Cloud Federation with Resource Provisioning

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***Abstract*—Cloud computing has enhanced the technique of computing and the way in which utility services are offered through public network. The IT corporations and Cloud suppliers can join hands and allocate the resources through Cloud federation. By selecting multiple cloud providers in place of a single provider, the different computational obligations can be improved and cost can be reduced. Maximizing performance, improving reliability, scalability, multi-location deployment for error tolerance and recovery, cost minimization, less energy consumption and partnership with other providers are advantages of Federated cloud. But cloud federation has many portability and interoperability issues and encounters many challenges in the deployment of cloud federations like Identity and Access Management.**

In the paper, we will discuss meaning of cloud federation, benefits of using cloud federation, federation managers especially CCFM (Cross Cloud Federation Manager), classification of federation architectures as per the level of the coupling, resource procuring challenges in a federated cloud and federated architectures.

Keywords-Cloud Federation, Cross Cloud Federation Manager, Resource Provisioning, Federated Cloud, Federation Architectures, Information Technology (IT), Quality of Service (QoS), Virtual Machine (VM), Virtual Infrastructure (VI), Virtual Infrastructure Manager (VIM), Peer to Peer (P2P).

I. INTRODUCTION

Definition of cloud

As per the certified definition by NIST, "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models."

Deployment models

Public cloud: here the cloud suppliers provide the Information Technology facility to all the customers on the internet.

Private cloud: here a selected group of customers who are a part of a venture are provided Information Technology facility. The cloud supplier can be an in-house IT business (the similar business of the customer or of a third party).

Hybrid cloud: here a blend of the public clouds and the private clouds offered by a business creates the environment.

Community clouds: They support a particular society that has shared concerns and are shared by many businesses.

Architectural Service Layers

Software as a Service (SaaS): This type is the peak layer where the entire application is offered in multi-location background. Salesforce is an outstanding example of SaaS.

Platform as a Service (PaaS): This type offers the middleware layer of deployment and development. Main providers are the Google App Engines, Microsoft Azure platforms, etc.

Infrastructure as a Service (IaaS): This type is lowermost layer which provides the services like networking and compute storage. Amazon EC2 service is an outstanding example of IaaS. The work accounted in this service is chiefly service deliverance model of IaaS.

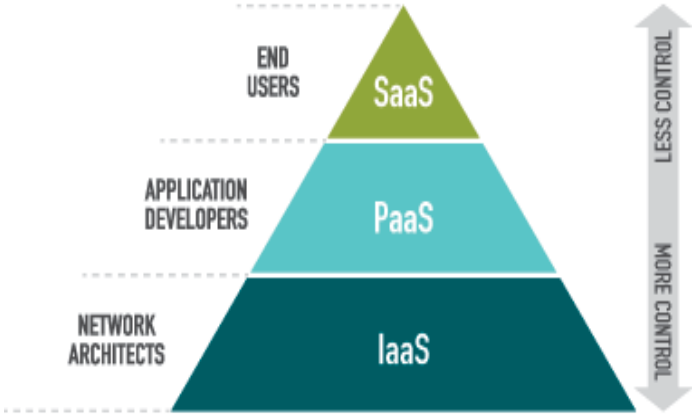

Figure 1. "What Is Paas - Platform As A Service | Redcentric". Redcentricplc.com. N.p., 2017. Web. 17 Apr. 2017.

A Cloud provider is believed to be having almost unlimited resources, but depending upon the constraints of networking bandwidth, of available hardware, etc. there can be definitely an upper limit. When some Cloud provider puts forward many infrastructure offers, there can occur a situation when the Cloud provider faces resource depletion. The Single cloud model of deployment faces many challenges when the cloud service becomes not available to customers due to natural disasters, outrages and attacks and the customers cannot access the data and the services [1]. In view of the above, the conclusion is that the use of multiple clouds accomplishes better reliability, QOS, service, etc.

