IAAS CLOUD EXCHANGE WHITEPAPER

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ABSTRACT

This whitepaper will review the challenges, technology and workload requirements for implementing an infrastructure as a service (IaaS) cloud exchange. A market model will then be proposed based on this review.

INTRODUCTION

The idea of a cloud exchange is a much discussed topic within academic and high-performance computing circles (see Breest, 2007; Buyya, Ranjan, & Calheiros, 2009). The discussion can vary widely based on the type of cloud service being discussed.

Cloud services are commonly divided into three types: IaaS, platform as a service (PaaS) and software as a service (SaaS) (Liu et al., n d). There are several SaaS solutions and services in the marketplace that claim to deliver a cloud brokerage or exchange, however these services integrate SaaS offerings in the cloud rather than the buying and selling of services in their respective domains. This means that a SaaS cloud broker can more accurately be described as an integrator of SaaS services. This offering is completely different from an IaaS exchange from both a business and technical standpoint.

The goal of an IaaS cloud exchange is to create a distributed infrastructure in which different components are interchangeable. Controlled by the cloud exchange, the distributed infrastructure not only increases technical capabilities – such as availability and resilience – it also allows consumers to make economic decisions regarding scheduling workloads. While this is valuable to customers, it also increases the technical complexity of an IaaS cloud exchange compared to SaaS. This complexity means there are currently more SaaS services available than IaaS Cloud exchange services.

The remainder of this paper discusses the challenges, requirements and technology for an IaaS cloud exchange.

CHALLENGES

One of the main reasons cloud exchanges are complex is because of the need to closely integrate completely decoupled infrastructure elements. This is made more difficult because the decoupled pools are often geographically distributed and non-homogenous. This means the technologies being used by suppliers will not be the same, which is due to infrastructure vendors trying to differentiate their offerings. Making the environment as homogenous as possible for customers is one of the challenges of cloud exchange technology.

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In addition, workloads in a cloud environment need to be decoupled. A normal workload consists of several compute and data workloads connected to each other at the network level. This requires a resource component to provision and fulfill various service level agreement (SLA) criteria. The three workload components are different in character; the pure compute component can be moved around easily, while storage has a fixed location. In addition, transporting huge amounts of storage carries a network cost and a time penalty. The network itself is constrained, as in many cases, an SLA cannot be implemented in the networks (e.g., when using a VPN or internet connections the traffic is routed on best-effort alone).

When discussing an IaaS cloud exchange these technical challenges focus attention on operational settlement, however trading functionality is also important. Market liquidity in an IaaS cloud exchange is one of the most important factors for generating dynamic pricing. This is only possible if the IaaS products traded are easy to compare and traded within one market. This is possible through existing hypervisor technologies and because of the simplistic nature of the data compute and storage products being traded. This in turn allows common trading technologies to be used to make the cloud exchange a viable marketplace.

Despite these challenges, the requirements for an IaaS cloud exchange include:

Decoupled architecture

different cloud exchange partners run their own infrastructure and need to be detached, therefore the control-points for the resource allocator and the resource consumer will need to be separated.

Support for different consumer business models

different consumer business models are possible, including enterprise customers consuming infrastructure or service providers reselling it.

Support for different seller business models

seller business models can vary from permanent resource sales to temporary sales of under-utilized infrastructure.

Single pane of glass

provisioning and scheduling algorithms must be able to view the entire pool of resources, even if they are sourced from multiple cloud exchange vendors.

Legal and compliance

systems must make the SLA transparent to the user and be legally compliant, which includes detailed restrictions on metadata handling.

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TECHNOLOGY OUTLINE

Zimory's Exchange Edition settlement technology needs to comply with all the requirements described above. These can be turned into architectural principles as well as functional requirements.

ARCHITECTURAL PRINCIPLES

Zimory's solution architecture also complies with the following principles:

Independent

supporting multiple underlying technologies.

Open and complete application programming interfaces (APIs)

this includes having open APIs on the user/ customer interface, as well as well-defined, open and complete APIs between solution modules.

Scalable

supporting the integration of different sizes of resource-pools.

Multi-tenant capability on multiple levels

supporting different multi-tenancy models with different costs and security measures assigned (e.g., physical versus logical separation).

Decoupled

the distribution of functional building blocks across cloud exchange partners (following each partner's control scope model).

These principles can be mapped to the non-functional requirements of the stakeholders in a cloud exchange. Different stakeholders will have different challenges; consumers want homogenous services, while sellers are interested in delivering a differentiated, value-added solution.

