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Open Cloud Computing Interface - Infrastructure

Status of this Document

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

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[1] model-based services, allowing for the development of interoperable tools for common tasks including deployment, autonomic scaling and monitoring. It has since evolved into a flexible API with a strong focus on interoperability while still offering a high degree of extensibility. The current release of the Open Cloud Computing Interface is suitable to serve many other models in addition to IaaS, including PaaS and SaaS.

In order to be modular and extensible the current OCCI specification is released as a suite of complimentary documents, which together form the complete specification. The documents are divided into three categories consisting of the OCCI Core, the OCCI Renderings and the OCCI Extensions.

- The OCCI Core specification consists of a single document defining the OCCI Core Model. The OCCI Core Model can be interacted with *renderings* (including associated behaviours) and expanded through *extensions*.
- The OCCI Rendering specifications consist of multiple documents each describing a particular rendering of the OCCI Core Model. Multiple renderings can interact with the same instance of the OCCI Core Model and will automatically support any additions to the model which follow the extension rules defined in OCCI Core.
- The OCCI Extension specifications consist of multiple documents each describing a particular extension of the OCCI Core Model. The extension documents describe additions to the OCCI Core Model defined within the OCCI specification suite. They do not require changes to the HTTP Rendering specifications as of this version of the specification.

The current specification consists of three documents. This specification describes version 1.1 of OCCI. Future releases of OCCI may include additional rendering and extension specifications. The documents of the current OCCI specification suite are:

OCCI Core describes the formal definition of the the OCCI Core Model [1].

OCCI HTTP Rendering defines how to interact with the OCCI Core Model using the RESTful OCCI API [2]. The document defines how the OCCI Core Model can be communicated and thus serialised using the HTTP protocol.

OCCI Infrastructure contains the definition of the OCCI Infrastructure extension for the IaaS domain [3]. The document defines additional resource types, their attributes and the actions that can be taken on each resource type.

OCCI makes an ideal interoperable boundary interface between the web and the internal resource management system of infrastructure providers.

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 [4].

[1] Infrastructure as a Service

3 Infrastructure

The OCCI Infrastructure document details how an OCCI implementation can model and implement an Infrastructure as a Service API offering by utilising the OCCI Core Model. This API allows for the creation and management of typical resources associated with an IaaS service, for example, creating a Compute instance and Storage instance and then linking them with StorageLink. The main infrastructure types defined within OCCI Infrastructure are:

Compute Information processing resources.

Network Interconnection resource and represents a L2 networking resource. This is complimented by the IPNetwork Mixin.

Storage Information recording resources.

Supporting these Resource types are the following Link sub-types:

NetworkInterface connects a Compute instance to a Network instance. This complimented by an IPNetworkInterface Mixin.

StorageLink connects a Compute instance to a Storage instance.

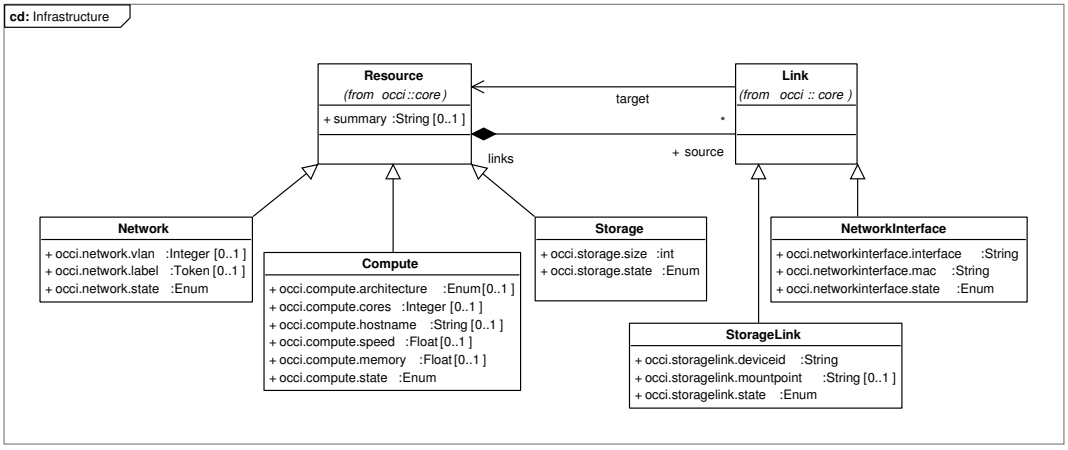

Figure 1. Overview Diagram of OCCI Infrastructure Types.