II. CLOUD FEDERATION

Outsourcing the available resources to another provider as per the demand requirements/variation is permitted by Cloud Federation. It also permits a provider to rent out part of underutilized resources to another provider. In Cloud federation, the services of different providers are combined in particular pool which supports the 3 basic interoperability characteristics - resource migration, resource redundancy and amalgamation of matching resources. Migration permits the repositioning of resources, such as source code, data items, virtual machine images, etc. from one service domain to another domain. Simultaneous usage of service features which are similar in different domains is allowed by Redundancy. Combining different types to aggregated services is permitted by amalgamation of complementary resources and services [2].

III. BENEFITS

Federated cloud has the following advantages over single cloud deployment.

A. Scalability:

As the demand increases upwards and when computing resources of providers diminishes, cloud bursting deals with high demands of customers by bursting their workload to an exterior cloud on the basis of demand and they have to pay according to the usage [1]. Cloud providers pool resources with different cloud providers and share the infrastructure between them.

B. *Multi-site Deployment:*

This type permits infrastructure collaboration across allocated data centers for availability of services; guideline on data placement inside definite physical boundary, minimize data transmit cost by facilitating service in data centers in non-peak hours and meet local jurisdiction [1].

C. Reliability:

In this type, duplication of service in multi-location deployment allows fault tolerance with high accessibility of services such as negligible downtime when a site fails, data backup, natural disaster recovery, etc.

D. Cost and Performance :

The deployment of services nearer to the end users will enhance the performance by improving the response time and lessen the data traffic [1]. Alliance between cloud providers enables cloud providers to increase their services and also do not have to pay out much on infrastructure.

IV. CLASSIFICATION OF CLOUD FEDERATION ARCHITECTURE BASED ON LEVELS OF COUPLING

A. Loosely Coupled Federation:

In this group, cloud instances have fewer inter operations amongst themselves [1]. Monitoring is restricted and they can carry out only the fundamental operations on VMs such as stop, resume and start.

B. Partially Coupled Federation :

In this type, various cloud partners are involved in framework accord with the terms and conditions explaining access techniques for remote resources [1]. Some advanced networking features among partner cloud, detailed monitoring and certain level of control over remote resources is permitted by the framework accord.

C. Tightly Coupled Federation :

This group is generally administered by the same Cloud OS type and normally formed by clouds which belong to the same business. A Cloud occasion can have right to use all the monitoring information of remote resources and have advanced control over remote resources. Cloud instance can also support attributes such as formation of virtual storage systems across location boundaries, cross-location movement of VMs, formation of cross-location networks, and execution of highest availability methods among remote cloud occasions [1].

V. FEDERATED ARCHITECTURES

Using diverse architectures with different pairing levels of resources, a Federated cloud can be put into operation. Following are the various Cloud Architectures:

A. Cloud Bursting Architecture:

When the demand of a cloud consumer increases upwards and consumer runs out of computing resources from the consumer's in-house data-center or another interior private cloud, the consumer can deal with the high demand by bursting their workload to an exterior cloud (Public Clouds) on the basis of demand and they have to pay according to the usage [1]. It is shown in figure 2.

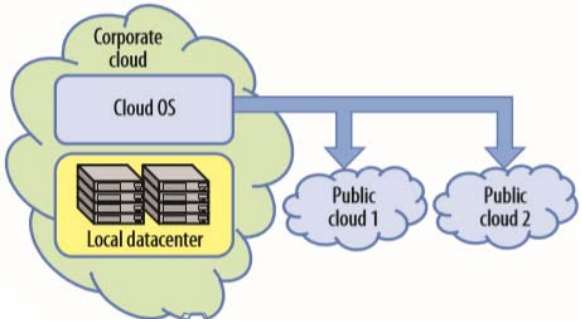

Figure 2. Cloud Bursting Architecture [4]

B. *Cloud Broker Architecture:*

The Choice and Integration of cloud services from diverse cloud providers is so complex that cloud consumers cannot manage themselves [1]. Cloud customers therefore instead of getting in touch with cloud suppliers directly, speak to a cloud broker for their cloud requirements. Cloud Broker as shown in Figure 3 operates as a bridge among the cloud suppliers and cloud customers. The Cloud Brokers discuss the contracts with cloud suppliers on behalf of the cloud consumers.

