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Open Cloud Computing Interface - Core

Status of this Document

This document provides information to the community regarding the specification of the Open Cloud Computing Interface. Distribution is unlimited.

Obsoletes

This document obsoletes GFD-xxx [REFERENCE].

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Abstract

This document, part of a document series, produced by the OCCI working group within the Open Grid Forum (OGF), provides a high-level definition of a Protocol and API. The document is based upon previously gathered requirements and focuses on the scope of important capabilities required to support modern service offerings.

Contents

1   Introduction

The Open Cloud Computing Interface (OCCI) is a RESTful Protocol and API for all kinds of Management tasks. OCCI was originally initiated to create a remote management API for IaaS model based Services, allowing for the development of interoperable tools for common tasks including deployment, autonomic scaling and monitoring. It now can be used to severe other models as well. To be modular and extensible the current specification itself is currently split into three complimentary documents:

- Core - this defines the OCCI model

- HTTP Rendering - this defines how to manipulate the core model using the OCCI RESTful API. The document defines how the OCCI model can be communicated and thus serialized using HTTP.

- Infrastructure - this defines the infrastructure domain resource types, the required attributes for each and the actions that can be taken on each.

2   Notational Conventions

All these parts and the information within are mandatory for implementors (unless otherwise specified). The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

3   OCCI model

OCCI is a boundary protocol and API that acts as a service front-end to a provider's internal management framework. Figure 1 shows OCCI's place in a provider's architecture.
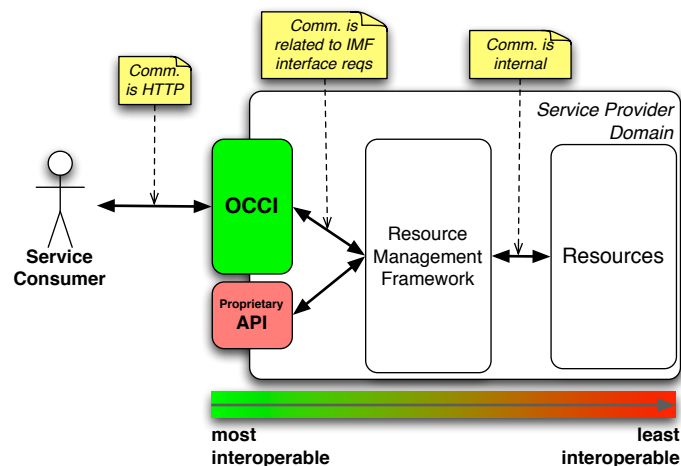

Figure 1.   OCCI's place in a provider's architecture

The heart of the OCCI model is the `Resource` type. Any resource exposed through OCCI is a `Resource` or sub-type thereof. A resource can be e.g. a virtual machine, a job in a job submission system, a user, etc. The `Resource` type contains a number of common attributes that domain-specific `Resource` types inherit. The `Resource` type is complemented by the `Link` type which associates one `Resource` instance with another. The `Link` type also contains a number of common attributes that domain-specific `Link` types inherit.

`Entity` is an abstract type which both `Resource` and `Link` inherit. Each sub-type of `Entity` is identified by a unique `Kind` instance. The `Kind` type comprise the classification system built into the OCCI model. `Kind` is a specialisation of `Category` and introduce additional capabilities in terms of `Action` types.
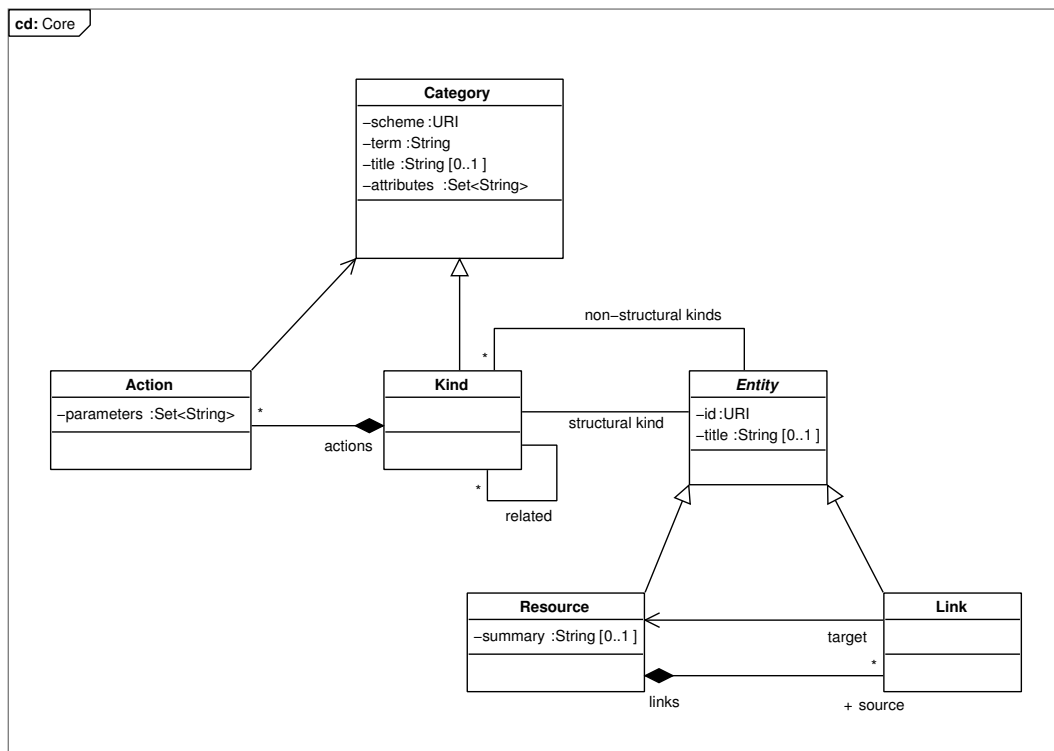
Figure 2.   UML class diagram of the OCCI model. The diagram provides an overview of the OCCI model but is not a standalone definition thereof

