Inter Cloud Computing

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Cloud computing is typically defined as a type of computing that relies on *sharing computing resources* rather than having local servers or personal devices to handle applications. In cloud computing, the word cloud (also phrased as "the cloud") is used as a metaphor for "*the Internet*," so the phrase *cloud computing* means "a type of Internet-based computing," where different services — such as servers, storage and applications —are delivered to an organization's computers and devices through the Internet. Cloud computing is comparable to grid computing, a type of computing where unused processing cycles of all computers in a network are harnesses to solve problems too intensive for any stand-alone machine.

The cloud isn't just for techies anymore. Understanding what's next for cloud computing is crucial for businesses at all levels. Managers are responding to the real opportunities that the cloud offers to develop new business models, forge closer ties with customers and tap into the expertise of employees and partners. From a technology that was initially adopted for efficiency and cost savings, the cloud has emerged into an innovation powerhouse.

The next generation of cloud computing will deliver value to the business faster by automating everything from request to deployment and configuration—and it will do so up and down the stack and across the entire infrastructure. In order for the next generation of computing to achieve these goals, there are five platform requirements:

1. A management platform that engenders a high degree of service flexibility
2. A platform that can support multiple constituencies
3. A platform that is not tied to a single infrastructure
4. An intelligent platform
5. A platform that is integrated with your existing enterprise management technology and processes

Introduction of Cloud of Clouds or Intercloud:

This represents a new model for cloud computing services, based on the idea of combining many different individual clouds into one seamless mass in terms of on-demand operations. The intercloud would simply make sure that a cloud could use resources beyond its reach by taking advantage of pre-existing contracts with other cloud providers.

The architecture is based mainly in OpenStack as an open source platform for managing largescale physical servers in a cloud-computing environment. This includes the transformation of the psychicalresources to a virtual ones that could by delivered over the Internet as Virtual Machines (VMs).Using it, resource providers can controls large pools

of compute, storage, and networking resources throughout their datacentres through interfaces. OpenStack offers also a common API that workswith RESTFul protocol and provides remote access to all local services. The inter-cloud service is designed to be flexible, thus allowing interactions with other cloud that offer AWS, OpenNebula and VCloud API interfaces. These include services for on-demand self-service (users can access needed computing capacities), network access to cloud resources, elasticity to provision based on the user needs and monitoring of services according to the usage. With regards to the service models, OpenStack provides support for SaaS so consumers can deploy software and access it usually as a web-based service, PaaS to deploy applications through a programming language or tools and IaaS for instances, network connection and storage.

The key services offered by the Inter-Cloud Service are as follows:

- Identity Service: It provides an API as the mean for authentication and authorization by offering a service that generates access tokens for other OpenStack services. This includes a catalog of endpointsfor all OpenStack services. Similarly, identical endpoints are defined in order to authorize inter-cloud communication

- Image Service: It provides an API for management of images that are ready and pre-installed VMs that usually include operating systems along with some software configurations. Cloud administrators run this process, but users can also upload images from the inter-cloud service. Images are used to create new instances of services (containers of SaaS and PaaS). In the inter-cloud, images from all clouds are retrieved and shown in the common management space.

- Compute Service: It provides an API for managing the whole lifecycle of instances (that are generated images) in an OpenStack environment. Key responsibilities include spawning, scheduling and decommissioning of VMs on demand.

- Network Service: It provides the network capabilities, e.g. to create new virtual networks and routers for network connectivity. Also, it provides the capability to build private networks of VMs and supports many popular networking vendors

The benefits of an Inter-Cloud:

Diverse geographical locations- Leading cloud service providers have established data centres worldwide. However, it is unlikely that any provider will be able to establish data centres in every country and administrative region . Many applications have legislative requirements as to where data are stored. Thus, a data centre within a region of countries may not be enough, and application developers will need fine-grained control (specific country or state) as to where resources are positioned. Only by utilizing multiple clouds can one gain access to so widely distributed resources and provide well-performing and legislation-compliant services to clients.

Better application resilience-During the past several years, there have been several cases of cloud service outages, including ones of major vendors . The implications from one of Amazon's data centres failure were very serious for customers who relied on that location only. In a post-mortem analysis, Amazon advised their clients to design their applications to use multiple data centres for fault tolerance . Furthermore, in Berkeley's report on Cloud computing, Armbrust et al. emphasise that potential unavailability of service is the number one inhibitor to adopting Cloud computing . Thus, they advise the use of multiple providers. Besides fault tolerance, using resources from different providers acts as an insurance against a provider being stopped because of regulatory or legal reasons as well.

Avoidance of vendor lock-in. By using multiple clouds and being able to freely transit workload among them, a cloud client can easily avoid vendor lock-in. In case a provider changes a policy or pricing that impact negatively its clients, they could easily migrate elsewhere.

We can broadly classify Inter-Clouds as follows:

Volunteer Federation – when a group of cloud providers voluntarily collaborate with each other to exchange resources. As identified, this type of Inter-Cloud is mostly viable for governmental clouds or private cloud portfolios.

_ *Independent* – when multiple clouds are used in aggregation by an application or its broker. This approach is essentially independent of the cloud provider and can be used to utilize resources from both governmentally and private clouds. Another term used for this is *Multi-Cloud*.