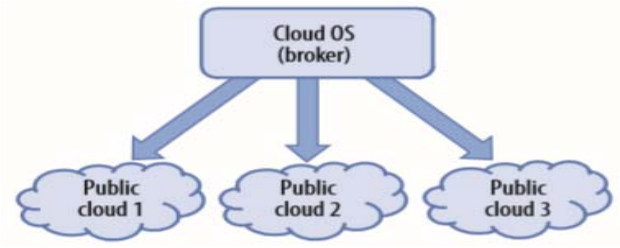

Figure 3. Cloud Broker Architecture[4]

C. Aggregated Cloud Architecture :

A Cloud is believed to be having almost unlimited resources, but depending upon the constraints of networking bandwidth, of available hardware, etc. there can be definitely an upper limit. When some Cloud provider puts forward many infrastructure offers, there can occur a situation when the Cloud provider faces resource depletion [1]. Collective cloud architecture acts underneath the layers to satisfy the infrastructure obligations of cloud consumers seamlessly. Cloud suppliers offer their users with a bigger virtual infrastructure by combining and inter-operating their owned resources based on contracts or framework accords. It is shown in Figure 4.

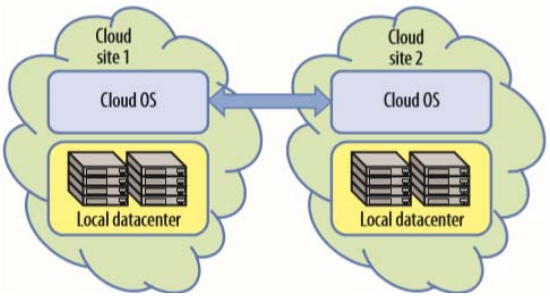

Figure 4. Aggregated Cloud Architecture [4]

D. Multi-site Cloud Architecture :

Multi-location cloud architecture as shown in Figure 5 is put into operation in organizations having geographically diversified data center and cloud infrastructures. They are depicted as a single cloud to customers and have complete control over cloud infrastructures [1]. The cloud occasions are securely coupled and can accomplish live migration of Virtual Machines and cross-location networking.

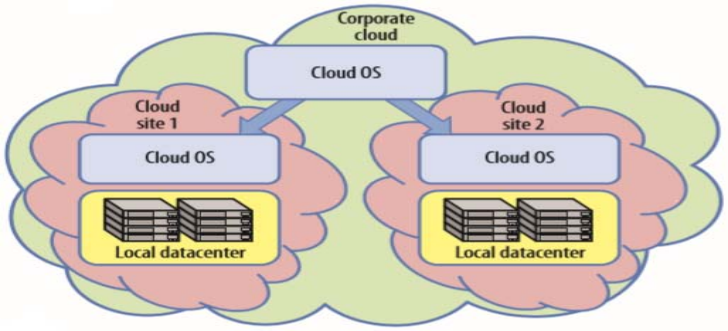

Figure 5. Multi-site Cloud Architecture [4]

VI. RESOURCE PROVISIONING

The method of offering computing infrastructure to cloud customers for their computational requirements in an IaaS cloud is called Resource provisioning.

A. Resource Provisioning Challenges in a Federated Cloud

Integration of different clouds makes resource provisioning a challenging assignment.

1) Application Architecture:

While procuring of resources and creating deployment plan in the federated environment, the architecture of an environment or an application has to be considered. Insecurely coupled applications can be set up in the multiple clouds; restriction over choice of deployment and resources is minimum [1]. Application modules that are having added coordination, having extra information flow with another modules and which are less independent (i.e. securely coupled applications) should always be set up in single cloud or the same server.

