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# Cloud Interoperability and Standardization

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*Adoption of cloud rests largely on interoperabilty and standardization as they define the new age IT industry*

Cloud computing can be defined as accessing third party software and services on web and paying as per usage. It facilitates scalability and virtualized resources over internet as a service providing cost effective and scalable solution to customers. Cloud computing has evolved as a disruptive technology and picked up speed in 2008 and 2009 with the presence of many vendors in cloud computing space.

With the presence of numerous vendors, the need is emerging for interoperability between clouds so that a complex and developed business application on clouds is interoperable. In this paper we provide cloud computing standards and interoperability view, examine some high level approaches for interoperability and look at important interoperability factors.

## NEED FOR INTEROPERABILITY

Every new cloud service provider have their own way on how a user or cloud application interacts with their cloud leading to *cloud API propagation [1].* This kills the cloud ecosystem by limiting cloud choice because of vendor lock-in, portability, ability to use the cloud services provided by multiple vendors including the ability to use an organization's own existing data center resources seamlessly. Business applications and data remain in cloud silos. There is a need for complex developed business applications on the clouds to be interoperable. Cloud adoption will be hampered if there is not a good way of integrating data and applications across clouds.

## CLOUD COMPUTING STANDARDS AND INTEROPERABILITY VIEW

To start with, we provide a cloud computing standards and interoperability view to show some aspects/areas of interoperability and standardization in the cloud computing landscape [Fig. 1 overleaf]. When we look across the broad range of things that people consider in cloud computing, potentially hundreds of standards will be involved. The good news is that many of these standards

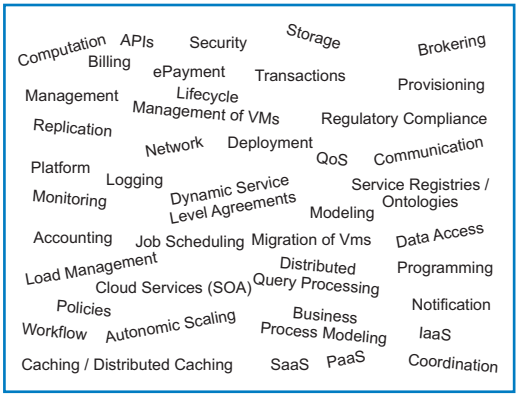


***Figure 1:*** *Cloud Computing Interoperability View*
***Source:*** *Infosys Research*

probably already exist. Reuse of good standards should therefore be a primary strategy. Creating a big picture view of the cloud computing landscape is therefore necessary to understand the *what, where* and *why* of standards. Once the overall view is understood, a gap analysis on the standards can then be done to see what standards we have and the standards we need.

## INTEROPERABILITY APPROACHES

We discuss some of the emerging approaches for interoperability at a high level.

### Approach 1: Unified Cloud Interface/Cloud Broker

Cloud computing vendors have formed a common platform – cloud computing interoperability forum (CCIF) – to address the problem of cloud interoperability and standardization [2]. The purpose of CCIF is to discuss and come up with a common cloud computing interface. CCIF is planning to come up with a *unified cloud interface* (a.k.a. cloud broker) whose features are as follows:

- Unified cloud computing is trying to unify various cloud APIs and abstract it behind an open and standardized cloud interface. Thus a key driver of the unified cloud interface (UCI) is to create an API about other APIs.

- It is a singular abstraction/programmatic point of contact that encompasses the entire infrastructure stack as well as emerging cloud centric technologies through a unified interface.

- The purpose of cloud broker is to serve as a common interface for the interaction between remote platforms, networks, systems, applications, services, identity and data.

- Having a common set of cloud definitions is an important factor that would enable vendors to exchange management information between distant cloud providers.

- The important parts of unified cloud interface (UCI) or cloud broker are a specification and a schema. The actual model descriptions are provided by the schema and the details for integration with other management models are defined by the specification.

- The unified cloud model will address both the platforms as service offerings as well as infrastructure cloud platforms. It will enable a hybrid cloud computing environment that is decentralized, extensible and secure.