The UML class diagram shown in figure 2 gives an overview of the OCCI model. For compliance with OCCI Core, all of the types defined in the OCCI model MUST be implemented. The following sections of the specification define the details of the OCCI model.

3.1   Classification and Identification

The OCCI model provides a built in classification system allowing for safe extension towards domain-specific usage. This system is like a "type system" but with the possibility of being easily exposed over a text based protocol. The classification system can be summarised with the following key features:

- Each OCCI base type and extension thereof is assigned a unique identifier, a structural `Kind`, which allow for dynamic discovery of available types.

- The relationship of structural `Kinds` is part of the system and thus the inheritance model is also discoverable.

- The classification system allows non-structural `Kinds` to be assigned to resource instances adding new capabilities using a mix-in like model.

- Tagging of resource instances is supported through mix-in of non-structural `Kinds` which have no additional capabilities defined.

- A collection of associated resources is implicitly defined for each structural and non-structural `Kind`. I.e. all resource instances associated with a particular `Kind` instance form a collection.

3.1.1   Kind

The `Kind` type comprises the classification system provided by the OCCI model. It MUST be implemented. A `Kind` instance can be either structural or non-structural.

Table 1.   Attributes defined for the `Kind` type

Attribute	Type	Multiplicity	Client Mutability	Description
actions	Action	0..*	Immutable	Set of `Actions` defined by the `Kind` instance.
related	Kind	0..*	Immutable	Set of related `Kind` instances.
entity	Entity	0..1	Immutable	`Entity` type uniquely identified by the `Kind` instance.

The `Kind` type inherits the `Category` type and all inherited attributes MUST be implemented. Table 1 defines the additional attributes the `Kind` type MUST implement to be compliant.

Structural Kind   A structural `Kind` is an instance of `Kind` assigned as the unique identifier of an `Entity` sub-type. The following rules apply:

- A structural `Kind` define the capabilities of an `Entity` sub-type in terms of attributes and `Actions`.

- A unique structural `Kind` MUST be assigned to each and every sub-type of `Entity`.

- A structural `Kind` MUST be related, either directly or indirectly, to the structural `Kind` of `Entity`, i.e. *http://schemas.ogf.org/occi/core#entity*. See section 3.1.3 for the definition of `Kind` relationship.

- If type **B** inherit type **A**, where **A** is a sub-type of `Entity`, the structural `Kind` of **B** MUST be directly related to the structural `Kind` of **A**.

Non-structural Kind   A non-structural `Kind` is an instance of `Kind` *not* assigned as the unique identifier of any `Entity` sub-type. The following rules apply:

- A non-structural `Kind` define additional capabilities for each `Entity` sub-type instance it is associated with. A non-structural `Kind` add capabilities using a mix-in like model.

- A non-structural `Kind` MUST only be associated with `Entity` sub-type *instances*, either at creation-time or run-time.

- A non-structural `Kind` MUST NOT be related, neither directly nor indirectly, to the structural `Kind` of `Entity`, i.e. *http://schemas.ogf.org/occi/core#entity*. See section 3.1.3 for the definition of `Kind` relationship.

- A non-structural `Kind` defining no additional capabilities in terms of attributes or `Actions` is considered to be a tag.