These infrastructure types inherit the OCCI Core Model Resource base type and all their attributes. The HTTP Rendering document [2] defines how to serialise and interact with these types using RESTful communication. Implementers are free to choose what Resource and Link sub-types to implement. Those that are supported by an implementation will be discoverable through the OCCI Query Interface.

As REQUIRED by the OCCI Core Model specification, every type instantiated that is a sub-type of Resource or Link MUST be assigned a Kind that identifies the instantiated type. Each such Kind instance MUST be related to the Resource or Link base type's Kind. That assigned Kind instance MUST always remain immutable to any client.

Table 1 describes the Kind instances defined for each of the infrastructure Resource or Link sub-types. For information on extending these types, please refer to the OCCI Core Model document [1].

The following sections on Compute, Storage and Network types detail the attributes, Actions and states defined for each of them, including type-specific mixins (IPNetwork and IPNetworkInterface) where appropriate. Following those, the definition of infrastructure-related Link sub-types are given and finally OS and Resource Templates are defined. Figure 1 gives an overview of the various types involved in this infrastructure specification.

Table 1. The Kind instances defined for the infrastructure sub-types of Resource, Link and related Mixins. The base URL **http://schemas.ogf.org/occi** has been replaced with <**schema**> in this table for a better readability experience.

Term	Scheme	Title	Related Kind
compute	<schema>/infrastructure#	Compute Resource	<schema>/core#resource
storage	<schema>/infrastructure#	Storage Resource	<schema>/core#resource
storagelink	<schema>/infrastructure#	StorageLink Link	<schema>/core#link
network	<schema>/infrastructure#	Network Resource	<schema>/core#resource
ipnetworking	<schema>/infrastructure/network#	IP Networking Mixin	–
networkinterface	<schema>/infrastructure#	NetworkInterface Link	<schema>/core#link
ipnetworkinterface	<schema>/infrastucture/networkinterface#	IP NetworkInterface Mixin	–

3.1 Compute

The Compute type represents a generic information processing resource, e.g. a virtual machine. Compute inherits the Resource base type defined in OCCI Core Model [1]. Compute is assigned the Kind instance *http://schemas.ogf.org/occi/infrastructure#compute*. A Compute instance MUST use and expose this Kind.

Table 2. Attributes defined for the Compute type.

Attribute	Type	Multiplicity	Mutability	Description
occi.compute.architecture	Enum {x86, x64}	0...1	Mutable	CPU Architecture of the instance.
occi.compute.cores	Integer	0...1	Mutable	Number of CPU cores assigned to the instance.
occi.compute.hostname	String	0...1	Mutable	Fully Qualified DNS hostname for the instance.
occi.compute.speed	Float, 10^9 (GHz)	0...1	Mutable	CPU Clock frequency (speed) in gigahertz.
occi.compute.memory	Float, 10^9 (GiB)	0...1	Mutable	Maximum RAM in gigabytes allocated to the instance.
occi.compute.state	Enum {active, inactive, suspended}	1	Immutable	Current state of the instance.

Table 2 describes the attributes[2] defined by Compute through its Kind instance. These attributes MUST be exposed by an instance of the Compute type.

Table 3. Actions applicable to instances of the Compute type. The Actions are defined by the Kind instance *http://schemas.ogf.org/occi/infrastructure#compute*. Every Action in the table is identified by a Category instance using the *http://schemas.ogf.org/occi/infrastructure/compute/action#* categorisation scheme. "Action Term" below refers to the term of the Action's Category identifier.