Architectural Principle	Consumer Requirement	Seller Requirement
Independent	Enables the cloud exchange to be integrated with consumers' systems without further adjustments to the cloud exchange	Allows sellers to reuse available technology and operations experience within the cloud exchange, as well as create different sourcing strategies
Open and Complete APIs	Reduced lock-in and possibility of advanced service-composition	Reduced lock-in and able to compose best-of-breed solutions
Scalable	Improving the number of available offerings and allowing more specialized market offerings	Empowers the seller to leverage more resources and grow the offering with a non-disruptive growth Small installation footprints also enable specialized offerings to appear in the market
Multi-tenancy	Allows users to buy cloud services with different security requirements Enables a better service composition.	Provides a differentiated offering aligned to the security requirements of the country and target customers.
Decoupled	Allows consumers to gain complete control over the aspects within their control scope. Enables other models like reselling Cloud Exchange capacity.	Enables sellers to focus responsibility on the service scope.

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FUNCTIONAL REQUIREMENTS

Cloud exchange buyers and sellers clearly have different usage requirements which need to be mapped to the technology modules and their distribution across the cloud exchange sites.

The following core functions need to be available for cloud buyers and sellers:

Buyer	Seller
• Define sourcing strategy • Compose SLAs • Allow inspection of SLA and legal requirements • Administer users, including technical and commercial permissions	• Manage access to local environment • Define customer separation • Define SLAs

MAPPING OF ZIMORY ARCHITECTURE

The previous sections described the architectural principles and functional requirements that can be mapped to the Zimory architecture. With buying and selling occurring in an external cloud exchange module, the Zimory technology stack takes on the settlement role. Buying and selling can be done in various ways, from long-term contracting to a short-term stock exchange model.

The Zimory Cloud Suite consists of two core components:

1. **zimory®manage**
   (including the "Business Administrator")

2. **zimory®connect**
   (consisting of the modules "Central", "Storage" and "Runtime Storage")

zimory®manage manages users' access to the distributed cloud environment. It therefore features both a business administrator front-end to control the users and a user front-end to access the cloud environment.

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zimory®connect provides the main logic, database and messaging component of Zimory cloud. It also provides a web-portal for the data center administrator where the cloud is hosted.

zimory®connect Storage stores all templates and virtual machine disk images. This area of the cloud is for currently unused instances or backups of instances. This storage sub-system can be built on top of many different commercially available storage systems. This component allows all cloud data to be consolidated into a single location, making the rest of the datacenter independent from the cloud.

zimory®connect Runtime Storage handles the rapid provisioning, migration and cloning of virtual machines (VMs). It might be located on the same storage server as Zimory Storage, but will need to be exported via Network File System (NFS).
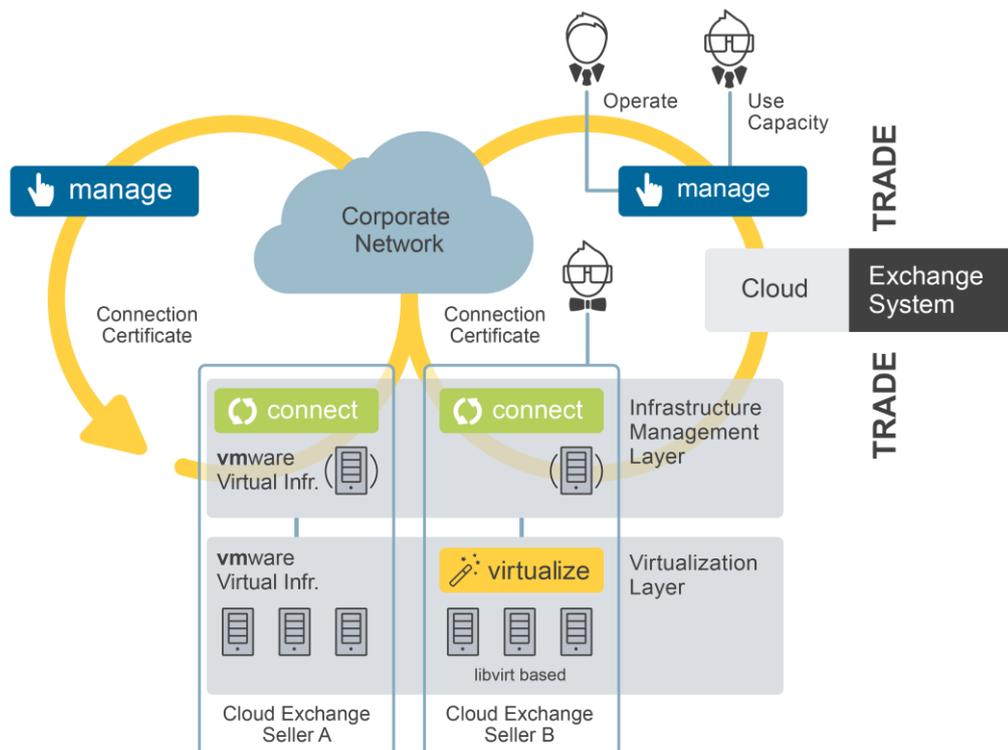
Figure 1: Components of Zimory cloud stack in the cloud exchange setup