Figure 2 shows a bird's eye view about the vision of the UCI project of CCIF [3, 4]. The primary goal is to come up with an abstraction

layer that is agnostic to any cloud API, platform or infrastructure. The architecture comprises of layers and components with a use case described at the UCI project requirement page [5]. The architecture abstracts the usage of any cloud API and unifies them in one layer. This is done with the help of semantic web and OWL which has a pool of resources semantically understood and described. This enables the user to use these resources irrespective of whether these resources are being allocated from provider Amazon EC2 or Enomaly platform, etc. Having a unified interface with common definitions of these resources helps to do operations like allocation, de-allocation, provisioning of virtual machines or managing them through the UCI layer using the agent component. Assuming that the interface to UCI is provided to the user via a web browser or UCI cloud client, the UCI should provide a kind of a dashboard that shows the state of all allocated resources and running VMs. A component on the left side of Figure 2 is used to depict this. [6].

**Approach 2: Enterprise Cloud Orchestration Platform /Orchestration layer**

According to IDC, in virtually every industry, thousands of companies are trying to simplify the speed and adoption of their products and services by transforming them into cloud services. We see that the race to the cloud is accelerating [7]. The scenario that is unfolding is that there will not be just one cloud but numerous types -- private clouds and public ones. These will further get divided into general-purpose and specialized ones. Similar to the way that internet is a network of networks, InterCloud means a federation of all kinds of clouds. All these clouds will be full of applications and services. It will not be possible to use these without some type of orchestration.

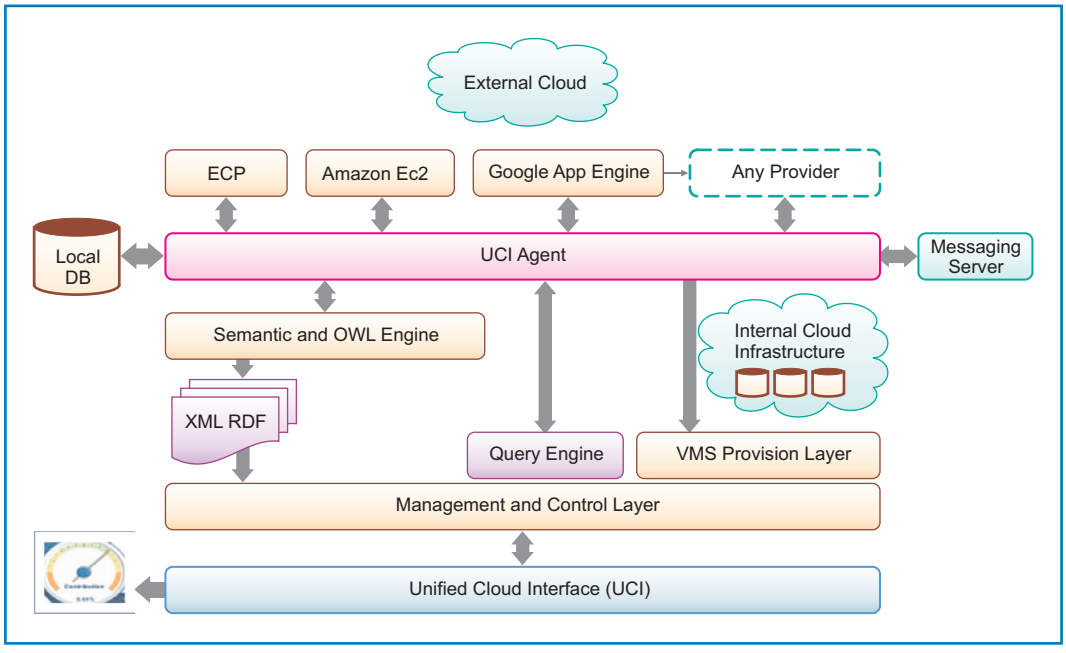


***Figure 2:*** *UCI Architecture* ***Source:*** *www.code.google.com [8]*

The initiatives of some of the early adopters towards Cloud Orchestration are discussed below.

