a customer, as well as any customer returns or service needs.

The information flow involves transmitting orders and updating the status of delivery.

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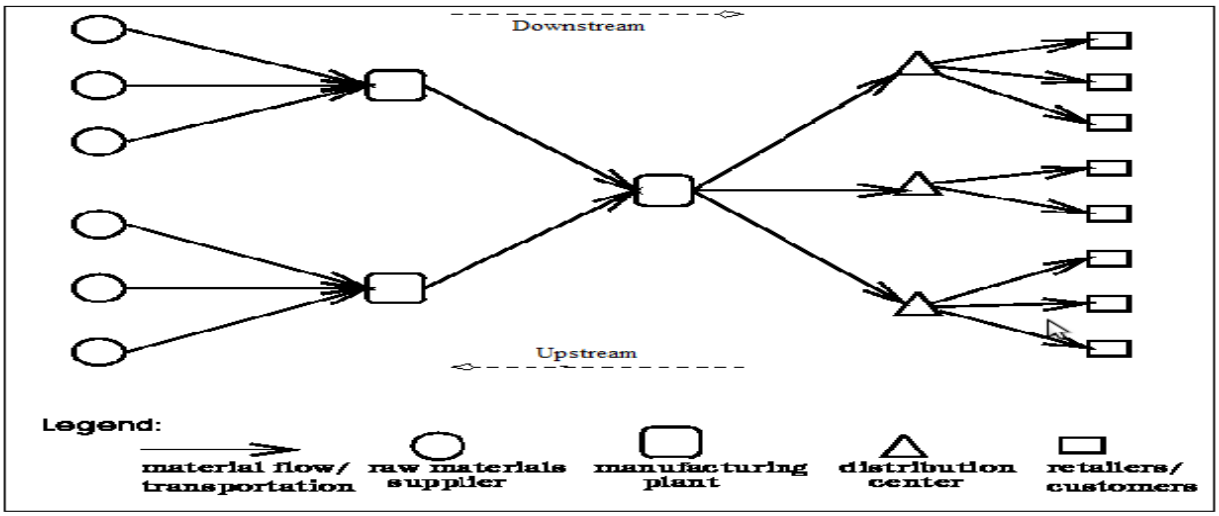

Fig.1: Example of a Supply Chain

The financial flow consists of credit terms, payment schedules, and consignment and title ownership arrangements [8].

1. Goal of installing supply chain management software

Before the Internet came along, the aspirations of supply chain software devotees were limited to improving their ability to predict demand from customers and make their own supply chains run more smoothly. But the cheap, ubiquitous nature of the Internet, along with its simple, universally accepted communication standards, has thrown things wide open. Now, companies can connect their supply chain with the supply chains of their suppliers and customers together in a single vast network that optimizes costs and opportunities for everyone involved. This was the reason for the idea that everyone a company does business with could be connected together into one big happy, cooperative family. Of course, reality isn't quite that happy and cooperative. But today most companies share at least some data with their supply chain partners. The goal of these projects is greater supply chain visibility. The supply chain in most industries is like a big card game: the players don't want to show their cards because they don't trust anyone else with the information, but if they showed their hands they could all benefit. Suppliers wouldn't have to guess how many raw materials to order, and manufacturers wouldn't have to order more than they need from suppliers to make sure they have enough on hand if demand for their products unexpectedly increases. And retailers would have fewer empty shelves if they shared the information they had about sales of a manufacturer's product in all their stores with the manufacturer. The Internet makes showing your hand to others possible, but centuries of distrust and lack of coordination within industries make it difficult.

The payoff of timely and accurate supply chain information is the ability to make or ship only as much of a product as there is a market for. This is the practice known as just-in-time manufacturing, and it allows companies to reduce the amount of inventory that they keep. This can cut costs substantially, since you no longer need to pay to produce and store excess goods. But many companies and their supply chain partners have a long way to go before that level of supply chain flexibility can be achieved [9].

C. Collaborative computing with SCM

The game-changer for the SCM world is "Cloud computing" and, as a subset of that, software-as-a-service (SaaS) applications. Simply put, the "Cloud" is a metaphor for the Internet-based tools used by a multitude of diverse customers at any time from any location. Industry analyst firm Gartner defines Cloud computing as a style of computing where massively scalable IT-enabled capabilities (such as software) are delivered as a service to external customers using Internet technologies. As a subset of Cloud computing, SaaS is defined by Gartner as software that's owned, delivered and managed remotely by one or more providers. The provider delivers an application based on a single set of common code and data definitions, which are consumed in a one-to-many model by all contracted customers on a pay-for-use basis or as a subscription based on use metrics.