To offer services in the marketplace, every seller on the cloud exchange requires at least one instance of zimory®connect in each of the datacenters as a local management hub.

In the case of multiple geographically distributed datacenters, sellers may have several zimory®connect instances which can be managed independently by local teams. The entire zimory®connect stack enables sellers to connect their heterogeneous infrastructure to the cloud exchange without investing in additional hardware.

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In addition, every buyer in the cloud exchange requires at least one instance of zimory®manage, which creates an entry point for consumers and end-user, and provides the cloud API. Consumers can choose to use the portal to resell cloud capacity to end-customers or use the internal capacity pool for other purposes, such as serving their internal cloud. Consumers can also connect via the zimory®manage cloud API and use any other system to manage the cloud resources.

The connection between the instances is controlled by the cloud exchange system. The cloud exchange system outputs certificates that control the connection. The cloud exchange is therefore able to control the ordering delivery mechanism and review the transaction settlement status.

From this basic architecture it is easy to understand that the functional split between consumers and sellers as described in the "Functional Requirements" section of this document. All consumer functions are compiled by zimory®manage, whereas seller's functional requirements are handled by zimory®connect. Both modules are also interconnected using an open API, which enables both parties to buy and sell capacity without being locked into the technology.

In addition, zimory®connect is built modularly. For scalability, all modules in the zimory®connect framework can scale horizontally across datacenters and can be built according to how the different capabilities will be used. The growth across decoupled environments – and even datacenters – also can be accomplished with the modularity of the zimory®connect system.

The driver strategy can be implemented on the following three levels:

1.   Component level

drivers directly manage a resource component
(e.g., directly attached physical compute capacity).

2.   Component manager level

drivers interface with a component management framework
(e.g., interfacing with a virtualization management framework).

3.   Workflow level

drivers trigger workflows that manage more complex and possibly
 pre-defined workflows.

The granularity and semantics of the operations are different on each level. Nevertheless, this framework allows sellers to use zimory®connect to include different technologies and best practices in their cloud exchange offering. This enables the requirements for independence and APIs to be fulfilled.

Finally, multi-tenancy is another core requirement. The modularity of the Zimory technology stack allows each component to be used in a shared, group-shared or exclusive mode. This allows the user to run the platform with various strict requirements for multi-tenancy or even mega-tenancy.

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MANAGEMENT OF CONNECTION CERTIFICATES

The cloud exchange requires connection control between the zimory®connect and zimory®manage modules. To do this, the Cloud Exchange module – where the trading takes place – delivers the following information about contracts between partners:

1. **Contract parties**
2. **Contract volume**
3. **Contract duration**

With this information, the Zimory platform generates certificates to enable a temporary connection between specific zimory®connect and a zimory®manage instances. The certificates will be generated by the cloud exchange module and automatically pulled by the zimory®manage and zimory®connect instance.

Based on this certificate, consumers can use the resources, monitor end-users' use, as well as define decoupled end-user pricing that suits their business models. Consumers can use the Zimory chargeback module to define various types of dynamic pricing (including spot-pricing), which allows them to reflect the dynamics of the sourcing price in the end-user pricing model. Alternately, consumers can control the volume being used and define resource-oriented use and revenue statistics. This flexible connection management supports a cloud exchanges' various market models.

CONCLUSION

Zimory's IaaS cloud exchange technology is based on strong architectural principles, including independence, open and complete APIs, scalability, multi-tenancy and decoupling. These principles not only enforce best-practices, but also enable consumers and sellers to buy and sell capacity without being locked into any one technology or vendor.

Controlled by the cloud exchange, the Zimory distributed infrastructure not only increases technical capabilities such as availability and resilience, it also allows consumers to implement economic decisions about scheduling workloads. This creates considerable value for customers; however it increases the technical complexity of a cloud exchange for IaaS when compared to SaaS. This has resulted in more SaaS services being available than IaaS Cloud Exchange services.

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