Action Term	Target state	Attributes
start	active	–
stop	inactive	method={graceful, acpioff, poweroff}
restart	active (via stop and start chain)	method={graceful, warm, cold}
suspend	suspended	method={hibernate, suspend}

Table 3 describes the Actions defined for Compute by its Kind instance. These Actions MUST be exposed by an instance of the Compute type of an OCCI implementation. Figure 2 illustrates the state diagram for a Compute instance.

3.2 Network

The Network type represents a L2 networking entity (e.g. a virtual switch). It can be extended using the mixin mechanism (or sub-typed) to support L3/L4 capabilities such as TCP/IP etc. For the purposes of this specification we define an OCCI mixin so that IP networking can be supported where required. Network inherits the Resource base type defined in OCCI Core Model [1].

[2] See the "`attributes`" attribute defined by the Category type and inherited by Kind [1].

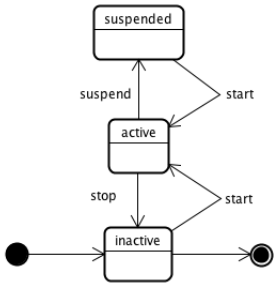

Figure 2. State Diagram for a Compute instance.

The Network type is assigned the *http://schemas.ogf.org/occi/infrastructure#network* Kind. A Network instance MUST use and expose this Kind.

Table 4. Attributes defined for the Network type.

Attribute	Type	Multiplicity	Mutability	Description
occi.network.vlan	Integer: 0-4095	0...1	Mutable	802.1q VLAN Ientifier (e.g. 343).
occi.network.label	Token	0...1	Mutable	Tag based VLANs (e.g. external-dmz).
occi.network.state	Enum {active, inactive}	1	Immutable	Current state of the instance.

Table 4 describes the attributes[3] defined by Network through its Kind instance. These attributes MUST be exposed by an instance of the Network type.

Table 5. Actions applicable to instances of the Network type. The Actions are defined by the Kind instance *http://schemas.ogf.org/occi/infrastructure#network*. Every Action in the table is identified by a Category instance using the *http://schemas.ogf.org/occi/infrastructure/network/action#* categorisation scheme. "Action Term" below refers to the term of the Action's Category identifier.

Action Term	Target State	Attributes
up	active	–
down	inactive	–

Table 5 describes the Actions defined for Network by its Kind instance. These Actions MUST be exposed by an instance of the Network type of an OCCI implementation. Figure 3 illustrates the state diagram for a Network instance.

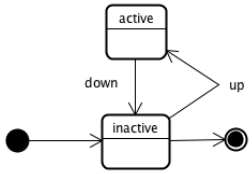

Figure 3. State Diagram for a Network instance.

3.2.1 IPNetworking Mixin

In order to support L3/L4 capabilities (e.g. IP, TCP etc.) an OCCI mixin is herewith defined.

The IPNetworking mixin is assigned[4] the "`scheme`" of *http://schemas.ogf.org/occi/infrastructure/network#* and the "`term`" value *ipnetwork*. An IPNetworking mixin MUST support these values.

[3] See the "`attributes`" attribute defined by the Category type and inherited by Kind [1].
[4] Both assignments use data members from the inherited Category type [1].

Table 6 define the attributes introduced by the IPNetworking mixin. A Network instance associated with the IPNetworking mixin Mixin instance MUST implement these attributes.

Table 6. Attributes defined by the IPNetworking mixin. A Network instance associated with this Mixin instance MUST expose these attributes.

Attribute	Type	Multiplicity	Mutability	Description
occi.network.address	IPv4 or IPv6 Address range, CIDR notation	0...1	Mutable	Internet Protocol(IP) network address (e.g. 192.168.0.1/24, fc00::/7)
occi.network.gateway	IPv4 or IPv6 Address	0...1	Mutable	Internet Protocol(IP) network address (e.g. 192.168.0.1, fc00::)
occi.network.allocation	Enum {dynamic, static}	0...1	Mutable	Address allocation mechanism: *dynamic* e.g. uses the dynamic host configuration protocol, *static* e.g. uses user supplied static network configurations.