2) Portability and Interoperability:

The federated cloud architecture should be having capability to:

a) Move applications, data, and Virtual Machines from one cloud computation environment to other.
b) Mix and match federated cloud services depending on industry requirements.
c) Merge private and the public cloud atmospheres into hybrid cloud.
d) Control and Develop cloud environments via standard API's of industry.
e) Manage industry continuity threat and security across several cloud suppliers.

3) Deployment Plan:

Cloud suppliers provide diverse environments with various service quality and pricing models, in the federated cloud. Choice of the topmost resources based on application requisites to minimize the funds of consumer and make best use of the resource performance such as reliability, minimum response time, utilization and availability is a complex task. Making an optimal deployment arrangement/plan under ambiguity is challenging assignment because of doubt over availability of resources, price among suppliers and demand from consumer [1]. Locality of data center determines dynamic content, speed of delivery and streaming to end customers. Hence it is superior to have the location of data centers near the end customers.

4) Quality of Service:

QoS is an important features of cloud computing. SLA has a vital role to play in maintaining the QoS. SLA is an element of service contracts among cloud suppliers and cloud customers that describes the level of service in a prescribed way [1]. In the cloud computation environment which is federated, QoS is sustained during maximum demands by acquiring resources from another cloud if resource is drained out, transparently transferring environments to other suppliers with fewer or no downtime or recovery from failures by copying customer application in various clouds or data centers all over the World.

5) User Specific Constraints:

The user can state various constraints to install their applications which can limit the procedure decisions [1]. Example, hardware and platform restrictions such as operating system, type of hypervisor, etc., Service Level Agreement restrictions such as secure operational reliability, guaranteed CPU capability, similarity restrictions such as two or more Virtual Machines that are required to be installed in the same physical cluster or a server, site restrictions such as geographical boundaries of data center of supplier where data and applications are to be positioned, etc.

6) Jurisdiction and Regulation:

Cloud providers have to obey with the state, international, or federal directives so as to follow that data must be located inside definite physical boundaries. Hence, consumer can set up his applications in the various cloud suppliers who are obeying the regional laws and offering their services for that specific region [1].

7) Resource Pricing and Instance Type:

Pricing methods of virtual resources differs amongst the cloud suppliers. Amazon EC2 gives three kinds of pricing method namely Spot, On Demand and Reserved Instances for supplying VI. ElasticHosts permits users to make to order requests and pricing methods based on instance resources such as memory, CPU, data transfer rate, disk and SSD. The Billing is based on yearly, monthly and hourly subscription, in GoGrid and ElasticHosts [1]. Rackspace provides servers based on RAM size and charges are as per hours used. Mostly cloud suppliers charge based on networking bandwidth, storage and memory whereas long term subscriptions gives huge amount of saving to customers. However, judgment making on which subscription is a daunting job.

VII. PROBLEM STATEMENT

The future advancement of cloud computation can be imagined in three consequent stages: stage 1 or “Monolithic”, wherein cloud environments are based on autonomous proprietary architectures; stage 2 or “Vertical Supply Chain”, wherein cloud suppliers shall obtain cloud services from another suppliers; stage 3 or “Horizontal Federation”, wherein larger, medium and small cloud suppliers shall associate together to gain advantage of a growth of their capabilities and the scale economics. Presently, the chief clouds are planning the changeover to the stage2, but how and when to accomplish the stage 3 is uncertain as some architectural constraints are required to be overcome.

VIII. SOLUTION STATEMENT

This paper explains as to how to make up an interoperable diverse cloud environment in the “Horizontal Federation” pattern. It also describes how clouds can collaborate together to accomplish trust environments and make available newer business opportunities such as on-demand resource procurement, cost-effective assets optimization and power saving. A solution is suggested based on the Cross Cloud Federation Model.