3.1.2   Category

The `Category` type comprises the basis of the identification mechanism used by the OCCI classification system. It MUST be implemented. Instances of the `Category` type are only used to identify `Action` types. All other uses of `Category` properties are managed through its sub-type `Kind`. Table 2 defines the attributes the `Category` type MUST implement to be compliant.

Table 2.   Attributes defined for the `Category` type

Attribute	Type	Multiplicity	Client Mutability	Description
term	String	1	Immutable	Unique identifier of the `Category` instance within the categorisation scheme.
scheme	URI	1	Immutable	The categorisation scheme.
title	String	0..1	Immutable	The display name of an instance.
attributes	String	0..*	Immutable	The set of resource attribute names defined by the `Category` instance.

A `Category` is uniquely identified by concatenating the categorisation scheme with the category term, e.g. *http://example.com/category/scheme#term*. This is done to enable discovery of `Category` definitions in text based renderings such as HTTP. All renderings MUST make use of and understand concatenated unique identifiers of `Category` types. Sub-types of `Category` such as `Kind` inherit this property.

The categorisation schemes defined in the OCCI specification all use the *http://schemas.ogf.org/occi/* base URL. This base URL is reserved for OCCI an MUST NOT be used by domain-specific extensions.

Attribute names defined by `Category` instances[1] use the `occi.` prefix. This prefix is reserved for OCCI and MUST NOT be used by domain-specific extensions.

3.1.3   Kind relationship

As previously defined a structural `Kind` MUST be related, either either directly or indirectly, to the structural `Kind` of `Entity`, i.e. *http://schemas.ogf.org/occi/core#entity*. The OCCI base types `Resource` and `Link` extend `Entity`. This together with any further sub-typing implies a hierarchy of related structural `Kind` instances. The `Kind` relationships thus mirror the type inheritance structure of the OCCI model and any extension thereof.

In an example where a domain-specific "Custom Compute Resource" is a sub-type the OCCI infrastructure type `Compute`, which in turn is a sub-type of the `Resource` type, four related structural `Kinds` would be involved. Table 3 illustrates the exemplified hierarchy of `Kind` instances relating the domain-specific structural `Kind` to the structural `Kind` of `Entity`.

Table 3.   Example of the `Kind` relationship involved for a domain-specific extension of the OCCI infrastructure type `Compute`.

Structural Kind	Related Structural Kind
http://example.com/occi/custom#compute	*http://schemas.ogf.org/occi/infrastructure#compute*
http://schemas.ogf.org/occi/infrastructure#compute	*http://schemas.ogf.org/occi/core#resource*
http://schemas.ogf.org/occi/core#resource	*http://schemas.ogf.org/occi/core#entity*

3.1.4   Kind assignment

A structural `Kind` MUST be statically assigned to each sub-type of `Entity` defined by an implementation. An `Entity` sub-type instance MUST be automatically associated with its structural `Kind` at creation-time. The structural `Kind` associated with an instance MUST remain associated with the instance during its lifetime.

A non-structural `Kind`, also known as a mix-in, MAY be associated with an `Entity` sub-type instance, either at creation-time or run-time. An OCCI implementation MAY restrict which instances can be associated with a particular non-structural `Kind`.

3.1.5   Collections

One or more `Entity` sub-type instances associated with the same `Kind`, may it be structural or non-structural, automatically form a collection. Each `Kind` instance in the system identifies a collection consisting of all different `Entity` sub-type instances associated with the `Kind`.

An `Entity` sub-type instance is always a member of the collection implied by the `Entity`'s structural `Kind`. This follows from the rule that an `Entity` sub-type instance MUST be associated with the structural `Kind` assigned to the sub-type. Since a non-structural `Kind` can be assigned to any `Entity` sub-type instance a collection can contain instances of different `Entity` sub-types. For example, an instance of the `Resource` type will always be associated to the structural `Kind` *http://scheme.ogf.org/occi/core#resource* and thus part of the collection implied by the `Kind`.

Adding an instance to a collection is accomplished by associating the corresponding non-structural `Kind` to the `Entity` sub-type instance.

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[1]Also applies to `Kind` instances.

Removing an instance from a collection is accomplished by disassociating the corresponding non-structural `Kind` from the `Entity` sub-type instance.

An OCCI implementation MUST allow a client to navigate collections. The following basic navigation operations MUST be supported:

- Retrieve the whole collection.
- Retrieve a specific item in a collection.
- Retrieve a subset of a collection.

The details of collection navigation is rendering specific.

