# TABLE OF CONTENTS

Legal Notice .......................................................................................................................................................................................... 3
Executive Summary ................................................................................................................................................................................. 4
Purpose .................................................................................................................................................................................................... 5
Overview .................................................................................................................................................................................................... 5
Interoperability................................................................................................................................................................................. 6
Service Layer Relationships ................................................................................................................................................................. 7
Service Assurance Levels .......................................................................................................................................................... 8
Usage Requirements ........................................................................................................................................................................... 9
\hspace{1em} IaaS Interoperability Requirements .............................................................................................................................................. 9
\hspace{1em} PaaS Interoperability Requirements ........................................................................................................................................ 10
\hspace{1em} SaaS Interoperability Requirements ........................................................................................................................................ 10
RFP Requirements ............................................................................................................................................................................ 10
Summary of Industry Actions Required ........................................................................................................................................ 11
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Published August 2012.
EXECUTIVE SUMMARY
As organizations make extensive use of cloud services, there will be an increasing need for cloud-based applications and services, and for non-cloud systems, to coexist and interact with each other throughout various data center environments. It is critical for ODCA member organizations to realize this level of application and service interoperability if they are to reap the full benefits of cloud computing and to meet one of the collective goals of the ODCA—an open and extensible cloud ecosystem. To this end, the ODCA is documenting cloud interoperability requirements for mid- to enterprise-size organizations.

Organizations are currently utilizing and deploying internal private clouds, as well as continuing to increase their use of private and public external clouds. Across these cloud offerings, organizations are consuming Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). However, as they interact with service providers in the current cloud marketplace, they are encountering barriers to deploying, migrating, and interconnecting cloud services in a manner that is considered satisfactory. To guide the cloud marketplace to greater utility, cloud consumers and providers need to come together and address the underlying issues that manifest as hurdles to a truly interoperable computing infrastructure.

The ODCA will continue to develop portability and interconnectability requirements consistent with enabling workload interoperability for cloud subscribers. As a result, service providers can anticipate growth in the marketplace. Enterprise customers have shown they will more rapidly adopt consistent interfaces and environments when transitioning to new technologies.

This document serves a variety of audiences. Business decision makers and enterprise IT groups involved in planning, operations, and procurement will find useful guidance in this document. Solution providers and technology vendors will benefit from its content to better understand customer needs and to tailor service and product offerings. Standards organizations will find the information helpful in defining end-user relevant and open standards.
PURPOSE
This document and its accompanying usage models describe the proposed requirements for interoperability, portability, and interconnectability in order to foster companies’ ability to more easily move workloads across clouds. Additionally, it defines a terminology for communication between cloud consumers and providers of IaaS, PaaS, and SaaS layers so that seamless portability and interconnectability are assured.

OVERVIEW
This guide defines aspects of interoperability across clouds, and is described from two perspectives: portability: the serial process of moving a system from one cloud environment to another; and interconnectability: the parallel process in which two co-existing environments communicate and interact.

Each of these is described within the logical layers at which cloud services are delivered, i.e., IaaS, PaaS, and applications, including those delivered by SaaS. Dependencies, such that providing capabilities at any one layer is dependent upon the configuration of the other layers, are not discussed because this document is written from a cloud consumer’s viewpoint; the topic of dependencies is beyond its scope.

The requirements for both portability and interoperability are defined in some detail, such that cloud consumers can define requirements from which the providers can create solutions that are easily adopted.

There are both portability and interconnectability considerations at each of the cloud service layers. In this set of documents, the ODCA has chosen to address the following three key areas:

- **IaaS Portability**—Describes how to move physical workloads between environments over short or long distances as prescribed in the ODCA Long Distance Workload Migration usage model.

- **Application Portability and Interconnectability Between PaaS Environments**—Describes how to move applications between different PaaS environments. PaaS environments have a number of relevant attributes, such as feature sets, configurability, and orchestration. Various considerations between PaaS as a development environment and PaaS as a runtime environment are also covered.