According to IDC, the Cloud computing market has matured and continues to evolve on a number of fronts: the move from earlier standardized applications to more customized applications; increased service levels and load capacity; reduced operating costs; and a computing environment able to handle and distribute ever larger amounts of data across more organizations. By leveraging "SCM in the Cloud" technology, companies are finally able to make good on the promise of collaborative computing for supply communities. According to Joshua Greenbaum, principal with Enterprise Applications Consulting, "SaaS-based SCM solutions are ideal for cost- and risk-averse supply communities, who can take advantage of critical advancements in the scalability, security and reliability of today's more mature cloud environment."

To position the company for growth, Orthera turned to an SCM in the Cloud solution for three reasons: 1) low

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total cost of ownership; 2) flexibility, with the ability to customize; and 3) simple implementation, with minimal technical requirements and easy management. With a customer-specific, SCM in the Cloud-enabled solution, Orthera is able to centralize information, bridge process gaps and create real-time, cross-community visibility with their retail customers. And, critically important in the reality of economy-driven business decisions, they're able to accomplish this with a budget-friendly "pay-for-what-you-use" model [10].

SAN MATEO, Calif. – May 27, 2009 – Amitive, Inc, the pioneer of Community Supply Chain Management (C-SCM), today unveiled the industry's first supply chain management (SCM) solution delivered in the cloud: Amitive Unity 5.0. Delivered via the Software as a Service (SaaS) model, Amitive Unity enables Community SCM for both large and small companies that outsource manufacturing. Now in version 5.0, Amitive introduces critical architectural enhancements that let communities of supply chain owners, customers and supply partners leverage the true value of cloud computing in any public or private cloud environment. With "SCM in the Cloud," product companies can take advantage of the lowest cost, most flexible IT solutions for global supply chain management.

Already, several leading-edge companies are looking to Amitive's novel approach to SCM in the Cloud. By leveraging global resources and shared, scalable technology on a centralized SCM solution, these supply chain communities will benefit from Amitive Unity's performance, security, availability and flexibility at a significantly lower cost than traditional self-managed IT services. [11].

II. DISTRIBUTED ENVIRONMENT OF CLOUD FOR SUPPLY CHAIN MANAGEMENT

A. Drawback of centralized environment of cloud

All storage and computing resources are managed centrally in the cloud computing. Even if there exist load balancing, there are chances of network congestion. Cloud architecture for identification of radio frequency is proposed by Dabas & Gupta. Radio frequency reader captures the data. This data is sent to the data processing system that is present in the cloud. A considerable time delay may be experienced, if cloud resources and radio frequency reader are actually located far away from each other. In current scenario almost all existing cloud computing architectures have centralized resources at the location of cloud provider .it leads to increment in latencies.

B. Proposed architecture

Because of world-wide publicity and rapid growth in related technologies, Cloud computing clients continue to increase. There are a large number of service requests that fulfill the demand of a huge number of users. It extends the problem related to latency. Cloud service provider may exist far away from the client. So data may get forced to travel from a number of network equipments and mediums. It imposes a time delay in getting cloud services. Currently exiting cloud providers, that host storage and computing needs of the clients, uses centralized data-center. So here a new energy efficient and intelligent cloud computing architecture is proposed that is based upon distributed data centers. In this architecture client's instance is formed in nearest neighborhood, and client's requests are fulfilled with optimized latency.

C. Cloud computing model

In the cloud architecture that is proposed here, master-slave method is used for data-center's working. Data-centers that exists close by each other, structures a computing zone, and it is optional for users to create their instances in more than one zones. The main units involved in proposed architecture are:

(i) Data-centers:

(a) Master data-centers: It is located at cloud provider's administrative ground. User's bookkeeping on pay-as-you-go basis is done here.

(b) Slave data-centers: Slave data-centers are situated at geographically scattered locations, and serves to user's request within minimum physical distance.

(ii) Users or brokers: There are two ways for user to communicate with master data center. In the first approach user communicate directly with master data center and in another approach brokers plays the role of intermediate between user and master data center.

(iii) Service Level Agreements (SLAs): Pricing negotiation and Quality of Service (Qos) are settled through service level agreement. Master data centers look into service level agreement whenever it has to host user's need.