- Vendors like Cordys advocate the need for a layer in the cloud that provides assembly and orchestration for enterprises, which helps to deliver useful business advantages [9, 10]. Cordys delivers an enterprise cloud orchestration platform that helps enterprises to quickly adopt new ways of running their business and reaching their customers.

- Rightscale is another vendor that provides an orchestration layer/ cloud management platform. A single management platform is provided to conveniently manage multiple clouds that facilitates businesses to migrate deployments [11]. It helps businesses to manage and scale cloud deployments as well as facilitate application migration and management across multiple clouds. Similarly organizations like Suntec are looking at building an orchestration layer for billing infrastructure.

- Eli Lilly, a pharmaceuticals company uses Amazon web services and other cloud services to provide high-performance computing to hundreds of its scientists based on need. In future, it foresees the possibility of using cloud services from many different vendors and wants to avoid a scenario where Eli Lilly has to configure and manage each of those separately [12]. Eli Lilly describes the need for an intermediate orchestration layer that is in-between Eli Lilly and the various cloud services it subscribes to. This layer should be provided by another vendor and not Eli Lilly itself and should comprise of various algorithms that determine the best cloud service for a particular job based on factors like highest performance, lowest cost or other requirement. This approach will help Eli Lilly and other users to write to a single API rather than many and help to optimize service usage. Eli Lilly also sees the potential of using cloud computing for external collaboration. It is already doing some of this, but foresees that going forward, the cloud will become a point of integration between Eli Lilly and outside researchers. They have work going on at present that starts to fit into this collaborative scheme. This gives an example of how standardization needs are driven both by vendors as well as end users.

- CSC has recently announced cloud orchestration services for cloud services integration. This provides clients with features like service level management, data transparency, remote monitoring, auditing and reporting [13]. These services also provide automated arrangement, management, federation, coordination, security and operation of public, private and hybrid cloud computing environments, supporting industry-specific compliance, etc.

Figure 3 illustrates how a client can consume the services offered by more than one cloud service provider (CSP) via an orchestration layer.

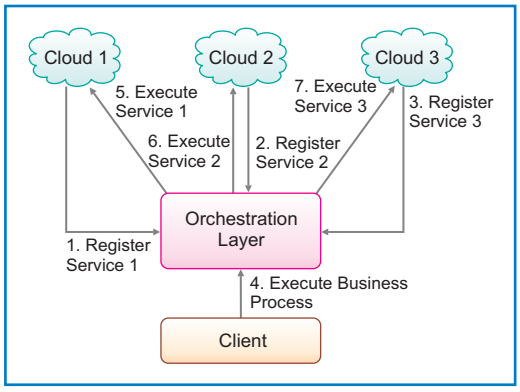


***Figure 3:*** *Cloud Orchestration*
***Source:*** *Infosys Research*

The features of the approach are explained below.

- Different cloud service providers can register the cloud services that they offer with the *orchestration layer*. This is similar to vendors who offer web services publishing their web services with the Universal Description, Discovery and Integration (UDDI). The orchestration layer can then dynamically select and bind to services based on criteria/ algorithms that determine the best cloud service for a particular job based on factors like highest performance, lowest cost or other requirement as specified by the client.

- Note that since the orchestration layer interacts with the cloud services offered by different vendors via different APIs, it can use user-computer interface (UCI) for interacting with different CSPs or have similar functionality built-in to be able to understand and interact with different CSPs via different APIs.

- Note that the client uses only one single API offered by the orchestration layer and thus is insulated from the different APIs offered by different CSPs.

- Figure 3 shows an example of how a client request for executing a business process (or workflow) is satisfied by the orchestration layer by invoking a sequence of three different services provided by three different CSPs.

The challenges with such an approach are discussed below.

- **Service Level Management:** Since the orchestration layer provides functionality to dynamically select and bind to services based on criteria/ algorithms that determine the best cloud service for a particular job based on highest performance, lowest cost or other requirement as specified by the client, such an approach will involve performance overhead due to runtime binding delays.