- **Portability and Interconnectability of SaaS Environments**—Business process functionality offered through SaaS solutions can be initially connected, transferred, or interconnected. SaaS interconnectability allows organizations to create mash-ups from multiple SaaS and non-SaaS applications. This is an issue that primarily concerns data exchange, which includes metadata, and interface compatibility.
INTEROPERABILITY

As described in the overview, there are two key aspects of interoperability: portability and interconnectability. When considering the aspects of interoperability, portability and interconnectability, each comes with its own set of unique requirements.

For example, portability is required to be triggered as needed, as an event, including maintaining access to data and control over the workload, and allowing dynamic configuration and reconfiguration. Interconnectability, on the other hand, addresses the need for applications or services to establish and preserve, on an on-going basis, complex connections that occur between different systems.

When considering applications and services across the SaaS, PaaS, and IaaS cloud delivery models, the targets of portability and interconnectability differ. Because of this broad range, the generic term, business system, is used to refer to the application, service, or component to which interoperability applies. In other words, a business system is related to its components (i.e., IaaS, PaaS, and SaaS) typically owned by the cloud subscriber as follows:

- For IaaS, the business system is the physical or virtual machine instance or image—the logical storage and network definition, and all components installed on top of that platform. For example, this typically covers an operating system build and an application hosting layer, hosting a business application, and all of the associated hosting elements down to the virtual machine, with the exception of the underlying IaaS service components, such as the hypervisor or the hardware.

- For PaaS, the business system is the application, as well as any related logical data structures, including the business process and business information run by that application. For example, this is typically focused on the application and the data structures, but not the middleware, the OS, or the underlying technical components.

- For SaaS, the business system is the business process and any related business information. For example, this typically covers functionality, such as a client relationship management service or a payroll service, which includes the business information (i.e., transactions, client records, etc.), but not the application or the internal data representation.

For simplicity, generic business system is referenced throughout this document. It can be applied to a specific implementation or type of cloud service where appropriate.

As with other ODCA usage models, the concept of service assurance tiers is applied to business system interoperability. Requirements are described in terms of Bronze, Silver, Gold, and Platinum tiers of interoperability.

One key area that differentiates tiers regarding portability is whether a system needs to be closed down, transferred, and possibly re-installed and initiated on another environment, or whether that process can take place while in flight.

While it might be seen that these service tiers place obligations only on the cloud provider, in reality, the execution of interoperability requires an increasing focus by both the cloud provider and cloud subscriber. In order to achieve the ultimate goal of seamless interoperability within and between multiple cloud providers, and with the cloud subscriber’s internal services, significant effort is required by both providers and subscribers in the planning, implementing, and management of the business system.

Business system interoperability is a key enabler for all parties. It creates the necessary preconditions to permit the implementation of elastic business systems so that they can function successfully in a dynamic marketplace. With this focused usage model, the Open Data Center Alliance seeks to clarify the meaning of interoperability, and encourages the faster creation of interoperable solutions for enterprise adoption.
SERVICE LAYER RELATIONSHIPS
The following illustration shows the components within each of the three cloud service layers.

The bottom-most infrastructure domain layer represents the types of components typically found in an IaaS offering from a cloud provider. Components include all the hardware and software needed to deliver a working infrastructure service, such as a fully functional virtual machine, complete with network connectivity and disk storage. When using IaaS services, the cloud subscriber is responsible for a well-defined physical or virtual delineation point upwards, such as from the empty virtual machine or from an unconfirmed set of storage logical unit numbers (LUNs).

The middle layer represents the types of components typically found in a PaaS offering from a cloud provider, who typically provides facilities to build or run the applications in the top layer. It can extend into the development tools for the cloud subscriber’s application developers (e.g., code interactive development environments, load testers, source code analysis, application programming interfaces (APIs), etc.). Services also include the application-execution environments needed to run cloud subscribers’ applications, such as Java Virtual Machine services, .NET, Ruby, Python, and so on.