In Figure 4 a UML object diagram depicts how Network would be associated with an IPNetwork Mixin when both are instantiated.

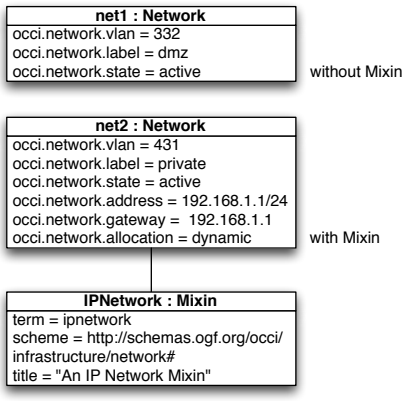

Figure 4. Object Diagram of a Network Instance and its Associated IPNetwork Mixin.

3.3 Storage

The Storage type represent resources that record information to a data storage device. Storage inherits the Resource base type defined in the OCCI Core Model [1]. The Storage type is assigned the Kind instance *http://schemas.ogf.org/occi/infrastructure#storage*. A Storage instance MUST use and expose this Kind.

Table 7. Attributes defined for the Storage type.

Attribute	Type	Multiplicity	Mutability	Description
occi.storage.size	Float, 1^{09} (GiB)	1	Mutable	Storage size in gigabytes of the instance.
occi.storage.state	Enum {online, offline, backup, snapshot, resize, degraded}	1	Immutable	Current status of the instance.

Table 7 describes the attributes[5] defined by Storage through its Kind instance. These attributes MUST be exposed by an instance of the Storage type.

Table 8 describes the Actions defined for Storage by its Kind instance. These Actions MUST be exposed by an instance of the Storage type of an OCCI implementation. Figure 5 illustrates the state diagram for a Storage instance.

[5]See the "`attributes`" attribute defined by the Category type and inherited by Kind [1].

Table 8. Actions applicable to instances of the Storage type. The Actions are defined by the Kind instance *http://schemas.ogf.org/occi/infrastructure#storage*. Every Action in the table is identified by a Category instance using the *http://schemas.ogf.org/occi/infrastructure/storage/action#* categorisation scheme. "Action Term" below refers to the term of the Action's Category identifier.

Action Term	Target State	Attributes
online	online	–
offline	offline	–
backup	None	–
snapshot	None	–
resize	None	size = Float 10^9 (GiB)

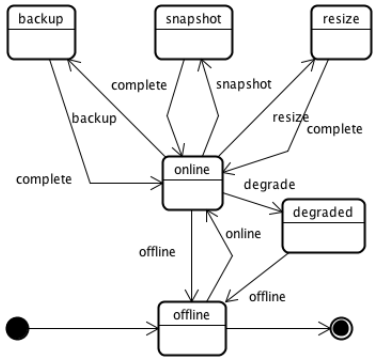

Figure 5. State Diagram for a Storage instance.

OCCI can be used in conjunction with the SNIA cloud storage standard, Cloud Data Management Interface (CDMI) [5] to provide enhanced management of the cloud computing storage and data. For storage managed through CDMI, see the section on StorageLink

3.4 Linking Infrastructure Resources

In order to create entities like virtual data centres or virtual clusters, it is necessary to allow the linkage of the previously defined infrastructure Resource sub-types. This is accomplished by extending (sub-typing) the OCCI Core Model Link base type. This is done as the Link base type cannot fully represent specific types of infrastructure links (e.g. links to storage or networks). These infrastructure links require additional attributes (e.g. network interface name) which can only be supported by sub-typing the Link base type.

3.4.1 Linking to Network

The NetworkInterface type represents an L2 client device (e.g. network adapter). It can be extended using the mix-in mechanism or sub-typed to support L3/L4 capabilities such as TCP/IP etc. NetworkInterface inherits the Link base type defined in the OCCI Core Model [1].