  The orchestration layer also needs to interpret client API calls and translate them suitably to invoke services provided by different CSPs. This will involve latency as well.

- **Data Volumes:** Depending on the provided service, the data volumes required to be transported across cloud services is another important factor to be considered. For certain types of services, this could be a limiting factor due to the overhead involved.

- **Platform Support:** Depending on the

service, the platform support required by the service could also be a limiting factor.

- **Others:** Apart from the above, there could be other challenges like security, regulatory compliance, data transparency, etc.

## IMPORTANT INTEROPERABILITY FACTORS

This section discusses the emerging scenario and other important interoperability factors from different viewpoints.

We see that there are multiple initiatives by stakeholders from industry, academia and users. This does help the problem or parts of the problem being addressed by multiple standard bodies/forums/consortiums in parallel and also provide diverse view points. But it is important for the standard bodies, vendors and users to sit together, discuss and arrive at a consensus on the standards and APIs in different areas and share information. This is all the more essential due to the duplication and overlaps among the various groups involved. The flip side of the story is that this could lead to the possibility of several standards emerging and possible lack of consensus. It is important for the standard bodies/forums/consortiums to have balanced representation of interests in order to avoid bias towards certain stakeholders' agenda.

Though initiatives like OGF's OCCI are trying to come up with standards in a quick timeframe, it takes time for standards to mature and for reference implementations to become available. Till then the users will use APIs/platforms from cloud computing vendors, whichever they feel is most suitable for their requirements. When standards emerge and these vendors want to use the services of other vendors, then they will need to use brokers/adapters for interoperability. New users however will be able to natively use the standard API. There will also be vendors developing orchestration layers to build business processes/workflows using the cloud services provided by different vendors. With some of the major vendors like Microsoft and Amazon rejecting the CCIF agenda and pursuing their own interoperability agenda, this makes standardization and consensus more difficult and could lead to multiple standards. This could lead to a scenario in the long run where multiple standards co-exist and customers using brokers/adapters for interoperability for using services from multiple cloud service providers.

It is also important to look at standards required from the perspective of different industry verticals. For example, HIPAA compliance could be important for healthcare services, SOX compliance could be important for financial services, etc. This requires active participation from different vendors and users from these verticals in standard bodies. It will also be good if different vertical specific groups are setup in order to focus and discuss the vertical specific requirements and come up with standards that are vertical specific.

Another challenge is that since there are many models of cloud computing (SaaS, PaaS, IaaS), standards are required for particular models and not just one set. There is a need to prioritize and concentrate on core set of standards to start with and then expand to other areas. It is important to note that over specification inhibits innovation. Patents and intellectual property could be a hurdle for standardization process. Unlike Sun's open cloud platform APIs, it will be interesting to see if other vendors give their cloud APIs and protocols to the community.

When applications are migrated from one cloud to another, apart from functionality, it is also important to ensure that non-functional requirements (NFRs) are satisfied as well in the new migrated environment. This requires standards for defining and exchanging meta information regarding the application between the cloud service providers to check for compliance of NFRs before actual migration of the application via VM migration. The scenario could be complex considering the fact that there could be several NFRs pertaining to security, availability, reliability, performance, scalability, etc., that requires compliance.

## CONCLUSION

Interoperability and standardization have huge impact on the cloud adoption and usage and thus the industry is witnessing high amount of energy and thrust towards these from different stakeholders viz., users, vendors and standard bodies. Standardization will increase and accelerate the adoption of cloud computing as users will have a wider range of choices in cloud without vendor lock-in, portability and ability to use the cloud services provided by multiple vendors. This will also include the ability to use an organization's own existing data center resources seamlessly. Standardization further promises to help towards complexly developed business applications on the cloud to be interoperable and ensure data and application integration across clouds. It also provides business opportunities to users to choose and use services provided by many different cloud vendors based on various criteria. On the other hand it helps vendors to provide additional higher level services like orchestration, apart from normal cloud services that are needed by the users. Standardization will thus pave the way towards realizing the true potential/ benefits of cloud computing.

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