Within a PaaS environment, there might also be application-specific components providing services that could otherwise be considered as SaaS, such as databases, web hosting, email, billing, security, checkout services, etc.. ODCA takes the view that when a service is provided for incorporation into or directly to support a cloud subscriber’s application, then it is a PaaS. Conversely, if the service can run on its own, then it is SaaS.
There tends to be an assumed relationship between the layers—SaaS sits on top of PaaS, which sits on top of IaaS. In practice, that is not usually the case. Rather, services are made available at one of the layers. The customer completes the environment with whatever is needed for their business above that delivered layer. The components to fulfill that layer are completed using whatever facilities the service provider finds most useful and efficient. This is illustrated in the following diagram.

The requirements between layers vary regarding portability and interoperability. Portability typically refers to the ability to port the layer above. For instance, PaaS portability is needed when moving applications. Interoperability typically relies on provisioning within the layer itself. For example, SaaS-to-SaaS interoperability occurs between application layers.

In any case, the layer that is referenced uses the layers that lie beneath. Applications run on a platform, which, in turn, depends on provisioning in the infrastructure layer, whether it is delivered as a service or not. Application interconnectability presumes, at the lowest level, that actual network connectivity and addressability exist between applications environments.

Within most cloud environments, billing typically takes place at two of these layers:

- Within the SaaS environment, functionality is typically charged per transaction or per nominated user.
- Within the IaaS environment, resources that are allocated or consumed, such as processing and storage capacity, incur charges.

Other resources are usually accounted for and charged within these models. For example, charging for PaaS facilities is typically incurred at the infrastructure (which might be IaaS) layer beneath it.

**SERVICE ASSURANCE LEVELS**

In the *ODCA Usage Model: Standard Units of Measure for IaaS*[^2], four levels of service differentiation — Bronze, Silver, Gold and Platinum — were introduced. These terms were applied to the various service assurance parameters. In this usage model, these service levels have been extended to include interoperability.

- At the Bronze level, the cloud provider is asked to make basic provisions for portability and interconnectability of their service with the cloud subscriber’s own services and solutions. This includes basic services to port and interconnect infrastructure workloads, applications, or business processes within or across the same cloud provider’s systems and locations.
- At the Silver level, in addition to the Bronze level requirements, the cloud provider is asked to make more advanced and complex provisions for portability and interconnectability of their service with the cloud subscriber’s services and solutions, adding scale, performance, and greater focus on minimization of downtime. At this level, global portability and interconnectability within the cloud provider’s environment is also expected.
- At the Gold level, in addition to Silver-level requirements, the cloud provider is asked to extend its interoperability considerations to accommodate simple portability and interconnectability to a second cloud provider, or between a cloud provider and a cloud subscriber’s internal IT.

[^2]: Open Data Center Alliance: Guide to Interoperability Across Clouds
• At the Platinum level, all previous levels are included. Additionally, the cloud provider is asked to provide greater focus on interoperability at scale, with more automated interconnectability and more seamless portability for the cloud subscriber. This includes more sophisticated options to migrate workloads with less disruption and more attention to details that make the solution interoperable with different hardware and software platforms. At this level, it is expected to see full documentation about data import and export structures, interfaces, and protocols. Live reference examples of all the interoperability features and best practice documentation to assist the cloud subscriber to automatically exploit all the features at any time are also expected.

**USAGE REQUIREMENTS**

We envision cloud development over time towards a situation where cloud subscribers can mix and match services between multiple cloud and non-cloud environments to produce the blend they require for their businesses. And that blend can, itself, develop and change in response to changes in their requirements or in available services.

This blending process can occur by porting and interconnecting between environments, as explained in this document. It can do so at any or all of the layers: IaaS, PaaS or SaaS.

The three associated usage model documents about PaaS, SaaS and long-distance workload migration provide more details of the intentions and requirements from the perspective of that particular layer.

**IaaS Interoperability Requirements**

IaaS interoperability with respect to portability is addressed in the *ODCA Long Distance Workload Migration Usage Model*. It outlines six usage scenarios as follows:

• Data Affinity
• Follow-the-Sun
• Disaster Recovery
• Follow-the-Moon
• Cloud Bursting
• Disaster Avoidance

Based on the usage scenarios, service tiers are defined along service assurance levels. The service tiers describe expected features including manageability, live and at rest migration, performance and distance. From these service tiers, two groupings of RFP requirements are derived: 1) Service Provider and 2) Solution Provider. In addition, an industry call to action is presented.