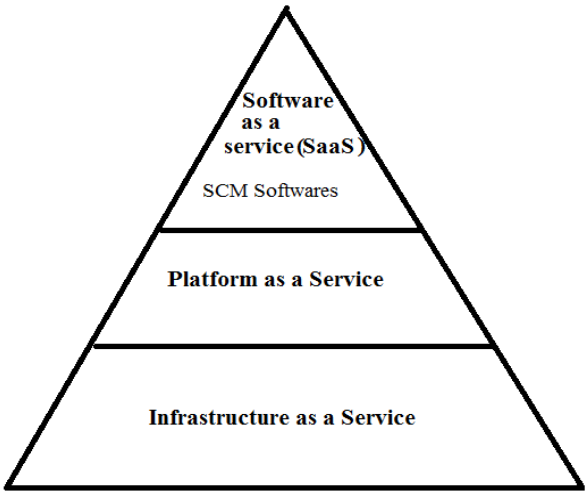

Fig.2: SCM Software availability at SaaS level

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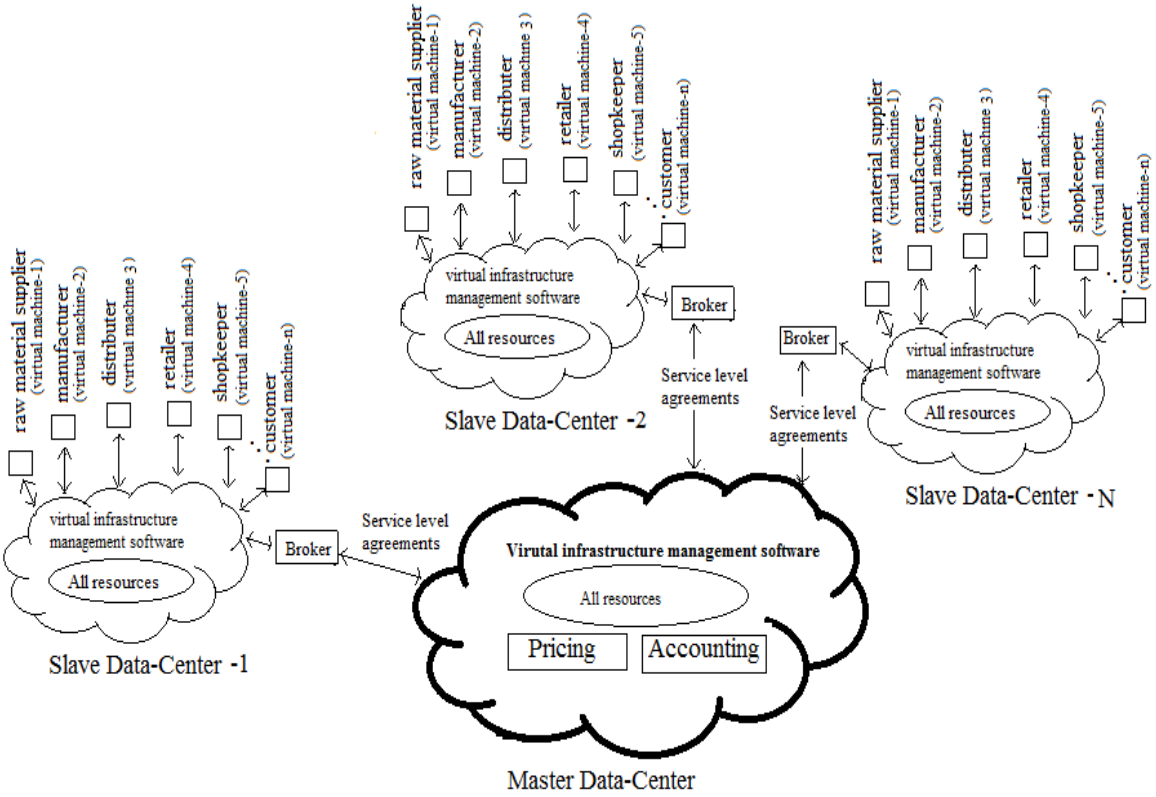