The NetworkInterface type is assigned the Kind instance *http://schemas.ogf.org/occi/infrastructure#networkinterface*. A NetworkInterface instance MUST use and expose this Kind. The Kind instance assigned to the NetworkInterface type MUST be related to the *http://schemas.ogf.org/occi/core#link* Kind.

Table 9 describes the attributes[6] defined by NetworkInterface through its Kind instance. These attributes MUST be exposed by an instance of the NetworkInterface type. Figure 6 illustrates the state diagram for a NetworkInterface instance.

3.4.1.1 IPNetworkInterface Mixin In order to support L3/L4 capabilities (e.g. IP, TCP etc.) with the NetworkInterface type, an OCCI Mixin instance is herewith defined.

[6] See the "`attributes`" attribute defined by the Category type and inherited by Kind [1].

Table 9. Attributes defined for the NetworkInterface type.

Attribute	Type	Multiplicity	Mutability	Description
occi.networkinterface.interface	String	1	Immutable	Identifier that relates the link to the link's device interface
occi.networkinterface.mac	String	1	Mutable	MAC address associated with the link's device interface
occi.networkinterface.state	Enum {active, inactive}	1	Immutable	Current status of the instance.

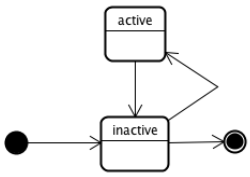

Figure 6. State Diagram for a NetworkInterface instance.

The IPNetworkInterface mixin is assigned[7] the "scheme" of *http://schemas.ogf.org/occi/infrastructure/networkinterface#* and the "term" value *ipnetworkinterface*. An IPNetworkInterface mixin MUST support these attributes.

Table 10 define the attributes introduced by the IPNetworkInterface mixin. A NetworkInterface instance associated with the IPNetworkInterface mixin Mixin instance MUST expose these attributes.

Table 10. Attributes defined by the IPNetworkInterface mixin. A NetworkInterface instance associated with this Mixin instance MUST expose these attributes.

Attribute	Type	Multi-plicity	Mutability	Description
occi.networkinterface.address	IPv4 or IPv6 Address	1	Mutable	Internet Protocol(IP) network address (e.g. 192.168.0.1/24, fc00::/7) of the link
occi.networkinterface.gateway	IPv4 or IPv6 Address	0...1	Mutable	Internet Protocol(IP) network address (e.g. 192.168.0.1/24, fc00::/7)
occi.networkinterface.allocation	Enum {dynamic, static}	1	Mutable	Address mechanism: *dynamic* e.g. uses the dynamic host configuration protocol, *static* e.g. uses user supplied static network configurations.

In Figure 7 a UML object diagram depicts how NetworkInterface would be associated with an IPNetworkInterface Mixin when both are instantiated.

3.4.2 Linking to Storage

The StorageLink type represents a link from a Resource to a target Storage instance. This enables a Storage instance be attached to a Compute instance, with all the prerequisite low- level operations handled by the OCCI implementation. Storage inherits the Link base type defined in the OCCI Core Model [1].

The StorageLink type is assigned the Kind instance *http://schemas.ogf.org/occi/infrastructure#storagelink*. A StorageLink instance MUST use and expose this Kind. The Kind instance assigned to the StorageLink type MUST be related to the *http://schemas.ogf.org/occi/core#link* Kind.

Table 11 describes the attributes[8] defined by StorageLink through its Kind instance. These attributes MUST be exposed by an instance of the StorageLink type. Figure 8 illustrates the state diagram for a StorageLink instance.

[7] Both assignments use data members from the inherited Category type [1].
[8] See the "attributes" attribute defined by the Category type and inherited by Kind [1].

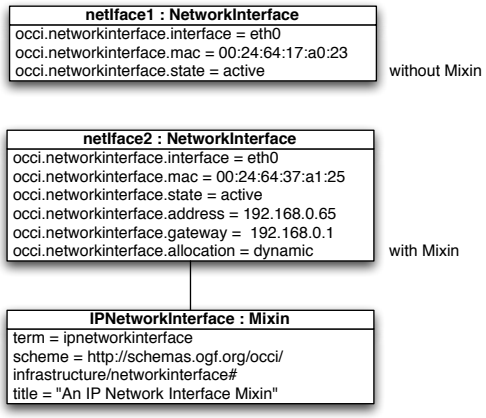

Figure 7. Object Diagram of a NetworkInterface Instance and its Associated IPNetworkInterface Mixin.