Please refer to the *ODCA Long Distance Workload Migration Usage Model* for further detail.

In addition, we expect some over-arching requirements, such as the following, to be provided to encourage transparency across and between environments:

• Service descriptions and levels should be consistent, so as to ensure sufficient transparency.
• The security environment should be maintained: federated identity management should ensure accessibility only by controlled users, and moving workloads or interacting with others should not leave data exposed and insecure.
• Charging and billing structures should be consistent between environments and so on.
PaaS Interoperability Requirements
The ODCA PaaS Interoperability Usage Model contains the following five usage scenarios:

- Rapid Application On-Boarding
- Configure PaaS Environment
- Application Scalability
- Operation and Monitoring
- Application Migration

For the purposes of the ODCA, the definition of PaaS is intentionally constrained to the subscriber view of deploying a single application developed for a specific programming language within a hosted application container. However, providers may offer support for multiple languages and multitenant containers in their PaaS offering.

While two perspectives of interoperability and portability are relevant to PaaS, in the case of application-level interconnectibility, it is expected that PaaS providers enable the ability for applications to interconnect while leaving the actual interconnectability firmly in the hands of the application developer.

In addition to the usage scenarios, service provider requirements and an industry call to action are presented.

Please refer to the ODCA PaaS Interoperability Usage Model for further detail.

SaaS Interoperability Requirements
The ODCA SaaS Interoperability Usage Model seeks to raise an understanding of the key requirements for SaaS interoperability across SaaS applications and between SaaS applications and the cloud subscriber’s enterprise environments. It outlines the following five usage scenarios:

- Service Configuration
- Bulk Data Transfer
- Real Time Data Access
- Service Aggregation
- Service Transfer

In addition, service provider requirements and an industry call to action are presented. Usage requirements are documented, along with defined service assurance levels on items including self-service configuration, metadata and data, and scope and standards for web services. From these usage requirements, three groupings of RFP requirements are presented: 1) Configuration and Administration, 2) Data Exchange and 3) Web Services.

Please refer to the ODCA SaaS Interoperability Usage Model for further detail.

RFP REQUIREMENTS
The Alliance believes that requests for proposal to cloud providers should meet the following principle requirements: Solution is open, works on multiple virtual infrastructure platforms, and is standards-based. The provider should describe how the solution meets this principle and any limitations towards the ODCA principle.

More detailed requirements are identified within the supporting usage model documents that focus specifically on IaaS, PaaS and SaaS implementations, as referenced in the previous section.

Click here for an online assistant, Proposed Engine Assistant Tool (PEAT), to help you detail your RFP requirements.
SUMMARY OF INDUSTRY ACTIONS REQUIRED

In the interest of giving guidance on how to create and deploy solutions that are open, multi-vendor, and interoperable, specific areas have been identified where the Alliance believes there should be open specifications, formal or de facto standards, or common intellectual property-free (IP-free) implementations.

Where the Alliance has a specific recommendation on the specification, standard or open implementation, it has been identified within the supporting usage model documents that focus specifically on IaaS, PaaS and SaaS implementations as referenced in the “Usage Requirements” section.

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3 ODCA PaaS Interoperability Usage Model: [www.opendatacenteralliance.org/docs/ODCA_PaaS_Interop_UM_Rev1.0.pdf](www.opendatacenteralliance.org/docs/ODCA_PaaS_Interop_UM_Rev1.0.pdf)
4 ODCA SaaS Interoperability Usage Model: [www.opendatacenteralliance.org/docs/ODCA_SaaS_Interop_UM_Rev1.0.pdf](www.opendatacenteralliance.org/docs/ODCA_SaaS_Interop_UM_Rev1.0.pdf)
5 Proposed Engine Assistant Tool: [http://www.opendatacenteralliance.org/ourwork/proposalengineassistant](http://www.opendatacenteralliance.org/ourwork/proposalengineassistant)