# A formal framework for the management of any digital resource in the cloud - Simulation

#### <u>Abstract</u>

This document provides information regarding our proposed simulation extension integrated in the formal framework for the management of any digital resource in the cloud. The extension is associated with a tool for simulating every kind of computing cloud computing resources by using cloudSim.

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## 1 Introduction

Cloud computing has been adopted as a dominant delivery model for computing resources [1]. This model defines three well discussed layers of services known as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) [2]. In this context, there is a plethora of cloud resource management [3] interfaces for provisioning, supervising, and managing cloud resources. Thereby standards are required to cope with heterogeneity, interoperability, integration, and portability issues in cloud computing. To this end, Open Cloud Computing Interface (OCCI) [4] proposes one of the first widely accepted, community-based, open standards for managing any kinds of cloud resources. But as it is specified in natural language, OCCI is imprecise, ambiguous, incomplete, and needs a precise definition of its core concepts. To tackle these issues OCCIware project [5] launched. It aims at proposing a formal framework, model-driven and associated with tools for managing every kind of computing resources as services. This framework covers all steps from modelization, design, development, simulation, deployment, execution and administration of cloud computing resources.

As part of our work, we aim to extend the OCCIware metamodel specifications mainly dedicated for simulation cloud resources. According to the advantages of CloudSim simulator [6], we believe that it is the most appropriate simulator to achieve our goal. It allows us to model and simulate all the cloud infrastructure resources, it requires very less effort and time to implement Cloud based application provisioning test environment and developers can model and test the performance of their application services in heterogeneous Cloud environments (Amazon EC2, Microsoft Azure) with little programming and deployment effort.

This document is organized as follows: Section 2 describes the main defined OCCI resource types. Section 4 details the OCCI resources (i.e. Datacenter, CloudLet). Section 5 describes resource Links between the defined OCCI resources. Section 6 lists a set of Mixin of specific resources.

## 2 Definition of the resources

Before defining the OCCI simulation resources, it is important to define the different entities used by CloudSim tool. Like this, it will be easier to extract the resource needed to the simulation. In the following, we give an overview of CloudSim mechanism before describing OCCI simulation extension.

## 2.1 CloudSim entities

Figure 1 presents the class design diagram for the CloudSim simulator. In CloudSim, Datacenter class models the core infrastructure level services (hardware, software) offered by resource providers in Cloud computing environment. It encapsulates a set of compute Hosts and their resource configurations (memory, cores, capacity, and storage). Furthermore, every Datacenter component instantiates

a generalized resource provisioning component that implements a set of policies for allocating bandwidth, memory, and storage devices.

Each Host component can instantiate multiple Vms and allocate cores based on predefined processor sharing policies. Each Vms has a owner, which can submit Cloudlets to the Vm to be executed.

According to the resources needed by CloudSim, some of them must be defined as a new Kind in OCCI metamodel, while others can be defined as a configuration from the existing Kind following OCCI core [7] and infrastructure [8] model.

## 3 OCCI resources

This section presents the defined resources used for our extension upon OCCI metamodel. The resources types are derived directly from OCCI infrastructure model [8]. The later is derived from Resource entity at OCCI core level [7]. The resource Mixins are applies for from Mixin entity at OCCI core level. The interfaces which link these resources between them are derived from Link entity at OCCI core level.



Figure 1. CloudSim class design diagram.

Figure 2 details the overview of the different OCCI resources and the connection of these types with the OCCI core and infrastructure entities.



Figure 2. Overview of the defined extension.

The main OCCI resources types defined are:

- Datacenter Datacenter component is the main hardware infrastructure that provide services for servicing user requests. It is composed of a set of host, which are responsible for managing VM during their life cycle,
- Cloudlet it models the Cloud-based application services,
- SanStorage it represents a storage area network composed of a set of harddisks connected in a LAN.

We also define a relation between resources by using a container link provided for this purpose:

• Contains to connect the resources between them. For example, Datacenter contains a list of hosts. Each Host contains a list of VM. Each VM contains a list of CloudLet, etc.

In addition to that, a set of resource Mixins are defined:

- ProvisSchedul: it represents the provisioning and scheduling policies used by the compute resource,
- simStorageLink: the size amount of storage,
- bandwidth: provisioning policy of bandwidth to virtual machines inside a Host.

Table 1 describes the Kind instances defined for each one of the Resource or Link sub-types. For information on extending these types, please refer to the OCCI Core Model document [7] and infrastructure [8].

Table 1. The kind instances defined for the subtypes of Resources, Links and related Mixins.

Term	Scheme	Title	RelatedKind
Datacenter	<schema>/infrastructure#</schema>	Data center Resource	<schema>/infrastructure#compute</schema>
SanStorage	<schema>/infrastructure# <schema>/infrastructure#</schema></schema>	San Storage Resource	<schema>/infrastructure#compute <schema>/infrastructure#storage</schema></schema>
Contains	<schema $>/$ infrastructure $#$	Contains Link	<schema>/infrastructure#link</schema>
ProvisSchedul	<schema>/infrastructure-compute#</schema>	Provisioning and Scheduling policies Mixin	-
simStorageLink	<schema $>/$ infrastructure-storagelink $#$	Storage size Mixin	-
bandwidth	<schema $>/$ infrastructure-networkinterface $#$	Bandwidth Mixin	-

## 4 OCCI platform resources

This section details attributes for each one of the defined OCCI resource types.

#### 4.1 Datacenter resource

The Datacenter resource type represents the resource providers in CloudSim. It has set of hosts(physical machine), VM and different management components and policies. A data center has a set of interconnected hosts that are managed by a set of management policies. The Database type inherits the Resource base type defined in the OCCI infrastructure [8]

Table 2 describes the attributes describing the Datacenter type through its Kind instance. These attributes are exposed by all Datacenter type instances.