Fig.3: Proposed Cloud Architecture

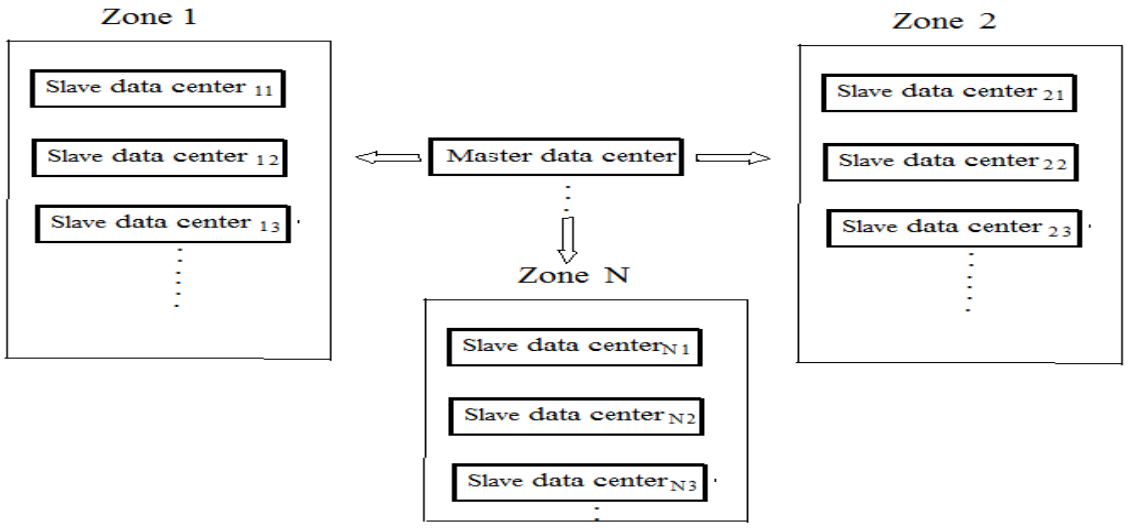

Fig.4: Demo diagram for distributed data centers

D. Informal description of algorithm

Users send request to master data-center for creating an instance. After receiving this request master data center check for the availability of resources in the data centers that are local to the user. If needed resources are available, then its needed instances are allotted to the user. Thus user can run his application with least amount of latency. If user does not get his required resource instance in the local data center then master data center proceeds towards the other slave data center of the same zone, for the searching of required resources. If master data center is unable to allot required resource instance to the user, from the zone of local data center, due to lack of availability, then it looks for the resources in another zone.

E. Advantages of distributed data centers in cloud

- Users get fast response to their requests with smallest amount of latency.
- Commodity hardware may be used to form a data center, instead of expensive hardware of centralized data center.
- Industrialists may shape local data centers on their currently existing IT infrastructures for security issues. Thus it forms a hybrid cloud.

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- A huge number of network equipments and services come together in the centralized data center. Thus it requires more air conditioning and electricity etc. but less power consumption and air conditioning etc are required by distributed data center thus creating an eco friendly environment.

F. Suitability of distributed environment for supply chain management

- Supply chain functioning is of distributed nature, so in supply chain management it may be proved very efficient to have distributed data center.
- Fiber optical cable may be used for direct connectivity between users and local data center, thus providing a highest bandwidth.
- Local data centers may be created on the existing IT infrastructure to host a cloud.
- User's instances will be created as virtual machines. For the purpose of load balancing these virtual machines will be transferred across the physical servers of the data center. There will be fewer number of virtual machine migrations if compared with centralized data centers because computing resources are scattered across geographic location. Maximum migrations will take place within the zone that is local to the user. And less inter-zone migrations will occur. Thus it will provide better results in terms of response time. Data centers are made up of a large number of storage, computing and network devices. Electricity is consumed by these devices as well as by cooling system. Thus more carbon dioxide is emitted in a local area than permissible according to the government's emission standard. Cloud architectures proposed by a number of authors are based upon the concept of central data center. But in this proposed architecture for SCM having distributed data centers, less carbon would be emitted (within permissible limit), because resources are scattered in a broad geographical area.

III.CONCLUSION

We still have an immature cloud computing architectural design. And need to explore towards the well organized utilization of big scale IT infrastructure. In this paper, a better cloud computing architecture for supply chain management is presented that is based upon the distributed data centers. This architecture gives data and application access to the users in least amount of latencies and creates an eco friendly and energy efficient computing environment. Existing IT setups can be used as local data center. That's why this architecture may be proved cost-effective for many organizations. Fiber optical cable may be used for direct connectivity between users and local data center, thus providing a highest bandwidth.

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