3.1.6 Discovery

An OCCI client MUST be able to discover all instances of `Kind` and `Category` a particular service provider's OCCI implementation support. By examining these instances a client MUST be able to, at a minimum, deduce the following information:

- The `Entity` sub-types available from a the service provider, including domain-specific extensions.
- The attributes associated with each `Entity` sub-type.
- The invocable operations, i.e. `Actions`, defined for each `Entity` sub-type.
- Additional mix-ins or tags, i.e. non-structural `Kinds`, applicable to `Entity` sub-type instances.

The above requirements comprise the OCCI discovery mechanism. It MUST be implemented. The details of exactly how the `Category` and `Kind` instances are exposed to an OCCI client is specific to the particular rendering used. The relevant details can be found in the OCCI rendering documents.   References?

3.2 The OCCI base types

The following sections describe the OCCI base types defined by the OCCI model. The base types are `Entity`, `Resource`, `Link` and `Action`. All base types MUST be implemented.

3.2.1 Entity

The `Entity` type is the abstract base type for `Resource` and `Link` and any domain-specific sub-types thereof. It MUST be implemented. Table 4 defines the attributes the `Entity` type MUST implement to be compliant.

Table 4.   Attributes defined for the `Entity` type.

Attribute	Type	Multiplicity	Client Mutability	Description
id	URI	1	Immutable	A unique identifier (within the service provider's namespace) of the `Entity` sub-type instance.
title	String	0..1	Mutable	The display name of the instance.
structural kind	Kind	1	Immutable	The structural `Kind` of the instance.
non-structural kinds	Kind	0..*	Mutable	The non-structural `Kinds` associated to this instance. Consumers can expect the attributes and `Actions` of the associated non-structural `Kinds` to be exposed by the instance.

`Entity` enforces for all sub-types a required `id` attribute and an optional `title` attribute. Every sub-type of `Entity` MUST be assigned a structural `Kind`, see section 3.1.1. `Entity` itself is assigned the structural `Kind` *http://schemas.ogf.org/occi/core#entity*. An `Entity` sub-type instance MAY be associated with one or more non-structural `Kinds`.

An `Entity` sub-type instance MUST expose its structural `Kind` and any associated non-structural `Kinds` together with their associated attributes and `Actions`.

3.2.2   Resource

The `Resource` type inherit `Entity` and describes a concrete resource that can be inspected and manipulated. It represents a general object in the OCCI model and MUST be implemented. The `Resource` type MUST implement all attributes inherited from the `Entity` type together with the attributes defined in table 5 in order to be compliant. The Resource type is assigned the structural Kind *http://schemas.ogf.org/occi/core#resource*.

Table 5.   Attributes defined for the `Resource` type.

Attribute	Type	Multiplicity	Client Mutability	Description
summary	String	0..1	Mutable	A summarising description of the `Resource` instance.
links	Link	0..*	Mutable	A set of `Link` compositions. Being a composite relation the removal of a `Link` from the set MUST also remove the `Link` instance.

`Resource` enforces the inheritance of a set of common attributes into sub-types. Moreover, it introduces relationships to other `Resource` instances through instances of the `Link` type. The `Resource` type is the entry point for domain-specific extensions of the OCCI model, see section 3.4.

3.2.3   Link

An instance of the `Link` type defines a base association between two `Resource` instances. It MUST be implemented. A `Link` instance indicates that one `Resource` instance is connected to another. The `Link` type MUST implement all attributes inherited from the `Entity` type together with the attributes defined in table 6 in order to be compliant. The Link type is assigned the structural Kind *http://schemas.ogf.org/occi/core#link*.

Table 6.   Attributes defined for the `Link` type.

Attribute	Type	Multiplicity	Client Mutability	Description
source	Resource	1	Mutable	The `Resource` instances the `Link` instance originates from.
target	Resource	1	Mutable	The `Resource` instances the `Link` instance points to.

An instance of the `Link` type MUST NOT refer to an external resource. A provider MAY however create a sub-type of `Link` with different semantics, e.g. have a target attribute containing an URI and thus the ability of linking with external resources. The `Link` type can be sub-typed for domain-specific extensions of the OCCI model, see section 3.4.

3.2.4   Action

The `Action` type defines an invocable operation applicable to an `Entity` sub-type instance or a collection thereof. It MUST be implemented. In general, `Actions` modify state by e.g. performing a complex operation such as rebooting a virtual machine. Table 7 defines the attributes the `Action` type MUST implement to be compliant.

Table 7.   Attributes defined for the `Action` type.

Attribute	Type	Multiplicity	Client Mutability	Description
category	Category	1	Immutable	The identifying `Category` of the `Action`.
parameters	String	0..*	Immutable	Enumeration of valid parameters for the `Action`.