#### 4.2 Cloudlet resource

The Cloudlet resource represents the CloudSim task running in Vms. Each cloudlet is defined by the number of CPU operations it requires.

Table 3 describes the attributes describing the Cloudlet type through its Kind instance. These attributes are exposed by all Cloudlet type instances.

#### 4.3 SanStorage

SanStorage represents a storage area network composed of a set of hard disks connected in a LAN.

Table 4 describes the attributes describing the SanStorage type through its Kind instance. These attributes are exposed by all SanStorage type instances.

Attribute	Туре	Multiplic	ityMutability	Description
id	Integer	1	Mutable	The resource id.
architecture	String	1	Mutable	The architecture.
vmm	String	1	Immutable	The virtual machine monitor.
OS	String	1	Immutable	The operating system.
host	EObject	1*	Mutable	The host list.
timeZone	Integer	1	Mutable	The time zone – difference from GMT.
costPerSecond	Float	1	Mutable	the cost per sec to use this resource.
allocationPolicy	Integer	1	Mutable	Resource Types – allocation policy.
regionalCisName	String	1	Mutable	The regional name.
vmAllocationPolicy	EObject	1	Immutable	The vm provisioner.
name	String	1	Mutable	name of the datacener.
storage	EObject	1 *	Mutable	The storage list.
schedulingInterval	Integer	1	Mutable	The scheduling interval.
costPerMem	Float	1	Mutable	the cost to use memory in this resource.
costPerStorage	Float	1	Mutable	the cost to use storage in this resource.
costPerBw	Float	1	Mutable	the cost per bw.

 Table 2.
 Attributes describing the Datacenter type.

Table 3. Attributes describing the Cloudlet resource.

Attribute	Туре	Multiplicit	yMutability	Description
userld	Integer	1	Mutable	the unique ID of this cloudlet.
cloudletLength	Integer	1	Mutable	the length or size (in MI) of this cloudlet to be executed in a PowerDatacenter.
cloudletFileSize	Integer	1	Mutable	the file size (in byte) of this cloudlet before sub- mitting to a PowerDatacenter.
cloudletOutputSize	Integer	1	Mutable	the file size (in byte) of this cloudlet after sub- mitting to a PowerDatacenter.
pesNumber	Integer	1	Mutable	the pes number.
utilizationModelCpu	EObject	1	Immutable	the utilization model cpu.
utilizationModelRam	EObject	1	Immutable	the utilization model ram.
utilizationModelBw	EObject	1	Immutable	the utilization model bw.

Table 4. Attributes describing the SanStorage resource.

Attribute	Туре	MultiplicityMutability		Description
capacity	Float	1	Mutable	Storage device capacity.
bandwidth	Float	1	Mutable	Network bandwidth.
networkLatency	Float	1	Mutable	Network latency.

## 5 OCCI simulator Links

This section describes how defined platform resources can be linked in order to connect resource components. This is accomplished by extending the OCCI core Model Link base type.

### 5.1 Contains

The Contains link represents the link through which it is possible to connect multiple resource instances (See Figure 3).

## 6 OCCI simulator mixins

This section lists the identified Mixins. These mixins are defined to support specific features and operations offered by some resources. To simplify the modernization, we propose one Mixin per Kind following the OCCI infrastructure model [8].



Figure 3. Contains link.

#### 6.0.1 ProvisSchedul Mixin

ProvisSchedul Mixin represents the different provisioner and scheduler policies applied for compute resources. Table 5 defines the attributes describing the ProvisSchedul Mixin. Each compute instance that has a ProvisSchedul Mixin need to implement at least one of these attributes.

	Table 5.	Imm Attributes describing the ProvisSch	edul Mixin.
RamProvisionerPolicy	EObject	1 Immutabl	e it represents the provisioning policy for allocating memory to VMs.
PeProvisonerPolicy	EObject	1 Immutabl	e PE provisioner provides the MIPS, which is the measure for the computing performance
CloudletScheduler	EObject	1 Immutabl	e CloudletScheduler determines how the available CPU resources of virtual machine are divided among Cloudlets
VmAllocationPolicy	EObject	1 Immutabl	e represents the provisioning policy of hosts to vir- tual machines in a Datacenter.
vmScheduler	EObject	1 Immutabl	e The VmScheduler models the behavior of scheduling at virtual machine level like VMMs such as Xen and VMware

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#### 6.0.2 bandwidth Mixin

The bandwidth Mixin is applied for network interface link. It connects a Compute (Host) instance to a Network instance. It is used by the simulation extension to represent the provisioning policy of bandwidth to virtual machines inside a Host. Each host instance need to implement all the attributes of bandwidth Mixin.

	Table 6	Attributes describing the bandwidth Mixin.			
Attribute	Туре	Multi- plicity	Mutability	Description	
bw bwProvisionerPolicy	Integer EObject	1 1	Mutable Immutable	amount of bandwidth. it models the provisioning policy of bandwidth to VMs that are deployed on a Host component.	

able 6.	Attributes	describing the	bandwidth	Mixin.
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#### 6.0.3 simStorage Mixin

simStorage Mixin is applied for StorageLink according to OCCI infrastructure model [8]. It connects a Compute (VM or Host) instance to a Storage instance. Each Compute instance need to specify the amount of storage needed.

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Attribute	Туре	Multi- plicity	Mutability	Description
storage	Enum	1	Mutable	amount of storage.

 Table 7.
 Attributes describing the simStorage Mixin.

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