IX. CROSS - CLOUD FEDERATION MODEL

In this model, the federation is established, among a cloud requiring exterior resources and a cloud providing resources, and has to pass through three main stages: authentication, discovery and match-making [3].

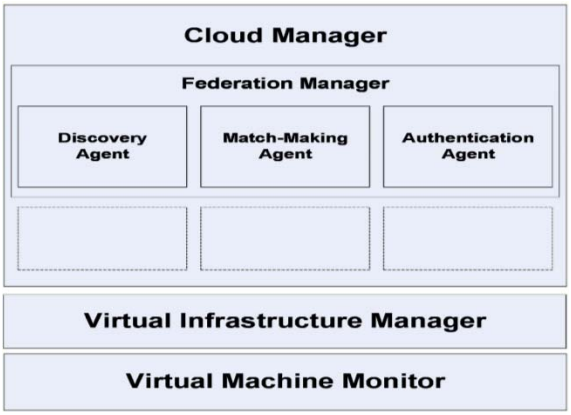

Figure 6. Cross Cloud Federation Model [3]

Additional environment and resource demand may cause VIM to drain all accessible resources at considered cloud supplier [3]. When federation demand is activated by VIM, federation manager has to take action via launching a secure federation by means of that cloud which is giving best offer.

The federation algorithm is shown below:

```
If (federation request is received) {
Offeres [ ][ ] = Discovery (P2P group);
best_offer = Match_making ( Offeres );
Authentication(best _offer);
}
```

The federation algorithm will wait for the VIM to activate a federation demand and then perform its logic. Logic shall activate its Discovery sub-block to check the P2P groupings and obtain offers from the accessible cloud suppliers. These proposals shall afterwards be studied by the match-making agent, after which the optimum contender shall be selected. The authentication agent shall afterwards create safe connection onto selected supplier [3]. The authentication agent is outside the scope of this paper.

Discovery agent will be accountable for obtaining offers from accessible cloud suppliers interested in cloud federation. The algorithm for Discovery agent is as follows:

```
Offers[ ] Discovery (P2P group) {
Cloud_Provider_Information_and_contactcloud[] = new Cloud_Provider_Information _and_contact [group length];
CloudFederation_offersOffers[] = new CloudFederation_offers[group.length];
for (int i = 0 ; i < group.length ( ) ; i ++)
{
Request_offer (cloud [ i ] );
Offers [ i ] = Receive_offer ( );
}
Return Offers;
}
```

The cloud supplier belongs to a P2P group and the supplier can subscribe to P2P group by issuing its contacts [3]. Discovery agent shall obtain list of all the accessible cloud suppliers taking part in same P2P group and accumulates their contact data in array called "Cloud". Every cloud which belongs to the above array shall definitely be asked for an offer and received offers shall be assembled together in other array called "Offers". Offers are then sent back to be utilized by match-making agent. Match-making agent is accountable for choosing topmost contender offer which is based on algorithm as shown below:

```
Offer match – making ( Offers [ ] )
{
int j = 0;
for ( int i = 0 ; i < Offers.length ; i ++ )
{  if ( (Offers[i].idP = = this.idP) && (Offers[i].QoS >= this.QoS ) &&
 ( Offers[i].offeredresources > this. requiredresources ) )
{ qualified_offers [ j ] = Offers [ i ] ; j ++}
}
Sort ( qualified_offers, cost, desc );
return qualified _offers [0];
 }
```

Match-making algorithm sorts all offers which do not meet conditions and lists remaining in "qualified offers" [3]. From the qualified offers, most favorable one (based on a selection algorithm) is selected and regarded as the federation candidate.

CONCLUSION AND FUTURE WORK

Cloud Federation has a lot of benefits and it will prove very useful in the future. But, it also has some limitations which can be overcome by using horizontal federation.

In future, I intend to do research work on horizontal cloud federation and authentication agent of Cross Cloud Federation Model.

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