Table 11. Attributes defined for the StorageLink type.

Attribute	Type	Multi-plicity	Mutability	Description
occi.storagelink.deviceid	String	1	Mutable	Device identifier as defined by the OCCI service provider.
occi.storagelink.mountpoint	String	0...1	Mutable	Point to where the storage is mounted in the guest OS.
occi.storagelink.state	Enum {active, inactive}	1	Immutable	Current status of the instance.

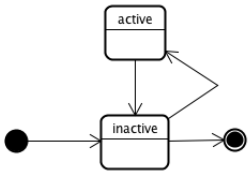

Figure 8. State Diagram for a StorageLink instance.

3.4.3 Linking to CDMI Managed Storage

As previously stated, OCCI can be used in conjunction with the SNIA cloud storage standard, Cloud Data Management Interface (CDMI) [5] to provide enhanced management of the cloud computing storage and data. In order to integrate the two, the use of StorageLink should be used. This will link OCCI managed Resources to CDMI resources. The 'occi.storagelink.deviceid' attribute of StorageLink, defined above, should be set to the CDMI Object ID of an exported CDMI Container.

3.5 Infrastructure Templates

Infrastructure Templates allow clients of an OCCI implementation to quickly and conveniently apply predefined configurations to OCCI Infrastructure defined types. They are implemented using Mixin instances. There are 2 supported infrastructure template types in OCCI Infrastructure.

3.5.1 OS Template

OS (Operating System) Templates allow clients specific what operating system must be installed on a requested Compute resource. OCCI implementations SHOULD support this, otherwise what they provision will

be merely offer Resources without any available execution environment (e.g. operating system). Of the two supported template types, this is the most basic and necessary template that a provider SHOULD offer.

Its construction is a Mixin instance consisting of a provider specific "scheme" and a descriptive "title" detailing the OS. The "term" value of the template Mixin is a provider-specific identifier that corresponds to a particular virtual machine image configuration. Where an implementation requires additional attributes associated with the OS Template, it can do so using "`attributes`" value inherited from the Category type.

A implementation-defined OS Template Mixin MUST be related to the OCCI OS Template Mixin in order to give absolute type information.

The OCCI OS Template is defined by the *http://schemas.ogf.org/occi/infrastructure#os_tpl* Mixin and MUST be supported SHOULD OS Templates be offered by the OCCI implementation.

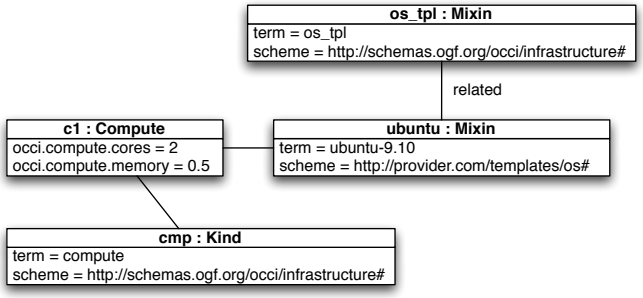

Figure 9. Object Diagram of a Compute Instance and its Associated OS Template Mixin.

A typical example of using such a Mixin is shown in figure 9 using a UML object diagram. In the example a provider has defined an OS template which offers the ability to run Ubuntu Linux, verson 9.10, upon a client's provisioned compute resource.

How a provider manages their set of OS templates will be determined by themselves and so implementation-specific.

3.5.2 Resource Template

The Resource Template Mixin builds upon the concept of OS Templates. A Resource Template is a provider-defined Mixin instance that refers to a preset Resource configuration.

The preset Resource configuration is not visable through the OCCI Discovery mechanism. The Mixin.`attributes` (inherited from Category) is empty for a Resource Template Mixin. The side-effect of initialising Resource attributes with pre-defined values is handled by the implementation.