An `Action` is always bound to a `Kind` instance through a composite association. An `Action` is considered a capability of the `Kind`. An `Action` MAY be invoked on any `Entity` sub-type instance associated with the `Kind` instance defining the `Action`. An OCCI implementation MAY refuse an `Action` from being invoked if currently not applicable.

An `Action` MAY be invoked on a collection of `Entity` sub-type instances. The `Action` is only considered valid if all instances of the collection are associated with the `Kind` defining the `Action`.

The Action type is assigned the `Category` identifier *http://schemas.ogf.org/occi/core#action*. The `Action` type can be sub-typed for domain-specific extensions of the OCCI model, see section 3.4.

3.3   Mutability

Attributes of an OCCI model type instance, a resource instance, are either client mutable or client immutable. If an attribute is noted to be mutable this MUST be interpreted that a client can create a resource instance that is parametrised by the attribute. Likewise, if an attribute is mutable, a client can update that resource instance's mutable attribute value and the server side MUST support this. If an attribute is marked as immutable, it indicates that the server side implementation MUST manage these exclusively. Immutable attributes MUST NOT be modifiable by clients under any circumstance.

3.4   Extensibility

The OCCI model has a flexible yet fairly simple extension mechanism based on the classification system described in section 3.1. The OCCI model can be extended using two different methods, sub-typing and mix-in. Both methods involve the use of domain-specific `Kind` or `Category` instances. The following sections define the requirements for extensions of the OCCI model. The rules defined in section 3.1 and 3.2 are REQUIRED for all extensions of the OCCI model.

3.4.1   `Kind` **and** `Category` **instances**

Domain-specific `Kind` and `Category` instances MAY be introduced by an OCCI implementation. A `Kind` or `Category` instance defined outside of the OCCI specification MUST use a categorisation scheme unique to the provider, e.g. *http://example.com/occi#*. An attribute introduced by a domain-specific `Kind` or `Category` MUST use an attribute name prefix. This prefix MUST NOT be the "`occi.`" prefix which is reserved for the OCCI specification. Domain-specific attribute names SHOULD use a prefix consisting of the provider's reverse domain name, e.g. "`com.example.`".

3.4.2   Sub-typing

The OCCI model MAY be extended through sub-typing for domain-specific purposes. Three OCCI model types MAY be sub-typed, those are `Resource`, `Link` and `Action`.

In order to define a sub-type of `Resource` or `Link` a domain-specific structural `Kind` MUST be defined and assigned to the sub-type. This structural `Kind` MUST be directly related to the structural `Kind` of the type extended.

In order to define a sub-type of `Action` a domain-specific `Category` instance MUST be assigned to the `Action` sub-type as its unique identifier. Furthermore the `Action` sub-type MUST be associated as a capability of a domain-specific `Kind` instance.

3.4.3   Mix-ins

The OCCI model MAY be extended through domain-specific mix-ins, i.e. non-structural `Kinds`. A non-structural `Kind` MAY be associated with any `Entity` sub-type instance although a provider MAY apply restrictions.

In order to support user-defined tags an OCCI implementation must allow non-structural `Kinds` to be created and destroyed by request of a client. There is no limitation in the OCCI model from doing so but it is RECOMMENDED to assign a separate categorisation scheme for each user's non-structural `Kinds`[2].

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[2]A tag is a non-structural `Kind` which do not introduce additional capabilities.

4 Contributors

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TBD: Bunch op people missing here - create table. . .

5 Glossary

Term	Description
`Action`	An OCCI base type. Represent an invocable operation on a `Entity` sub-type instance or collection thereof.
`Category`	A type in the OCCI model. The parent type of `Kind`.
Client	An OCCI client.
Collection	A set of `Entity` sub-type instances all associated to a particular `Kind` instance.
`Entity`	An OCCI base type. The parent type of `Resource` and `Link`.
`Kind`	A type in the OCCI model. The central piece in the OCCI classification system.
`Link`	An OCCI base type. A `Link` instance associate one `Resource` instance with another.
Mix-in	A non-structural `Kind`.
Non-structural Kind	An instance of `Kind` *not* used as an unique identifier of an OCCI base type.
OCCI	Open Cloud Computing Interface
OCCI base type	One of `Entity`, `Resource`, `Link` or `Action`.
OGF	Open Grid Forum
`Resource`	An OCCI base type. The parent type for all domain-specific resource types.
Structural Kind	An instance of `Kind` assigned as the unique identifier of an OCCI base type.
Tag	A non-structural `Kind` with no attributes or actions defined.
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
URN	Uniform Resource Name

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9 References

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