The OCCI implementation associates a set of Resource attributes (via Category's 'attributes') with a particular term identifier.

An implementation-defined Resource Template Mixin MUST be related to the OCCI Resource Template Mixin in order to give absolute type information. The OCCI Resource Template is defined by the Mixin instance *http://schemas.ogf.org/occi/infrastructure#resource_tpl* and MUST be supported SHOULD Resource Templates be offered by the OCCI implementation.

A typical example of such a Mixin's use is shown in figure 10) using a UML object diagram. In this example, the provider offers Compute Resources based on different sizes (i.e. small, medium, large). Each "size" of Compute (i.e. the term) corresponds to a predetermined set of OCCI Resource-specific attributes. In the example below a 'small' Compute instance is created. Specifying "small" as the term corresponds to an implementation-specific Compute Resource-specific attribute set[9] that is shown by the object instance named "attributes" in figure 10.

From the administrative point of view, how an OCCI service provider manages their set of Resource Templates will be determined by themselves and so is implementation-specific.

[9] This attribute set is implementation-specific and is *not* related to Mixin.`attributes` inherited from the Category type [1].

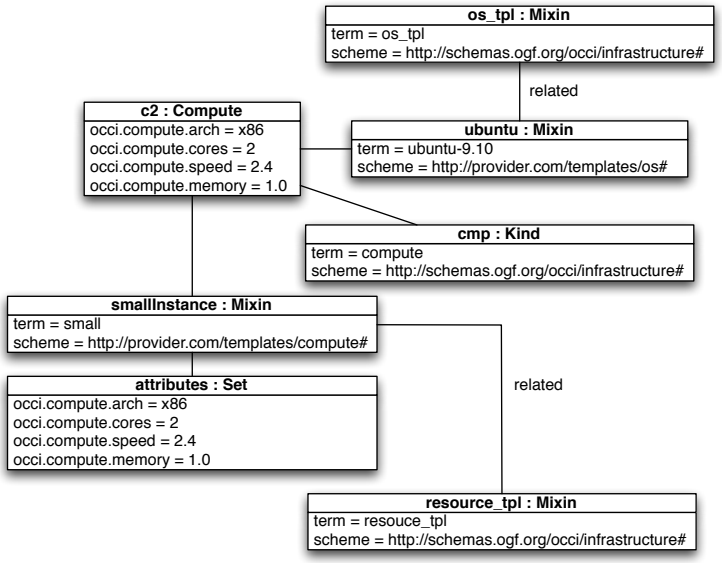

Figure 10. Object Diagram of a Compute Instance and its Associated OS Template Mixin and Resource Template Mixin.

4 Security Considerations

The OCCI Infrastructure specification is an extension to the OCCI Core and Model specification [1]; thus the same security considerations as for the OCCI Core and Model specification apply here.

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 or Mixin instance.
Entity	An OCCI base type. The parent type of Resource and Link.
Kind	A type in the OCCI model. A core component of the OCCI classification system.
Link	An OCCI base type. A Link instance associate one Resource instance with another.
mixin	An instance of the Mixin type associated with a **resource instance**. The "mixin" concept as used by OCCI *only* applies to instances, never to Entity types.
Mixin	A type in the OCCI model. A core component of the OCCI classification system.
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.
resource instance	An instance of a sub-type of Entity. The OCCI model defines two sub-types of Entity, the Resource type and the Link type. However, the term *resource instance* is defined to include any instance of a *sub-type* of Resource or Link as well.
Tag	A Mixin instance with no attributes or actions defined.
Template	A Mixin instance which if associated at resource instantiation time pre-populate certain attributes.
type	One of the types defined by the OCCI model. The OCCI model types are Category, Kind, Mixin, Action, Entity, Resource and Link.
concrete type/sub-type	A concrete type/sub-type is a type that can be instantiated.
URI	Uniform Resource Identifier.
URL	Uniform Resource Locator.
URN	Uniform Resource Name.

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